Executive Function & ADHD: A View From the Conductor

Questions & Answers

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Q: I was always taught that attention was an executive function. Can you talk more about why you consider it a separate cognitive function rather than an executive skill?

A: Many have struggled with the relationship between the constructs of attention and executive function. It is helpful to define each to more thoroughly examine the relationship between the two constructs. We discussed the construct of executive function in the webinar, but not specifically "attention" as a cognitive construct.

In *Principles of Psychology* (1890), William James says, "attention is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence." In other words, it is the cognitive process of detecting and focusing on a stimulus. In my neuropsychology training in the 1990s, I learned to test components of attention such as selective attention, alternating attention, divided attention, and sustained attention. In writing assessment reports, however, it became increasingly difficult and confusing to separate these attentional processes (e.g., alternating attention) from executive functions (e.g., shifting set). At the same time, more and more writers were re-examining attention as we think of it in everyday terms such as "paying attention" and being "distracted," and starting to view attention as the ability to notice a stimulus versus "paying attention" as the executive control of attention.

In practical terms, if attention is the ability to notice a stimulus, then executive regulation of attention explains what happens in the real world with "paying attention." A student must initiate attention (start paying attention), sustain attention (keep focusing attention or concentration), inhibit attention (resist distraction), and shift attention (the process of inhibiting attention to one stimulus, shifting to a new stimulus, and initiating attention to that stimulus). Martha Denckla used to refer to these as the "ISIS" functions (initiate, sustain, inhibit, and shift) when controlling attention.

Conceiving of attention in James' cognitive terms allows for a clearer relationship with executive functions: Attention is noticing something, and the rest is the executive control of attention. This brings it into line with the notion of executive control of language, sensory input, motor output, learning, memory, emotions, and so on.

Q: In addition to OHI, I have seen executive functioning deficits listed under the category of specific learning disability, with a processing disorder under cognitive abilities. What are your thoughts?

A: Much of the time, deficits in executive functions are viewed as a component of an other health impairment (OHI) as it is built into the definition:

"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 due to a chronic or acute health problem…"

Problems with initiating and sustaining typically equate to the "vitality and alertness" part, and problems with inhibitory control or being distractible can be seen in the "heightened alertness" part of this definition. The next requirement, however, is that these executive deficits are part of a health condition, most commonly ADHD but also sleep apnea, seizure disorders, post-radiation or chemotherapy for cancer, long-term steroid use for arthritis or asthma, or many other health conditions that impact on executive functioning.

Some school districts or teams reason that executive functions are some of the "basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell or do mathematical calculations." While we typically think of those "basic psychological processes" as functions like phonological processing/awareness, phonological memory, and automaticity, executive functions do play a role in Specific Learning Disabilities, though to a lesser extent than in conditions such as ADHD. See the next question and answer below for more on this topic.

Q: What are your thoughts on using EF deficits to support a diagnosis of a learning disorder/learning disability and EF as processing deficit?

A: Executive functions play a role in specific learning disabilities. Most research has focused on the specific contribution of working memory to learning disabilities affecting reading fluency (e.g., dyslexia) and math calculation (e.g., learning

disabilities that involve grasping concepts like listening or reading comprehension or math reasoning/problem solving that may involve organization, but this is less studied). Findings suggest that children with common learning disabilities (e.g., dyslexia) show weaknesses in working memory, though to a lesser extent than do children with attention disorders.

Profiles on the BRIEF2 bear this out as well. In our discussion of evidence for validity of BRIEF2 scores based on diagnostic criterion relationships in Chapter 6 of the BRIEF2 Professional Manual, we show scores for groups of children with ADHD-I, ADHD-C, ASD, LD, anxiety, epilepsy, TBI, and others. These are shown graphically on page 40 in Chapter 3. You can see that the most prominent weaknesses in working memory are consistently seen in children with ADHD diagnoses of either type, and the most subtle weaknesses are seen in children with LD diagnoses.

