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 have authored books marketed by Springer, Wiley, Guilford, Double Day, McGraw Hill, Brookes, Kluwer and Specialty Press.

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.

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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).

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

Tara E. McKee[1]

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)

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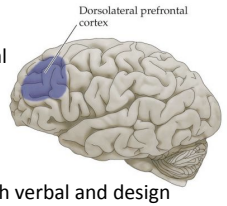
ADHD appears to be a condition stemming in part from inefficient operation of EF.

A Bit of EF Neuroanatomy

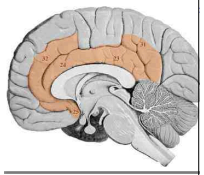
- Prefrontal
- Rich cortical, sub-cortical and brain stem connections.

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.

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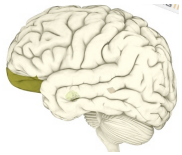
And Finally:



- 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.

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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).

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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

1902 - 1977

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).

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What is Executive Function(s)

4. Denckla (1996): "EF (is) a set of **domain-general control processes**…" (p. 263).
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).

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What is Executive Function(s)

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 contro**l" (p. 105).

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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).

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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).

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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).

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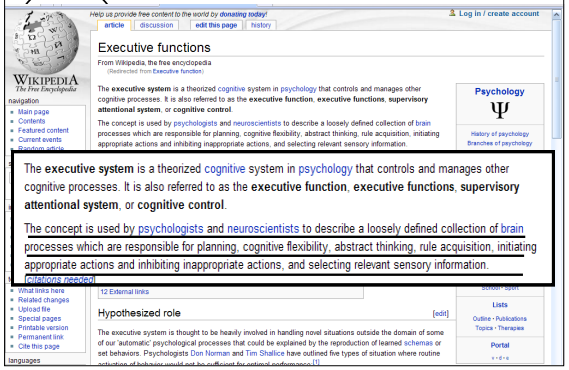
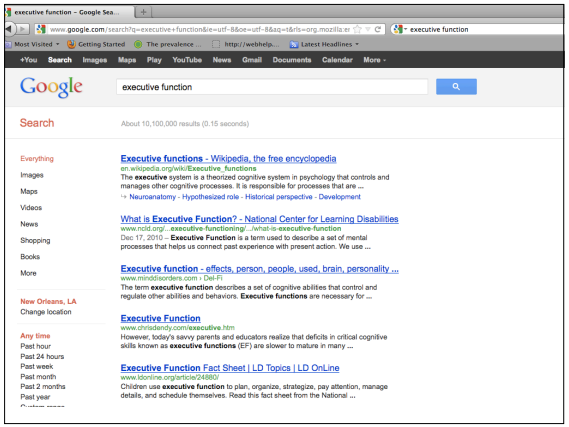
Executive Functions





And Finally. . . .

An NICHD panel in 1994 identified 33 EFs by consensus!

The Top Six Were:

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

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

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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

Dement Neuropsychol 2011 December;5(4):337-345 Original Article

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

An exploratory comparative study

Nicolle Zimmermann[1,2], Gigiane Gindri[2,3], Camila Rosa de Oliveira[1,2], Rochele Paz Fonseca[1,4]

Abstract – *Objective:* To describe the frequency of pragmatic and executive deficits in right brain damaged (RBD) and in traumatic brain injury (TBI) patients, and to verify possible dissociations between pragmatic and executive functions in these two groups. *Methods:* The sample comprised 7 cases of TBI and 7 cases of RBD. All participants were assessed by means of tasks from the Montreal Communication Evaluation Battery and executive functions tests including the Trail Making Test, Hayling Test, Wisconsin Card Sorting Test, semantic and phonemic verbal fluency tasks, and working memory tasks from the Brazilian Brief Neuropsychological Assessment Battery NEUPSILIN. Z-score was calculated and a descriptive analysis of frequency of deficits (Z< -1.5) was carried out. *Results:* RBD patients presented with deficits predominantly on conversational and narrative discursive tasks, while TBI patients showed a wider spread pattern of pragmatic deficits. Regarding EF, RBD deficits included predominantly working memory and verbal initiation impairment. On the other hand, TBI individuals again exhibited a general profile of executive dysfunction, affecting mainly working memory, initiation, inhibition, planning and switching. Pragmatic and executive deficits were generally associated upon comparisons of RBD patients and TBI cases, except for two simple dissociations: two post-TBI cases showed executive deficits in the absence of pragmatic deficits. *Discussion:* Pragmatic and executive deficits can be very

EF Deficits and ASD

J. Child Psychol. Psychiat. Vol. 32, No. 7, pp. 1081–1105, 1991
Printed in Great Britain.

0021-9630/91 $3.00 + 0.00
Pergamon Press plc

Executive Function Deficits in High-Functioning Autistic Individuals: Relationship to Theory of Mind

Sally Ozonoff,* Bruce F. Pennington* and Sally J. Rogers†

Abstract—A group of high-functioning autistic individuals was compared to a clinical control group matched on VIQ, age, sex and SES. Significant group differences were found on executive function, theory of mind, emotion perception and verbal memory tests, but not on spatial or other control measures. Second-order theory of mind and executive function deficits were widespread among the autistic group, while first-order theory of mind deficits were found in only a subset of the sample. The relationship of executive function and theory of mind deficits to each other, and their primacy to autism, are discussed.

