Understanding and Evaluating Executive Functioning in ADHD Across the Life Span

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Disclosure
My expenses for this talk are supported by Multi-Health Systems.
I have developed tests marketed by Multi-Health Systems, Pro-Ed and Western Psychological Services.
I am Editor in Chief of the Journal of Attention Disorders (Sage) and Co-Editor of the Encyclopedia of Child Development (Springer)

What is ADHD?
ADHD is a bio-psychosocial condition characterized by core symptoms of inattention, hyperactivity and impulsivity leading to/interacting with cognitive deficits causing impairment in all walks of life.
What is ADHD?

➢ ADHD appears to primarily involve the basal ganglia, cerebellum and the frontal lobes.
➢ Co-morbidity of other developmental, emotional and behavioral conditions with ADHD probably confounds findings from different study groups. (Hendren et al, JAACP, (2000) 39, 815-820.
➢ The symptoms of ADHD lead to a nearly infinite number of consequences.

Current diagnostic criteria specify that ADHD involves difficulties with inattention and/or hyperactivity/impulsivity. Researchers using factor analysis have consistently found support for an inattention factor in both children and adults. Findings have been mixed regarding whether hyperactivity and impulsivity reflect one or two dimensions (For Review see Barkley, 3rd Edition, 2005).

Examining the Dimensionality of ADHD Symptomatology in Young Adults Using Factor Analysis and Outcome Prediction

The prediction of outcomes provided support that complemented confirmatory factor analysis for the separation of the hyperactivity and impulsivity constructs. Impulsivity uniquely predicted more outcomes than hyperactivity alone. Results were consistent with the conceptualization of ADHD as primarily a disorder of behavioral inhibition. Future research using alternative outcomes and clinical populations should be conducted. (JAD, 2012)
ADHD appears to be a condition stemming in part from inefficient operation of EF.

A Bit of EF Neuroanatomy

➢ Prefrontal
➢ Rich cortical, sub-cortical and brain stem connections.

More Specifically

➢ The dorsolateral prefrontal cortex (DLPFC) is involved with integrating different dimensions of cognition and behavior.
  • This area is associated with verbal and design fluency, ability to maintain and shift set, planning, response inhibition, working memory, organizational skills, reasoning, problem solving and abstract thinking.
And:
➢ The anterior cingulate cortex (ACC) is involved in emotional drives, experience and integration, inhibition of inappropriate responses, decision making and motivation.
   • Lesions in this area can lead to low drive states such as apathy and may also result in low drive states for such basic needs as food or drink and possibly decreased interest in social or vocational activities and sex.

And Finally:
➢ The orbitofrontal cortex (OFC) plays a key role in impulse control, maintenance of set, monitoring ongoing behavior and socially appropriate behaviors.
   • Lesions in this area can cause dis-inhibition, impulsivity, aggressive outbursts, sexual promiscuity and antisocial behavior.

Another View: Hot and Cool EF
➢ Cool (metacognitive) – functions associated with cognition such as planning and problem solving (leading to a Dorsolateral Syndrome).
➢ Hot (emotional/motivational) – functions associated with coordinating and controlling emotions (leading to an Orbitofrontal/Medial Syndrome).
What do we mean by the term Executive Function(s)?

Executive Function(s)

➢ In 1966 Alexandr Luria first wrote and defined the concept of Executive Function (EF)
➢ He credited Bianchi (1895) and Bekhterev (1905) with the initial definition of the process

What is Executive Function(s)

There is no formal excepted definition of EF. We typically find a vague general statement of EF (e.g., goal-directed action, cognitive control, top-down inhibition, effortful processing, etc.).

• Or a listing of the constructs such as
  • Inhibition,
  • Working Memory,
  • Planning,
  • Problem-Solving,
  • Goal-Directed Activity,
  • Strategy Development and Execution,
  • Emotional Self-Regulation,
  • Self-Motivation
**Does Experience Shape EF?**

➢ The Family Life Project has demonstrated that poverty is associated with elevated cortisol in infancy and early childhood.
➢ This association is mediated through characteristics of the household.
➢ Parenting sensitivity mediates the relationship between poverty and stress physiology.
➢ In combination parenting sensitivity and elevated cortisol mediate the association between poverty and poor EF in children.

