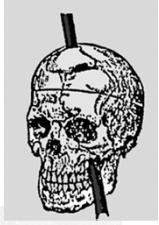
Executive Function in the Everyday Context:
The Evidence for Assessment and Intervention

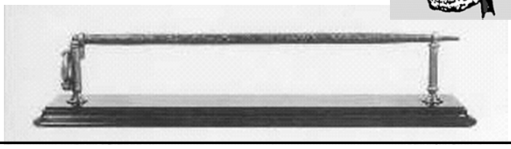
Peter K. Isquith, Ph.D.
Staff Psychologist, Hanover High School, NH
Senior Attending Neuropsychologist, Boston Children's Hospital
Instructor, Harvard Medical School
Assistant Professor, Geisel School of Medicine at Dartmouth

Peter.Isquith@QPsych.com

Phineas Gage: Cavendish, VT 1848

- 3' tamping iron shot through left cheek and exited left frontally
- Destroyed much of left frontal lobe





Phineas Gage: A changed man

"He is fitful, irreverent, indulging at times in the grossest profanity, impatient of restraint or advice when it conflicts with his desires; at times pertinaciuously obstinate yet capricious and vascillating. His friends and acquaintances said he was no longer Gage"

Harlow, 1868

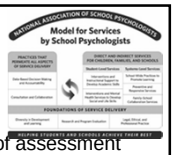
Inhibit Shift Emotional Control

Goal:
Increase expertise in executive function assessment & intervention

Plan:

- Introduce models of executive function
- Review assessment approaches
- Demonstrate utility of the BRIEF family
- Evidence Based Assessment of ADHD
- Discuss interventions to enhance executive function

NASP Data-Based Decision Making and Accountability



Relevance:

- Knowledge of varied models and methods of assessment and data collection for identifying strengths and needs
- Systematically collecting data form multiple sources and using ecological factors as context for all assessment & intervention decisions
- Using assessment data to understand students' problems and implement evidence-based instructional, behavioral & mental health services
- Measuring progress & outcomes
- Evaluate effectiveness and need for modification to school-based interventions

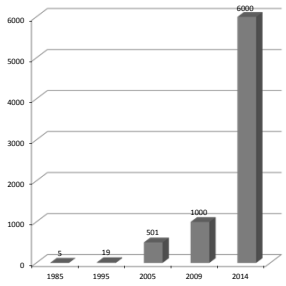
5

Disclosure

Peter Isquith is a co-author of the Behavior Rating Inventory of Executive Function family of instruments (BRIEF), the ConcussTrack PostConcussion Executive Inventory, the Tasks of Executive Control (TEC), and the Adaptable Pediatric Neurocognitive Battery, some of which may be discussed at this presentation.

Interest in Executive Function in Children

- 5 articles in 1985
- 14 articles in 1995
- 501 articles by 2005
- >1000 articles by 2010
- >6000 articles by 2014



- *Bernstein & Waber In Meltzer (2007) Executive Function in Education*

Why are executive functions important?

Executive Functioning Predicts School Readiness and Success: Implications for Assessment and Intervention

For example, EF has been described as the single best predictor of school readiness (Blair & Razza, 2007). Moreover, EF has been implicated in numerous facets of functioning, such as academic, social, psychological, and behavioral domains. (Zhou, Chen, & Main, 2012).

Cantin, R.H., Mann, T.M. & Hund, A.M. (2012). NASP Communiqué, 41.

Definition & Models of Executive Function

The unity and diversity of executive functions

Teuber, 1972

Two Levels of Executive Function Definitions

Unity: The orchestration of basic cognitive processes during goal oriented problem solving

Diversity: Inhibit impulses, shift flexibly, and initiate, sustain, plan, organize and monitor behavior, emotion, and cognition

Three Primary Models of Executive Function

Neuroanatomical- "Frontal Lobe"

Neurocognitive- What tests test

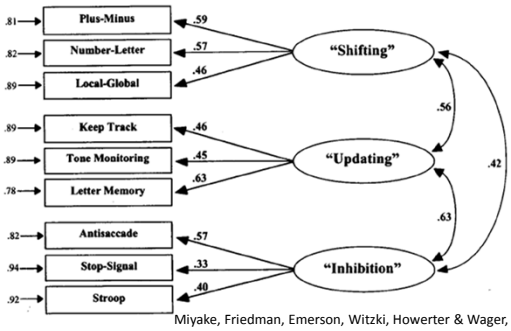
Behavioral- What we observe

Neuroanatomical Model: Executive Functions & the Frontal Lobes

"There is no unitary executive function. Rather, distinct processes related to the frontal lobes can be differentiated which converge on a general concept of control functions."

Stuss, D.T., & Alexander, M.P. Psychological Research, 2000.

Neurocognitive Model: The Unity and Diversity of Executive Functions



Miyake, Friedman, Emerson, Witzki, Howerter & Wager, 2000

The Unity and Diversity of Executive Functions and Their Contributions to Complex "Frontal Lobe" Tasks: A Latent Variable Analysis

Akira Miyake, Naomi P. Friedman, Michael J. Emerson, Alexander H. Witzki, and Amy Howerter

Cognitive Psychology **41,** 49–100 (2000)

The main results from the CFA analyses indicate that executive functions may be characterized as separable but related functions that share some underlying commonality. Thus, as Teuber (1972) suggested in his review of frontal lobe functions more than a quarter of a century ago, the results point to both unity and diversity of executive functions and indicate that both of these aspects need to be taken into consideration in developing a theory of executive functions (see also Duncan et al., 1997).

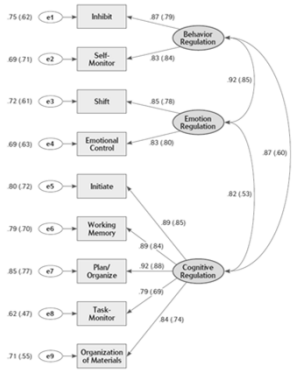
Behavioral Model: EF is a multidimensional construct

An umbrella term encompassing distinct, but interrelated, abilities that contribute to management of goal-directed behaviors including inhibiting, shifting, and regulating emotions; initiating; planning; organizing; and monitoring while holding goals in working memory.

Gioia, Isquith, Guy & Kenworthy, 2000

BRIEF2 Multidimensional Factor structure

Parent Form
Confirmatory Factor Analysis



"…results from analyses reveal that the behaviors that are rated on the CEFI represent a single construct: Executive function."

Naglieri & Goldstein, 2012 pg 72

Unitary vs Multidimensional?

Our Conclusion. . .

The concept of Executive Function is best defined as a unitary construct….how you do what you do.

He got in it and he drew up the covers.

Naglieri & Goldstein, 2012

Fifty Years of Prefrontal Cortex Research: Impact on Assessment Paul W. Burgess,[1] AND Donald T. Stuss[2,3,4]

Journal of the International Neuropsychological Society (2017), **23**, 755–767.

