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Creativity Lost

The Importance of Testing Higher-Level Executive Functions in School-Age Children and Adolescents

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In school settings, students are typically evaluated using group achievement tests, IQ scales, and college entrance exams that focus more on rote-verbal skills (e.g., vocabulary, mathematical facts) than on higher level executive functions (e.g., abstract thinking, problem solving). However, recent neuropsychological findings suggest that rote-knowledge skills and executive functions are divergent cognitive domains that can be dissociated in both adults with frontal lesions and children with neurodevelopmental disorders. New correlational findings obtained from 470 children and adolescents provide additional support for the divergent nature of these cognitive domains and the existence of subgroups of students who exhibit either strengths in abstract, creative thinking with relative weaknesses in rote-verbal skills or vice versa. The results suggest that current school assessment practices may result in academic roadblocks for those students who have strengths in abstract, creative thinking but whose relative weaknesses in rote-verbal skills may hinder their ability to take college entrance exams.

Keywords: *IQ; Delis-Kaplan Executive Function System; neuropscyhology; achievement tests*

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In recent decades, the field of neuropsychology has made great strides in charting the cognitive architecture of the brain. One of the most important discoveries centers on the role of the frontal lobes, which were among the last and most complex brain regions to evolve, in mediating cognitive functions. Research has shown that patients with focal damage in the frontal lobes often perform normally on IQ composite measures and other tests of basic achievement skills (e.g., reading and spelling; Damasio, 1995; Luria, 1973; Mesulam, 1986; Stuss et al., 1983; Teuber, 1964). Rather, these patients tend to exhibit deficits in higher-level cognitive skills, such as abstract thinking, problem solving, inhibition, concept formation, mental fluency, multitasking, and cognitive flexibility (Cato, Delis, Abildskov, & Bigler, 2004; Bechara, Damasio, Damasio, & Anderson, 1994; Delis, Kaplan, & Kramer, 2001; Luria, 1973; Stuss & Knight, 2002). These higher-level cognitive abilities are referred to collectively as "executive functions" because they often draw on more fundamental or primary cognitive skills, such as attention, language, and perception, to generate higher levels of creative and abstract thought. These important findings have compelled neuropsychologists to broaden the scope of the types of cognitive tests they administer to individuals with possible brain injury or disease to include measures of executive functions in addition to tests of intellectual abilities and other, more fundamental cognitive skills. These discoveries have also given neuropsychologists an appreciation of the limitations of traditional IQ and achievement tests for evaluating the full spectrum of human cognitive abilities.

In school settings, however, tests of basic achievement skills and intellectual functions tend to dominate the assessment landscape. School systems frequently track the academic progress of students by administering annual group achievement tests that assess more rote-verbal skills such as vocabulary, reading, spelling, and math. When a child is referred for an individual assessment to evaluate a potential learning disorder or other cognitive problems, the child is typically assessed with an intelligence scale and additional achievement tests. In high school, college-bound adolescents are typically required to take group entrance exams such as the Scholastic Aptitude Test (SAT), the results of which often play a critical role in the admissions criteria used by colleges and universities. All of these traditional school-based cognitive tests–group achievement tests, IQ measures, and college entrance exams–share two general features. First, these tests tend to focus more on the acquisition of rote knowledge and skills (e.g., vocabulary level; math facts and equations). And second, these tests often do not provide an adequate and comprehensive evaluation of higher-level executive functions such as abstract thinking, concept formation, and problem solving (see also Gardner, 1993; Sternberg, 1985; Sternberg, Lautrey, & Lubart, 2003).

Rote-knowledge skills such as vocabulary, reading, and basic mathematics are unquestionably vital cognitive abilities for success in all aspects of life, including academic and occupational attainment. It is essential that school-age children and adolescents continue to receive regular evaluations of these more fundamental cognitive abilities. However, the relative lack of formal cognitive evaluations of higher-level executive functions in school settings may represent a serious deficiency in our educational system.