Keywords: Autism, executive function, theory of mind

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EF and Learning Disabilities

Working Memory Impairments in Children with Specific Arithmetic Learning Difficulties ☆ ☆☆

Janet F. McLean, Graham J. Hitch

Lancaster University, Lancaster, United Kingdom

http://dx.doi.org/10.1006/jecp.1999.2516, How to Cite or Link Using DOI
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Abstract

Working memory impairments in children with difficulties in arithmetic have previously been investigated using questionable selection techniques and control groups, leading to problems concluding where deficits may occur. The present study attempted to overcome these criticisms by assessing 9-year-old children with difficulties specific to arithmetic, as indicated by normal reading, and comparing them with both age-matched and ability-matched controls. A battery of 10 tasks was used to assess different aspects of working memory, including subtypes of executive function. Relative to age-matched controls, children with poor arithmetic had normal phonological working memory but were impaired on spatial working memory and some aspects of executive processing. Compared to ability-matched controls, they were impaired only on one task designed to assess executive processes for holding and manipulating information in long-term memory. These deficits in executive and spatial aspects of working memory seem likely to be important factors in poor arithmetical attainment.

If all of these conditions are statistically related to behaviors and abilities reflecting EF than a common denominator must exist.

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An examination of older factor analytic studies examining EF in children finds only a single factor- planning – common to all studies.

Anderson, 2002
Clin. Neuropsych.

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 Function**s** 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 Function***s …*** 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 is just one underlying factor called Executive Function), or do the behaviors group together into different constructs suggesting a multidimensional structure?

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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).

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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.

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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 indicted that one factor was the best solution

Table 8.2. Eigenvalues from the Inter-Item Correlations

	Factor						
Form	1	2	3	4	5	6	7
Parent	43.7	4.1	2.3	1.5	1.3	1.3	1.0
Teacher	56.8	3.8	2.3	1.3	1.1	1.1	0.8
Self-Report	29.9	6.3	2.7	2.1	1.9	1.8	1.5

Note. Extraction: 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 8.4. Eigenvalues of the CEFI Scales Correlations

	Factor							
Form	1	2	3	4	5	6	7	
Parent	7.5	0.2	0.0	0.0	0.0	0.0	0.0	
Teacher	7.8	0.3	0.0	0.0	0.0	0.0	0.0	
Self-Report	6.3	0.2	0.1	0.0	0.0	0.0	-0.1	

Note. Extraction method: Png.

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Exploratory Factor Analyses

- Coefficients of Congruence – all very high

Table 8.6. Consistency of Factor Loadings Across Groups

Grouping Factor	CEFI Form	Coefficient of Congruence	Group 1				Group 2			
			Level	*N*	*M*	*SD*	Level	*N*	*M*	*SD*
Gender	Parent	.999	Male	700	98.1	14.9	Female	699	101.8	15.0
	Teacher	.999	Male	700	96.7	14.4	Female	700	103.2	15.0
	Self-Report	.992	Male	350	98.9	15.4	Female	350	101.0	14.6
Race/ Ethnic Group	Parent	.996	Non-White	615	99.8	15.6	White	784	100.0	14.6
	Teacher	.999	Non-White	609	97.8	15.3	White	791	101.6	14.6
	Self-Report	.995	Non-White	308	100.3	15.0	White	392	99.7	15.1
Age	Parent	.999	5 to 11	699	99.9	15.1	12 to 18	700	100.0	15.1
	Teacher	.999	5 to 11	700	100.0	15.1	12 to 18	700	100.0	15.0
	Self-Report	.995	12 to 15	400	98.7	15.0	16 to 18	300	101.6	15.0
Clinical/ Educational	Parent	.993	Non-Clinical	1,298	101.0	14.7	Clinical/Educational	277	84.6	12.4
	Teacher	.994	Non-Clinical	1,338	100.7	14.9	Clinical/Educational	280	87.1	12.2
	Self-Report	.976	Non-Clinical	632	100.8	14.8	Clinical/Educational	121	91.7	14.3

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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* function**s** is the best term to use.

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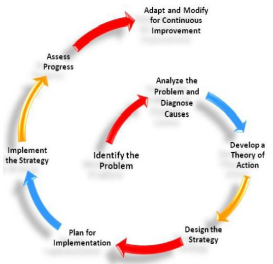
Naglieri & Goldstein, 2012

- Executive Function is: how efficiently you do what you decide to do.



Naglieri & Goldstein, 2012

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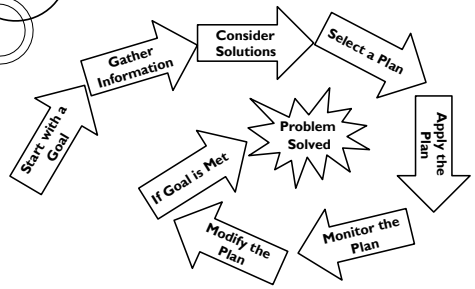

Latent class analysis of frontal lobe tasks strongly suggests a general EF that reflects the efficiency and perhaps automaticity of the executive management system.

Miyake, Friedman, et al 2008
Cognitive Psychology

EF skills may develop in different tracks but merge in function as children develop.

Wasserman and Wasserman, 2013
Applied Neuropsych. Child

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

Wiebe, Scheffield, et al, 2011
J. Of Exp. Child Psych.

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

Huizinga, Dolan et al, 2006
Neuropsyhologica

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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.)