The executive system has multiple subsystems with anatomical & behavioral separation

Unity:

Executive Function is the orchestration of basic cognitive processes during goal oriented problem solving

or

Self-Regulation

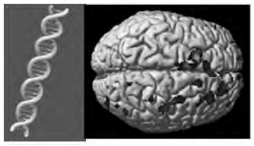
Diversity:

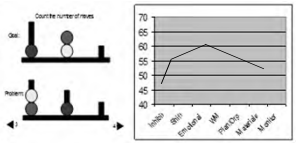
Functions of the "Orchestra"	Functions of the "Conductor"
•Perception	•Inhibit
•Attention	•Self-Monitor
•Language processes	•Shift Flexibly
•Visual-spatial processes	•Modulate Emotions
•Memory	•Initiate
•Sensory inputs	•Working Memory
•Motor outputs	•Plan
•Knowledge & skills • social • academic	•Organize •Task-Monitor

Methods of Assessing EF

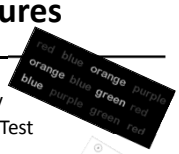
Micro — **Molar** — **Macro**

Genetics | **Structural & Functional Imaging** | **Performance Measures ("tests")** | **Observations Rating Scales**

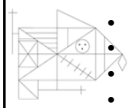


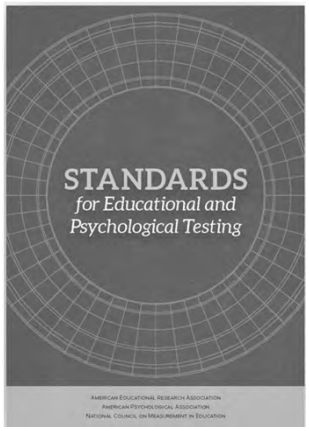


Performance Measures



- Verbal Fluency / Figural Fluency
- Stroop Color-Word Interference Test
- Rey-Osterrieth Complex Figure
- Tower of Hanoi / Tower of London
- Wisconsin Card Sorting Test
- Mazes
- Trail Making
- Continuous Performance Tests
- n back
- Go/No-go
- Tasks of Executive Control (TEC)





Advantages of EF Performance Tests:

- Increased specificity of processes
- Increased task control and internal validity
- Decades of research on test behavior

"Dogmatic adherence to the psychometric tradition of understanding and assessing EF at its most basic cognitive level is grossly inadequate. It provides only a superficial evaluation of even the conventional phenotypic view of EF. It fails to capture entirely the multilevel, concentrically arranged, affectively/motivationally charged, socially important and culturally facilitated nature of the extended phenotype of EF/SR in everyday human activities."

Barkley, 2012, pg 190

1994—Recognized the need for:

- Standardized data about everyday executive function
- Standardized parent / teacher/ self ratings
- Efficient assessment of multiple aspects of executive functioning

A BRIEF History

2000 2003 2004 2005

Since publication:

- Expanded to cover ages 2-90 years
- >1400 peer-reviewed empirical publications
- >60 clinical trials and outcome studies
- Translated into more than 188 languages
- Used on 6 continents

School-Age Executive Function Rating Scales

2000: Behavior Rating Inventory of Executive Function (939)

2012: Barkley Deficits in Executive Functions Scale-Child (8)

2012: Comprehensive Executive Function Inventory (3)

2012: Delis Ratings of Executive Function (1)

2015: McCloskey Scales of Executive Function (0)

2018: Brown EF/Attention Scales (0)

(n) = peer reviewed empirical studies with children and adolescents

At a Glance

Ages: 5-18 years

Administration time:
- 5 minutes Screening
- 10 minutes full

Parent, Teacher, Self-Report Forms

Representative standardization sample

Demographic Characteristics of the BRIEF2 Standardization Sample

Characteristic	Sample: Parent	Teacher	Self-Report
n	1,400	1,400	803
Gender			
Male	49.1	48.6	49.3
Female	50.9	51.4	50.7
Age (years)			
M	11.51	11.51	14.50
SD	4.03	4.03	2.29
Range	5-18	5-18	11-18
Race/ethnicity (%)			
Caucasian	56.1	61.4	65.3
African American	14.1	11.6	11.6
Hispanic	18.9	18.4	15.7
Other	10.9	8.6	7.5
Parent education level (%)			
<12 years	10.5	11.5	11.1
12 years	26.6	27.9	26.3
13-15 years	28.7	26.5	27.8
16+ years	34.2	34.1	34.9

Note. Percentages may not sum to 100% due to rounding.

No effects of race, ethnicity, or parent education.

More concise scales: Shorter by a Quarter

	BRIEF			BRIEF-2		
Scale	**Parent**	**Teacher**	**Self-Report**	**Parent**	**Teacher**	**Self-Report**
Inhibit	10	10	13	8	8	8
Self-Monitor	--	--	--	4	5	5
Shift	8	10	10	8	8	8
Emotional Control	10	9	10	8	8	6
Initiate	8	7	--	5	4	--
Task Completion	--	--	10	--	--	7
Working Memory	10	10	12	8	8	8
Plan/Organize	12	10	13	8	8	10
Task-Monitor	--	--	--	5	6	--
Organization of Materials	6	7	7	6	5	--
Monitor	8	10	5	--	--	--
Additional Clinical Items	14	13	--	--	--	--
Infrequency	--	--	--	3	3	3
Total	**86**	**86**	**80**	**63**	**63**	**55**

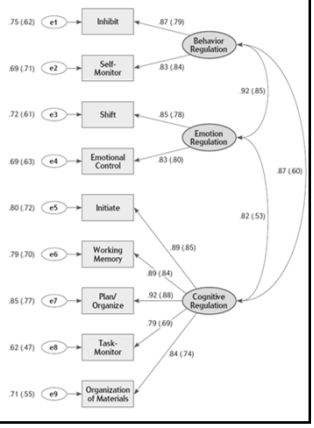
Equivalence with the BRIEF

No new items on clinical scales, allowing for consistency of data collection between the BRIEF and BRIEF2

BRIEF2 scores are within 4 *T* score points of BRIEF scores in clinical groups

Factor structure

- Scales & Indexes supported by confirmatory factor analysis
- Three indexes consistent with widely accepted theory



New to the BRIEF2

Infrequency scale

Infrequency scale helps identify unusual responding

Parent Form	Teacher Form	Self-Report Form
Forgets his/her name	Forgets his/her name	I forget my name
Has trouble counting to three	Has trouble counting to three	I have trouble counting to three
Cannot find the front door of home	Cannot find the front door of school	I cannot find the front door of my home

Infrequency Scale

- Infrequency items are indicated by an F in the margin of the scoring sheet. Circle the item number on the right for each Infrequency item with a score of 2 or 3.
- Count the number of circled items to determine the **Infrequency score**.
- Circle the appropriate protocol classification based on that score.

Item no.
18.
36.
54.