**What Neural Activities Require EF?**

➢ Those that involve planning or decision making.
➢ Those that involve error correction or troubleshooting.
➢ Situations when responses are not well-rehearsed or contain novel sequences of actions.
➢ Dangerous or technically difficult situations.
➢ Situations that require the overcoming of a strong habitual response or resisting temptation.

**Goldstein, Naglieri, Princiotta, & Otero (2013)**

➢ We found more than 30 definitions of EF(s).
➢ Executive function(s) has come to be an umbrella term used for many different abilities, including planning, working memory, attention, inhibition, self-monitoring, self-regulation and initiation carried out by pre-frontal areas of the frontal lobes.
What is Executive Function(s)

1. Barkley (2011): “EF is thus a self-directed set of actions” (p. 11).
2. Dawson & Guare (2010): “Executive skills allow us to organize our behavior over time” (p. 1).
3. Delis (2012): “Executive functions reflect the ability to manage and regulate one’s behavior (p. 14).

5. Gioia, Isquith, Guy, & Kenworthy (2000): "a collection of processes that are responsible for guiding, directing, and managing cognitive, emotional, and behavioral functions” (p. 1).

6. Pribram (1973): "executive programmes ... to maintain brain organization " (p. 301).
7. Roberts & Pennington (1996): EF “a collection of related but somewhat distinct abilities such as planning, set maintenance, impulse control, working memory, and attentional control” (p. 105).
What is Executive Function(s)

6. Stuss & Benson (1986): "a variety of different capacities that enable purposeful, goal-directed behavior, including behavioral regulation, working memory, planning and organizational skills, and self-monitoring" (p. 272).

7. Welsh and Pennington (1988): "the ability to maintain an appropriate problem-solving set for attainment of a future goal" (p. 201).

What is Executive Function(s)

10. McCloskey (2006): "a diverse group of highly specific cognitive processes collected together to direct cognition, emotion, and motor activity, including ...the ability to engage in purposeful, organized, strategic, self-regulated, goal directed behavior" (p. 1)

"think of executive functions as a set of independent but coordinated processes rather than a single trait" (p. 2).

What is Executive Function(s)

10. Lezak (1995): "a collection of interrelated cognitive and behavioral skills that are responsible for purposeful, goal-directed activity," ...

11. "how and whether a person goes about doing something" (p. 42).

12. Luria (1966): "... ability to correctly evaluate their own behavior and the adequacy of their actions" (p. 227).
Executive Functions

The executive system is a hierarchical cognitive system in psychology that controls and manages other cognitive processes. It is also referred to as the executive functions, supervised attentional system, or cognitive control.

An NICHD panel in 1994 identified 33 EFs by consensus! And Finally...
The Top Six Were:

➢ Self-regulation
➢ Sequencing of behavior
➢ Flexibility
➢ Response inhibition
➢ Planning
➢ Organization of behavior

What is the relationship of EF to ADHD and other defined disorders?

EF and ADHD

EF deficits are not necessarily unique to ADHD. They are neither necessary nor sufficient to make a diagnosis of ADHD. When EF impairments are measured in children with ADHD they tend to reflect specific rather than global impairments.
EF and Other Disruptive Disorders (ODD & CD)

Early reviews reported that EF deficits were not characteristic of children and adolescents with ODD and CD after co-morbid ADHD was factored out. More recent studies, however, suggest that inhibition deficits may be characteristic of both ADHD and CD but whether children with CD display impairments on additional EF measures is equivocal.

EF and Tourette’s

Distinct and robust impairments in EF do not appear to be characteristic of children with TD.