> Impairment in executive function is common in a number of internalizing and externalizing forms of psychopathology (Willcutt et al., 2005; see chapter 2, *Theory and Research*, for further discussion). For instance, research and theory has pointed to executive function deficits in Attention-Deficit/Hyperactivity Disorder (ADHD) and mood disorders (e.g., Weyandt et al., in press), as well as Autism Spectrum Disorders (ASD; e.g., Gilbert, Bird, Brindley, Frith, & Burgess, 2008; Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Happé, Booth, Charlton, & Hughes, 2006; Ozonoff, Pennington, & Rogers, 1991; Solomon, Ozonoff, Ursu, Ravizza, Cummings, Ly, & Carter, 2009).

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Group Differences: ADHD (Naglieri & Goldstein, 2013)

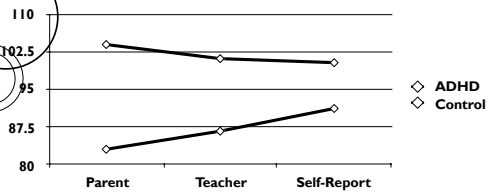

Table 8.19 Differences Between ADHD and Matched General Population Samples: CEFI Full Scale

Form		ADHD	Matched Gen. Pop.	*d*-ratio	*F* (*df*)	*P*
Parent	*M*	83.1	103.9	-1.59	216.56 (1, 340)	< .001
	SD	13.0	13.0			
	N	171	171			
Teacher	*M*	86.7	101.1	-1.07	79.93 (1, 278)	< .001
	SD	13.5	13.5			
	N	138	142			
Self-Report	*M*	91.2	100.3	-0.62	22.21 (1, 232)	< .001
	SD	14.7	14.7			
	N	117	117			

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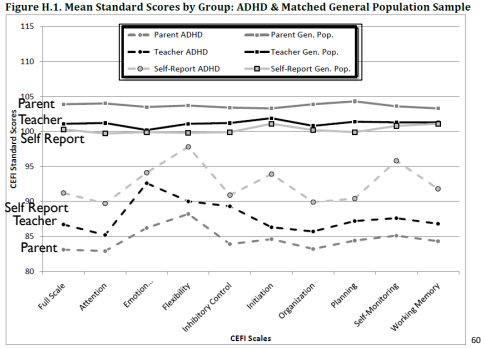
CEFI Scales: ADHD (Naglieri & Goldstein, 2013)

Figure II.1. Mean Standard Scores by Group: ADHD & Matched General Population Sample



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Group Differences: ASD (Naglieri & Goldstein, 2013)

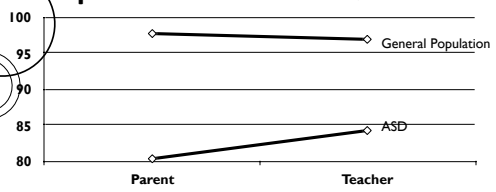
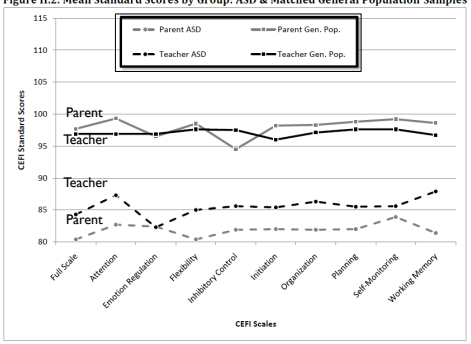


Table 8.20 Differences Between ASD and Matched General Population Samples: CEFI Full Scale

Form		ASD	Matched Gen. Pop.	*d*-ratio	*F* (*df*)	*p*
Parent	*M*	80.4	97.7	-1.41	48.96 (1, 96)	< .001
	SD	12.2	12.2			
	N	48	50			
Teacher	*M*	84.3	96.9	-0.99	23.11 (1, 92)	< .001
	SD	12.7	12.7			
	N	47	47			

CEFI Scales: ASD (Naglieri & Goldstein, 2013)

Figure H.2. Mean Standard Scores by Group: ASD & Matched General Population Samples



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Group Differences: Learning Disabilities

(Naglieri & Goldstein, 2013)

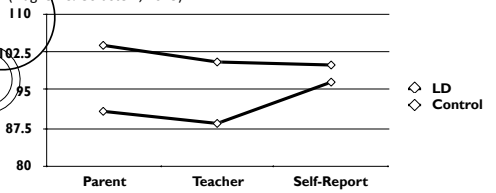
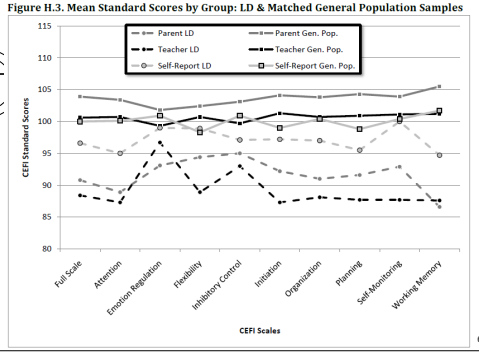


Table 8.22 Differences Between LD and Matched General Population Samples: CEFI Full Scale

Form		LD	Matched Gen. Pop.	*d*-ratio	*F* (*df*)	*p*
Parent	*M*	90.8	103.9	-0.92	19.89 (1, 93)	< .001
	SD	14.4	14.4			
	N	47	48			
Teacher	*M*	88.4	100.6	-0.91	37.29 (1, 178)	< .001
	SD	13.4	13.4			
	N	90	90			
Self-Report	*M*	96.6	100.0	-0.21	1.45 (1, 126)	0.231
	SD	15.9	15.9			
	N	64	64			