Infrequency score (range 0 to 3)

Infrequency score	Cumulative percentile	Protocol classification
0	99	Acceptable
≥1	>99	Questionable

Screening Forms

12-item Parent, Teacher and Self-Report Screening Forms

Indicate whether further assessment is needed

BRIEF2 SCREENING PARENT FORM

New statistics that support interpretation

- Reliable change indexes
- Interrater agreement metrics
- Base-rate tables
- Contingency statistics for Screening Forms and select diagnostic groups:
  - Sensitivity/specificity
  - Predictive power
  - Likelihood ratios

Five-Step Model for BRIEF2 Interpretation

Step	Reference*	Procedure	Example statements
1. Examine validity	Tables 3.2-3.8, Appendix D, and BRIEF2 Profile/ Score Summary Sheet	Review and report Inconsistency, Negativity, and Infrequency scale and other indications of compromised validity.	Ratings on the BRIEF2 were valid. Review of validity scales raised concerns about validity.
2. Interpret scores relative to normative expectations	Appendixes A, B, and C	Review and report BRIEF2 *T* scores and percentiles for scales, indexes, and GEC.	Parent ratings noted difficulties on the Inhibit, Working Memory, and Plan/Organize scales but typical functioning on the Emotional Control, Self-Monitor, Initiate, and Task-Monitor scales.
	Appendixes E and M	Compare *T* scores to base-rate tables.	Elevations of this magnitude on the Inhibit and Working Memory scales occur in less than 10% of students his age.
3. Interpret within-test score profile	Figures 3.1, 3.2, and 3.3	Review and report BRIEF2 *T*-score peaks and valleys; examine profile relative to diagnostic groups.	The profile pattern is like that seen in students diagnosed with attention disorders.
4. Interpret ratings between informants (e.g., Parent, Teacher, Self-Report forms)	Tables 3.10-3.14, 6.7-6.12	Examine discrepancies between raters; consider interrater reliabilities, base rates of differences, and possible explanations.	Teacher ratings revealed a similar pattern of concerns with inhibitory control, working memory, and planning and organization but also suggested problems with self-monitoring in the social setting. Teacher and parent ratings were in good agreement in general.
5. Interpret between-test change	Appendix G	If multiple BRIEF2 forms are available, calculate *T*-score differences and examine and report the significance level of the difference.	Ratings over time showed a significant decrease in behavior regulation concerns. However, whereas there was some decrease in emotion and cognitive regulation scores, the change was not beyond that expected within an 80% confidence interval.

*From the BRIEF2 Professional Manual.

Anthony

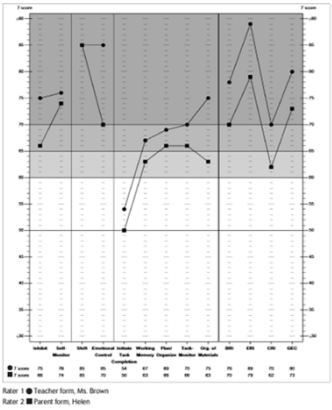
- 10 year-old fifth grade student
- History of diagnosed ASD and ADHD-C
- No BRIEF2 Screening Form completed given readily apparent problems

Anthony: Validity Scales

Validity scale	Parent Raw Score (Protocol Classification)	Teacher Raw Score (Protocol Classification)
Negativity	2	6
	(Acceptable)	(Elevated)
Inconsistency	3	3
	(Acceptable)	(Acceptable)
Infrequency	0	0
	(Acceptable)	(Acceptable)

Ratings of Anthony's self-regulation in the classroom tended to be more extreme than for most students, reflecting substantial difficulty in the school setting.

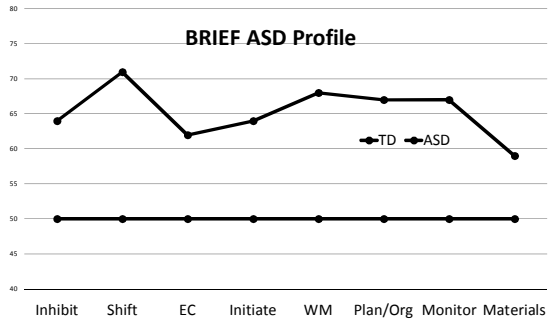
Anthony Scores



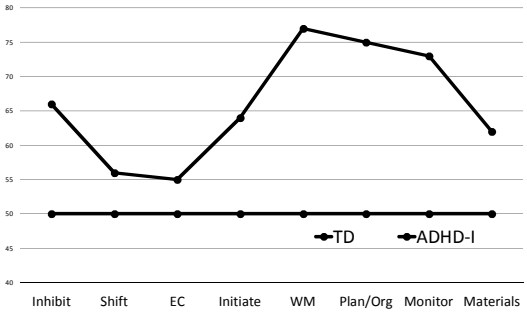
Describe peak scales from left to right

Parent and teacher ratings of Anthony's everyday self-regulation described him as having greatest difficulty adjusting to change and as having problems regulating his emotions, inhibiting impulses, and monitoring the impact he has on others. He is well-able to get started on tasks at home and in school, and able to maintain good organization of his materials in school. He has difficulty with working memory, planning, organization, and monitoring his own output.

Compare to clinical group profiles

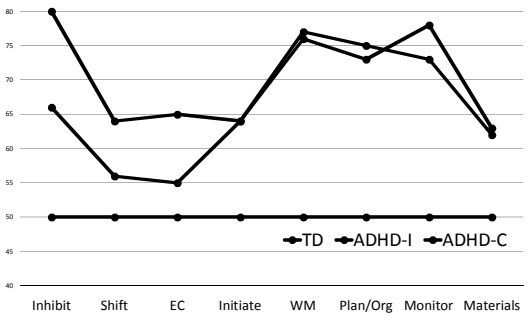


Parent Ratings on BRIEF2 Scales in ADHD-I



Gioia, Isquith, Kenworthy & Guy, 2015

Parent Ratings on BRIEF2 Scales in ADHD-C

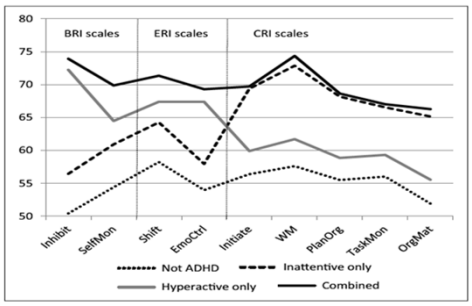


Gioia, Isquith, Kenworthy & Guy, 2015

Initial Examination of the BRIEF2 in Clinically Referred Children With and Without ADHD Symptoms

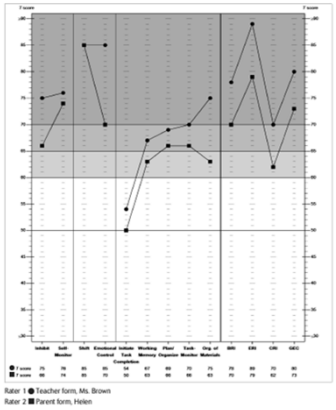
Journal of Attention Disorders, 2016

Lisa A. Jacobson[1,2], Alison E. Pritchard[1,2], Taylor A. Koriakin[3], Kelly E. Jones[1,2], and E. Mark Mahone[1,2]



Peak on Shift with poor social monitoring like ASD

Elevated Inhibit like ADHD-C



Compare to clinical group profile

Anthony's severe problems adjusting to change, monitoring social behavior, and managing his emotional outbursts are like those seen in children with autism spectrum disorders. He also has difficulty inhibiting impulses, which is consistent with his diagnosis of ADHD-C.

