Executive Function in the Everyday Context: The Evidence for Screening, Assessment, Intervention and Progress Monitoring

Gerard A. Gioia, PhD
Chief, Division of Pediatric Neuropsychology
Children’s National Health System
Professor, Dept. of Pediatrics and Psychiatry & Behavioral Sciences
George Washington University
School of Medicine

Objectives
The learner will:
(1) explain the nature of the executive functions and the associated pros and cons of performance-based and rating scale measures;
(2) discuss an screening and assessment approach to identifying executive dysfunction in various clinical scenarios;
(3) describe the process of targeted executive function intervention planning, and monitoring progress.
(4) Articulate the challenges that students with concussions face in their return to school, including the executive functions.

 Disclosure Statement
Psychological Assessment Resources, Inc.
– Test Author (royalties)
  • Behavior Rating Inventory of Executive Function (BRIEF)
  • Tasks of Executive Control (TEC)
Many other tests & measures (no royalties)
  • Acute Concussion Evaluation (ACE) – office, ED
  Acute Concussion Care Plan; Home/School Instructions
  • Post-Concussion Symptom Inventory (PCSI) 5-7, 8-12, 13-18; Parent
  • BRIEF – Concussion Monitoring – Parent, Self-Report
  • Children’s Exertional Effects Rating Scale (ChEERS)
  • Concussion Learning Assessment & School Survey (CLASS) – Parent, Self-Report
  • Progressive Activities of Controlled Exertion (PACE) – Self Efficacy (Child, Parent)
  • Multimodal Assessment of Cognition & Symptoms (MACS)
  • Concussion Recognition & Response (CRR) – Parent/Coach app
  • Concussion Assessment & Response (CARE) – Medical app

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 pertinaciously obstinate yet capricious and vacillating. His friends and acquaintances said he was no longer Gage”

Inhibit  Shift  Emotional Control

Overview
• Introduction to Executive Function
• Assessment of Executive Function
• A Brief History of the BRIEF
• What’s new in the BRIEF2
• Evidence-Based Interpretation
• Intervening in executive function problems
• Monitoring the executive functions

Harlow, 1868
Behavior is in the Brain

Why Are Executive Functions Important?

Questionnaire Use Among Nordic Neuropsychologists: Shift From Assessing Personality to Checking Ecological Validity of Neuropsychological Assessments?

Associations between teacher ratings on the BRIEF-P at 4 years and performance on WJ3 Math Fluency at 6 years

Early executive functions are predictive of later academic skill (math) development.

What Specific Facets of Executive Function Are Associated with Academic Functioning in Youth with Attention-Deficit/Hyperactivity Disorder?

Executive Functioning and Non-Verbal Intelligence as Predictors of Bullying in Early Elementary School

In conclusion, our study showed that peer interactions may be to some extent influenced by children’s executive function and non-verbal intelligence.

The EF Planning and Organization subscale as rated by both parents and teachers predicted school grades above and beyond symptoms of ADHD and relevant covariates (achievement, IQ). Parent ratings of youth’s ability to transition effectively between tasks/situations (Shift) also predicted school grades.
Better maternal self-regulation was associated with lower infant negative emotionality (NE) broadly, as well as lower infant sadness and distress...and better falling reactivity (i.e., emotion regulation), specifically. Maternal self-regulation also predicted less chaotic home environments and better maternal inter-parental relationship adjustments.

Infant Behavior & Development 38 (2013) 534-547

Parenting stress was significantly associated with both performance-based and parent measures of child executive functioning. Child executive functioning significantly predicted stress even after controlling for socio-demographic and clinical factors, and the final model accounted for 42% in parent stress levels.

Psycho-Oncology 22: 1774-1782 (2013)

Multi-level modeling results found that deficits in shifting, inhibition, emotional control, planning/organizing, monitoring and initiating all predicted higher average obsessive compulsive severity across treatment. Interestingly, out of the eight domains of EF investigated, only emotional control moderated treatment outcome....


Better self-reported executive functioning and mood were significant independent predictors of higher social functioning, even in a sample of healthy adults.

JOURNAL OF CLINICAL AND EXPERIMENTAL NEUROPSYCHOLOGY
NOV 30, 2017 VOL. 39 NO. 5
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 & Wecker
In Meltzer (2007) Executive Function in Education

What is executive function?

What are executive functions?

The unity and diversity of executive functions
Teuber, 1972

Executive Function Deficits in Daily Life Prospectively Predict Increases in Depressive Symptoms
Alison M. Lettieri, Gregory A. Miller, Laura D. Crocker, Stacy L. Warren, Zachary P. Infante, and Katherine J. Mimnaugh

Use of the Behavior Rating Inventory of Executive Function and Child Behavior Checklist in Ugandan Children With HIV or a History of Severe Malaria
Rexel Familiar, MD, PhD; Horacio Rutangisiro-Sinduza, MD, MSc; Bruno Gaudrain, PhD; Paul Jungnitsch, PhD; Noeline Nakanjako, PhD; Robert Opoka, MPH; and Michael Bozin, PhD

Abstract
Objective: To assess the inter-rater reliability and concurrent validity of the Behavior Rating Inventory of Executive Function (BRIEF) and Child Behavior Checklist (CBCL) among children in Uganda. Method: The BRIEF ratings for the BRIEF and CBCL were obtained for 18 independent samples of school-aged children (5-11 years old, 100% male) with a history of severe malaria and/or HIV-infected children (5-11 years old, 100% male) in Uganda. Exploratory factor analysis was used to evaluate the factor structure of the 4 scales of the BRIEF and the 4 scales of the CBCL to determine prediction. Results: Overall, children in the severe malaria group had higher (mean score) BRIEF and CBCL scores than those in the HIV-infected group. Two factors that appeared reasonable to the data and could be characterized as 3 independent domains were identified: (1) Meta-cognition, which consisted of the scales in the BRIEF meta-cognition domain and the Externalizing Symptoms scale in the CBCL; and (2) Behavioral Adjustment, which comprised of the scales in the BRIEF Behavioral Regulation domain and the Internalizing Symptoms Scale in the CBCL. The BRIEF behavior, Regulation and CBCL Externalizing Symptoms scales, however, did overlap in terms of assessing similar behavior symptoms. These findings were consistent across the severe malaria and HIV-infected samples of children. Conclusion: The BRIEF and CBCL instruments offer distinct, yet complementary, assessments of behavior in clinical pediatric populations in the Ugandan context, supporting the use of these measures for future research settings.

Behavioural ratings of self-regulatory mechanisms and driving behaviour after an acquired brain injury
Per-Ola Nils1, Pål Ulfberg2, Maria T. Schulte3, Anna Lundqvist3, & Anne-Kristine Scharle1,2

Objective: To explore whether self-regulatory mechanisms and cognitions predict driving behavior after an acquired brain injury (ABI).

Methods: A 12-month, longitudinal, prospective study was conducted with a convenience sample of people with ABI (n = 109) who were involved in a road traffic accident.

Results: The participants who survived the MDA were less likely to return to driving.

Conclusion: Executive Self-regulation can be associated with driving behavior. May be important factor to consider in driving assessment.
Approaches to defining Executive Functions

- Evolutionary purpose - allow organism to engage in goal oriented problem-solving
- Neuroanatomy - frontal lobe function
- Neurocognitive processes - what tests test
- Complex skills - what we observe (inhibit, shift, working memory, plan, organize, monitor)

Suchy, Y. 2009

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.”