EF and Anxiety Disorders

EF deficits in set-shifting, cognitive flexibility, concept formation, interference control, and verbal fluency have been documented among children with separation anxiety disorder, overanxious disorder, and PTSD. EF in OCD has not been well addressed.
EF and Depression

Scant research has been conducted on the EF abilities among youth with depression. Studies that have included older adolescents have suggested some degree of sensitivity of EF tasks in identifying unipolar depression, but less specificity.

EF and Bi-Polar Disorder

There is a growing consensus about the nature of BD among children. Several studies have targeted its EF concomitants. Although results often have been confounded with significant co-morbidity issues, children and adolescents with BD reliably have demonstrated impairments relative to those without any history of mood disorders on several EF measures (e.g. working memory, set shifting).

EF and Traumatic Brain Injury

Pragmatic and executive functions in traumatic brain injury and right brain damage

An exploratory comparative study

Nicole Stemmerer1, Gagnon Cindy1, Camille Bisa de Oliveira1, Berteau Fanny1
If all of these conditions are statistically related to behaviors and abilities reflecting EF than a common denominator must exist.
An examination of older factor analytic studies examining EF in children finds only a single factor—planning—common to all studies.

Anderson, 2002

Executive Function

- EF is a unitary construct (e.g., Duncan & Miller, 2002; Duncan & Owen, 2000).
- EF is unidimensional in early childhood not adulthood.
- Both views are supported by some research (Miyake et al., 2000), -- EF is a unitary construct ...but with partially different components

Executive Functions

- EF has three components: inhibitory control, set shifting (flexibility), and working memory (e.g., Davidson, et al., 2006; Miyake et al., 2000).
- EF has independent abilities (Wiebe, Espy, & Charak, 2008).
- Executive Functions is a multidimensional model (Friedman et al., 2006; Miyake et al., 2000).

Executive Function(s)

> Given all these definitions of EF(s) we wanted to address the question...
  
  Executive Functions ... or Executive Function?
Executive Function(s)
➢ One way to examine this issue is to research the factor structure of behaviors related to EF(s).
➢ To do so, we examined the factor structure of a nationally representative sample of children.
➢ We conducted a series of research studies to answer the following question:
  • What is the underlying structure of EF behaviors?
  • Is there just one underlying factor called Executive Function), or do the behaviors group together into different constructs suggesting a multidimensional structure?

Exploratory Factor Analyses
➢ Both item-level and scale-level exploratory factor analyses (EFA) were conducted.
➢ The normative samples for parents, teacher, and self ratings were randomly split into two samples and EFA conducted using
  • the item raw scores
  • nine scales’ raw scores
➢ We used a standardization sample from our instrument the Comprehensive Executive Functioning Inventory (CEFI).

CEFI Standardization
➢ Sample was stratified by
  • Sex, age, race/ethnicity, parental education level (PEL; for cases rated by parents), geographic region
  • Race/ethnicity of the child (Asian/Pacific Islander, Black/African American/African Canadian, Hispanic, White/Caucasian, Multi-racial by the rater
  • Parents provided PEL of both parents
    • The higher of the two levels was used to classify the parental education level of the child.
  • All raters completed the questionnaire via paper-and-pencil or online methods.
EXPLORATORY FACTOR ANALYSES
➢ For the first half of the normative sample using item scores: EFA of the 90 items was conducted
➢ The scree plot test and the very simple solution criterion both indicated that only one factor should be retained.
➢ The ratio of the first and second eigenvalues was greater than four for all three forms, which is a common rule to support a one factor solution.

EXPLORATORY FACTOR ANALYSES
➢ Item level factor analysis clearly indicated that one factor was the best solution

Table 8.2. Eigenvalues from the Inter-Item Correlations

<table>
<thead>
<tr>
<th>Form</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
<th>Factor 6</th>
<th>Factor 7</th>
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</thead>
<tbody>
<tr>
<td>Parent</td>
<td>43.7</td>
<td>4.1</td>
<td>2.3</td>
<td>1.5</td>
<td>1.3</td>
<td>1.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Teacher</td>
<td>56.8</td>
<td>3.8</td>
<td>2.3</td>
<td>1.3</td>
<td>1.1</td>
<td>1.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Self-Report</td>
<td>29.9</td>
<td>6.3</td>
<td>2.7</td>
<td>2.1</td>
<td>1.9</td>
<td>1.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Note: Extraction method is Principal Axis Factoring. Only the first 10 eigenvalues are presented.