Pulling it all together

Parent and teacher ratings of Anthony's everyday self-regulation noted greatest difficulty adjusting to change and remaining flexible in problem solving. This was accompanied by difficulty regulating his emotions, as Anthony often becomes emotionally distressed and may have meltdowns, particularly with change or the unexpected, thought his is more so at school than at home. He also has difficulty inhibiting impulsive behavior and monitoring his social impact.

With difficulties in fundamental behavior and emotion regulation, it is often the case that students like Anthony will also show problems with cognitive regulation such as sustaining attention and working memory, and with planning, organizing and monitoring problem-solving efforts.

Students with substantial problems adjusting to change as reflected in the highly elevated Shift scale scores are more likely to be accurately diagnosed with an autism spectrum disorder than to be a typically developing student. This does not, however, constitute a diagnosis and must be viewed in the context of observations, history and all other assessment data.

Fifty Years of Prefrontal Cortex Research: Impact on Assessment

Paul W. Burgess,[1] AND Donald T. Stuss[2,3,4]

Eight principles:

1. You can't measure all cognitive abilities using the same methodology (not just tests)
2. Function & structure are different levels of explanation; don't expect 1:1 correspondence
3. Small differences in tasks lead to big differences in results
4. Variability & inconsistency within person is normal; measure & explain the variability

Journal of the International Neuropsychological Society (2017), **23**, 755–767.

Fifty Years of Prefrontal Cortex Research: Impact on Assessment Paul W. Burgess,[1] AND Donald T. Stuss[2,3,4]

5. The executive system has multiple subsystems with anatomical & behavioral separation
6. Some EF's are used in multiple situations; assessing them may be most useful
7. Measures that mimic naturalistic situations may be as effective as lab tests that do not
8. Normal test performance does not mean no executive function deficit

Journal of the International Neuropsychological Society (2017), **23**, 755–767.

Identifying Students with ADHD: Evidence-Based Assessment with the BRIEF2

Why?

- 12% ADHD Diagnosis by end of school years
- One of the most common referral questions
- Practitioners rely on a wide range of measures, primarily scales and observations
- Important to use tools that are validated for identifying students with ADHD subtypes

Definition & Models of Executive Function

The unity and diversity of executive functions

Teuber, 1972

The Clinical Diagnosis of ADHD

Rule In / Rule Out

Current DSM-V ADHD Diagnosis

Attention-Deficit/Hyperactivity Disorder,

- 314.01-Combined Presentation
- 314.00- Predominantly Inattentive Presentation
- 314.01-Predominantly Hyperactive/Impulsive Presentation

Current DSM-V ADHD Diagnosis

Rule in Requirements:

- 6 or more inattentive or hyperactive/impulsive criteria
- 6 months or longer
- Several symptoms prior to age 12
- Symptoms present in 2 or more settings (e.g., home, school)
- Clear evidence that symptoms interfere with functioning

ADHD Inattentive Symptoms

Problems with:

- Paying close attention
- Sustaining attention
- Listening
- Forgetful
- Finishing tasks
- Avoids sustained mental effort
- Organizing
- Losing materials
- Distracted

ADHD Hyper/Impulsive Symptoms

- Fidgets & Squirms
- Can't stay seated
- Runs about & climbs
- Can't play quietly
- On the go, driven
- Talks excessively
- Blurts
- Can't wait turn
- Interrupts others

Current DSM-V ADHD Diagnosis: Rule Outs

NOT due exclusively due to:

Psychosis
Mood
Anxiety
Dissociative
Personality
Substance use

But no mention of:

Brain injury
Medical conditions
Learning disabilities
Trauma
Sleep problems
Chemo / Rads
etc., etc., etc.

Educationally Handicapping Condition

Rule In:

Other health impairment means having limited strength, vitality, or alertness, including a heightened alertness to environmental stimuli, that results in limited alertness with respect to the educational environment, that—

- (i) Is due to chronic or acute health problems such as asthma, attention deficit disorder or attention deficit hyperactivity disorder…; and
- (ii) Adversely affects a child's educational performance.

Educationally Handicapping Condition

Rule Out:

The main factor in OHI cannot be due to-

- an environmental, cultural or economic disadvantage;
- limited English proficiency;
- a specific learning disability, and/or;
- an emotional disturbance
- lack of inappropriate instruction

The Relationships Between ADHD Diagnoses & Executive Functions

ADHD & Executive functions

With a better understanding of brain-behavior relationships, ADHD has been redefined as THE developmental disorder of executive functions

- Denckla, 1996
- Barkley, 1997, 2000
- Brown, 1999
- Gioia & Isquith, 2000, 2002

Executive Function & ADHD Dx

Executive Function

- Sustaining working memory
- Organizing
- Planning
- Monitoring
- (inhibiting)

ADHD-Inattentive Symptoms

- Paying close attention
- Sustaining attention
- Listening
- Forgetful
- Finishing tasks
- Organizing
- Losing materials
- Distracted

Executive Function & ADHD Dx

Executive Function

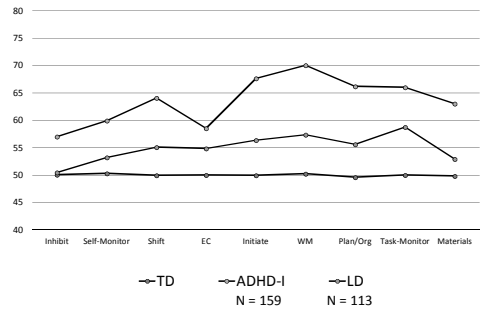
- Inhibition
  - Motor
  - Verbal
  - Behavioral
  - Social?
  - Emotional?

ADHD-Hyp/Imp Symptoms

- Fidgets
- Can't stay seated
- Runs about & climbs
- Can't play quietly
- On the go, driven
- Talks excessively
- Can't wait turn
- Interrupts others

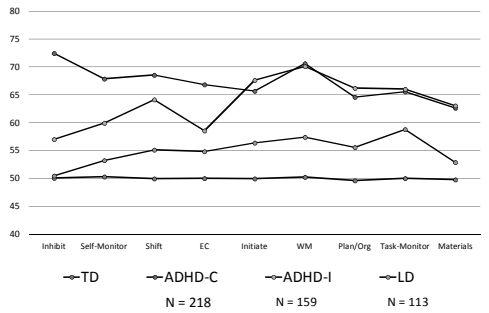
BRIEF Profiles of Students with ADHD

BRIEF2 profiles in ADHD-I



Gioia, Isquith, Guy & Kenworthy, 2015, Behavior Rating Inventory of Executive Function, 2nd Edition