CEFI Scales: SLD (Naglieri & Goldstein, 2013)

Figure H.3. Mean Standard Scores by Group: LD & Matched General Population Samples



Group Differences: Mood Disorders

(Naglieri & Goldstein, 2013)

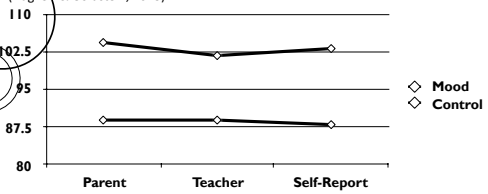
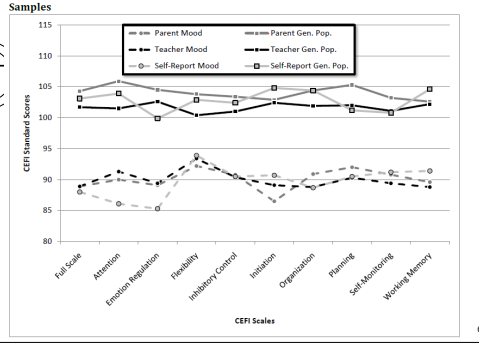


Table 8.21 Differences Between Mood Disorder and Matched General Population Samples: CEFI Full Scale

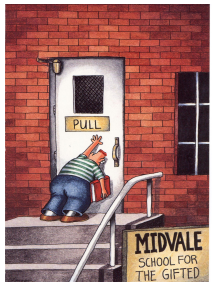
Form		Mood Disorder	Matched Gen. Pop.	*d*-ratio	*F* (*df*)	*p*
Parent	*M*	88.9	104.3	-1.11	22.66 (1, 71)	< .001
	SD	13.8	13.8			
	N	36	37			
Teacher	*M*	88.9	101.7	-1.01	14.9 (1, 57)	< .001
	SD	12.8	12.8			
	N	29	30			
Self-Report	*M*	88.0	103.1	-1.09	16.34 (1, 53)	< .001
	SD	13.9	13.9			
	N	27	28			

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

Figure H.4. 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.

From Weyandt et al, 2012

Executive Function Test	Number of Times Used	Sensitivity to Group Differences	Percentage of Significant Differences Between Clinical and Control Groups	Percentage of Significant Group Differences Between Two Clinical Groups
Stroop Color and Word Test and variants	41	28/73 = 38%	22/37 = 59%	6/36 = 17%
Wisconsin Card Sorting Test (including computerized and non-computerized versions)	34	75/226 = 33%	60/139 = 43%	14/88 = 16%
Trail Making Test and variants	26	43/121 = 36%	35/79 = 44%	8/42 = 19%
Continuous Performance Test and variants	19	31/72 = 43%	26/52 = 50%	5/15 = 33%
BRIEF	16	177/266 = 67%	88/104 = 85%	24/64 = 38%
Go/No-Go Test	14	37/81 = 46%	23/41 = 56%	7/17 = 41%
Tower of London test and Variants	13	3/75 = 4%	1/39 = 3%	2/39 = 5%
Rey-Osterith Complex Figure Test (ROCF) or Rey Complex Figure Test (RCFT)	12	31/93 = 33%	24/56 = 43%	7/37 = 19%

In general single EF tests share at most 10% of the variance with EF ratings and observations of everyday behavior.

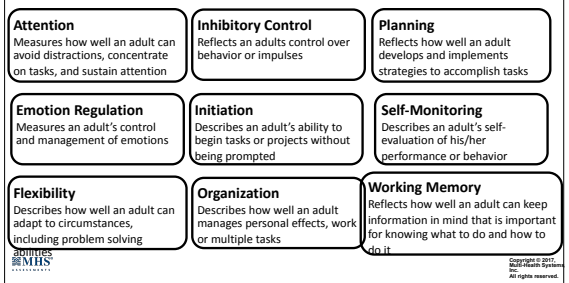
Batteries of combined EF tests fare a bit better sharing up to 20% of the variance with observation and reported behavior.

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



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

Demographic		Sample					
		CAS		WISC-IV		WJ III ACH	
		N	%	*N*	%	*N*	%
Gender	Male	38	61.3	29	67.4	36	62.1
	Female	24	38.7	14	32.6	22	37.9
Race/Ethnic Group	Hispanic	1	1.6	1	2.3	1	1.7
	Asian	2	3.2	2	4.7	2	3.4
	White	55	88.7	38	88.4	52	89.7
	Other	4	6.5	2	4.7	3	5.2
Parental Education Level	High school diploma or less	1	1.6	0	0.0	1	1.7
	Some college or associate's degree	21	33.9	12	27.9	18	31.0
	Bachelor's degree or higher	36	58.1	26	60.5	34	58.7
	Missing information	4	6.5	5	11.6	5	8.6
Diagnostic or Educational Group	ADHD	24	38.7	15	34.9	20	34.5
	Anxiety	15	24.2	9	20.9	14	24.1
	ASD	7	11.3	5	11.6	7	12.1
	LD	3	4.8	3	7.0	3	5.2
	Mood	4	6.5	3	7.0	5	8.6
	Other	9	4.8	8	4.6	9	5.1
Total		62	100.0	43	100.0	58	100.0
Age *M (SD)*		10.4 (2.9)		10.2 (2.6)		10.5 (2.7)	

Note. ADHD = Attention-Deficit/Hyperactivity Disorder; Anxiety = Anxiety Disorder; ASD = Autism Spectrum Disorder; LD = Learning Disorder; Mood = Mood Disorder.