EXPLORATORY FACTOR ANALYSES
➢ Using the second half of the normative sample EFA was conducted using raw scores for the Attention, Emotion Regulation, Flexibility, Inhibitory Control, Initiation, Organization, Planning, Self-Monitoring, and Working Memory scales
➢ Both the Kaiser rule (eigenvalues > 1) and the Eigenvalue Ratio criterion (≥ 4) unequivocally indicated one factor.
EXPLORATORY FACTOR ANALYSES

➢ Factor analysis of the CEFI Scales also clearly indicated a one factor solution

<table>
<thead>
<tr>
<th>Form</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
<th>Factor 6</th>
<th>Factor 7</th>
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</thead>
<tbody>
<tr>
<td>Parent</td>
<td>0.5</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Teacher</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Self Report</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

Note: Extraction method: PFX

EXPLORATORY FACTOR ANALYSES

➢ Coefficients of Congruence – all very high

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Coefficient of Congruence</th>
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</thead>
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<tr>
<td>Parent</td>
<td>0.88</td>
<td>0.89</td>
</tr>
<tr>
<td>Teacher</td>
<td>0.88</td>
<td>0.89</td>
</tr>
<tr>
<td>Self Report</td>
<td>0.88</td>
<td>0.89</td>
</tr>
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</table>

EXPLORATORY FACTOR ANALYSES

➢ Conclusions

• When using parent (N = 1,400), teacher (N = 1,400), or self-ratings (N = 700) based on behaviors observed and reported for a nationally representative sample (N = 3,500) aged 5 to 18 years Executive Function 
  not functions is the best term to use.
Executive Function is: how efficiently you do what you decide to do.

Latent class analysis of frontal lobe tasks strongly suggests a general EF that reflects the efficiency and perhaps automaticity of the executive management system.
EF skills may develop in different tracks but merge in function as children develop.

Wasserman and Wasserman, 2013
Applied Neuropsych. Child

EF appears to be a unitary, more domain specific process in children


Conclusive evidence concerning the developmental trajectories in children of the different EF components on neuropsychological tests has yet to be established.

Hustings, Dulan et al, 2006
Neuropsychologia
CEFI Scores by Diagnosis

➢ We expected that individuals with ADHD, mood disorders, and Autism Spectrum Disorders might earn a low scores on this measure of EF behaviors.

➢ We compared groups matched on gender, race/ethnicity, and parental education (Naglieri, J. A., & Goldstein, S. (2013). Comprehensive Executive Functioning Index. Toronto: Multi Health Systems.)

Group Differences: ADHD (Naglieri & Goldstein, 2013)

<table>
<thead>
<tr>
<th></th>
<th>Parent</th>
<th>Teacher</th>
<th>Self-Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADHD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Parent T eacher Self Report

CEFI Scales: ADHD (Naglieri & Goldstein, 2013)
Table A.23 Differences Between ASD and Matched General Population Samples: CEFI Full Scale

<table>
<thead>
<tr>
<th></th>
<th>ASD</th>
<th>Matched Gen. Pop.</th>
<th>d diff</th>
<th>F(1)</th>
<th>p</th>
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<td>Parent</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13.2</td>
<td>12.4</td>
<td>-0.81</td>
<td>43.76</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Male</td>
<td>13.2</td>
<td>12.4</td>
<td>-0.81</td>
<td>43.76</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Female</td>
<td>13.2</td>
<td>12.4</td>
<td>-0.81</td>
<td>43.76</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Teacher</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>12.7</td>
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<tr>
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<td>0.00</td>
<td>23.11</td>
<td>&lt; .01</td>
</tr>
</tbody>
</table>