BRIEF2 profiles in ADHD-C

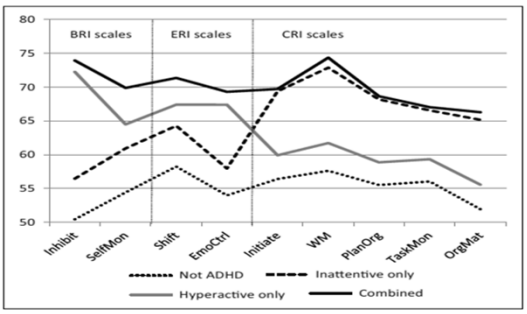


Gioia, Isquith, Guy & Kenworthy, 2015, Behavior Rating Inventory of Executive Function, 2nd Edition

Initial Examination of the BRIEF2 in Clinically Referred Children With and Without ADHD Symptoms

Journal of Attention Disorders
1–10
© The Author(s) 2016
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1087054716663632
jad.sagepub.com
SAGE

Lisa A. Jacobson[1,2], Alison E. Pritchard[1,2], Taylor A. Koriakin[3], Kelly E. Jones[1,2], and E. Mark Mahone[1,2]

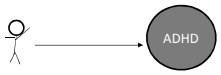


n = 1969 clinically referred 5-18 year-olds

Null Hypothesis Testing vs Evidence Based Assessment

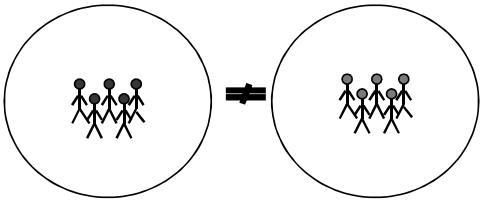
Null Hypothesis: Are these groups different?

Evidence Based Assessment: What is the likelihood that this person has X diagnosis?



Null Hypothesis Testing

Are Groups of Children with / without ADHD Different?



Children with ADHD score substantially and significantly higher on the BRIEF2.

Null Hypothesis Testing Model: ADHD

Table 6.44
Mean BRIEF2 Parent Form *T* Scores for ADHD-C and TD Groups

	Participant group					
	ADHD-C[a]		TD[b]			
Scale/index/composite	*M*	*SD*	*M*	*SD*	Mean difference	*d*
Inhibit	72.47	9.83	50.05	8.45	22.43***	2.45
Self-Monitor	67.89	9.72	50.41	9.13	17.47***	1.86
Behavior Regulation Index	72.55	9.51	50.22	8.67	22.33***	2.46
Shift	68.54	12.61	49.40	8.49	19.13***	1.78
Emotional Control	66.82	11.64	49.75	9.11	17.07***	1.64
Emotion Regulation Index	68.52	11.55	49.56	8.36	18.96***	1.88
Initiate	65.70	9.69	49.82	8.78	15.88***	1.72
Working Memory	70.60	9.02	50.34	8.46	20.26***	2.32
Plan/Organize	64.63	10.87	49.07	8.28	15.56***	1.61
Task-Monitor	65.57	9.57	50.12	8.50	15.45***	1.71
Organization of Materials	62.67	10.87	49.90	8.34	12.77***	1.32
Cognitive Regulation Index	68.25	10.23	49.84	8.08	18.41***	2.00
Global Executive Composite	72.20	8.91	50.36	8.03	21.84***	2.58

Note. ADHD-C = attention-deficit/hyperactivity disorder, combined type; TD = typically developing.
[a]*n* = 218. [b]*n* = 218.
***$p < .001$.

Gioia, Isquith, Guy & Kenworthy, 2015

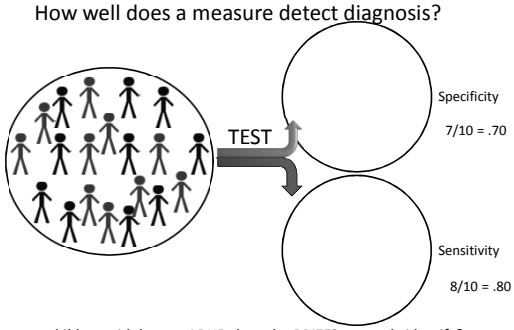
EBA Statistics: Example

403 ADHD & 527 No Dx

		Actual Diagnosis	
		No ADHD	ADHD
Test Result	ADHD	False Positive 74	True Positive 346
	No ADHD	True Negative 453	False Negative 57

EBA: Sensitivity & Specificity

How well does a measure detect diagnosis?



How many children with known ADHD does the BRIEF2 correctly identify?

How many children without ADHD does the BRIEF2 accurately rule out?

Evidence-Based Model: ADHD

Table F.1
BRIEF2 Parent Form Classification Measures for the Working Memory and Inhibit Scales in ADHD Research and Clinical Samples

	TD vs. ADHD		ADHD-C vs. ADHD-I			
	ADHD research sample[a]	ADHD clinical sample[b]	ADHD research sample[c]		ADHD clinical sample[d]	
Classification measure	Working Memory $T \geq 65$	Working Memory $T \geq 65$	Inhibit $T \geq 65$	Inhibit $T \geq 70$	Inhibit $T \geq 65$	Inhibit $T \geq 70$
True positive	101	282	80	66	170	133
False positive	13	20	17	10	40	18
False negative	32	95	18	32	48	85
True negative	120	357	18	25	119	141
Sensitivity	.76	.75	.82	.67	.78	.61
Specificity	.90	.95	.51	.71	.75	.89
Positive predictive value	.89	.93	.82	.87	.81	.88
Negative predictive value	.79	.79	.50	.44	.71	.62
Positive likelihood ratio	7.77	14.10	1.68	2.36	3.10	5.39
Negative likelihood ratio	0.27	0.27	0.36	0.46	0.29	0.44
Classification accuracy (%)	83.08	84.75	73.68	68.42	76.66	72.68

Note. ADHD = attention-deficit/hyperactivity disorder; TD = typically developing; ADHD-C = attention-deficit/hyperactivity disorder, combined type; ADHD-I = attention-deficit/hyperactivity disorder, inattentive type.
[a]n = 266. [b]n = 754. [c]n = 133. [d]n = 377.

Gioia, Isquith, Guy & Kenworthy, 2015

Predictive Power

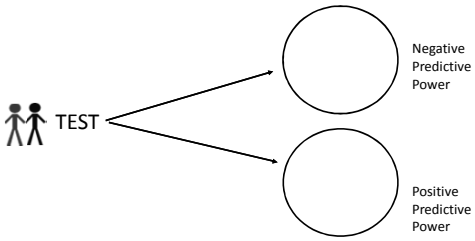
Positive: The likelihood that a child with a score above the cutoff truly has ADHD

Negative: The likelihood that a child with a score below the cutoff does NOT have ADHD

Both consider the *prevalence,* or the frequency of the diagnosis in your population (e.g., school)

EBA: Positive / Negative Predictive Power

How well does a measure predict diagnosis?



Given a known prevalence of ADHD, how many children does the BRIEF2 Accurately identify?