CEFI, WISC-IV, CAS, Achievement

Table 8.27 CEFI Manual Other Measure		Corrected *r*	*N*	CEFI Full Scale		CAS, WISC-IV, or WJ III ACH	
				M	*SD*	*M*	*SD*
WISC-IV	Full Scale	.39*	41	93.1	12.0	95.5	18.1
	Working Memory	.30	42	93.0	11.9	92.6	17.5
	Verbal Comprehension	.44**	42	93.0	11.9	96.8	14.7
	Perceptual Reasoning	.27	42	93.0	11.9	101.5	17.5
	Processing Speed	.34*	42	93.0	11.9	90.7	19.4
CAS	Full Scale	.45**	60	91.4	13.2	95.8	17.1
	Attention	.37**	60	91.4	13.2	96.5	15.1
	Planning	.49**	60	91.4	13.2	92.4	14.5
	Simultaneous	.43**	60	91.4	13.2	101.6	17.0
	Successive	.32*	60	91.4	13.2	98.0	14.6
WJ III ACH	Total Achievement	.51**	40	93.4	12.1	96.6	16.8
	Broad Reading	.48**	54	91.9	12.4	98.1	14.2
	Broad Math	.49**	53	92.0	11.9	97.7	16.9
	Broad Written Language	.47**	41	93.5	12.3	94.9	16.8

CEFI & WISC-IV

Table H.25. Correlations Between the CEFI (5–18 Years) Teacher Form and the WISC-IV

CEFI	WISC-IV										CEFI	
	Full Scale		Working Memory		Verbal Comprehension		Perceptual Reasoning		Processing Speed			
	Obt. *r*	Cor. *r*	Obt. *r*	Cor. *r*	Obt. *r*	Cor. *r*	Obt. *r*	Cor. *r*	Obt. *r*	Cor. *r*	*M*	*SD*
Full Scale	.37*	.39*	.28	.30	.35*	.44**	.25	.27	.35*	.34*	93.0	11.9
Attention	.36*	.39*	.36*	.40**	.25	.33*	.28	.32*	.34*	.35*	91.8	11.2
Emotion Regulation	.17	.14	-.07	-.06	.24	.25	.09	.08	.14	.11	97.2	14.7
Flexibility	.52**	.57**	.40**	.46**	.55**	.68**	.40**	.45**	.35*	.37*	93.8	11.0
Inhibitory Control	.22	.21	.09	.08	.18	.20	.13	.13	.32*	.27	97.7	13.5
Initiation	.30	.25	.24	.21	.31*	.31*	.17	.14	.32*	.25	91.2	15.1
Organization	.16	.15	.15	.14	.15	.17	.07	.06	.20	.17	92.2	13.6
Planning	.42**	.46**	.34*	.38*	.42**	.54**	.27	.31*	.37*	.39*	93.6	11.1
Self-Monitoring	.36*	.39*	.29	.33*	.35*	.45**	.28	.31*	.26	.27	92.0	11.3
Working Memory	.41**	.38*	.38*	.36*	.39*	.43**	.33*	.31*	.26	.23	92.5	13.6
WISC-IV *M*	95.5		92.6		96.8		101.5		90.7			
WISC-IV *SD*	18.1		17.5		14.7		17.5		19.4			

Note. Pair-wise deletion of missing cases was used (N = 41–43); Obt. r = Obtained r; Cor. r = Corrected r.
*p < .05; **p < .01

CEFI & CAS

Table H.18. Correlations Between the CEFI (5–18 Years) Teacher Form and the CAS

	CAS										CEFI	
	Full Scale		Attention		Planning		Simultaneous		Successive			
CEFI	Obt. *r*	Cor. *r*	Obt. *r*	Cor. *r*	Obt. *r*	Cor. *r*	Obt. *r*	Cor. *r*	Obt. *r*	Cor. *r*	*M*	*SD*
Full Scale	.45**	.45**	.33*	.37**	.43**	.49**	.42**	.43**	.28*	.32*	91.4	13.2
Attention	.40**	.41**	.26*	.30*	.36**	.42**	.38**	.39**	.30*	.35**	90.3	12.8
Emotion Regulation	.26*	.24	.24	.24	.21	.22	.26*	.23	.12	.13	96.9	14.7
Flexibility	.52**	.53**	.35**	.40**	.47**	.54**	.50**	.51**	.37**	.42**	92.2	13.0
Inhibitory Control	.27*	.25*	.17	.18	.26*	.29*	.24	.22	.19	.21	96.0	13.9
Initiation	.40**	.33**	.33**	.30*	.38**	.37**	.38**	.31*	.21	.20	89.0	16.3
Organization	.29*	.27*	.19	.20	.33**	.36**	.23	.21	.21	.23	90.5	14.3
Planning	.47**	.49**	.31*	.37**	.46**	.54**	.44**	.46**	.31*	.38**	92.5	12.4
Self-Monitoring	.48**	.50**	.37**	.43**	.42**	.50**	.46**	.49**	.29*	.35**	91.2	12.4
Working Memory	.48**	.45**	.36**	.38**	.42**	.46**	.47**	.45**	.27*	.30*	91.0	14.0
CAS *M*	95.8		96.5		92.4		101.6		98.0			
CAS *SD*	17.1		15.1		14.5		17.0		14.6			

Note. Pair-wise deletion of missing cases was used (N = 60–62); Obt. *r* = Obtained *r*; Cor. *r* = Corrected *r*. *p < .05; **p < .01.