Table A.22 Differences Between LD and Matched General Population Samples: CEFI Full Scale

<table>
<thead>
<tr>
<th></th>
<th>LD</th>
<th>Matched Gen. Pop.</th>
<th>d diff</th>
<th>F(1)</th>
<th>p</th>
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<td>Parent</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total</td>
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<tr>
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<td>12.8</td>
<td>12.4</td>
<td>-0.40</td>
<td>18.80</td>
<td>&lt; .01</td>
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<tr>
<td>Female</td>
<td>12.8</td>
<td>12.4</td>
<td>-0.40</td>
<td>18.80</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Teacher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>12.4</td>
<td>0.00</td>
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<tr>
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<td>57.26</td>
<td>&lt; .01</td>
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<tr>
<td>Female</td>
<td>12.4</td>
<td>12.4</td>
<td>0.00</td>
<td>57.26</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Self-report</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>3.45</td>
<td>0.05</td>
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<tr>
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<td>12.5</td>
<td>0.00</td>
<td>3.45</td>
<td>0.05</td>
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</table>
CEFI Scales: SLD (Naglieri & Goldstein, 2013)

Figure H-5: Mean standard scores by group SLD & matched general population samples

Group Differences: Mood Disorders
(Naglieri & Goldstein, 2013)

<table>
<thead>
<tr>
<th></th>
<th>Parent</th>
<th>Teacher</th>
<th>Self-Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table H-1: Differences between Mood Disorder and Matched General Population Samples: CEFI Full Scores

<table>
<thead>
<tr>
<th>Group</th>
<th>Mood</th>
<th>Control</th>
<th>Parent Mean</th>
<th>Parent SD</th>
<th>Teacher Mean</th>
<th>Teacher SD</th>
<th>Self-Report Mean</th>
<th>Self-Report SD</th>
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</thead>
<tbody>
<tr>
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<td></td>
<td>85.0</td>
<td>10.0</td>
<td>81.0</td>
<td>10.0</td>
<td>87.5</td>
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<tr>
<td>Teacher</td>
<td>-0.5</td>
<td>-0.5</td>
<td>85.0</td>
<td>10.0</td>
<td>81.0</td>
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<td>87.5</td>
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<tr>
<td>Self-Report</td>
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<td>10.0</td>
<td>81.0</td>
<td>10.0</td>
<td>87.5</td>
<td>10.0</td>
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</table>

Mood Control

CEFI Scales: Mood Disorders (Naglieri & Goldstein, 2013)

Figure H-6: Mean Standard Scores by Group: Mood Disorder & Matched General Population samples
How can we reliably and validly evaluate EF?

How to Measure Executive Function(s)

A recent review by Weyandt et al (2012) found 168 measures used to evaluate EF.
In general single EF tests share at most 10% of the variance with EF ratings and observations of everyday behavior.

Batteries of combined EF tests fare a bit better sharing up to 20% of the variance with observation and reported behavior.

The more tests in an EF battery the more factors identified in both exploratory and confirmatory studies.
**EF Rating Scales**

- Measures real world behavior
- Able to sample multiple sources (self, parents, teachers)
- Efficient ways to evaluate EF
- However
  - Self-ratings may be limited by impaired self-awareness
  - Observers may not be good at observing!

---

**Executive Function Full Scale**

<table>
<thead>
<tr>
<th>Subdomain</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>Measures how well an adult can avoid distractions, concentrate on tasks, and sustain attention</td>
</tr>
<tr>
<td>Inhibitory Control</td>
<td>Reflects an adult's control over behavior or impulses</td>
</tr>
<tr>
<td>Planning</td>
<td>Reflects how well an adult develops and implements strategies to accomplish tasks</td>
</tr>
<tr>
<td>Emotion Regulation</td>
<td>Measures an adult's control and management of emotions</td>
</tr>
<tr>
<td>Initiation</td>
<td>Describes an adult's ability to begin tasks or projects without being prompted</td>
</tr>
<tr>
<td>Self-Monitoring</td>
<td>Describes an adult's self-evaluation of his/her performance or behavior</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Describes how well an adult can adapt to circumstances, including problem solving</td>
</tr>
<tr>
<td>Organization</td>
<td>Describes how well an adult manages personal effects, works on multiple tasks</td>
</tr>
<tr>
<td>Working Memory</td>
<td>Reflects how well an adult can keep information in mind that is important for knowing what to do and how to do it</td>
</tr>
</tbody>
</table>