Neurocognitive Processes

Miyake, Friedman, Emerson, Witzki, Howarter & Wagner; 2000

Complex Skills: Executive function 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
“There is no unitary executive function.”

“EF is an umbrella term encompassing distinct, but interrelated, abilities that contribute to management of goal-directed behaviors.”
Gioia, Isquith, Guy & Kenworthy, 2000

“Both the unity and diversity of executive functions need to be taken into account in developing a theory of executive functions.”
Miyake et al., 2000

Two Levels of Executive Function Definitions

Unity: Evolutionary purpose - allow organism to engage in goal oriented problem-solving

Diversity:
- Neuroanatomy: frontal lobe function
- Neurocognitive processes: what tests test
- Complex skills: what we observe (inhibit, shift, working memory, plan, organize, monitor)

Individual differences in executive functions:
1. Show unity and diversity - are related yet separable
2. Reflect substantial genetic contributions
3. Are related to clinically & societally important phenomena
4. Show some developmental stability

Executive control is
“The orchestration of basic cognitive processes during goal oriented problem solving”

in Cognitive Psychology
Ulric Neisser, 1967
**Functions of the “Conductor”**
- Inhibit
- Self-Monitor
- Shift Flexibly
- Modulate Emotions
- Initiate
- Working Memory
- Plan
- Organize
- Task-Monitor

**Functions of the “Orchestra”**
- Perception
- Attention
- Language processes
- Visual-spatial processes
- Memory
- Sensory inputs
- Motor outputs
- Knowledge & Skills
  - Social
  - Academic

---

**Methods of Assessing EF**

<table>
<thead>
<tr>
<th>Micro</th>
<th>Molar</th>
<th>Macro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetics</td>
<td>Structural Imaging</td>
<td>Functional Imaging</td>
</tr>
</tbody>
</table>

**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

---

**Color-Word (Stroop) Interference Test**

**The Rey-Osterrieth Complex Figure**
10 year-old boy with ADHD-C

10 year old with ADHD-I

8 year-old boy with Asperger's

Verbal Fluency

Tower of London 6 Move
Advantages of EF Performance Tests:

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

Limitations to Performance Tests:

Performance tests tap individual components of executive function over a short time frame and not the integrated, multidimensional, relativistic, priority-based decision-making that is often demanded in real world situations

(Goldberg & Podell, 2000)

“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 need for:

- external validation, ecological validity for test data
- Standardized information about everyday executive function
- Efficient collection of parent / teacher/ self observations
- assess multiple aspects of executive functions
- Time & cost efficiency

What’s in a name

- Children’s Behavior Questionnaire (CBQ)
- Executive Function Questionnaire (EFQ)
- Developmental Executive Function Test (DEFT)
- Behavioral Evaluation of Executive Function (BEEF)
- Behavioral Assessment of Regulatory Function (BARF)
- Planning and Organization Rating Questionnaire (PORQ)
- Behavioral Evaluation of Executive Regulation (BEER)
- Behavior Rating Inventory of Executive Function (BRIEF)
**A BRIEF History**

- 2003
- 2000
- 2004
- 2005

**Since publication:**

- Expanded to cover ages 2-90 years
- More than 800 peer-reviewed publications
- More than 40 clinical trials and outcome studies
- Translated into more than 60 languages
- Used on 6 continents

---

**Parent Ratings on BRIEF Scales in ADHD**

- **BRIEF**
- **BDEFS**
- **DREF**
- **CEFI**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ages</td>
<td>2-90</td>
<td>5-81</td>
<td>5-18</td>
</tr>
<tr>
<td>Forms</td>
<td>PTS</td>
<td>P</td>
<td>PT</td>
</tr>
<tr>
<td>Scales</td>
<td>9</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Languages</td>
<td>&gt;60</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Peer-Reviewed</td>
<td>926</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>Empirical Studies</td>
<td>838</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Clinical Trials</td>
<td>56</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>INS Papers 2016-17</td>
<td>62</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: CEFI re-scored as T scores with M=50±10 to match BRIEF scores
*From CEFI Manual; **From Gioia et al., 2002 Profiles of Everyday Executive Function

---

**Parent Ratings on BRIEF in ASD**

- **BRIEF**
- **BDEFS**
- **DREF**
- **CEFI**

**At a Glance**

- **Ages:** 5-18 years
- **Administration time:** 5 minutes Screening, 10 minutes full
- **Parent, Teacher, Self-Report Forms:** Paper & pencil, iConnect

*From CEFI Manual; **From Gioia et al., 2002 Profiles of Everyday Executive Function*
Enhancements in the BRIEF2

Standardization
- 1400 Parents
- 1400 Teachers
- 800 Students
- Even across age groups
- Stratified by gender, ethnicity, parent education, geographic region
- No meaningful effects of ethnicity, parent education, or geographic region

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

More concise scales
Shorter by a Quarter

<table>
<thead>
<tr>
<th>Scale</th>
<th>BRIEF</th>
<th></th>
<th>Parent</th>
<th>Teacher</th>
<th>Self-Report</th>
<th>Parent</th>
<th>Teacher</th>
<th>Self-Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhibit</td>
<td>10</td>
<td>10</td>
<td>13</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Self-Monitor</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Shift</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Effort</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Inattention</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Task Completion</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Working Memory</td>
<td>10</td>
<td>10</td>
<td>12</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Plan/Organize</td>
<td>12</td>
<td>10</td>
<td>13</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Task Monitor</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Organization of Materials</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Monitor</td>
<td>8</td>
<td>10</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Additional Clinical Items</td>
<td>14</td>
<td>13</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Infrequency</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>96</td>
<td>80</td>
<td>69</td>
<td>63</td>
<td>69</td>
<td>63</td>
<td>63</td>
</tr>
</tbody>
</table>

Multiple Raters on Protocol Summary
Parallelism in item content

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhibit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (P/T)</td>
<td>Is fidgety</td>
<td>--</td>
<td>Never</td>
</tr>
<tr>
<td>1 (SR)</td>
<td>I have trouble sitting still</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>10 (P/T)</td>
<td>Does not think before doing (is impulsive)</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>10 (SR)</td>
<td>I am impulsive (I don’t think before doing)</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>16 (P/T)</td>
<td>Gets out of control more than friends</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>16 (SR)</td>
<td>I get out of control more than my friends</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>24 (P/T)</td>
<td>Talks at the wrong time</td>
<td>Never</td>
<td>Never</td>
</tr>
<tr>
<td>24 (SR)</td>
<td>I talk at the wrong time</td>
<td>Never</td>
<td>Never</td>
</tr>
<tr>
<td>30 (P/T)</td>
<td>Gets out of seat at the wrong times</td>
<td>Never</td>
<td>Never</td>
</tr>
<tr>
<td>30 (SR)</td>
<td>I have problems waiting my turn</td>
<td>Never</td>
<td>Never</td>
</tr>
<tr>
<td>39 (P/T)</td>
<td>Acts too wild or “out of control”</td>
<td>Sometimes</td>
<td>Never</td>
</tr>
<tr>
<td>39 (SR)</td>
<td>I interrupt others</td>
<td>Never</td>
<td></td>
</tr>
</tbody>
</table>