CEFI & WJ-III *Total* Achievement

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

	WJ III ACH Total Achievement		CEFI	
	Obt. *r*	Cor. *r*	*M*	*SD*
Full Scale	.47**	.51**	93.4	12.1
Attention	.51**	.59**	92.5	10.9
Emotion Regulation	.22	.18	96.5	16.1
Flexibility	.56**	.61**	94.0	11.9
Inhibitory Control	.24	.23	97.8	14.0
Initiation	.37*	.32*	91.5	15.6
Organization	.32*	.32*	92.5	13.5
Planning	.51**	.58**	94.1	11.3
Self-Monitoring	.46**	.53**	92.7	11.1
Working Memory	.57**	.57**	93.2	13.1
WJ III ACH *M*	96.6			
WJ III ACH *SD*	16.8			

Note. Pair-wise deletion of missing cases was used (N = 40–41); Obt. *r* =

80

CEFI & WJ-III *Reading*

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

	WJ III ACH Broad Reading		CEFI	
	Obt. *r*	Cor. *r*	*M*	*SD*
Full Scale	.39**	.48**	91.9	12.4
Attention	.41**	.52**	90.9	11.7
Emotion Regulation	.25	.27*	96.9	14.6
Flexibility	.43**	.50**	92.5	12.8
Inhibitory Control	.26	.32*	96.6	13.0
Initiation	.26	.26	89.1	16.1
Organization	.27*	.31*	91.0	13.9
Planning	.43**	.54**	92.8	11.5
Self-Monitoring	.40**	.51**	91.4	11.7
Working Memory	.43**	.48**	91.5	13.7
WJ III ACH *M*	98.1			
WJ III ACH *SD*	14.2			

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

81

CEFI & WJ-III Broad *Math*

Table H.28. Correlations Between the CEFI (5–18 Years) III ACH Broad Math Cluster

	WJ III ACH Broad Math		CEFI	
	Obt. *r*	Cor. *r*	*M*	*SD*
Full Scale	.44**	.49**	92.0	11.9
Attention	.40**	.46**	90.7	11.4
Emotion Regulation	.16	.15	96.7	14.8
Flexibility	.52**	.55**	93.0	12.1
Inhibitory Control	.15	.15	96.6	13.0
Initiation	.43**	.38**	89.9	15.1
Organization	.33*	.33*	90.8	13.4
Planning	.49**	.57**	93.1	10.8
Self-Monitoring	.46**	.51**	91.6	11.4
Working Memory	.59**	.60**	91.6	13.1
WJ III ACH *M*	97.7			
WJ III ACH *SD*	16.9			

Note. Pair-wise deletion of missing cases was used (*N* = 53–54); Obt. *r* =

82

CEFI & WJ-III Written Language

Table H.29. Correlations Between the CEFI (5–18 Years) III ACH Broad Written Language Cluster

	WJ III ACH Broad Written Language		CEFI	
	Obt. *r*	Cor. *r*	*M*	*SD*
Full Scale	.44**	.47**	93.5	12.3
Attention	.47**	.55**	92.5	10.9
Emotion Regulation	.20	.17	97.4	15.9
Flexibility	.50**	.54**	94.2	12.2
Inhibitory Control	.27	.26	98.1	13.8
Initiation	.33*	.28	91.6	15.6
Organization	.34*	.33*	92.0	13.8
Planning	.44**	.50**	94.4	11.5
Self-Monitoring	.44**	.49**	92.5	11.5
Working Memory	.47**	.47**	93.4	13.5
WJ III ACH *M*	94.9			
WJ III ACH *SD*	16.8			

Note. Pair-wise deletion of missing cases was used (*N* = 41–42); Obt. *r* =

83

Is broad or global EF training effectively transferred to the natural setting?

84

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.

85

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.

86

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

87

Is real world, content based EF instruction effective?

88

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

89

A modest group of studies has demonstrated that setting and work modifications as well as strategy development and mastery improves 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

90

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A Cognitive Strategy Instruction to Improve Math Calculation for Children With ADHD and LD: A Randomized Controlled Study

Jackie S. Iseman[1] and Jack A. Naglieri[1]

Abstract

The authors examined the effectiveness of cognitive strategy instruction based on PASS (Planning, Attention, Simultaneous, Successive) given by special education teachers to students with ADHD randomly assigned by classroom. Students in the experimental group were exposed to a brief cognitive strategy instruction for 10 days, which was designed to encourage development and application of effective planning for mathematical computation, whereas the comparison group received-standard math instruction. Standardized tests of cognitive processes and math achievement were given at pretest. All students completed math worksheets throughout the experimental phase. Standardized achievement tests (*Woodcock-Johnson Tests of Achievement, Third Edition*, Math Fluency and *Wechsler Individualized Achievement Test, Second Edition*, Numerical Operations) were administered pre- and postintervention, and Math Fluency was also administered at 1 year follow-up. Large pre–post effect sizes were found for students in the experimental group but not the comparison group on math worksheets (0.85 and 0.26), Math Fluency (1.17 and 0.09), and Numerical Operations (0.40 and −0.14, respectively). At 1 year follow-up, the experimental group continued to outperform the comparison group. These findings suggest that students with ADHD evidenced greater improvement in math worksheets, far transfer to standardized tests of math (which measured the skill of generalizing learned strategies to other similar tasks), and continued advantage 1 year later when provided the PASS-based cognitive strategy instruction.

