## General Introduction

Neuropsychological testing in pediatric epilepsy poses unique challenges compared to adults given the developmental trajectory that affects the normative/reference databases. Also different in pediatric epilepsy is that the frequency and types of syndromes differ, with a larger representation of catastrophic and generalized epilepsies, with fewer patients with focal onset epilepsy. The list of cognitive domains listed below is not exhaustive, but intended to capture relevant areas across a variety of pediatric epilepsy syndromes that are seen in the 6-16 year old age range to facilitate direct comparisons across studies and potentially to permit data pooling across studies or epilepsy centers. Specific tests have been recommended in different cognitive domains.

We also recognize that established investigators may wish to use tests that differ from those recommended in order to maintain continuity within and fidelity to their own research program. We have made specific recommendations for normative values. We also recognize that some of the norms are less than ideal, and expect that normative recommendations may change as better normative information accumulates. However, normative information can always be updated from original raw score values. The recommended tests are intended for use either by appropriately trained psychologists, or by neuropsychology technicians under appropriate supervision.

The selection of tests was based upon multiple factors, including previous use in the literature, adult CDE recommendations, and Spanish form availability. Wherever possible, Spanish versions of neuropsychological tests are indicated, and the availability of parallel Spanish tests was one fact influencing test recommendation. We note, however, that the strict equivalence to English language versions has not always been demonstrated, and the normative data available for Spanish is often less than English language versions of the tests. Nevertheless, using these measures increases the potential participation of non-English speaking subjects and increase the generalizability of research findings, and Spanish test versions should be utilized even in the absence of equivalent normative information.

## Section I: Specific Test Recommendations (6-16 year olds)

### GENERAL FUNCTION

1. Formal IQ
   1. Purpose: To characterize level of general cognitive abilities using standardized IQ assessment.
   2. Recommended Test: Wechsler Intelligence Scale for Children -Fourth Edition (WISC-IV) or Wechsler Abbreviated Scale of Intelligence (WASI). Alternatively, a WISC-IV short-form could be used.

### LEARNING/MEMORY

1. Verbal Memory
   1. Purpose: To assess verbal learning and memory.
   2. Recommended Test: California Verbal Learning Test Children’s Version (CVLT-C)
   3. Alternative Test for Older Children 15-16: Rey Auditory Verbal Learning Test (AVLT)
2. Visual Memory
   1. Purpose: To assess non-verbal learning and memory
   2. Recommended Test: None

Comment: There is no recommended visual memory CDE since there are few studies on right TLE/ATL and visual memory in children, making it premature to recommend a common memory test for this construct.

### LANGUAGE

1. Naming
   1. Purpose: To assess the ability to name common objects.
   2. Recommended Test: Boston Naming Test (BNT)
2. Generative Verbal Fluency (phonemic)
   1. Purpose: To assess lexical retrieval. May also be used as a measure of “executive function.”
   2. Recommended Test: Controlled Oral Word Association (COWA), aka FAS
3. Generative Verbal Fluency (semantic)
   1. Purpose: To assess retrieval from semantic storage.
   2. Recommended Test: Animal Fluency (aka Animal Naming)
4. Language Development (optional domain)
   1. Purpose: To assess grammatical and pragmatic aspects of language development
   2. Recommended Test: Clinical Evaluation of Language Fundamentals- Fourth Edition (CELF-4)

### VISUOSPATIAL (optional domain)

1. General Visuospatial Function
   1. Purpose: To assess non-verbal spatial perception and reasoning.
   2. Recommended Test: WISC-IV or WASI Block Design

Comment: This test is administered for studies that use the WISC-IV or WASI.

1. Perceptual Reasoning
   1. Purpose: To assesses non-verbal spatial perception and reasoning
   2. Recommended Measures: WISC-IV Perceptual Reasoning Index
2. Setshifting
   1. Purpose: Assess visual search, mental flexibility, and task alternation.
   2. Optional Test: Trail Making A and B
3. Simple Span of Attention
   1. Purpose: To assessment immediate attention
   2. Recommended Tests: Digit Span subtest from the WISC-IV
4. Hypothesis Testing (optional)
   1. Purpose: To assess deductive reasoning ability, perseverative ideation, and failure to maintain cognitive set.
   2. Recommended Test: Wisconsin Card Sorting Test (64 card version)
5. Executive Function Rating
   1. Purpose/Rationale: Problems with executive functioning are common in children with epilepsy seen in tertiary centers, and may significantly impact quality of life. However, by virtue of being administered in a structured, novel, quiet, one-on-one testing environment, standard tests of executive functioning do not always allow executive deficits to emerge during test administration. Specialized questionnaires completed by family members are therefore a useful alternative to cognitive testing for assessing executive functions in children. The only executive functioning scale for use with children is the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy & Kenworthy, 2000).