One reason for the lack of formal assessments of executive functions in school settings may stem, in part, from long-standing beliefs about the utility of the IQ composite measure in providing an adequate global index of all cognitive skills. That is, since the early 1900s, a popular psychometric theory has been that all cognitive functions are significantly intercorrelated and ultimately load on the G factor or IQ index (Jensen, 1998). According to this traditional psychometric view, there would be little to no need to assess executive functions independent of the cognitive functions tapped by IQ tests, because the variance in all cognitive functions is explained sufficiently by IQ indices. However, three lines of modern research run counter to this notion. First, as discussed above, patients with acquired focal frontal-lobe damage often exhibit intact intellectual abilities in the face of significant deficits in higher-level executive functions (e.g., Bechara et al., 1994; Cato et al., 2004; Luria, 1973). Such cognitive dissociations indicate that IQ tests are not sufficient for evaluating the full spectrum of executive functions. Second, pediatric case studies have documented the presence of developmental learning disabilities in which the children exhibit selective deficits on executive-function tests with normal scores on IQ and achievement tests (Bohm, Smedler, & Forssberg, 2004; Filley, Young, Reardon, & Wilkening, 1999; Geurts, Verte, Oosterlaan, Roeyers, & Sergeant, 2005). These cases suggest that, even in the absence of *acquired* brain damage, some children still show marked dissociations between more rote-knowledge skills as assessed by IQ and achievement tests on one hand and higher-level executive functions on the other. And third, preliminary studies on the correlations between IQ and executive-function measures in children have found that the correlation coefficients tend to be either non-significant or significant but relatively low, with the IQ scores accounting for only about 4% to 25% of the variance on executive-function measures (Ardila, Pineda, & Rosselli, 2000; Welsh, Pennington, & Grossier, 1991).

These initial findings, which suggest that IQ and executive-function measures may tap different components of cognition, have potentially important implications for school assessment practices. These results invite the hypothesis that there may be subgroups of normal-functioning children who show different profiles of strengths and weaknesses on IQ measures relative to executive-function measures. That is, there may be some children who have strong rote-knowledge skills but who have relative weaknesses in their capacity for abstract, creative thinking. In contrast, another subgroup of children may have strengths in higher-level executive functions such as abstract thinking and problem-solving skills in the face of relative weaknesses in more rote-knowledge skills as assessed by IQ and achievement measures. If such subgroups of children exist, then our current school assessment practices, which tend to emphasize IQ and achievement testing over the assessment of executive functions, may have at least two major shortcomings. First, these practices may fail to identify children with normal verbal skills but with developmental weaknesses or disorders in areas of higher-level executive functions. And second, the current assessment practices may create academic roadblocks for children who are very creative but who have relative weaknesses in more rote-verbal skills, because the scholastic entrance exams that are often used as a key criterion for college admission (e.g., SAT) tend to focus primarily on their areas of weaknesses and fail to also identify their areas of strength.

A problem in this area of research is that the few studies that have been conducted thus far to examine correlations between IQ and executive-function tests in children have often use relatively small sample sizes (e.g., $N = 50$) with restricted age ranges (e.g., 13-16 years old; see Ardila et al., 2000; Welsh et al., 1991). In addition, these studies have not investigated whether or not subgroups of normal-functioning children exist who show discrepancies between their

IQ and executive-function abilities. In the present study, we undertook a large-scale investigation of 470 normal-functioning children and adolescents, ages 8 to 19, who were administered both an IQ scale and a set of nationally normed executive-function tests. Using this large sample, we conducted (a) correlational analyses between the IQ and executive-functions measures, and (b) discrepancy analyses to determine if there are subgroups of children and adolescents with IQ/executive-function discrepancies. On the basis of past correlational studies, we hypothesized that (a) the correlations between the IQ indices and executive-function measures would tend to be relatively low, thereby supporting the divergent nature of these two domains of cognition, and (b) discrepancy analyses would reveal subgroups of children with better performances on executive-function measures relative to IQ tests or vice versa.

Method

Participants

Four hundred and seventy healthy youths, ages 8 to 19, participated in this study. The sample represents children involved in the national standardization study of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) and the Delis-Kaplan Executive Function System (D-KEFS; Delis et al., 2001). The WASI and D-KEFS were costandardized using a national sample of individuals matched to the demographic characteristics of the U.S. population based on the 2000 U.S. census report. The normative sample matched the U.S. population in terms of age, sex, race/ethnicity, years of parental education, and geographic region. Specific details about the national standardization study are described in the technical manuals of the WASI and D-KEFS (Delis et al., 2001; Wechsler, 1999). The WASI normative sample included 1,000 youths between the ages of 8 and 19, and the D-KEFS normative sample included 875 youths between the ages of 8 and 19. Of these individuals, 470 youths were administered both the WASI and the D-KEFS; these children and adolescents comprised the sample for the present study. Table 1 provides a demographic breakdown of this sample.