Increased sensitivity

- Items were selected for maximum performance in more than 6,000 clinical cases
- Increased sensitivity to executive function problems in clinical groups, such as attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorders (ASD)

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

Lisa A. Jacobson, Alison E. Pritchard, Taylor A. Koritsiani, Kelly E. Jones, and E. Mark Mahone

<table>
<thead>
<tr>
<th>Table 4. Classification Accuracy Measures for Discriminating Between Groups With Selected Scales at T ≥ 70.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any ADHD symptoms vs. non-ADHD</td>
</tr>
<tr>
<td>IA only vs. H only</td>
</tr>
<tr>
<td>T ≥ 70</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Inhibit</td>
</tr>
<tr>
<td>NHT</td>
</tr>
<tr>
<td>Org</td>
</tr>
<tr>
<td>SEC</td>
</tr>
</tbody>
</table>

n = 1969 clinically referred 5-18 year-olds
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 from 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

New to the BRIEF2

Infrequency scale
Infrequency scale helps identify unusual responding

<table>
<thead>
<tr>
<th>Parent Form</th>
<th>Teacher Form</th>
<th>Self-Report Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forgets his/her name</td>
<td>Forgets his/her name</td>
<td>I forget my name</td>
</tr>
<tr>
<td>Has trouble counting to three</td>
<td>Has trouble counting to three</td>
<td>I have trouble counting to three</td>
</tr>
<tr>
<td>Cannot find the front door of home</td>
<td>Cannot find the front door of school</td>
<td>I cannot find the front door of my home</td>
</tr>
</tbody>
</table>

Screening Forms

12-item Screening Parent, Teacher and Self-Report Forms quickly indicate whether further assessment is needed

Correlate with GEC > 93

New statistics that support interpretation

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

Base rates – standardization sample

| BRIEF2 Parent Form Base Rates of Elevated T Scores for the Standardization Sample |
|-----------------------------|---------------------|---------------------|---------------------|
| Scale/Index/composite       | ≥70                 | ≥65                 | ≥60                 |
| Behavior Regulation Index   | 5                   | 10                  | 17                  |
| Emotional Control           | 6                   | 10                  | 19                  |
| Inhibition                  | 5                   | 10                  | 17                  |
| Emotional Regulation Index  | 5                   | 10                  | 17                  |
| Working Memory              | 5                   | 10                  | 16                  |
| Attention                   | 4                   | 8                   | 16                  |
| Organization of Materials   | 4                   | 8                   | 16                  |
| Global Executive Composite  | 6                   | 11                  | 17                  |

N = 1,400
Base rates – clinical samples

<table>
<thead>
<tr>
<th>Clinical Group</th>
<th>ADHD-Combined</th>
<th>ADHD/Learning Disability</th>
<th>TBI</th>
<th>ADHD-Inattentive</th>
<th>ASD</th>
<th>Epilepsy</th>
<th>ADHD-Subtypes</th>
<th>Neurofibromatosis type 1</th>
<th>Diabetes</th>
<th>Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADHD-Combined</td>
<td>ADHD/Learning Disability</td>
<td>TBI</td>
<td>ADHD-Inattentive</td>
<td>ASD</td>
<td>Epilepsy</td>
<td>ADHD-Subtypes</td>
<td>Neurofibromatosis type 1</td>
<td>Diabetes</td>
<td>Anxiety</td>
<td></td>
</tr>
<tr>
<td>ADHD-Combined</td>
<td>ADHD/Learning Disability</td>
<td>TBI</td>
<td>ADHD-Inattentive</td>
<td>ASD</td>
<td>Epilepsy</td>
<td>ADHD-Subtypes</td>
<td>Neurofibromatosis type 1</td>
<td>Diabetes</td>
<td>Anxiety</td>
<td></td>
</tr>
</tbody>
</table>

Inter-rater agreement metrics

<table>
<thead>
<tr>
<th>BRIEF2 Index Composite</th>
<th>Percentages of the Combined Clinical Sample That Obtained Various T-Score Differences Between BRIEF2 Parent and Teacher Forms for Index and GEC Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-score difference</td>
<td>BRIEF2 Index Composite</td>
</tr>
<tr>
<td>Parent more than 30 T-score points &gt; Teacher</td>
<td>7</td>
</tr>
<tr>
<td>Parent 10-20 T-score points &gt; Teacher</td>
<td>17.7</td>
</tr>
<tr>
<td>Parent and Teacher within 10 T-score points</td>
<td>54.6</td>
</tr>
<tr>
<td>Parent 10-20 T-score points &lt; Teacher</td>
<td>12.1</td>
</tr>
<tr>
<td>Parent more than 20 T-score points &lt; Teacher</td>
<td>8.1</td>
</tr>
</tbody>
</table>

Reliable change

<table>
<thead>
<tr>
<th>BRIEF2 Parent Form Reliable Change Scores by Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale/Composite</td>
</tr>
<tr>
<td>Inhibit</td>
</tr>
<tr>
<td>ADHD memory</td>
</tr>
<tr>
<td>Emotional Control</td>
</tr>
<tr>
<td>Emotion Regulation Index</td>
</tr>
<tr>
<td>Initiate</td>
</tr>
<tr>
<td>Working Memory</td>
</tr>
<tr>
<td>Plan/organize</td>
</tr>
<tr>
<td>Task Monitor</td>
</tr>
<tr>
<td>Organization of Materials</td>
</tr>
<tr>
<td>Cognitive Regulation Index</td>
</tr>
<tr>
<td>Global Executive Composite</td>
</tr>
</tbody>
</table>

Evidence-Based Interpretation

Using statistics/psychometrics to benefit your clinical decision-making Following a systematic method

BRIEF2 interpretation

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Example statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review validity scales</td>
<td>Ratings on the BRIEF2 were valid</td>
</tr>
<tr>
<td>Compare to base rates</td>
<td>Elevations of this magnitude on the Inhibit and Working Memory scales occur in less than 10% of students his age.</td>
</tr>
</tbody>
</table>
Jeremy: 7 year-old boy with ADHD-C

- Impulsivity, hyperactivity, inattention identified by kindergarten with impact on academic functioning but not skills
- Pediatrician administered BRIEF2 Screening
- Parent (23) and teacher (20) scores indicated high risk for EF problems

Jeremy is a 7-year-old boy with a history of impulsivity, hyperactivity, and inattention first identified in kindergarten with impact on academic functioning despite good skills.