Willcutt, et al. (2001) used performance measures to look at shared and distinct contributors to profiles in children with reading disorders (RD) and those with ADHD. Both ADHD and RD groups showed slower processing speeds, lower working memory, and worse inhibitory control on tests, though RD to a lesser extent. The one distinguishing factor was phonological processing.

A study that came across my desk as I was writing this response updates and adds to the Willcutt study (and several others in between). Kibby and colleagues (2021) administered a battery of performance measures and the BRIEF along with measures of cognition, academics, and phonological processing to 263 children with reading disability (RD), ADHD, and RD+ADHD. They found shared deficits in cognitive aspects of executive function in both ADHD and RD: working memory, shifting, and idea generation (with both tests and the BRIEF). Children with ADHD only showed deficits in inhibition and behavior regulation more generally while children with RD only showed deficits in phonological processing. Children with any ADHD diagnosis (ADHD, ADHD+RD) showed worse performance than children with RD only on most EF tasks and on the BRIEF scales. Like with prior research, performance measures accounted for a small proportion of variance between groups (<7%) while the BRIEF scales explained from 5 to 45% of variance, and 55% in ADHD groups.

Taken together, the data suggest that executive functions, mostly working memory, play a role in learning disabilities, but that it is a more subtle role and secondary to other characteristics such as automaticity and phonological processing.

Q: Is there an EF profile for students found to be intellectually gifted?

A: There is a developing literature on the relationship of intellectual giftedness in children and executive functioning. The profiles depend heavily on the type of measures used. Some, but not all, executive function performance measures (tests) are correlated with IQ scores. The BRIEF instruments tend not to correlate more than minimally with IQ scores, in part because parents and teachers, who adapt their ratings based on what they expect for the child, complete the ratings. For example, when we first developed the BRIEF, we collected a sample of about 50 children diagnosed with Intellectual Disabilities who had cognitive scores in the 50s and 60s. We expected to find a distinct profile on the BRIEF, but, instead, parents and teachers described only mild working memory problems. It turns out that when completing the BRIEF, people automatically adjust their expectations.

I found some articles in researching this question that might be of interest. See Arffa (2007), Eren et al. (2018), Hernandez et al. (2014) and Wood (2012).

Q: Do you have BRIEF profiles for people with other disorders, such as anxiety, ASD, fetal alcohol syndrome, etc.?

A: Profiles of BRIEF scores (from preschool through older adults) have been studied in a very wide range of conditions, ranging from common developmental conditions such as ADHD, LD, and ASD to less frequent genetic or acquired conditions such as Neurofibromatosis Type I, medulloblastoma, cochlear implant use, fetal alcohol spectrum disorders, TORCH infections, and so on. See Table 1.2 in the BRIEF2 Professional Manual for a sample of the more than1,600 peer-reviewed studies that relied on the BRIEF instruments.

In terms of specific profiles that are unique to clinical conditions, BRIEF2 profiles in children with ADHD-I and ADHD-C are well-established and consistent. The other group that has been widely studied and shows a consistent profile is in children with autism spectrum disorders. We included a section on profiles in the BRIEF2 manual starting on page 37 (Interpreting Profiles), with specific discussion of the ASD profile on Page 43.

Essentially, children with an ASD typically have a prominent elevation on the Shift scale (don't adapt to change), often accompanied by an elevation on the Emotional Control scale (don't like change and get upset) along with elevation on the Plan/Organize scale. But the Shift scale tells the tale. Caution is warranted, though, as the Shift scale is often elevated in children with anxiety, as they also dislike change. I learned this long ago when studying children in long-term foster care: Most of them had spikes on the Shift scale, but none were on the spectrum. We looked at the structured diagnostic interview data and BASC data and learned that this was associated with anxiety.

If you are considering a diagnosis of ASD, then a marked elevation on the Shift scale can support your confidence in the diagnosis. The ASD clinical group in the BRIEF2 manual showed a mean T score of approximately 70 for parent and teacher ratings. This level of elevation was associated with .90 or higher positive predictive value for detecting likelihood of ASD diagnosis. That is, if you are considering a diagnosis of ASD, a T score of approximately 70 or higher for parent and teacher ratings would predict 90% of true ASD diagnoses accurately (see the Interpretation chapter in the BRIEF2 manual). This information is also printed in detail in the BRIEF2 Interpretive Reports from PARiConnect.