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)

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Extensive Section on Strategies

CEFI (5–18 Years) Teacher Interpretive Report for John Hancock — Admin Date: 10/15/2012

Intervention Strategies

This section provides intervention strategies for improving upon the weaknesses identified by *Low Average* to *Well Below Average* scores on the CEFI Scales. References for the sources of these strategies are provided at the end of the Intervention Strategies section. (See *CEFI Items by Scale* for a full list of items with below average scores for item-level indicators of specific weaknesses.)

Executive Function

Executive function is a dynamic system; its successful operation involves the inhibition and activation of various processes in an integrated effort to direct goal-oriented behavior. Additionally, executive function has a developmental trajectory. As the brain develops, executive function behaviors are acquired and progressively refined. Since executive function involves the integrated effort of multiple processes, a wide range of abilities or behaviors are implicated in its operation. Any single behavior or domain of behaviors can present as a symptom of a problem if the executive function system is impaired. As such, specific behaviors can be targeted through intervention strategies that will have a broad impact on executive function behaviors in general.

General Intervention Strategies

- Take a child's natural development into account when planning intervention strategies. Executive function behaviors require greater effort and are less accurate in early stages of development.
- Develop intervention strategies that initially incorporate external controls, prompts and cues to help the child learn and develop new abilities.
- Have strategies in place that gradually remove external controls to promote internalization of new behaviors. Encourage a child to self-prompt so that newly acquired skills become habit.
- State behavioral challenges in a positive manner that indicates change is possible with intervention.

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Intervention Strategies for Inhibitory Control

Teaching a Child to Stop and Think!

To encourage positive self-control, a student should be first directly taught to pay attention to and think about his or her behavior. Teachers can explicitly teach the student that when the phrase "Stop and think!" is said, the student should think about what he or she is doing. The student then should be taught to ask him- or herself appropriate questions about actions, such as "What am I doing?" and "Is what I'm doing okay?" If the child is about to do something, the questions "What do I want to do?" and "Is what I want to do okay?" may be posed. Initially, these questions could be put on the student's desk or posted on the wall as a reminder.

The student may be given the following plan to follow to determine what is going on in a situation, think about what his or her options are, and choose the best one.

- Stop and think.
- Identify the situation.
- Ask, "What do I want to do?"
- Ask, "Is there a problem?"
- Ask, "What are possible solutions?"
- Consider the consequences to each solution.
- Choose the best solution.
- Evaluate the results.

Comprehensive Executive Function Inventory (5–18 Years)
Teacher Feedback Report

Child's Name/ID:	John Hancock	**Teacher's Name/ID:**	Mr. Lincoln
Age:	6 years	**Date of Assessment:**	October 15, 2012
Gender:	Male	**School:**	DC
Birth Date:	October 15, 2006	**Examiner:**	
Grade:	1		

Note: This feedback report is intended to provide a record of scores obtained on the CEFI. It does not replace a detailed explanation of the scores by the examiner, identified at the top of this report. If you have any questions or concerns regarding the material herein, please speak to the examiner.

About the CEFI

The Comprehensive Executive Function Inventory (CEFI) is a rating scale that is used to measure Attention, Emotion Regulation, Flexibility, Inhibitory Control, Initiation, Organization, Planning, Self-Monitoring, and Working Memory. The CEFI gives an overall score and scores on nine separate scales.

What CEFI Scores Mean

This report provides standard scores that are based on ratings of children in the normative sample (that is, children who represent the general population). The scores are set so that 100 is *Average*, and equal to the 50th percentile rank. This means that when a child obtains a score of 100, he did as well as or better than 50 percent of children his age. The *Average* category includes scores that range from 90 (25th percentile) to 109 (75th percentile). Scores below 90 may suggest difficulties in specific areas. Scores above 109 may suggest strengths in specific areas.

Cognitive Strategy = EF Instruction

- 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.

97

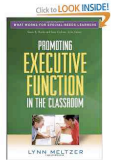
My Granddaughter Hones Her EF Skills

98

Practice Pays Off!

99

EF Instruction



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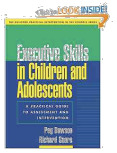

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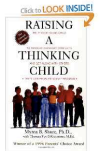

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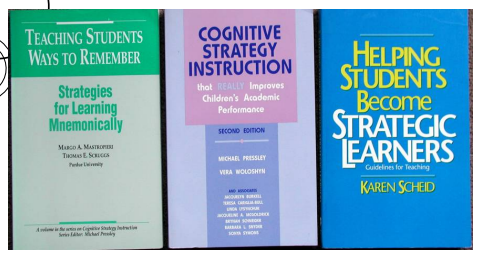
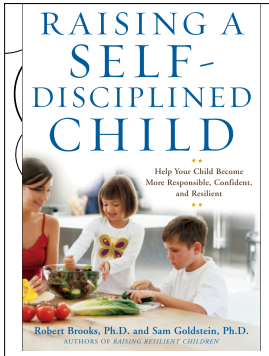
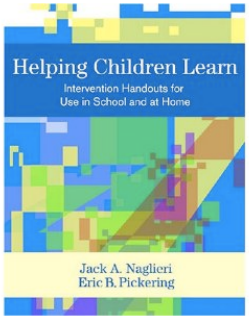
Cognitive Instructional Methods