Exclusion criteria. Screening for exclusion criteria was based on parent questionnaires about developmental, educational, medical, and psychiatric histories of the children. Potential participants were excluded if one or more of the following criteria were endorsed: insufficient English-language proficiency; color blindness; uncorrected visual impairment; seeing a health professional for cognitive problems; upper extremity motor disability; history of head trauma (hospitalization greater than 24 hours), or other significant medical, psychiatric (e.g., schizophrenia), or neurological disorder (e.g., epilepsy, meningitis) that could affect cognitive performance.

Materials and Procedures

The cognitive measures included in this study were administered to participants as part of a national standardization study. Examiners were selected on the basis of experience with psychometric testing, certification, and licensing.

Table 1
Demographic Characteristics and Mean IQ Scores of the Normal Child Sample (*N* = 470)

Variable	*N*	% Sample
Demographics		
Race/ethnicity		
Caucasian	384	81.7
African American	40	8.5
Latino	33	7.0
Other	13	2.8
Gender		
Female	260	55.3
Male	210	44.7
Geographic region		
Northcentral	136	28.9
Northeast	104	22.1
South	155	33.0
West	75	16.0
	M (*SD*)	Range (minimum-maximum)
Age at assessment	12.69 (3.02)	8–19 years old
Grade level at assessment	6.83 (3.14)	1st grade to post–high school
WASI Full Scale IQ (4 subtest)	102.48 (12.94)	(66-139)
WASI Verbal IQ	102.52 (13.83)	(63-142)
WASI Performance IQ	101.89 (12.79)	(64-135)

Note: WASI = Wechsler Abbreviated Scale of Intelligence.

WASI. The WASI (Wechsler, 1999) was developed to provide an abbreviated test of intellectual functioning. The scale, which consists of four subtests (Vocabulary, Similarities, Block Design, and Matrix Reasoning), yields measures of Verbal IQ (VIQ), Performance IQ (PIQ), and Full Scale IQ.

D-KEFS. The D-KEFS consists of executive-function tests that assess a broad range of higher-level cognitive skills. The present study focused on five executive-function measures that, in recent studies, have been found to be particularly sensitive to frontal-lobe damage (e.g., Baldo, Shimamura, Delis, Kramer, & Kaplan, 2001; Cato et al., 2004; Delis, Squire, Bihrle, & Massman, 1992; McDonald, Delis, Norman, Tecoma, & Iragui, 2005; McDonald, Delis, Norman, Tecoma, & Iragui-Madozi, 2005; McDonald, Delis, Norman, Wetter, et al., 2005). These measures include the Switching Condition of the D-KEFS Trail Making Test, the Category Switching Condition of the D-KEFS Verbal Fluency Test, the Switching Condition of the D-KEFS Design Fluency Test, the Inhibition/Switching Condition of the D-KEFS Color-Word Interference Test, and the Sort Recognition Description measure of the D-KEFS Sorting Test. Table 2 provides a brief description of these tasks. Details about these measures are provided in the D-KEFS manual (Delis et al., 2001).

Table 2
Description of Selected Executive-Function Measures From the Delis-Kaplan Executive Function System (D-KEFS)

Executive-Function Measure	Description
Category Switching Condition, D-KEFS Verbal Fluency Test	Say as many “fruits” and “pieces of furniture” in 60 seconds while alternating between the two categories.
Switching Condition, D-KEFS Design Fluency Test	Draw as many designs in 60 seconds while switching between connecting filled and empty dots.
Number-Letter Switching Condition, D-KEFS Trail Making Test	Draw a line connecting numbers and letters in order while switching between the two sequences.
Inhibition/Switching Condition, D-KEFS Color-Word Interference Test	Switch between saying the ink color or read the word on a Stroop task that uses color words printed in a dissonant colored ink.
Sort Recognition Description, D-KEFS Sorting Test	Describe each of eight sorting rules of six cards that can be sorted into two groups, with three cards in each group.