Parent ratings on the BRIEF2 Screening Form were at the 87th percentile. Students with scores at this level are four times more likely to have actual executive function problems than to be mistakenly identified.
Assess to rule-out other problems and observe / evaluate EF

- Average verbal/nonverbal functioning but below average PS and WM
- Academic skills average or better
- Fine motor mild weakness
- Deficits in sustained attention, vigilance, speed on continuous performance test

<table>
<thead>
<tr>
<th>BRIEF2 interpretation</th>
<th>Baseline assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale/index/composite</td>
<td>Parent Form</td>
</tr>
<tr>
<td>Raw score</td>
<td>t score</td>
</tr>
<tr>
<td>Inhibit</td>
<td>23</td>
</tr>
<tr>
<td>Self Monitor</td>
<td>11</td>
</tr>
<tr>
<td>BRI</td>
<td>34</td>
</tr>
<tr>
<td>Shift</td>
<td>14</td>
</tr>
<tr>
<td>Emotional Control</td>
<td>19</td>
</tr>
<tr>
<td>FRI</td>
<td>33</td>
</tr>
<tr>
<td>Initiate</td>
<td>11</td>
</tr>
<tr>
<td>Working Memory</td>
<td>21</td>
</tr>
<tr>
<td>Plan/Organize</td>
<td>20</td>
</tr>
<tr>
<td>Task Monitor</td>
<td>13</td>
</tr>
<tr>
<td>Organization of Materials</td>
<td>14</td>
</tr>
<tr>
<td>CBI</td>
<td>79</td>
</tr>
<tr>
<td>GEC</td>
<td>146</td>
</tr>
</tbody>
</table>

- Parent and teacher ratings on the BRIEF2 were valid.
- Significant elevations were seen on scales reflecting difficulties with inhibiting impulses, monitoring social interactions, and sustaining working memory.
- Jeremy was also described as having difficulty regulating emotions, and initiating, planning and organizing his work.
- Scores at this level occur in approximately 5% of typically developing students
• Students with Working Memory scores \( \geq 65 \) are over 7 times more likely to be correctly identified as a child with ADHD than incorrectly identified.

• Students in this group with Inhibit scores \( \geq 70 \) are 2-5 times more likely to be accurately identified as having ADHD-C than to be over-identified.

OR

• The pattern is like that seen in students diagnosed with ADHD-C.

---

**Table 1.1**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Parent Form</th>
<th>Teacher Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Memory</td>
<td>23 77 24 78</td>
<td>23 77 24 78</td>
</tr>
<tr>
<td>Inhibit</td>
<td>11 74 14 72</td>
<td>11 74 14 72</td>
</tr>
<tr>
<td>Self-Monitor</td>
<td>19 69 15 69</td>
<td>19 69 15 69</td>
</tr>
<tr>
<td>Emotional Control</td>
<td>13 65 26 62</td>
<td>13 65 26 62</td>
</tr>
<tr>
<td>Inhibit</td>
<td>11 63 11 68</td>
<td>11 63 11 68</td>
</tr>
<tr>
<td>Working Memory</td>
<td>21 72 22 74</td>
<td>21 72 22 74</td>
</tr>
<tr>
<td>Peer-Challenge</td>
<td>20 68 17 62</td>
<td>20 68 17 62</td>
</tr>
<tr>
<td>Task-Monitor</td>
<td>13 65 15 63</td>
<td>13 65 15 63</td>
</tr>
<tr>
<td>Organization of Materials</td>
<td>14 63 11 65</td>
<td>14 63 11 65</td>
</tr>
<tr>
<td>CR</td>
<td>79 68 76 76</td>
<td>79 68 76 76</td>
</tr>
<tr>
<td>GEC</td>
<td>198 75 142 72</td>
<td>198 75 142 72</td>
</tr>
</tbody>
</table>

---

**BRIEF2 interpretation (continued)**

**Procedure**

**Example statements**

The pattern is like that seen in students diagnosed with attention disorders.

Teacher and parent ratings were in good agreement. Teacher ratings revealed a similar pattern of concerns with inhibitory control and working memory but also suggested problems with self-monitoring in the social setting.

Ratings over time showed a significant decrease in behavior regulation concerns, but while there was some decrease in emotion and cognitive regulation scores, the change was not beyond that expected within an 80% confidence interval.

---

**Teacher and parent ratings were in good agreement.**

---

**Percentages of the Combined Clinical Sample That Obtained Various T-Score Differences Between BRIEF2 Parent and Teacher Forms for Index and GEC Scores**

<table>
<thead>
<tr>
<th>T-score difference</th>
<th>BRIEF2 Index composite</th>
<th>CR</th>
<th>GEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent more than 2T-score points &gt; Teacher</td>
<td>7.5 12.5 6.3 9.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent 10-20 T-score points &gt; Teacher</td>
<td>17.7 18.4 17.9 19.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent and Teacher within a 10 T-score points</td>
<td>54.6 53.0 58.0 52.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent 10-20 T-score points &lt; Teacher</td>
<td>12.1 10.8 10.2 9.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent more than 20 T-score points &gt; Teacher</td>
<td>8.1 5.2 3.7 4.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: T-score is 1.25 SD, GEC = Global Executive Composite, BRI = Behavior Regulation Index, CR = Emotion Regulation Index, BRI = Cognitive Regulation Index.*
**BRIEF2 interpretation (continued)**

**Procedure** | **Example statements**
---|---
Review profile | The pattern is like that seen in students diagnosed with attention disorders.
Examine inter-rater agreement | Teacher and parent ratings were in good agreement. Teacher ratings revealed a similar pattern of concerns with inhibitory control and working memory but also suggested problems with self-monitoring in the social setting.
Examine Reliable Change Scores | Ratings over time showed a significant decrease in behavior regulation concerns, but while there was some decrease in emotion and cognitive regulation scores, the change was not beyond that expected within an 80% confidence interval.

**Repeat ratings after a 3 week medication trial (Progress Monitoring)**

- Repeat assessment with the BRIEF2 after a 3 week trial of intervention resulted in marked improvements in behavior regulation and working memory, with significant decreases on Parent and Teacher BRI and Working Memory scales, both beyond the 99th percentile (p<.01) for reliable change.

**Clinical Profiles: ADHD**
Validity of the EF Theory of ADHD

- 83 Studies
- 3734 ADHD vs 2969 Controls
- Effects .43 - .69
- No subtype differences
- BUT < ½ in ADHD showed impairment on any EF tasks

Wilcutt, Doyle, Nigg, Faraone & Pennington, 2005

Profiles of Everyday Executive Function in Acquired and Developmental Disorders

- 34 Reading Disorder
- 27 ADHD-I
- 26 ADHD-C
- 54 ASD
- 33 Moderate TBI
- 34 Severe TBI
- 208 Controls

BRIEF-2 WM & Inhibit Predict ADHD

Parent Form Profile Analysis
Clinical Profiles: ASD

Classification Accuracy of BRIEF-2 in ASD

<table>
<thead>
<tr>
<th>Classification Measure</th>
<th>Parent</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.73</td>
<td>0.63</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.93</td>
<td>0.94</td>
</tr>
<tr>
<td>PPV</td>
<td>0.91</td>
<td>0.93</td>
</tr>
<tr>
<td>NPV</td>
<td>0.77</td>
<td>0.67</td>
</tr>
<tr>
<td>Likelihood Ratio +</td>
<td>10.61</td>
<td>13.9</td>
</tr>
<tr>
<td>Likelihood Ratio -</td>
<td>0.29</td>
<td>0.49</td>
</tr>
<tr>
<td>Correct Hit Rate %</td>
<td>83.02%</td>
<td>74.62%</td>
</tr>
</tbody>
</table>

Updated BRIEF Profiles in Children with Autism Spectrum Disorders
Parent ratings more sensitive than performance tests

It is important to note that parent report of EF revealed considerably more differences in the performance of the HFA group as compared to the other two groups, than did direct testing of EF. This discrepancy may indicate that individuals with HFA are able to demonstrate age-appropriate EF tasks under optimal testing conditions, but show difficulty with these activities in everyday situations. This discrepancy may also reflect parental bias, in that parents of individuals with ASDs may over- or under-report current symptoms relative to their prior functioning. This study would have benefited from the inclusion of a teacher’s rating on the BRIEF in order to limit parental bias and to assess EF in school settings.