Evidence-Based Model: ADHD

Table F.1
BRIEF2 Parent Form Classification Measures for the Working Memory and Inhibit Scales in ADHD Research and Clinical Samples

	TD vs. ADHD		ADHD-C vs. ADHD-I			
	ADHD research sample[a]	ADHD clinical sample[b]	ADHD research sample[c]		ADHD clinical sample[d]	
Classification measure	Working Memory $T \geq 65$	Working Memory $T \geq 65$	Inhibit $T \geq 65$	Inhibit $T \geq 70$	Inhibit $T \geq 65$	Inhibit $T \geq 70$
True positive	101	282	80	66	170	133
False positive	13	20	17	10	40	18
False negative	32	95	18	32	48	85
True negative	120	357	18	25	119	141
Sensitivity	.76	.75	.82	.67	.78	.61
Specificity	.90	.95	.51	.71	.75	.89
Positive predictive value	.89	.93	.82	.87	.81	.88
Negative predictive value	.79	.79	.50	.44	.71	.62
Positive likelihood ratio	7.77	14.10	1.68	2.36	3.10	5.39
Negative likelihood ratio	0.27	0.27	0.36	0.46	0.29	0.44
Classification accuracy (%)	83.08	84.75	73.68	68.42	76.66	72.68

Note. ADHD = attention-deficit/hyperactivity disorder; TD = typically developing; ADHD-C = attention-deficit/hyperactivity disorder, combined type; ADHD-I = attention-deficit/hyperactivity disorder, inattentive type.
[a]n = 266. [b]n = 754. [c]n = 133. [d]n = 377.

Gioia, Isquith, Guy & Kenworthy, 2015

Sensitivity and Specificity tell us about the test- how well does it detect diagnosed children?

Predictive Power tells us about how the test works in your population (school, clinic, etc.)- how well does it predict diagnosis?

What can you say?

Null Hypothesis: Johnny has elevated scores on the BRIEF2 Inhibit and WM Scales. The literature shows that children diagnosed with ADHD-C also have elevated Inhibit and WM scales.

Evidence Based Assessment: Johnny's scores on the BRIEF2 Inhibit and WM scales suggest that there is a high likelihood that he meets criteria for a diagnosis of ADHD-C.

New Predictive Power Tables

- Likelihood of ADHD-I or C Diagnoses in student
- Considers sensitivity / specificity of the BRIEF2
- In context of your base rate of ADHD
- Use these tables when questioning ADHD
- Use broadband measure (e.g., BASC) to rule out
- In context of History, Observations & Testing

Probability of <u>any</u> ADHD Dx from BRIEF2 Parent Working Memory T Score

Step 1: Rule In / Rule Out ADHD

Parent BRIEF2 Working Memory Score

T Score	Sensitivity	Specificity	Accuracy	PPP	NPP
60	0.86	0.85	86	0.85	0.86
63	0.83	0.9	86	0.89	0.84
65	0.75	0.95	85	0.94	0.79
67	0.71	0.96	84	0.95	0.77
70	0.62	0.98	80	0.97	0.72

Probability of ADHD-C Dx from BRIEF2 Parent Inhibit T Score

Step 2: Determine ADHD Subtype

Parent BRIEF2 Inhibit Score

Cutoff Score	Sensitivity	Specificity	Accuracy	PPP	NPP
60	0.89	0.62	77	0.7	0.85
63	0.82	0.72	77	0.75	0.80
65	0.78	0.75	77	0.76	0.77
67	0.67	0.8	73	0.77	0.71
70	0.61	0.89	72	0.85	0.70

Probability of any ADHD Dx from BRIEF2 Teacher Working Memory T Score

Teacher BRIEF2 WM T Score Cutoffs:

Cutoff Score	Sensitivity	Specificity	Accuracy	PPP	NPP
60	0.63	0.84	0.74	0.8	0.69
63	0.58	0.9	0.74	0.85	0.68
65	0.55	0.91	0.73	0.86	0.67
67	0.52	0.93	0.73	0.88	0.66
70	0.42	0.98	0.7	0.95	0.63

Clinical: Probability of ADHD-C Dx from BRIEF2 Teacher Inhibit T Score

Teacher BRIEF2 Inhibit Score

Cutoff Score	Sensitivity	Specificity	Accuracy	PPP	NPP
60	0.65	0.7	67	0.68	0.67
63	0.62	0.81	72	0.77	0.68
65	0.59	0.82	71	0.77	0.67
67	0.55	0.85	70	0.79	0.65
70	0.51	0.88	70	0.81	0.64

Rule in / Rule out

BRIEF2 helps rule in ADHD subtypes & define concerns more clearly

Broadband scale (e.g., BASC) helps rule out other potential issues that may mimic ADHD

Formal testing helps rule out LD, cognitive deficits, etc.

Principal Factor Analysis of BRIEF2 Parent Form Scores With BASC-2 PRS Scores Using Promax Rotation

Scale	Factor 1	Factor 2	Factor 3	Factor 4
BASC-2 PRS Hyperactivity	.962			
BASC-2 PRS Aggression	.867			
BRIEF2 Parent Inhibit	.865			
BASC-2 PRS Conduct Problems	.807			
BRIEF2 Parent Emotional Control	.526		.452	
BRIEF2 Parent Self-Monitor	.465			
BASC-2 PRS Attention Problems	.405			
BRIEF2 Parent Plan/Organize		.895		
BRIEF2 Parent Initiate		.815		
BRIEF2 Parent Working Memory		.801		
BRIEF2 Parent Organization of Materials		.776		
BRIEF2 Parent Task-Monitor		.687		
BASC-2 PRS Anxiety			.690	
BASC-2 PRS Depression			.637	
BASC-2 PRS Somatization			.594	
BASC-2 PRS Withdrawal				.834
BASC-2 PRS Atypicality				.687
BRIEF2 Parent Shift				.359
Variance (%)	**41.1**	**13.4**	**9.3**	**5.8** Σ = **69.6**

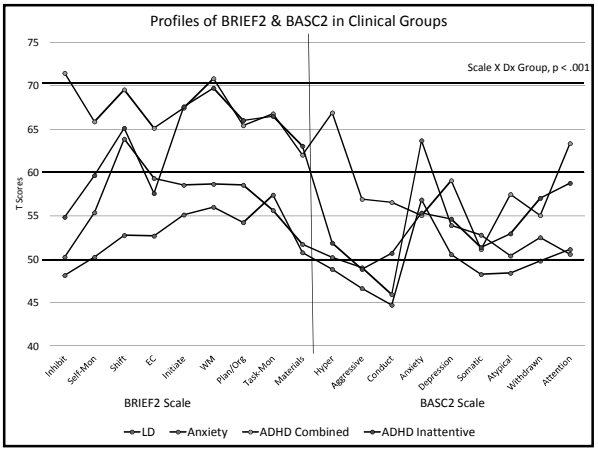
Note. n = 528. BASC-2 PRS = Behavior Assessment System for Children, Second Edition Parent Rating Scales (Reynolds & Kamphaus, 2004).