Statistical Analysis

We conducted Pearson correlations between the selected D-KEFS scaled scores and the WASI VIQ and PIQ indices. In addition, we computed standardized discrepancy scores between the D-KEFS and WASI measures. To conduct discrepancy analyses directly between the WASI IQ indices and the D-KEFS scores, each D-KEFS scaled score was first converted to an IQ-like standardized score. This transformation was accomplished by first converting participants’ scaled scores for each D-KEFS measure into z scores ([scaled score − 10] / 3] = z score), then transforming the participants’ z scores into an IQ-like metric ([15 × z score] + 100). Finally, these IQ-like D-KEFS standardized scores were subtracted from each participant’s WASI VIQ and PIQ indices, yielding standardized discrepancy scores between the D-KEFS and WASI measures. After computing these difference scores, we examined the percentages of participants who had (a) a standardized score on a D-KEFS measure that was at least 1.0 standard deviation higher compared to his or her WASI VIQ or PIQ and (b) a standardized score on a D-KEFS measure that was at least 1.0 standard deviation lower compared to his or her WASI VIQ or PIQ. We also conducted a subgroup analysis to examine the frequency with which the children and adolescents fell into one of the following two general categories: (a) above-average mean executive-function (EF) score with average or lower VIQ level (the high-EF group) or (b) below-average mean EF score with average or higher VIQ level (the low-EF group). We chose to analyze VIQ for this global subgroup analysis because most school group achievement tests and college entrance exams are verbal in nature. Consistent with standard IQ classification ranges, an above-average mean EF score or VIQ index was defined as 110 or higher, and a below-average mean EF score or VIQ index was defined as 89 or lower.

Results

Table 3 shows the results of the Pearson correlations between the five D-KEFS measures and the two IQ indices for the entire sample of children and adults. The most important

Table 3
Intercorrelations Between D-KEFS Measures and WASI Verbal and Performance IQ Indices for the Entire Sample of Children and Adolescents (N = 470)

Variable	VIQ	PIQ
Category Switching Accuracy	.263**	.154**
Design Fluency Switching	.186**	.336**
Trail Making Test: Switching	.248**	.341**
Color-Word Interference Test: Inhibition/Switching	.156**	.210**
Sort Recognition Description	.402**	.427**

Note: D-KEFS = Delis-Kaplan Executive Function System; WASI = Wechsler Abbreviated Scale of Intelligence; VIQ = Verbal IQ; PIQ = Performance IQ.
**$p < .01$.

Table 4
Intercorrelations Between D-KEFS Measures and WASI Verbal and Performance IQ Indices for Different Age-Groups

	8-10 Years		11-13 Years		14-16 Years		17-19 Years	
Variable	VIQ N = 133	PIQ N = 133	VIQ N = 143	PIQ N = 143	VIQ N = 137	PIQ N = 137	VIQ N = 57	PIQ N = 57
Category Switching Accuracy	.165	.032	.296**	.216**	.453**	.294**	.321*	.292*
Design Fluency Switching	.064	.271**	.283**	.428**	.176*	.262**	.220	.441*
Trail Making Test: Switching	.143	.321**	.256**	.416**	.399**	.296**	.193	.319*
Color-Word Interference Test: Inhibition/Switching	.029	.135	.099	.212*	.316**	.274**	.240	.237
Sort Recognition Description	.393**	.460**	.374**	.416**	.463**	.452**	.348**	.335*

Note: D-KEFS = Delis-Kaplan Executive Function System; WASI = Wechsler Abbreviated Scale of Intelligence; VIQ = Verbal IQ; PIQ = Performance IQ.
*$p < .05$. **$p < .01$.

finding was that the majority of the correlations were relatively low, accounting for 0% to 18% of the total variance. As can be seen, all but one of these relatively low correlations reached statistical significance, which was likely due to the large sample size used in the present study (470 participants).

We also conducted Pearson correlations between the five D-KEFS measures and the two IQ indices for different age-groups (see Table 4) and for male and female participants (Table 5). As can be seen, relatively low correlations were also found for these subgroups, with the IQ measures accounting for 0% to 22% of the variance of the EF measures.