---

**CEFi: WISC-IV, CAS, and WJ III**

- Data from the Neurology, Learning and Behavior Center in Salt Lake City, UT
- Children given the CEFI, WISC-IV (N = 43), CAS (N = 62), and the WJIII achievement (N = 58) as part of a typical test battery.
### CEFI, WISC-IV, CAS, Achievement

Table 8.26: Demographic Characteristics of the CAS, WISC-IV, and WJ III ACH Validity Samples

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<thead>
<tr>
<th>Demographic</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
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<td>0</td>
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<td>Diagnostic or Education Group</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

Table 8.27 CEFI Manual

<table>
<thead>
<tr>
<th>Other Measure</th>
<th>Corrected N</th>
<th>CEFI Full Scale</th>
<th>CAS, WISC-IV, or WI III ACH</th>
</tr>
</thead>
<tbody>
<tr>
<td>WISC-IV</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Full Scale</td>
<td>41</td>
<td>93.1</td>
<td>13.0</td>
</tr>
<tr>
<td>Working Memory</td>
<td>42</td>
<td>93.0</td>
<td>11.9</td>
</tr>
<tr>
<td>Verbal Comprehension</td>
<td>44**</td>
<td>93.0</td>
<td>11.9</td>
</tr>
<tr>
<td>Full Scale</td>
<td>42</td>
<td>93.0</td>
<td>11.9</td>
</tr>
<tr>
<td>Processing Speed</td>
<td>42</td>
<td>93.0</td>
<td>11.9</td>
</tr>
<tr>
<td>CAS</td>
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<tr>
<td>Full Scale</td>
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<td>91.4</td>
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<tr>
<td>Planning</td>
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<td>91.4</td>
<td>13.2</td>
</tr>
<tr>
<td>Simultaneous</td>
<td>60</td>
<td>91.4</td>
<td>13.2</td>
</tr>
<tr>
<td>Total Achievement</td>
<td>60</td>
<td>93.4</td>
<td>12.1</td>
</tr>
<tr>
<td>WI III ACH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>54</td>
<td>91.9</td>
<td>12.4</td>
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<tr>
<td>Math</td>
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</tr>
<tr>
<td>Total Mathematics</td>
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<td>92.0</td>
<td>11.9</td>
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</table>

### CEFI & WISC-IV

Table 8.25: Correlations Between the CEFI (5-10 Years) Teacher Form and the WISC-IV

<table>
<thead>
<tr>
<th>Scale</th>
<th>CEFI</th>
<th>WISC-IV</th>
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</thead>
<tbody>
<tr>
<td>Full Scale</td>
<td>0.78</td>
<td>0.36</td>
</tr>
<tr>
<td>Working Memory</td>
<td>0.28</td>
<td>0.31</td>
</tr>
<tr>
<td>Verbal Comprehension</td>
<td>0.20</td>
<td>0.31</td>
</tr>
<tr>
<td>Reasoning</td>
<td>0.24</td>
<td>0.31</td>
</tr>
<tr>
<td>Processing Speed</td>
<td>0.20</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Note: Pairwise deletion of missing cases was used (N = 61-63) GMC = Obtained; Cor. = Corrected; Z = Z Score.
### Table H.18. Correlations Between the CEFI (5–18 Years) Teacher Form and the CAS

<table>
<thead>
<tr>
<th>CEFI Full Scale</th>
<th>Full Scale</th>
<th>Attention</th>
<th>Cognitive Regulation</th>
<th>Flexibility</th>
<th>Inhibition</th>
<th>Initiation</th>
<th>Organization</th>
<th>Planning</th>
<th>Self-Monitoring</th>
<th>Working Memory</th>
<th>Total Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Pair-wise deletion of missing cases was used (N = 60–82). Obt. = Obtained; Cor. = Corrected.