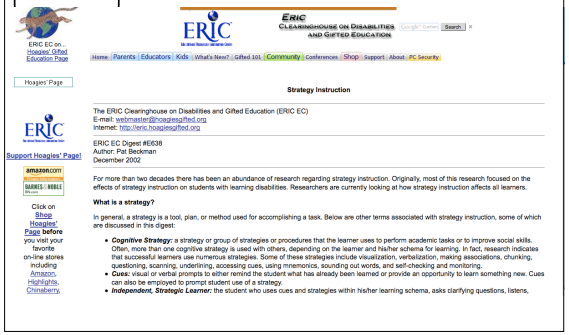




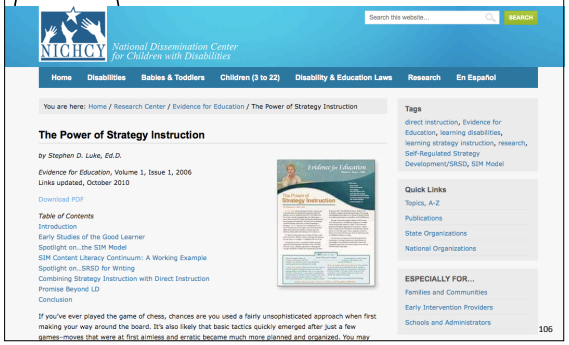


Tools of the Mind

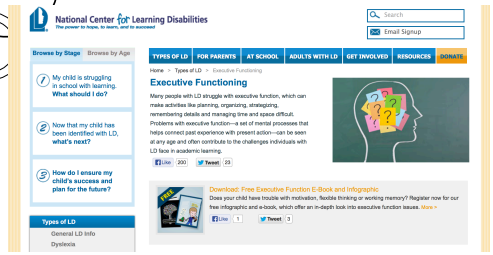
http://www.hoagiesgifted.org/eric/e638.html

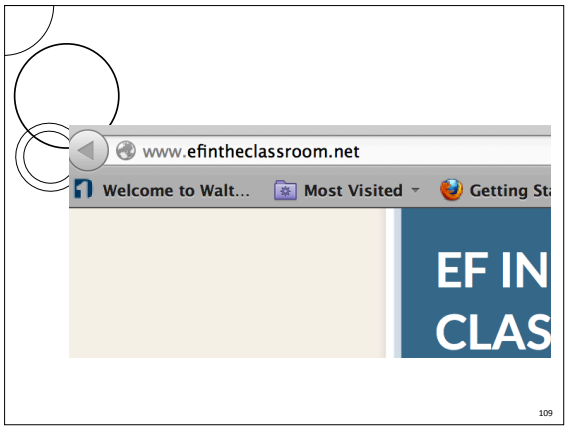


http://nichcy.org/research/ee/learning-strategies



http://www.ncld.org/at-school/especially-for-teachers/effective-teaching-practices/strategic-instruction-model-sim-how-to-teach-how-to-learn

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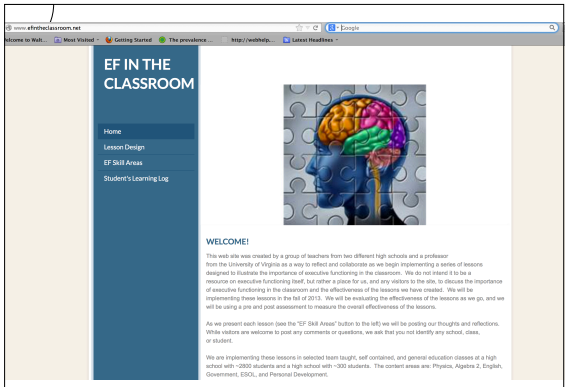
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Student's Learning Log
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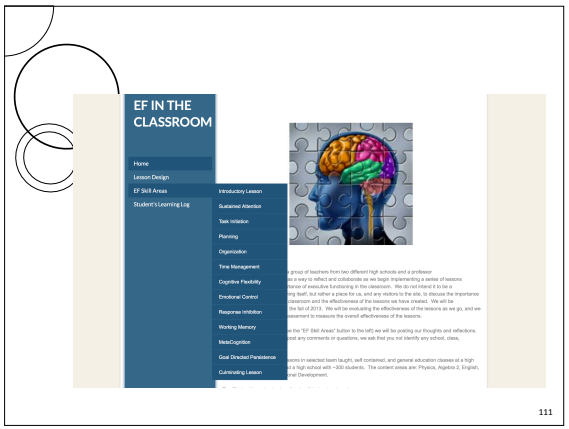
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Home
Lesson Design
EF Skill Areas
Student's Learning Log
Introductory Lesson
Sustained Attention
Task Initiation
Planning
Organization
Time Management
Cognitive Flexibility
Emotional Control
Response Inhibition
Working Memory
MetaCognition
Goal Directed Persistence
Culminating Lesson

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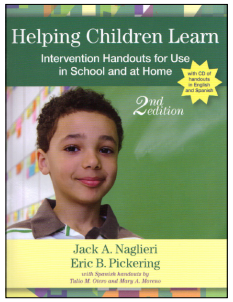
Teaching Children to use EF

- 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.

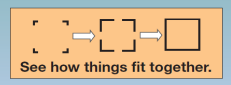


Four Ways to Think Smart!

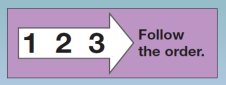
Think smart and use a plan!

Think smart and look at the details!

Think smart and put the pieces together!



Think smart and follow the sequence!



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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