Clinical Profiles: TBI

Neurobehavioral Measures in 10 Children with TBI at 12 Months post injury

<table>
<thead>
<tr>
<th>Measure</th>
<th>TBI, mean (SD)</th>
<th>OC, mean (SD)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMS Verbal</td>
<td>90.9 (14.3)</td>
<td>85.7 (13.9)</td>
<td>NS</td>
</tr>
<tr>
<td>WMS Nonverbal</td>
<td>95.5 (15.5)</td>
<td>104.3 (19.6)</td>
<td>NS</td>
</tr>
<tr>
<td>WMS Spald</td>
<td>91.4 (21.9)</td>
<td>101.2 (10.3)</td>
<td>NS</td>
</tr>
<tr>
<td>WMS General Cognitive Ability</td>
<td>94.5 (17.6)</td>
<td>101.1 (16.4)</td>
<td>NS</td>
</tr>
<tr>
<td>Executive Functioning</td>
<td>93.0 (18.6)</td>
<td>103.2 (13.1)</td>
<td>NS</td>
</tr>
<tr>
<td>WJ Letter Word Identification</td>
<td>90.7 (15.3)</td>
<td>107.1 (11.5)</td>
<td>NS</td>
</tr>
<tr>
<td>WJ Applied Problems</td>
<td>90.2 (15.6)</td>
<td>104.7 (12.4)</td>
<td>NS</td>
</tr>
<tr>
<td>WJ Spatial</td>
<td>93.6 (18.3)</td>
<td>101.0 (18.1)</td>
<td>NS</td>
</tr>
<tr>
<td>CSS, Prognosis</td>
<td>87.2 (18.1)</td>
<td>100.0 (17.7)</td>
<td>NS</td>
</tr>
<tr>
<td>BRIEF Emotional</td>
<td>57.1 (10.4)</td>
<td>64.0 (7.6)</td>
<td>0.01</td>
</tr>
<tr>
<td>BRIEF Global Executive Composite</td>
<td>48.1 (10.1)</td>
<td>59.9 (11.3)</td>
<td>0.04</td>
</tr>
<tr>
<td>Social Competence</td>
<td>44.4 (14.6)</td>
<td>54.9 (9.6)</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Neuroimaging Studies

**Neuroimaging Correlates of BRIEF Working Memory Scale in Typically Developing Children (n = 35)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**Diffuse Cortical Thinning Correlated with BRIEF Working Memory in Pediatric TBI**

- WM correlated with:
  - Inferior temporal
  - Left fusiform
  - Superior parietal
  - Inferior Parietal


**Executive Function and DTI in Pediatric TBI**

- Examined Fractional Anisotropy (FA) in 14 children with mild-moderate TBI vs Controls
- Higher FA = better white matter organization
- Three regions: Inferior frontal, superior frontal, supracallosal
- FA was significantly lower in all three regions for children with TBI
- Compared FA with EF tests and ratings

Wozniak, Kraus, Ward, Mueller et al., 2007

**Behavior and corpus callosum morphology in 22q11.2 deletion syndrome**

- Children with VCF had larger CC’s than controls
- Children with VCF+ADHD had smaller splenium volumes than those with VCF only
- VCF+ADHD had higher BRIEF scores, $\eta^2 = .44$
- BRIEF scores correlated with splenium volume:
  - Composite $r = -.70$
  - Inhibit $r = -.76$

**Executive Correlations with white matter integrity:**

<table>
<thead>
<tr>
<th>Test</th>
<th>TBI</th>
<th>Control</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>WISC-IV FS IQ</td>
<td>109.93 (15.74)</td>
<td>113.29 (9.14)</td>
<td>.496</td>
</tr>
<tr>
<td>VCI</td>
<td>108.79 (10.82)</td>
<td>111.43 (15.36)</td>
<td>.698</td>
</tr>
<tr>
<td>PRI</td>
<td>113.00 (18.09)</td>
<td>112.50 (10.63)</td>
<td>.930</td>
</tr>
<tr>
<td>WMI</td>
<td>104.93 (15.33)</td>
<td>106.93 (13.47)</td>
<td>.717</td>
</tr>
<tr>
<td>PSI</td>
<td>100.36 (12.47)</td>
<td>109.00 (8.71)</td>
<td>.843*</td>
</tr>
<tr>
<td>WCST Errors (SS)</td>
<td>97.77 (18.40)</td>
<td>104.15 (16.54)</td>
<td>.361</td>
</tr>
<tr>
<td>FAS Total Score (z)</td>
<td>-0.701 (0.750)</td>
<td>-0.575 (0.755)</td>
<td>.662</td>
</tr>
<tr>
<td>Stroop interference (t)</td>
<td>51.50 (5.79)</td>
<td>55.79 (5.49)</td>
<td>.055</td>
</tr>
<tr>
<td>Trails-B (time)</td>
<td>61.69 (24.06)</td>
<td>50.94 (16.10)</td>
<td>.181</td>
</tr>
<tr>
<td>Tower of London—excess moves (z-score)</td>
<td>-0.120 (8.922)</td>
<td>0.740 (6.360)</td>
<td>.004*</td>
</tr>
<tr>
<td>Trails-A (time)</td>
<td>25.53 (8.14)</td>
<td>19.96 (3.89)</td>
<td>.030*</td>
</tr>
</tbody>
</table>

**BRIEF Scale**

<table>
<thead>
<tr>
<th>Scale</th>
<th>TBI</th>
<th>Control</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional control</td>
<td>61.85 (10.07)</td>
<td>46.92 (8.03)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Inhibit</td>
<td>59.69 (8.57)</td>
<td>50.85 (9.93)</td>
<td>.023*</td>
</tr>
<tr>
<td>Shift</td>
<td>58.69 (7.65)</td>
<td>49.77 (9.04)</td>
<td>.012*</td>
</tr>
<tr>
<td>Initiate</td>
<td>60.77 (9.58)</td>
<td>49.23 (9.51)</td>
<td>.005*</td>
</tr>
<tr>
<td>Monitor</td>
<td>63.46 (10.57)</td>
<td>47.31 (7.77)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Plan/organize</td>
<td>65.92 (11.51)</td>
<td>48.23 (10.18)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Organization of materials</td>
<td>56.38 (13.04)</td>
<td>52.31 (10.58)</td>
<td>0.389</td>
</tr>
<tr>
<td>Working memory</td>
<td>67.23 (8.96)</td>
<td>46.62 (7.90)</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

**Executive Correlations with white matter integrity:**

- Tower of London: .40* , .52*
- Trials A time: -.58* , -.60*
- WISC-IV PSI: .24 , .41*
- BRIEF Emotional Control: -.45* , -.53*

**Method**

- Longitudinal data from NIH MRI study
- N=347, 6-16 years, 54.3% girls
- Race, ethnicity, SES census matched
- Correlated lobar, amygdala, hippocampus, basal ganglia volumes with:
  - BRIEF WM EC INH scales
  - WISC-III Digit Span
  - CANTAB Spatial Working Memory

**Neuroanatomical correlates of behavioral rating vs performance measures of working memory in typically developing children and adolescents**


**The Limbic System**

- BRIEF WM & PHG
- Digit/Visual Span & Hippocampus

• Ratings and tests tap different substrate—be cautious with labels

• BRIEF WM reflects “momentary binding of items and context” in memory, thus may reflect episodic memory