### SPEED

1. Processing Speed
   1. Purpose: Measure graphomotor and psychomotor speed.
   2. Recommended Tests: WISC-IV Coding and Symbol Search to generate the Processing Speed Index
2. Motor Speed
   1. Purpose: Assess fine motor speed
   2. Recommended Test: Grooved Pegboard
3. Sustained Attention
   1. Purpose: Assess sustained visual attention and inhibition of impulsivity over time.
   2. Recommended Test: Conners Continuous Performance Test II Version 5 (CPT-II V.5).

### BEHAVIORAL RATING SCALES

1. Behavior Co-morbidity Rating
   1. Purpose: To characterize behavioral and emotional problems
   2. Recommended Test: Child Behavior Checklist (CBCL)
2. Adaptive Behavior Rating (Optional)
   1. Purpose: To characterize adaptive behavior delays and developmental level, which is important in pediatric epilepsy research because of the high base rate of cognitive delays in children who have intractable or catastrophic epilepsies (e.g., pediatric epilepsy surgery candidates; Lennox-Gastaut). In addition, adaptive rating scales provide an estimate of functional ability in otherwise untestable children whose levels are too low for standard neuropsychological and cognitive testing, and appear to be highly predictive of quality of life in children with epilepsy.
   2. Recommended Test: Although research does not clearly point to one scale over others for assessing this domain, the Scales of Independent Behavior-Revised (SIB-R) is recommended because of its ease of use (can be administered in questionnaire format rather than via interview) and availability of a short form; other scales such as the Vineland Adaptive Behavior Scales, Second Edition (Vineland-II) and Adaptive Behavior Assessment Scale (ABAS-II) may also be considered as well.

## Section II: Rationale (6-16 year olds)

Whereas Section I contains the CDE Neuropsychology Group’s recommendations for specific test use, Section II is intended to provide the rationale behind specific test recommendation. Whenever possible, tests were selected that would permit long-term followup assessment into adulthood.

### FORMAL IQ

IQ is a more critical feature to formally assess in pediatric neuropsychology compared to adults, in part because of the higher base rate of cognitive disability in pediatric epilepsy samples, and because IQ levels are typically used to assign school resources and accommodations. Consequently, there are no non-IQ tests that allow estimation of levels as is present in the adult neuropsychology test recommendations (i.e., AMNART). We are recommending either the full standard IQ test (i.e., Wechsler Intelligence Scale for Children, 4th edition, or WISC-IV), the formal Wechsler Abbreviate Scale of Intelligence (i.e., WASI), or an acceptable short-form WISC-IV version.

The WASI, which can be administered to patients ranging in age from 6 to 89 years, has a clear advantage for studies spanning a larger age range or for longitudinal studies of childhood that extend into adulthood. However, the FSIQ, VIQ, and PIQ summary scores derived from the WASI do not include working memory or processing speed subtests, both of which are generally more sensitive to both disease and treatment effects. Consequently, using the FSIQ derived from the WASI may overestimate FSIQ in epilepsy patients compared to FSIQ scores derived from the WISC-IV.

The WISC-IV was released in 2003, and is the most commonly used IQ test for children. In addition, there is a formal WISC-IV Spanish version, which includes norms appropriate for the diverse U.S. Hispanic population.

Recommended Tests: WASI, WISC-IV, or WISC-IV short form ([Click here for the Pearson Clinical website](http://psychcorp.com/)).

### LANGUAGE

Language testing is an important part of neuropsychological evaluation in most clinical populations. As with adult assessment, naming using the Boston Naming Test and generative verbal fluency using letter prompts and category prompts (i.e., animals) form the core of most language assessments. Language development in children reflects acquisition of grammatical as well as lexical knowledge, and consequently, will require more specialized assessment. However, epilepsy is likely to have a broader impact on language development that affects a child’s ability to communicate effectively with parents, teachers, and peers and negatively influence academic and social development. In order to further assess more subtle but equally important dimensions of language development, several additional measures were considered, and the committee chose to make recommendation for optional test use (i.e., CELF 4) when a more comprehensive language assessment is needed to address study-specific language issues. Of note, there are other language tests and batteries that can be used for this purpose as well, since research does not yet inform on the differential sensitivity of different language tests/batteries in pediatric epilepsy. Spanish versions of all tests are available.

### Naming

The most common measure of naming is the 60-item Boston Naming Test (BNT). The BNT is sensitive to naming decline following surgical resection of the language dominant hemisphere, and there have been reports from multiple investigators suggesting a relationship between seizure onset laterality and BNT scores in patients with TLE (Busch, Frazier, Iampietro, Chapin, & Kubu, 2008). The BNT is widely used in other diseases including dementia, multiple sclerosis, and stroke.

Recommended Test: Boston Naming Test ([Click here for the Pearson Clinical website](http://psychcorp.com/)).

### Fluency

Generative verbal fluency is part of most neuropsychological assessment protocols and not only is sensitive to deficits in language fluency associated with linguistic impairment, but is also a common approach that has been associated with impairments in executive function.