Q: How do you address significant differences in ratings between home (parent) and school (teachers)?

A: Differences between home and school ratings are common. This is discussed beginning on page 43 in the BRIEF2 manual, with tables showing the percentages of clinical samples who had ratings within 10 points of each other, from 10-20 points, or more than 20 points. For example, parents and teachers were within +/- 10 points of each other for 57% of cases overall, with another 10% of parents 10-20 points lower than teachers and 20% of parents 10-20 points higher than teachers.

Interpreting these differences depends on many factors. It is common for children to function differently at home versus in school, with some doing better in one setting than in the other. It is also common for rater perspectives to be different based on expectations for typical functioning in one environment or the other. And there may be rater bias depending on a multitude of factors (e.g., parents who want or do not want their child identified for special education, a teacher is overwhelmed, etc.).

How we write about these differences is a different matter. It is usually important to encourage cooperation between home and school. Thus, pointing out that parents and teachers strongly disagree, or that the school is right the and parents are wrong, or vice versa, is typically not helpful. I prefer to note that it is common for children to function differently across settings and ask gentle supportive questions of the parents or teachers about their concerns and observations of the child. Often, this has the effect of bringing them closer together.

I recommend the excellent and thorough papers on biases in rating scale scores by De Los Reyes and Kazdin, particularly De Los Reyes & Kazdin (2005), De Los Reyes & Kazdin (2008), and De Los Reyes et al., (2013).

Q: Does this mean that we should look for evidence of low working memory in cognitive tests in conjunction with the BRIEF to suggest executive function impairment?

A: This is an excellent question. It is also a substantial topic that gets at the relationship between performance measures (i.e., cognitive tests) and ratings on the BRIEF instruments. I have a talk on that topic and hope to do it soon, as there is a lot of data on how the two do, and do not, work together.

The short story is that, while both the BRIEF instruments and performance measures or tests, particularly of working memory, have plenty of evidence of accuracy (validity), they correlate only to a small degree (on the order of r = .20 to .30). Debbie Waber and colleagues (2015) examined this in an analysis of imaging and test data from the NIH normal brain development study, a longitudinal data set with about 350 children that followed from birth into their 20s at this point. They found that span tasks (digits, spatial) that assess "working memory" correlated with hippocampal volumes. BRIEF Working Memory ratings correlated with para-hippocampal volumes (other BRIEF scales did not, as they should not). Thus, span tasks and BRIEF WM ratings were associated with brain regions adjacent to each other, but not quite the same. Waber and colleagues interpreted this to suggest that working memory tasks measure the act of holding in working memory while the BRIEF WM scale measures the interface between holding information and engaging with the outside world. This is what we intended for the BRIEF in the first place. We might find different labels for

these two types of measures to help clarify. For example, in my reports I refer to span tasks as "holding" or "short-term holding" and the BRIEF WM scale as "sustained working memory." I might say, for example, "While Piper is able to hold a typical amount of information in working memory briefly, she has difficulty sustaining working memory over time, such as for homework or a lesson in class."

In practice, Toplak and colleagues (2009) examined prediction accuracy in a matched sample of students with and without ADHD for the BRIEF scales and selected executive tasks. They found that the BRIEF scales, particularly the Working Memory scale, predicted diagnosis at more than 80% accuracy while task performance predicted 50 to 60% accurately. However, when they entered the task score in a regression equation and then added the BRIEF scales, accuracy improved substantially. The best predictor was span tasks with the BRIEF WM scale, which together detected 95% of ADHD cases and ruled out 97% of non-ADHD cases accurately.