Table 5
Intercorrelations Between D-KEFS Measures and WASI Verbal and Performance IQ Indices for Males and Females

	Males		Females	
Variable	VIQ $N = 210$	PIQ $N = 210$	VIQ $N = 260$	PIQ $N = 260$
Category Switching Accuracy	.240**	.143*	.302**	.186**
Design Fluency Switching	.174*	.408**	.217**	.306**
Trail Making Test: Switching	.252**	.413**	.260**	.303**
Color-Word Interference Test: Inhibition/Switching	.232**	.252**	.089	.191**
Sort Recognition Description	.472**	.413**	.364**	.459**

Note: D-KEFS = Delis-Kaplan Executive Function System; WASI = Wechsler Abbreviated Scale of Intelligence; VIQ = Verbal IQ; PIQ = Performance IQ.
$*p < .05$. $**p < .01$.

Table 6
Percentage of Children and Adolescents Whose Verbal or Performance IQ Indices Were Significantly Discrepant From Their Scores on Executive-Function Measures

D-KEFS Variables	Verbal IQ vs. Executive-Function Measure	Performance IQ vs. Executive-Function Measure
Design Fluency Switching		
IQ < Design Fluency Switching	20.2	14.5
IQ > Design Fluency Switching	22.6	21.3
Category Fluency Switching		
IQ < Category Fluency Switching	17.9	19.1
IQ > Category Fluency Switching	19.6	20.6
Color-Word Interference Test		
IQ < Inhibition/Switching	17.1	17.5
IQ > Inhibition/Switching	22.8	19.2
Trails Switching		
IQ < Trails Switching	16.7	13.0
IQ > Trails Switching	22.0	16.7
Sort Recognition Description		
IQ < Sort Recognition	16.5	15.0
IQ > Sort Recognition	20.3	15.0

Note: D-KEFS = Delis-Kaplan Executive Function System.

The percentages of participants who exhibited significant discrepancies between the IQ indices and each of the D-KEFS EF measures are shown in Table 6. These analyses revealed that the percentages of participants with such discrepancies ranged from 13% to 23% across the different measures. For the subgroup analysis, 12.9% of the youths fell into the high-EF subgroup (above-average mean EF score with average or lower VIQ), and 7.2% of the youths fell into the low-EF subgroup (below-average mean EF score with average or higher VIQ).

Thus, a substantial percentage of children and adolescents exhibited different profiles of strengths and weaknesses on the IQ and EF measures.

Discussion

Neuropsychological research has increasingly discovered that IQ and achievement tests, although critical for evaluating more rote knowledge or fundamental skills such as language, reading, spelling, math, and perception, generally do not provide an adequate assessment of higher-level executive functions that are thought to be mediated largely by the frontal lobes. These findings have created the need for neuropsychologists to include measures of executive functions in addition to tests of more rote-knowledge skills in the assessment of individuals with possible cognitive deficits from brain injury or disease. These discoveries have also raised concerns about long-standing assessment practices in school settings in which the emphasis has been placed largely on the evaluation of more rote-knowledge skills using IQ and achievement measures, with less attention given to the assessment of higher-level cognitive abilities (Gardner, 1993; Sternberg, 1985; Sternberg et al., 2003).

The present study examined this potential shortcoming further by (a) conducting a large-scale correlational study between IQ and EF measures using 470 normal-functioning children and adolescents, (b) exploring the frequency with which school-age youths exhibit significant discrepancies between their intellectual and EF skills, and (c) examining whether subgroups of children exist who have above-average EF skills with average or lower VIQ scores (the high-EF group) or who have below-average EF skills with average or higher VIQ scores (the low-EF group). Consistent with previous preliminary studies, we found that the correlations between IQ and EF measures for the entire sample of children and adolescents were generally low, with the IQ measures accounting for only 0% to 18% of the variance of the EF tests. These relatively low correlations were also found across the different age-groups and for male and female participants. These results suggest that, as reported in numerous neuropsychological studies, IQ and EF skills are relatively divergent cognitive domains and that IQ tests do not provide a sufficient or comprehensive assessment of higher-level executive functions.

The most important finding in the present study was the frequency with which children and adolescents exhibit significant discrepancies on IQ tests relative to EF measures. We found that 13% to 23% of children and adolescents display significant discrepancies on IQ tests relative to EF measures. In addition, in our sample of 470 youths, 12.9% fell into the high-EF subgroup (i.e., above-average EF skills with average or lower VIQ scores), whereas 7.2% fell into the low-EF subgroup (below-average EF skills with average or higher VIQ scores).