Assessment of Attention Deficit Hyperactivity Disorder (ADHD) Using the BASC and BRIEF

Kelly Pizzitola Jarratt, Cynthia A. Riccio, and Becky M. Siekierski

Although the BASC and BRIEF appear to be measuring similar behavioral constructs, the BRIEF focuses more on specific areas pertaining to metacognition and working memory. Taken together with these preliminary findings, use of the BASC and BRIEF in combination as components to comprehensive ADHD assessment appears promising and may generate additional areas in need of intervention (e.g., study skills, metacognition).

Applied Neuropsychology
2005, Vol. 12, No. 2, 83–93



Putting It All Together

Steps to Identifying Likely ADHD Dx

1. Compare BRIEF2 profile with ADHD profiles
2. Examine probability of any ADHD Dx
3. Examine probability of ADHD-C Dx
4. Rule out other problems (e.g., BASC3)

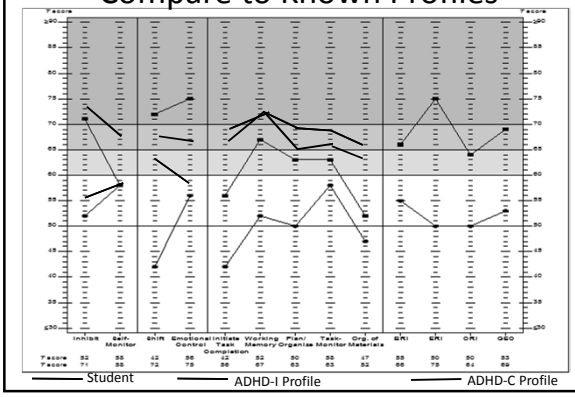
-Use BRIEF2 Manual or Interpretive Report
-Use Predictive Power tables here
-Watch for BRIEF2 for ADHD Supplement

Sam Adams

- 7 yr old 2nd grader
- Hx of:
  - severe language deficits in preschool
  - Impulsivity, inattention, hyperactivity
  - Familial ADHD-C
- Concerns with academic progress, behavior, attention in school but not at home
- Prior eval: Avg Literacy, 97th %ile math, Avg cognitive, very poor language

Reynolds Intellectual Assessment Scales-2	T (Mean = 50, SD 10)	Range
Guess What	29	Very low
Odd Item Out	54	Average
Verbal Reasoning	48	Average
What's Missing	10	Very low
	Summary Score SS (M = 100, SD = 15)	
Verbal Index	82	Below average
Nonverbal Index	71	Well below average
Composite Index	74	Well below average

Compare to Known Profiles



Probability of any ADHD Dx from BRIEF2 Parent Working Memory T Score

Step 1: Rule In / Rule Out ADHD

Parent BRIEF2 Working Memory Score

T Score	Sensitivity	Specificity	Accuracy	PPP	NPP
<60	0.86	0.85	86	0.85	0.86
63	0.83	0.9	86	0.89	0.84
65	0.75	0.95	85	0.94	0.79
67	0.71	0.96	84	0.95	0.77
70	0.62	0.98	80	0.97	0.72

Probability of any ADHD Dx from BRIEF2 Teacher Working Memory T Score

Teacher BRIEF2 WM T Score Cutoffs:

Cutoff Score	Sensitivity	Specificity	Accuracy	PPP	NPP
60	0.63	0.84	0.74	0.8	0.69
63	0.58	0.9	0.74	0.85	0.68
65	0.55	0.91	0.73	0.86	0.67
67	0.52	0.93	0.73	0.88	0.66
70	0.42	0.98	0.7	0.95	0.63

Clinical: Probability of ADHD-C Dx from BRIEF2 Teacher Inhibit T Score

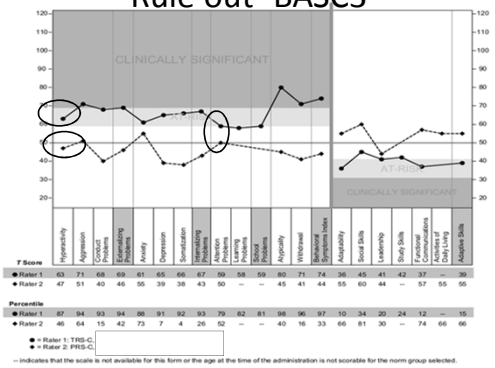
Teacher BRIEF2 Inhibit Score

Cutoff Score	Sensitivity	Specificity	Accuracy	PPP	NPP
60	0.65	0.7	67	0.68	0.67
63	0.62	0.81	72	0.77	0.68
65	0.59	0.82	71	0.77	0.67
67	0.55	0.85	70	0.79	0.65
70	0.51	0.88	70	0.81	0.64

- Teacher: there is a >80% chance that Sam would be diagnosed with ADHD-C
- Parent: there is a >90% chance that Sam should not be diagnosed with any ADHD

Now what?

Rule out- BASC3



Summary

Taken together, the present findings suggest that Sam is a sweet little boy who wishes to do well and likely has broadly average overall cognitive functioning. He does not understand language well even in conversation and this is likely exacerbated with academic language. When he is required to listen he tends to distract himself and becomes increasingly impulsive and dysregulated. Sam is at significant risk for self-regulatory difficulties, and these may be diagnosed as ADHD-combined type at some point, though it is difficult to entirely discern at this point given the difference between home and school functioning and the influence of language deficits.

Cautions

- These statistics are tools to help you estimate the likelihood of ADHD subtype diagnosis.
- Reporting the actual likelihood may be misunderstood by parents or others not familiar with EBA.
- E.g., Telling a parent that your child is 97% likely to have ADHD-C may overstate the case.

Cautions

- Many students are referred for possible ADHD. It is essential to both rule in symptoms and rule out other problems that look like ADHD.
- A combination of history, observations and formal test performance is needed

EF interventions

- Remedial interventions- train the function directly
  - e.g., WM training
  - Inhibition training?
- Compensatory- accommodate the function
  - Add auditory & visual inputs to reduce WM demand
  - Increase structure to reduce EF demand
  - Collaborative Problem-solving interventions

Knoors & Marschark, 2015

Interventions: General Findings

REVIEW

Interventions Shown to Aid Executive Function Development in Children 4 to 12 Years Old

Adele Diamond[1*] and Kathleen Lee[1]

Diamond, A. & Lee, K. (2011) Science, 333

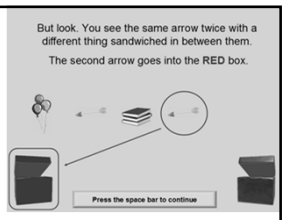
www.devcogneuro.com

Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not

Adele Diamond *, Daphne S. Ling

Developmental Cognitive Neuroscience 18 (2016) 34–48

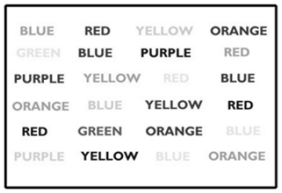
Working Memory Training



- Most studied intervention
- Narrow Transfer: Gains do not generalize beyond WM
- Some evidence of gains in classroom
- Gains maintained at six months
- Gains more limited at 1 year

Inhibition Training

- More limited success
- No evidence of transfer beyond computer



Aerobics?