### CEFI & WJ-III Total Achievement

#### Table H.26. Correlations Between the CEFI (5–18 Years) IVI Total Achievement Cluster

<table>
<thead>
<tr>
<th>IVI WJ-ACH Total Achievement</th>
<th>CEFI teacher</th>
<th>CEFI WJ-ACH</th>
<th>CEFI Cor.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive Regulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhibition</td>
<td>.13**</td>
<td>.16**</td>
<td>.16**</td>
</tr>
<tr>
<td>Initiation</td>
<td>.29**</td>
<td>.34**</td>
<td>.34**</td>
</tr>
<tr>
<td>Organization</td>
<td>.30**</td>
<td>.34**</td>
<td>.34**</td>
</tr>
<tr>
<td>Planning</td>
<td>.30**</td>
<td>.35**</td>
<td>.35**</td>
</tr>
<tr>
<td>Self-Monitoring</td>
<td>.52**</td>
<td>.58**</td>
<td>.58**</td>
</tr>
<tr>
<td>Working Memory</td>
<td>.57**</td>
<td>.63**</td>
<td>.63**</td>
</tr>
<tr>
<td>IVI WJ-ACH</td>
<td>93.6</td>
<td>114.0</td>
<td>114.0</td>
</tr>
</tbody>
</table>

Note: Pair-wise deletion of missing cases was used (N = 46–48). Obt. r =

### CEFI & WJ-III Reading

#### Table H.27. Correlations Between the CEFI (5–18 Years) WJ-ACH Broad Reading Cluster

<table>
<thead>
<tr>
<th>WJ-ACH Broad Reading</th>
<th>CEFI teacher</th>
<th>CEFI WJ-ACH</th>
<th>CEFI Cor.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive Regulation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhibition</td>
<td>.27**</td>
<td>.32**</td>
<td>.32**</td>
</tr>
<tr>
<td>Initiation</td>
<td>.25**</td>
<td>.30**</td>
<td>.30**</td>
</tr>
<tr>
<td>Organization</td>
<td>.25**</td>
<td>.30**</td>
<td>.30**</td>
</tr>
<tr>
<td>Planning</td>
<td>.47**</td>
<td>.55**</td>
<td>.55**</td>
</tr>
<tr>
<td>Self-Monitoring</td>
<td>.48**</td>
<td>.56**</td>
<td>.56**</td>
</tr>
<tr>
<td>Working Memory</td>
<td>.48**</td>
<td>.56**</td>
<td>.56**</td>
</tr>
<tr>
<td>WJ-ACH</td>
<td>90.1</td>
<td>115.2</td>
<td>115.2</td>
</tr>
</tbody>
</table>

Note: Pair-wise deletion of missing cases was used (N = 54–55). Obt. r =

---
Is broad or global EF training effectively transferred to the natural setting?
Four current reviews converge concluding that the efficacy of global EF training (e.g. training of attention, working memory, behavioral inhibition, etc.) has not been established.

Cortese et. al., 2015; Melby-Lervag et. al., 2013; Rapport et. al., 2015; Shipstead et. al., 2012.

These studies suggest that while training in game-like activities improves performance on those tasks as well as related ones (near transfer) any transfer from these tasks to global functioning in natural settings (far transfer) remains unproven.

Most treatment studies have focused on a single type of EF behavior (e.g. working memory). A recent study attempted to train multiple types of EF behaviors simultaneously. Their findings are similar to previous research. Near transfer effects do occur but transfer to the natural setting is limited.

Dovis, et. al., 2015
Is real world, content based EF instruction effective?

Can strategic, direct instructional interventions provide remedial and compensatory support for children with EF deficits?