• While not “working memory” per se, BRIEF WM captures important element of real world functioning not assessed on tests


Summary

• Executive function is a multimodal construct comprised of several executive functions

• Rating scales and performance tests are useful, but scales are more efficient/sensitive

• Rating scales can efficiently identify specific targets for intervention

Learning Executive Function 1965

Interventions: General Findings

www.devcognneuro.com

Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not
Adhe-Diamon, Daphna S. Ems
Developmental Cognitive Neuroscience 18 (2016) 36–48

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

Physical /Cognitive Training

- Physical training alone did not improve EF
- Cognitive training with physical activity improved EF
  - Oswald et al., 2006; Moreau et al., 2015
- Few studies (no studies?) have examined EF benefits in sports with mindfulness

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

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
Medication Intervention Studies using Rating Scale Measures

<table>
<thead>
<tr>
<th>ADHD</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biederman et al., 2011</td>
<td>Tourette’s: Cummings et al., 2002</td>
</tr>
<tr>
<td>DuPaul et al., 2012</td>
<td>TBI: Beers et al., 2005</td>
</tr>
<tr>
<td>Fidler et al., 2009</td>
<td>Depression: Roth et al., 2012; Madoo et al., 2014</td>
</tr>
<tr>
<td>Maziaa et al., 2009</td>
<td>Hypertension (Fanella et al., 2010)</td>
</tr>
<tr>
<td>Turgay et al., 2012</td>
<td></td>
</tr>
<tr>
<td>Voge et al., 2011</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Self-report and informant BREIF-A GEC T-Scales and MADRS Total Scores Full Analysis Set (LOCF)

<table>
<thead>
<tr>
<th></th>
<th>Self-report</th>
<th>Informed</th>
<th>Placebo (Set 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREIF-A Self-report GEC T-Score</td>
<td>Baseline, mean ± SD</td>
<td>76.8±46.66</td>
<td>74.3±46.86</td>
</tr>
<tr>
<td></td>
<td>Effect size</td>
<td>5.3±16.15</td>
<td>6.1±16.4</td>
</tr>
<tr>
<td>LS mean (95% CI) reduction at endpoint</td>
<td>Baseline</td>
<td>21.6±16.5 (13.3±9.0)</td>
<td>4.3±9.6 (1.0±2.5)</td>
</tr>
<tr>
<td>LS mean (95% CI) treament difference</td>
<td>Baseline</td>
<td>-10.1±14.0 (7.0±7.1)</td>
<td>1.9±10.5 (3.6±11.0)</td>
</tr>
<tr>
<td>BREIF-A Informed GEC T-Score</td>
<td>Baseline, mean ± SD</td>
<td>63.5±18.91</td>
<td>69.1±11.04</td>
</tr>
<tr>
<td></td>
<td>Effect size</td>
<td>6.4±11.0</td>
<td>6.9±10.74</td>
</tr>
<tr>
<td>LS mean (95% CI) reduction at endpoint</td>
<td>Baseline</td>
<td>21.6±16.5 (13.3±9.0)</td>
<td>4.3±9.6 (1.0±2.5)</td>
</tr>
<tr>
<td>LS mean (95% CI) treament difference</td>
<td>Baseline</td>
<td>-10.1±14.0 (7.0±7.1)</td>
<td>1.9±10.5 (3.6±11.0)</td>
</tr>
<tr>
<td>MADRS Total score</td>
<td>Baseline, mean ± SD</td>
<td>12.7±9.33</td>
<td>11.8±7.77</td>
</tr>
<tr>
<td></td>
<td>Effect size</td>
<td>7.2±9.9</td>
<td>6.9±8.97</td>
</tr>
<tr>
<td>LS mean (95% CI) reduction at endpoint</td>
<td>Baseline</td>
<td>19.8±1.6 (16.6±1.1)</td>
<td>4.3±1.0 (1.0±1.0)</td>
</tr>
<tr>
<td>LS mean (95% CI) treament difference</td>
<td>Baseline</td>
<td>-10.1±14.0 (7.0±7.1)</td>
<td>1.9±10.5 (3.6±11.0)</td>
</tr>
</tbody>
</table>

Figure 3. Self-report ratings of executive functioning across dosage conditions

Figure 2. LS Mean ± SE Changes From Baseline in BREIF-A Self-report GEC T-Scores, Full Analysis Set (LOCF)

Double-Blind, Placebo-Controlled, Crossover Study of the Efficacy and Safety of Lisdexamfetamine Dimesylate in College Students With ADHD

George J. DuPaul1, Lisa L. Weingold1, Joseph S. Revi1, Brigid A. Violante1, Sean M. O’Dea1, Kristen M. Carson1, Genevieve Verd1, and Anthony Swanson2

Abstract

Objective: To evaluate the clinical effectiveness of Lisdexamfetamine Dimesylate (Vyvanse) in adults with ADHD using double-blind, placebo-controlled, crossover design. Method: Participants included 54 college students with ADHD out of college settings without psychopathology. Lisdexamfetamine dimesylate (LDA) was given to ADHD participants over 4 weeks with in-period baseline, placebo, 30, 60, and 90 mg (2× daily). Self-reported measures of functioning and clinical assessment of ADHD symptoms, mental slowing, memory, and overall side effects were collected (24) for one month. Results: LDA was associated with large reductions in ADHD symptoms related to improved social functioning. Medication in ADHD symptoms was found for 54% of participants. However, large differences in symptoms and medications could be observed in treatment. Conclusion: LDA is a safe and effective treatment for symptom control in college settings, with ADHD, treatment may be less effective for academic functioning and treating psychiatric comorbidities (see abstract). J. Att. Dis. 2012, 14(1), 205-215

The effects of atomoxetine on emotional control in adults with ADHD: An integrated analysis of multicenter studies

P. Anderson1, S. Stens1, M. Nilsson Markhed1, L. Berggren1, P. Svanberg1, A. Katushchin1, J. W. Devlin1

- Emotional control recognized as a characteristic in ADHD for 100 years
- Thought to be associated with ADHD, but recent evidence suggests it may be a core symptom
- Treatment studies show emotional control responds to treatment for ADHD
- Integrated analysis of 2846 adults with ADHD treated with atomoxetine and 829 placebo controls in 10-12 week clinical studies

P. Anderson et al. European Psychiatry 30 (2015) 511-520
BRIEF-A Emotional Control scores in ADHD vs Controls

- ADHD patients
- Reference (normative) subjects

Approx. 50th percentile for the normal population, approx. 75th percentile for the patient population

% of ADHD patients or reference subjects

BRIEF-AS: Raw Emotional Control Section Score

BRIEF-A EC Correlates with Change in ADHD Symptoms

Table 5: Correlations of changes from baseline to endpoint between BRIEF-A emotional control subscale and selected scales, for the overall population.