- People who are more physically active and fit have better executive functions
- Meta-analyses of aerobic exercise alone in older adults showed little to no EF benefits
- 2 of 3 studies in children found little to no EF change

Martial Arts Executive Training?

Martial arts training *with mindfulness* associated with improved attention, emotion regulation, and behavior regulation vs regular PE

Yoga with *mindfulness* resulted in better EF

Tools of the Mind

- Preschool curriculum based on Vygotsky's notions of development
- Pretend play requires inhibition, flexibility, and working memory
- Children involved in Tools program showed better performance on range of EF tasks

- When "Tools" was used as an add-on, gains were limited and narrow
- When incorporated across the school day, gains were much larger and replicated
- BUT children with no EF risks showed minimal gains
- Children with low SES showed marked gains
  - Blair & Raver, 2014; Diamond et al., 2007

Take Aways:

- Direct EF training may improve an EF skill in isolation but transfer is narrow
- How an EF activity is presented is as important as the activity (i.e., coaching or mentoring)
- EF's need to be continually challenged
- Those with problems benefit more
- Training across the curriculum has greater benefit

EF Intervention

General Principles

- Teach goal-directed problem-solving process,
- within everyday meaningful routines,
- having real-world relevance and application,
- using key people as models & "coaches"

Based on the work of Mark Ylvisaker & Tim Feeney

Goal-Plan-Do-Review

GOAL

What do I want to accomplish?

PLAN

How am I going to accomplish my goal?

MATERIALS/ EQUIPMENT	STEPS/ASSIGNMENTS
1.	1.
2.	2.

PREDICTION: HOW WELL WILL I DO?

Self rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Other Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

How much will I get done?

DO

PROBLEMS	SOLUTIONS
1.	1.
2.	2.
3.	3.

REVIEW: HOW DID I DO?

Self rating	1	2	3	4	5	6	7	8	9	10
Other rating	1	2	3	4	5	6	7	8	9	10

WHAT WORKED?	WHAT DIDN'T WORK
1.	1.
2.	2.

WHAT WILL I TRY NEXT TIME?

COACHING

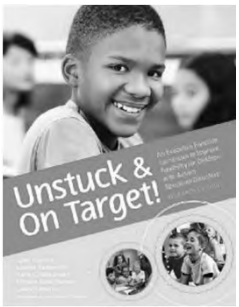
Intervention strategy in which a "coach" (adult or peer) works with a student to set goals (long-term, short-term, daily) designed to enhance executive skills and lead to improved self-regulation.

Dawson, P. Guare, R. (2012). Coaching Students with Executive Skills Deficits, Guilford Press

Key Components of Coaching

- Goal-setting (long, short-term)
- Correspondence training
- Coach in daily goal-oriented plans
- Teach students self-management

Real-World Collaborative Problem-Solving Intervention for EF in ASD



Lauren Kenworthy & Laura Anthony, Children's National

Unstuck Philosophy: Principles of Remediation

1. Teach by Doing—Coaching Model: Support, Fade, Generalize
2. Talk Less—Self-regulatory scripts
3. Be consistent
4. Provide visual cues
5. Collaborate, use humor, have fun

Ylvisaker & Feeny, 1998; Feeny & Ylvisaker, 2008

Unstuck and On Target!

Introduction	• Guide to Using This Manual
Topic 1	• The Meaning of Flexibility
Topic 2	• Cognitive Flexibility Defined
Topic 3	• Coping Strategies
Topic 4	• Personal Heroes
Topic 5	• Why Be Flexible?
Topic 6	• Your Goals: Getting What You Want
Topic 7	• Scripts for How to Be Flexible
Topic 8	• Journey to Target Island
Topic 9	• Being Flexible Makes You a Good Friend
Topic 10	• Flexible Futures

Flexible	• Flexible is stronger • If I am flexible, more good things happen for me
Unstuck	• I'm getting stuck on ___, how can I get unstuck?
Compromise	• Let's compromise so we both get some of what we want
Whim/On Target	• Is this a whim, or are we on target? • What is our target goal?
Plan A/Plan B	• What is our plan? • What is our Plan B?
Big Deal/Little Deal	• Is this a big deal or a little deal? • How can we make this big deal into a little deal?
Choice/No Choice	• Do we have a choice about this? • Is this a no choice situation?

Flexible	• Flexible is stronger • If I am flexible, more good things happen for me
Unstuck	• I'm getting stuck on ___, how can I get unstuck?
Compromise	• Let's compromise so we both get some of what we want
Whim/On Target	• Is this a whim, or are we on target? • What is our target goal?
Plan A/Plan B	• What is our plan? • What is our Plan B?
Big Deal/Little Deal	• Is this a big deal or a little deal? • How can we make this big deal into a little deal?
Choice/No Choice	• Do we have a choice about this? • Is this a no choice situation?

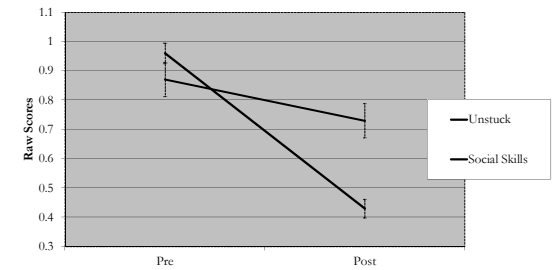
Goal	What do we want to do?
Plan	How will we do it?
Do	Let's try our plan
Check	How did it work?

"Real World," Well-Matched Methods

- 67 3rd-5th grade children in 14 schools randomized
- Children met full criteria for diagnosis and were already receiving services
- Existing school staff led interventions
- Interventions matched on number of sessions (28) and training:
  - Interventionists: Manual, 7 training sessions, 2 fidelity observations with feedback
  - Parents: Manual, 2 training sessions, visual supports
  - Mainstream Teachers: 1 training session, visual supports

Mean Challenge Task Flexibility

Higher score = Less flexible

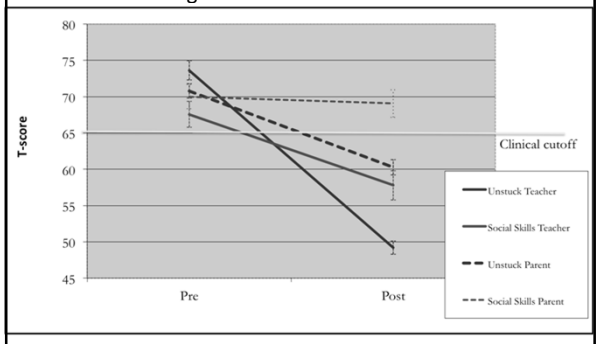


Cohens *d*=-0.72

Kenworthy & Anthony et al, 2014

Parent & Teacher BRIEF Shift

Higher score = Less flexible



Parent Cohen's *d*=-0.64; Teacher Cohen's *d*=-0.89

Review

- Executive functions are highly predictive of near and long-term outcomes
- We *can* improve executive functions
- A coaching model across the curriculum may be most effective
- Develop / Add specific programs to address particular deficits

Peter.Isquith@QPsych.com