The present findings have potentially important implications for school assessment practices. The results suggest that a significant subgroup of school-age children exists who have relative strengths in more rote-verbal skills but who have relative weaknesses in their capacity for abstract, higher-level thinking. For these children, the current emphasis on IQ and achievement testing in our school systems likely results in academic promotions and honors for them without identifying and helping them in their areas of weaknesses. The current findings also suggest that there is another subgroup of children who could represent perhaps the most alarming fallout of our current school assessment practices. Specifically, a substantial number of youths likely have relative weaknesses in more rote-verbal skills but have strengths in higher-level executive functions such as abstract thinking, cognitive flexibility, and problem-solving skills. These children and adolescents are at risk for being hindered or precluded in their pursuit of higher levels of educational attainment in large part by the relatively low scores they obtain on IQ scales, group achievement tests, and college entrance exams. That is, these tests may represent roadblocks to areas of study that could benefit from the creativity that these students offer. It is not uncommon for these students to develop lower self-esteem based on the scores they receive on these tests.

Although the current findings provide empirical support for the limitations of our long-standing school assessment practices, more poignant illustrations of these shortcomings can often be seen in the accounts of creative individuals who, at some point along their educational paths, had struggled with the hardships created by tests that focus primarily on more rote-verbal skills. For example, one scientist found that the most significant "blow" that he had experienced as an aspiring scholar occurred when he was trying to advance his academic career:

> At that time, the most famous technical school in central Europe outside of Germany was the Swiss Federal Polytechnic School in Zurich. Einstein went there and took the entrance examination. He showed that his knowledge of mathematics was far ahead of that of most of the other candidates, but his knowledge of modern languages and the descriptive natural sciences (zoology and botany) was inadequate, and he was not admitted. (Frank, Kusaka, & Rosen, 1947/2002, p. 18)

A recent account of how the emphasis on more rote-verbal testing in school settings may hinder a student's desire to pursue more creative fields of study was written by the renowned behavioral neurologist Dr. Kenneth Heilman. In a recent book called *Pathways to Prominence in Neuropsychology* (Stringer, Cooley, & Christensen, 2002), which is composed of autobiographical chapters written by famous neuropsychologists and neurologists on how they became researchers in this field, Dr. Heilman discussed his early struggles in school:

> When my friends were taking placement tests for college preparatory high schools in New York, I was not allowed to even attempt the tests. I had scored too low on standardized tests back in the third grade, and I was steered toward trade school. I knew, however, that if I went to trade school I could not be a scientist.
>
> I did not do well in my academic courses. For example, my Spanish teacher, Mrs. X, failed to understand why I could not spell in Spanish, since Spanish has complete sound-letter correspondence. Mrs. X told me that I was not "college material" and repeatedly failed me, I suspect, to prevent me from getting my college preparatory degree.
>
> I think that my third-grade teacher, my junior high advisors, and Mrs. X would be surprised that I graduated from high school, got into college, attended medical school, and contributed to the growth of scientific knowledge. When they predicted failure for me, they could not have known that I would be fortunate to have wonderful mentors, friends, and colleagues. It is the support, guidance, and knowledge of these people that allowed me to make contributions to our understanding of the brain. (Heilman, 2002, p. 139)

As discussed above, more rote-verbal skills like vocabulary, reading, and math are vital cognitive abilities for success in all aspects of life, including academic advancement and career success. It is essential that school-age children and adolescents continue to receive regular evaluations of these more fundamental cognitive abilities. However, the relative lack of formal evaluations of higher-level executive functions in school-age children and adolescents may represent a serious deficiency in our educational system. In our modern society, a growing number of professions are in need of individuals who have particular strengths in abstract, problem-thinking skills. The relative lack of assessment tools used in school settings to assess these higher-level cognitive skills may hinder our ability to steer the best students into these types of careers (see also Sternberg et al., 2003).

In summary, the present results suggest that school and university systems should strive to broaden the scope of their cognitive evaluations to include tests of both rote knowledge and higher-level executive functions. In this way, children with either selective deficits or strengths in executive functions can be more accurately identified and guided into the educational programs and career paths that best fit their needs and abilities.

References

Ardila, A., Pineda, D., & Rosselli, M. (2000). Correlation between intelligence test scores and executive function measures. *Archives of Clinical Neuropsychology*, *15*, 31-36.

Baldo, J. V., Shimamura, A. P., Delis, D. C., Kramer, J., & Kaplan, E. (2001). Verbal and design fluency in patients with frontal lobe lesions. *Journal of the International Neuropsychological Society*, *7*, 586-596.