% Accuracy

Equation	Controls	ADHD
Stop Task	59	62
+BRIEF Inhibit	91	86
Trails B	64	63
+BRIEF Shift	87	78
WM Task Composite	68	67
+BRIEF Working Memory	97	95

This suggests that using both the BRIEF scales and performance measures provides the most evidence to increase confidence in your diagnosis. We don't have formulas for doing so yet, but we are working on it. For now, the combinations we need to interpret are:

1. Span tasks and the BRIEF2 WM scale are good: The student has good working memory.

2. Span tasks and the BRIEF2 WM scale are problematic: The student has problems with working memory.
3. Span tasks are good and the BRIEF2 WM scale is elevated: We might say that the student is able to hold information in active working memory for a few moments, but has trouble doing so over a more natural period of time, such as for homework.
4. Span tasks are problematic but the BRIEF2 WM scale is elevated: We might say that, despite difficulty holding information accurately for short periods of time, the student compensates well in the everyday setting, sustaining working memory appropriate for tasks such as homework and listening to lectures in school.

Q: We have really enjoyed and appreciated using the BRIEF-P for some of our preschool evaluations. Do you have a timeline for when it may be updated?

A: We, too, like the BRIEF-Preschool. When the BRIEF first came out, our colleagues said, "this seems to work, but you probably can't measure executive functioning in little ones via rating scale." We thought that was a good empirical question and set about developing a version for young children. It turns out that you can measure the major characteristics of executive functioning in the preschool set, and that ratings are often predictive of later functioning in school.

We don't currently have a plan to revise the BRIEF-Preschool version. We are always thinking about what the next steps would be, and are interested in your feedback about what works, what doesn't work, and what features you would like to see in the next version. We keep track of this, and it influences what we do and when we do it. Feel free to let me know or let customer support at PAR know. You can call or stop by the PAR booth at NASP, INS, APA, or many state conferences, and they will relay your comments.

Q: Is the BRIEF available in Spanish?

A: The BRIEF2 forms are published in Spanish (the Professional Manual is in English). You can use paper versions of the Spanish-language BRIEF2 forms or administer and score them via PARiConnect.

The BRIEF instruments are also available in numerous languages upon request from Afrikaans to Zulu. You can find a list of translations and adaptations for each BRIEF instrument at parinc.com/Permissions_licensing.

Q: If a student experiences a traumatic brain injury at a very young age, between ages 2 and 3, and the student's behaviors strongly suggest executive dysfunction, is it reasonable to identify the student with TBI? Even if the injury happened 7 or more years earlier? All cognitive abilities and academic skills are average, with very elevated BRIEF2 scores.

A: It is entirely reasonable to identify a child with a history of documented traumatic brain injury who shows long-term effects as a student with an educationally handicapping condition of brain injury, or TBI, provided that there are adverse effects that are presumed to be related to the injury. This latter part depends on the sum of the data.

For example, in one case, a child might have had an injury and shown persistent changes in behavior and functioning since the injury, suggesting a clear pattern of injury then dysfunction. Another child might have had the same injury and persistent behavior and functional problems, but these problems predated the injury and may be better explained by trauma or psychiatric condition, thus might be identified as an emotional disorder/disturbance.

How the team identifies the educationally handicapping condition depends on the sum of the evidence and the most prevalent problem.

I discuss the situation where there was an injury but the only measure that is elevated (problematic scores) is the BRIEF in the next response. The references below may be helpful in addressing this situation as well.

Q: As a clinical neuropsychologist trained and specialized in neurodevelopmental and neuropsychiatric disorders, I applaud your message

to consider multiple factors when formulating a diagnosis of ADHD or any other disorder/syndrome. I have frequently, however, read reports where your original BRIEF or the BRIEF2 was included in medical legal reports as the sole instrument used for an "executive dysfunction (sic)" diagnosis in pediatric brain injury. Is there a way to get the message out that the BRIEF2 is not a brain injury diagnostic measure, and that it's designed for use as a component of neurodevelopmental disorder assessment, primarily ADHD?

A: This is a complex question with multiple parts. These include the intent/purpose of the BRIEF instruments, research on the BRIEF in children with histories of TBI, and use of data sources in forensic neuropsychology.