A modest group of studies has demonstrated that setting and work modifications as well as strategy development and mastery improve quality of work in near and far term activities related to the work for which strategies were practiced.

Jang, Schunn, & Nokes, 2011; Alloway, 2011; Gathercole & Alloway, de Jong, 2010; McNamara & Scott, 2001

**Abstract**

The authors examined the effectiveness of cognitive strategy instruction based on PASI (Planning, Attention, Simultaneous, Successive) for students with ADHD and LD. Students were divided into experimental and control groups. The experimental group received instruction for 10 days, which included planning, attention, and simultaneous-successive strategy instruction. The results showed that students in the experimental group improved significantly more than those in the control group. The results have implications for classroom instruction, particularly for students with ADHD and LD.

**Instructional Implications**

- Planning Strategy Instruction is easily implemented in the classroom and can be used to improve Executive Functioning.
- The method yields substantial results within a minimal of time (10 half-hour sessions over 10 days).
- Planning Strategy Instruction can be applied in math as well as other content areas (e.g., reading comprehension).

**Extensive Section on Strategies**

**Executive Function**

Executive function is a dynamic system. Its successful operation involves the inhibition and activation of various cognitive and emotional processes. The following strategies are designed to improve executive function:

- **Attention**
  - Increase awareness of attention and its role in learning.
  - Practice techniques for improving attention.

- **Planning**
  - Develop planning skills through structured tasks.
  - Use visual aids to enhance planning.

- **Self-Control**
  - Practice self-regulation techniques.
  - Use visual self-help materials.

These strategies are designed to be implemented in the classroom, particularly for students with ADHD and LD.
A strategy is a procedure that the learner uses to perform academic tasks

Using a strategy means the child thinks about ‘how you do what you do’

Successful learners use many strategies.

Some of these strategies include visualization, verbalization, making associations, chunking, questioning, scanning, using mnemonics, sounding out words, and self-checking and monitoring.
Steps to Strategic Instruction:

➢ Describe the strategy. Students obtain an understanding of the strategy and its purpose—why it is important, when it can be used, and how to use it.

➢ Model its use. The teacher models the strategy, explaining to the students how to perform it.

➢ Provide ample assisted practice time. The teacher monitors, provides cues, and gives feedback. Practice results in automaticity so the student doesn’t have to “think” about using the strategy.

➢ Promote student self-monitoring and evaluation of personal strategy use. Students will likely use the strategy if they see how it works for them; it will become part of their learning schema.

➢ Encourage continued use and generalization of the strategy. Students are encouraged to try the strategy in other learning situations.

My Granddaughter Hones Her EF Skills

Practice Pays Off!
Cognitive Instructional Methods
Teaching Children to use EF

- Helping Children Learn Intervention Handouts for Use in School and at Home, Second Edition
  By Jack A. Naglieri, Ph.D., & Eric B. Pickering, Ph.D.
  - Spanish handouts by Tulio Otero, Ph.D., & Mary Moreno, Ph.D.

Four Ways to Think Smart!

Think smart and use a plan!

Think smart and look at the details!

Think smart and put the pieces together!

Think smart and follow the sequence!

Use a plan.

Look at the details.

See how things fit together.

Follow the order.
Benefits of Strategy Instruction

- Students trust their minds
- Students know there is more than one right way to do things
- They acknowledge their mistakes and try to rectify them
- They evaluate their products and behavior
- Memories are enhanced
- Learning increases
- Self-esteem increases
- Students feel a sense of power
- Students become more responsible
- Work completion and accuracy improve
- Students develop and use a personal study process
- They know how to "try"
- On-task time increases: students are more "engaged"

Conclusions

➢ The concept of EF is evolving.
➢ Data from the our Standardization Sample indicate that when measured using observable behaviors the term Executive Function is supported.
➢ Good research can provide a well normed measure of EF that has demonstrated reliability & validity.
➢ There is also emerging evidence that children can be taught to be more strategic – an important indication of efficient EF.

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