<table>
<thead>
<tr>
<th>Correlation coefficient (Spearman)</th>
<th>95% confidence intervals</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAARS-Self scores SV total</td>
<td>0.49</td>
<td>0.46-0.52</td>
</tr>
<tr>
<td>Hyperactive-impulsive</td>
<td>0.46</td>
<td>0.42-0.49</td>
</tr>
<tr>
<td>Inattentive</td>
<td>0.46</td>
<td>0.43-0.49</td>
</tr>
<tr>
<td>CAARS-Opp scores SV total</td>
<td>0.41</td>
<td>0.38-0.45</td>
</tr>
<tr>
<td>Hyperactive-impulsive</td>
<td>0.38</td>
<td>0.35-0.42</td>
</tr>
<tr>
<td>Inattentive</td>
<td>0.39</td>
<td>0.35-0.42</td>
</tr>
<tr>
<td>AQoL total score</td>
<td>-0.54</td>
<td>-0.56-0.51</td>
</tr>
</tbody>
</table>

Treatment effects in Atomoxetine vs Placebo

<table>
<thead>
<tr>
<th>Variable</th>
<th>Atomoxetine</th>
<th>Placebo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in emotion control</td>
<td>20.1</td>
<td>16.3</td>
</tr>
<tr>
<td>Effect size</td>
<td>0.42</td>
<td>0.36</td>
</tr>
</tbody>
</table>

Non-medication interventions using Rating Scales as Outcome Measures

Liver transplant: Sorenson et al., 2011
Chemotherapy: Keizer et al., 2011; McDonald et al., 2013
Corticosteroids: Mrakostsky, 2012
Family Problem Solving: Wade et al., 2004, 2005
Cognitive Remediation: Beck et al., 2010; Hahn-Markowitz 2011, Toglia 2010
Flexibility in ASD: Kenworthy et al., 2014
The effects of problem-solving skills training based on metacognitive principles for children with acquired brain injury attending mainstream schools: a controlled clinical trial
D. Y. K. CHAN1,2 & K. N. K. FONG3

- 16 children with mod-severe TBI
- 16 non-injured children
- Participated in problem solving skills training to teach metacognitive awareness and problem solving

Disability and Rehabilitation, 2011; 33(21-22): 2023-2032

Table II. Summary of problem-solving skills training programme:

<table>
<thead>
<tr>
<th>Session</th>
<th>Theme</th>
<th>Hours</th>
<th>Example of activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Partner activities</td>
<td>1</td>
<td>Generate ideas for solving everyday problems.</td>
</tr>
<tr>
<td>2</td>
<td>Brainstorming and organizing</td>
<td>2</td>
<td>Group brainstorming on a topic.</td>
</tr>
<tr>
<td>3</td>
<td>Association</td>
<td>1</td>
<td>Connect ideas with similar themes.</td>
</tr>
<tr>
<td>4</td>
<td>Grouping</td>
<td>1</td>
<td>Categorize ideas into groups.</td>
</tr>
<tr>
<td>5</td>
<td>Comprehension</td>
<td>1</td>
<td>Understand the relationships between ideas.</td>
</tr>
<tr>
<td>6</td>
<td>Problem documentation</td>
<td>2</td>
<td>Write down solutions to problems.</td>
</tr>
<tr>
<td>7</td>
<td>Note-taking</td>
<td>2</td>
<td>Take notes during problem-solving activities.</td>
</tr>
</tbody>
</table>
| 8 | Group and self-evaluation | 1 | Evaluate group performance and individual contributions.
| 9 | Group and self-evaluation | 1 | Evaluate group performance and individual contributions.
| 10 | Monitoring | 1 | Observe and evaluate performance during problem-solving activities. |

Disability and Rehabilitation, 2011; 33(21-22): 2023-2032

Table III. Comparison of groups in post-test scores of dependent variables:

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Intervention group (n=10)</th>
<th>Comparison group (n=10)</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRIEF</td>
<td>Parent</td>
<td>31.16 (5.97)</td>
<td>31.94 (6.22)</td>
</tr>
<tr>
<td>Change</td>
<td>3.34 (5.72)</td>
<td>2.92 (5.58)</td>
<td>0.15</td>
</tr>
<tr>
<td>GDIQ - performance</td>
<td>Parent</td>
<td>40.75 (13.45)</td>
<td>42.37 (13.87)</td>
</tr>
<tr>
<td>Change</td>
<td>4.75 (5.87)</td>
<td>4.75 (5.87)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Disability and Rehabilitation, 2011; 33(21-22): 2023-2032

Improving School Readiness in Preschoolers with Behavior Problems: Results from a Summer Treatment Program
Paula A. Graziama • Jasmine Slavce • Katie Hart • Alwash Garcia • William E. Pelham Jr.

Well designed feasibility study with:
- 30 preschooler aged 4-6 years
- At risk or significant behavior/emotional problems
- 8 week summer intensive program:
  - Parent behavior management training
  - Behavior modification
  - School readiness
  - Social-emotional and self-regulation training

Disability and Rehabilitation, 2011; 33(21-22): 2023-2032

Change in EF and ER with Intervention

Note: Decreased BRIEF scores and increased Lab scores = improvement
Increased ER Checklist scores = improved functioning
A Collaborative Problem-Solving Model of Everyday Executive Function Intervention

- Knowledge Base
- Settings
- Delivery System
- Tool Kit

Inspired by Mark Ylvisaker & Tim Feeney

Knowledge Base

- Operational Definitions of EF
- Clinical Profiles
- Assess executive functions

Settings: Where to Intervene?

- Home
- School
- Community (Job, sports, theater, peers)

Delivery: Who Intervenes?

- Key Personnel: Mentor/ coach/ co-conductor
- “With” not “for”
- External to internal

Tool Kit

- Targeted Functional Domains
- Strategies
- Scripts/ Routines

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:

Prediction: How well will I do?

Self rating (1-10):

Other rating (1-10):

Problem:

Solutions:

DO

Review: How did I do?

Self rating (1-10):

Other rating (1-10):

What worked? What didn’t work?

What will I try next time?

Goal-Setting

Evidence shows that individuals who set goals are more likely to achieve higher levels of performance.

*Have student set goals*

Correspondence Training

Correspondence training is based on evidence that individuals who make a verbal commitment are more likely to follow through.

*Have students verbally state goals*

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.


Key Components of Coaching

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

Meet with students to make daily plans linked to their goals.

Basic Format: R.E.A.P.

Review: go over plans from previous session to determine if carried out

Evaluate: Did the student carry out plan? If not, why not?

Anticipate: Plan tasks to accomplish today--review upcoming tests, assignments.

Plan: Have the student identify when he plans to do each task and how he plans to do each task.
Change in grades with coaching

<table>
<thead>
<tr>
<th></th>
<th>A-B</th>
<th>C-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before coaching</td>
<td>19</td>
<td>81</td>
</tr>
<tr>
<td>During coaching</td>
<td>63</td>
<td>37</td>
</tr>
</tbody>
</table>

Chi Square = 39.41, p < .001

Family Problem-Solving Therapy for Adolescents with TBI

- Structured development of a realistic and optimistic approach to address problems
- Parents and teens collaborate in defining a problem and identifying solutions
- Provides a problem-solving heuristic to address executive dysfunction following TBI


Online Counselor Assisted Problem Solving (CAPS)

- 7 sessions address common consequences of TBI using a problem solving framework.
- Training in problem-solving and communication skills to address family/teen-identified goals.
- Initial session face-to-face in family’s home.
- All sessions include online module and videoconference with psychologist.