First, the BRIEF has always been designed as a measure of an individual's everyday executive functioning, or self-regulation, in their real-world environment. In keeping with the *Standards for Educational and Psychological Testing* (2014), we state:

> *The BRIEF2 is a rating scale completed by parents and teachers of school-age children (5 to 18 years) and by adolescents aged 11 to 18 years that assesses everyday behaviors associated with executive functions in the home and school environments. It is designed for a broad range of children for whom there may be concerns about self-regulation, such as those with autism spectrum disorder (ASD) learning disabilities (LD); attention disorder; traumatic brain injuries (TBI); depression; and other developmental, neurological, psychiatric, and medical conditions.*

In other words, it was intended to measure everyday executive functioning in the real world regardless of developmental or acquired conditions or diagnoses. We specifically included a few conditions such as ADHD, ASD, and brain injury, as there is a large literature on each of these conditions that includes the BRIEF instruments (see a few references below).



Second, there is a large body of research that looks at ratings on the BRIEF instruments (BRIEF-Preschool, BRIEF, BRIEF2, BRIEF-Adult) across the age spectrum. It tends to show that ratings on the BRIEF are one of the most sensitive measures of outcome both in the short run and in the long-term. We know that individuals with even severe TBI, absent focal damage, tend to show typical or normal performance on tests, though sometimes with somewhat reduced speed of output/processing and sometimes with mildly reduced performance on more demanding sustained attention and working memory measures. Still, if you consider a few low scores in the context of all the papers on multivariate base rates, a few low scores are not that convincing. And yet, these individuals may also show attentional, behavioral, emotional, and social dysfunction that is better captured by behavior assessment rating scales such as the BRIEF instruments.

As executive functions, particularly working memory, are typically the most vulnerable functions to injury, they are often the most protracted symptom. Indeed, Chevignard et al. (2012) reviewed ecological measures and noted that the BRIEF was one of the most sensitive measures to long-term outcomes following pediatric brain injury.

An article that was just published by Linda Ewing-Cobbs' lab (Keenan et al., 2021) in open journal format looks at repeated ratings on the BRIEF-P over time in very young children with mild to severe TBI. They found a dose-response effect and that there may be initial recovery, plateau, and then worsening over the long-term.

Taken together, the literature suggests that executive functions are some of the most vulnerable systems to the effects of TBI, even mild TBI, and that the BRIEF instruments are among the most sensitive instruments to those effects.

The third part of your question asks whether we should consider additional evidence of outcome or long-term impact of injury beyond the BRIEF instruments. In a word, yes. Particularly in a forensic setting, it is important to gather multiple sources of data that may confirm or dispute our assessment conclusions. The Specialty Guidelines for Forensic Psychology from APA provide clear guidance on the issue of data collection and interpretation in several parts, but the most relevant section is here:

9.02 Use of Multiple Sources of Information

> *Forensic practitioners ordinarily avoid relying solely on one source of data, and corroborate important data whenever feasible (American Educational Research Association, American Psychological Association, & National*



Council on Measurement in Education, in press). When relying upon data that have not been corroborated, forensic practitioners seek to make known the uncorroborated status of the data, any associated strengths and limitations, and the reasons for relying upon the data.

Whether we are working from a clinical or educational or forensic perspective, we should always consider history, observations, and formal test performance (i.e., multiple sources of data) that confirm or dispute our assessment. Given that executive function problems are often one of the long-term complaints following brain injury, we might use the BRIEF instruments from multiple respondents (parents, teachers, other observers) to gain measurable consensus as to the severity and pervasiveness of any problems. We would certainly also explore executive functions via performance tests in a forensic evaluation. We would also gather data by our own observations and from interviews with multiple observers (again, parents, teachers, others). We would likely also collect rating scale data on broadband behavior measures or measures that are designed to be sensitive to the effects of brain injury such as the PostConcussion Symptom Inventory-2 (PCSI-2) and the PostConcussion Executive Inventory by Gioia and colleagues.

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