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, *50*, 7-15.

Bohm, B., Smedler, A. C., & Forssberg, H. (2004). Impulse control, working memory and other executive functions in preterm children when starting school. *Acta Paediatrica*, *93*, 1363-1371.

Cato, M. A., Delis, D. C., Abildskov, T. J., & Bigler, E. (2004). Assessing the elusive cognitive deficits associated with ventromedial prefrontal damage: A case of a modern-day Phineas Cage. *Journal of the International Neuropsychological Society*, *10*, 453-465.

Damasio, A. R. (1995). *On some functions of the human prefrontal cortex*. New York: New York Academy of Sciences.

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan Executive Function System*. San Antonio, TX: The Psychological Corporation.

Delis, D. C., Squire, L. R., Bihrle, A. M., & Massman, P. J. (1992). Componential analysis of problem-solving ability: Performance of patients with frontal lobe damage and amnesic patients on a new sorting test. *Neuropsychologia*, *30*, 683-697.

Filley, C. M., Young, D. A., Reardon, M. S., & Wilkening, G. N. (1999). Frontal lobe lesions and executive dysfunction in children. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, *12*, 156-160.

Frank, P., Kusaka, S., & Rosen, G. (2002). *Einstein: His life and times*. New York: Da Capo Press. (Original work published 1947)

Gardner, H. (1993). *Frames of mind: The theory of multiple intelligences.* New York: Basic Books.

Geurts, H. M., Verte, S., Oosterlaan, J., Roeyers, H., & Sergeant, J. A. (2005). ADHD subtypes: Do they differ in their executive functioning profile? *Archives of Clinical Neuropsychology*, *20*, 457-477.

Heilman, K. M. (2002). The making of a behavioral neurologist-neuropsychologist. In A. Y. Stringer, E. L. Cooley, & A.-L. Christensen (Eds.), *Pathways to prominence in neuropsychology* (pp. 139-155). New York: Psychology Press.

Jensen, A. R. (1998). *The G factor: The science of mental ability*. Westport, CT: Praeger.

Luria, A. R. (1973). *The working brain*. New York: Basic Books.

McDonald, C. R., Delis, D. C. Norman, M. A., Tecoma, E. S., & Iragui, V. J. (2005). Discriminating patients with frontal lobe epilepsy and temporal lobe epilepsy: Utility of a multi-level design fluency test. *Neuropsychology*, *19*, 806-813.

McDonald, C. R., Delis, D. C., Norman, M. A., Tecoma, E. S., & Iragui-Madozi, V. I. (2005). Is impairment in set-shifting specific to frontal-lobe dysfunction? Evidence from patients with frontal-lobe or temporal-lobe epilepsy. *Journal of the International Neuropsychological Society*, *11*, 477-481.

McDonald, C. R., Delis, D. C., Norman, M. A., Wetter, S. R., Tecoma, E. S., & Iragui, V. J. (2005). Response inhibition and set-shifting in patients with frontal-lobe epilepsy or temporal-lobe epilepsy. *Epilepsy and Behavior*, *7*, 438-446.

Mesulam, M. (1986). Frontal cortex and behaviour. *Annals of Neurology*, *19*, 320-324.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. New York: Cambridge University Press.

Sternberg, R. J., Lautrey, J., & Lubart, T. I. (2003). *Models of intelligence*. Washington, DC: American Psychological Association.

Stringer, A. Y., Cooley, E. L, & Christensen, A.-L. (Eds.). (2002). *Pathways to prominence in neuropsychology*. New York: Psychology Press.

Stuss, D. T., Benson, D. F., Kaplan, E. F., Weir, W. S., Naeser, M. A., Lieberman, I., et al. (1983). The involvement of orbitofrontal cerebrum in cognitive tasks. *Neuropsychologia*, *21*, 235-248.

Stuss, D. T., & Knight, R. T. (2002). *Principles of frontal lobe function*. New York: Oxford University Press.

Teuber, H. L. (1964). The riddle of frontal lobe functions in man. In J. M. Warren & K. Akert (Eds.), *The frontal-granular cortex and behavior*. New York: McGraw-Hill.

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence*. San Antonio, TX: The Psychological Corporation.

Welsh, M. C., Pennington, B. F., & Grossier, D. B. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology*, *7*, 131-149.