The CAPS Intervention

- 7 core sessions
  - Face-to-face introduction/overview
  - Staying Positive
  - Solving Problems
  - Dealing with Cognitive Challenges
  - Staying in Control
  - Handling Crises
  - Planning for the Future

Study Design

- Randomized Controlled Trial, single blind
- Multicenter cross-section study
- CAPS group (57) had web/videoconference intervention.
- Control group (63) had internet resources regarding TBI (Internet Resource Comparison; IRC)
- All received computers and high speed internet access
- Evaluators were naïve to group assignment (single blind)
- Average age at injury 14.5 years, 3.6 months post injury
- Mean GCS 10.05; 40% with severe TBI
- Outcome Measure: BRIEF

Post-Intervention in Older Adolescents

- GEC mean change
  - CAPS -4.78, IRC -0.86
  - F=6.74, p=0.01
- Similar results for BRI and M1 subscales in older adolescents (High school age)
- No significant differences in CAPS and IRC in the entire sample or younger teens
Longitudinal Results

Kurowski et al., 2014 JAMA Pediatrics

Conclusion

- CAPS improved executive function immediately post-intervention
- Benefits maintained up to 12 months in older adolescents
- Large, randomized controlled treatment trials for pediatric TBI demonstrating efficacy of an online problem solving intervention for management of executive dysfunction
- Utilization of the CAPS intervention clinically should be considered

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

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?
  - Let’s compromise so we both get some of what we want

Compromise
- What’s our plan?
  - What is our Plan B?

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?
**“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

![Mean Challenge Task Flexibility Graph](image)

Cohen’s d = 0.72

Kenworthy & Anthony et al, 2014

**Parent & Teacher BRIEF Shift**

Higher score = Less flexible

![Parent & Teacher BRIEF Shift Graph](image)

Parent Cohen’s d = 0.70; Teacher Cohen’s d = 0.89

---

**Progress Monitoring**

- Tracking and monitoring of student progress toward an academic, behavioral, or social-emotional goal
- Quantifying progress
- Allows adjustment of goals and interventions
- Assists the determination of goal attainment

---

**Goal**

- What do we want to do?
- How will we do it?
- Let’s keep our plan.
- How did it work?

**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?
Realistically, a progress monitoring tool should contain/take:

- 5 items / less than 1 minute
- 10 items / 1-2 minutes
- 15 items / 2-3 minutes
- 20 items / 3-4 minutes
- 30 items / 5 minutes

**Monitoring the Executive Functions**

**Development of the Concussion Monitor version**

**Need**

- Impairment in the executive functions have been established in moderate-severe TBI
- Everyday manifestations of EF have been demonstrated (Gioia, Isquith & Kenworthy, 2010)
- Evidence exists that specific executive functions may also be impaired in mild TBI
- Need for a tool to monitor recovery progress, which changes relatively quickly

**Development Process**

- Five neuropsychologists with clinical experience with concussion symptomatology reviewed the 86-item BRIEF Parent form and 80-item Self-Report forms
- 1- SCALeS: Selected the scales most likely to capture acute problems following concussion.
  - Working Memory
  - Planning/Organization
  - Task Completion (self-report)
  - Initiation (parent report)
  - Emotional Control
  - (Inhibition)

**Development**

- 2- ITEMS: clinicians provided independent ratings of each item’s likely association with concussion effects
  - Ratings 0 (not likely), 1 (likely), 2 (highly likely)
  - Individual items were retained based on expert consensus
  - Item pool reduced to remove items with very similar content

**RESULTS**

- Parent concussion monitoring included
  - 31 items for children aged 5-18 years
  - BRIEF2: 23 items (8 trimmed out)
- Self-report concussion monitoring included
  - 28 items for adolescents aged 11-18 years
  - BRIEF2: 22 items (6 items trimmed out)
Development

- 3 - SCALING: Five-point dimensional scale (ranging from "almost never a problem" to "almost always a problem")
- 4 - SYMPTOM VALIDITY: Three symptom validity items of likely low endorsement (i.e., forgets where bedroom is located, cannot remember friends' names, has difficulty chewing food) were added to each form
- 5 - PRE-EVENT: The forms ask for retrospective pre-injury ratings alongside ratings of current (past week) post-injury functioning

Scale Structure

3-factor model assessed
- Emotion (i.e., Emotional Control)
- Behavior (i.e., Inhibition) Regulation
- Cognitive Regulation: Working Memory, Planning/Organization, Task Completion (or Initiation) items loaded
  - The absolute fit of each model examined using the normed chi-square ($\chi^2/df$), comparative fit index (CFI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA).
  - Indicators of adequate model fit included normed chi-square value less than 3, CFI greater than .90, and SRMR and upper end of the 90% RMSEA confidence interval less than .10 (Kline, 2004, 2010).

Self-Report

- All factor loadings were strong for items within each factor (see Table 1)
- Working Memory, Task Completion, and Planning/Organization scales were significantly correlated (pre-injury $r = .54$ to .69; post-injury $r = .63$ to .75), each contributed highly to the higher-order Cognitive Regulation Factor.
- Moderate correlations were found between the Cognitive, Emotion, and Behavior Regulation Factors (pre-injury $r = .36$ to .56; post-injury $r = .36$ to .51).
- Overall model fit was determined to be acceptable and no additional changes were made.
31-item parent report

- Two items were dropped from the Initiation scale due to low standardized factor loadings (< .50).
- Subsequent analyses conducted with 29-items, resulting in improved model fit.
- Pre- (n = 613) and post-injury (n = 578) symptom reports resulted in better model fit.
- Normed chi-square values were greater than recommended ($\chi^2/df = 4.7$ at pre-injury and 4.5 at post-injury)
- Model fit was otherwise within desired ranges (CFI = .91, SRMR = .05, RMSEA 90% CI = .07 to .08 at pre- and post-injury).

Parent Report

- Each item loaded strongly onto the corresponding factor
- Factor loadings were high for Cognitive Regulation Factor
- Strong correlations found between Cognitive Regulation subscales (i.e., Working Memory, Planning/Organization, Initiate; pre-injury $r = .61$ to .83; post-injury $r = .59$ to .63)
- Moderate correlations between the Cognitive, Emotion, and Behavior Regulation Factors (pre-injury $r = .49$ to .56; post-injury $r = .43$ to .53).

Reliability

- Internal consistency estimates: high for both pre- and post-injury ratings.
- Cronbach’s alpha for each factor
  - Self-report range = .70 to .95
  - Parent report range = .86 to .95
- Test-retest reliability (Pre-Injury ratings)
  - Pearson’s r & ICC (two-way mixed, single measure, consistency)
  - Total and factor scores for pre-injury symptoms for total sample, demonstrating moderate to good reliability
  - Self-report (ICC = .58 to .75, r = .61 to .77)
  - Parent (ICC = .70 to .85, r = .70 to .83) forms
  - Split retrospective timing (<13 days, ≥13 days) – similar stability

BRIEF Concussion Monitoring Mild TBI Total Scores at Serial Visits

*All contrasts significantly different from the prior visit at p < .01.

Parent Concussion Monitoring Mild TBI Sub-Scales Across Visits

Child Concussion Monitoring Mild TBI Sub-Scales Across Visits
Summary
- EF meets both unitary and diversity criteria as a construct
- Assessment: multiple modalities, evidenced based interpretation assists clinical decisions
- Clinical relevance of EFs demonstrated across many different human conditions
- Treatment/ intervention applications growing
- Monitoring of progress tied to interventions emerging to guide treatment process.