There are 2 common techniques to measuring generative verbal fluency. The first approach requires the patient to generate as many words as possible that begin with a specified letter of the alphabet, and is termed “phonemic” fluency. In most cases, there are three 60-second trials administered. The most common letters used are F-A-S, and this test if often informally referred to as the FAS test.

Parallel test versions have been constructed using C-F-L and P-R-W as stimulus prompts, and the Delis-Kaplan Executive Function System (D-KEFS) battery contains F-A-S and a parallel set using B-H-R as stimuli. However, despite the advantage of alternative versions that would facilitate followup testing, C-F-L is not of equivalent difficulty to F-A-S, and the committee did not want to require the purchase of the D-KEFS material that would be required for employing B-H-R parallel forms.

F-A-S is more commonly used both in clinical practice and in neurologic research studies. In addition, the available normative databases for F-A-S is greater, with the user able to select norms based upon the Heaton et al manual although pediatric norms do not exit, or relying on norms that form part of the Delis-Kaplan Executive Function System (D-KEFS). All stimulus versions (i.e., F-A-S, C-F-L, P-R-W) have been referred to as Controlled Oral Word Association (COWA).

The Spanish version of this test uses the letters using letters PMR to adjust for language difference in frequency of words beginning with different letters.

Recommended Test (phonemic): F-A-S, aka COWA

The second approach assessing generative verbal fluency uses semantic constraints, with the most common semantic category being animals (also called animal naming). Although there are inconsistent research findings contrasting phonemic to semantic fluency tasks, semantic fluency appears to be more disrupted in diseases that first affect the semantic memory systems (e.g., Alzheimer’s disease). It was the consensus of the committee that as greater understanding of the changes in semantic memory that occurs following temporal lobe resection is obtained, semantic fluency should be assessed routinely given its minimal additional time for assessment and scoring.

Other semantic fluency tasks include fruits and vegetables, items in a supermarket, etc. However, animal fluency is the most commonly administered task in both clinical and research settings. Animal Fluency is obtained as part of the D-KEFS, then the Animal Fluency score should be reported independently from the D-KEFS Semantic Fluency score, which is based upon Animal Fluency combined with other semantic fluency tasks.

Recommended Test (semantic): Animal Fluency (Animal Naming)

### Language Development (Optional)

The CELF 4 is a language battery designed to identify and describe language disorders in children and young adults from 5-21 years of age. It utilizes a stepwise approach to assessing language disorders that allows for flexibility in administration and decreases assessment time. Level 1 screens for language disorders. Subsequent levels permit further definition of the functional (e.g., strengths, weaknesses, affected modalities, content areas, conditions that enable the student to perform well) and structural (e.g., clinical skill deficits underlie the disorder such as working memory, automaticity of speech, phonological awareness) and applied dimensions of the language disorder. A Spanish version of the test is available.

Measures of test-retest reliability for the composite/index scores range from .88 to .92; internal consistency (Cronbach’s Alpha) ranges from .87 to .95 for composite/index scores. Several subtests require examiner judgment, and inter-rater reliability for these subtests is also good (.88 to .99). There are a number of validity studies that indicate sensitivity and specificity for diagnosing language disorders is high.

Despite clinical and technical advantages for the CELF 4 in assessing language disorders, there is little information on the clinical utility of the CELF 4 in children with epilepsy. One study, presented at the American Speech-Language Hearing Association conference in 2006 (Strekas et al., ASHA, 2006) found that children with left temporal lobe epilepsy performed more poorly on the CELF 4 Expressive Language index. However, the abilities assessed by this index of the CELF 4 include naming and expressive vocabulary, which are also assessed by other tests that are recommended (Boston Naming Test, WISC-IV Vocabulary subtest). Although there are other studies that indicate a high incidence of complex language disorders in children with different forms of epilepsy, the incremental value (beyond language measures already selected) of the CELF 4 in identification of epilepsy-specific language disorders has not been demonstrated.

Recommended Test (optional): Clinical Evaluation of Language Fundamentals- Fourth Edition (CELF-4) ([Click here for the Pearson Clinical website](http://psychcorp.com/)).

### Verbal Memory

Memory assessment options included a choice between a memory test battery (e.g., Children’s Memory Scale) and individual memory test. The committee did not consider making specific recommendations for a visual memory test given the limited research findings on a consistent clinical relationship to visual memory test findings.

Concerns were expressed about selecting a specific test battery such as the CMS, WRAML-2 or TOMAL-2 despite the use of some of these batteries in some clinical trials. In particular, there was concern for long-term consistency of the test materials since changes in test material and administration often accompanies test revisions, and since research was not yet informative as to which batteries were superior to others in children with epilepsy.

There were 4 verbal learning tests that were considered, 3 of which are explicitly designed for pediatric use: California Verbal Learning Test Children’s Version (CVLT-C), the Rey Auditory Learning Test (RAVLT), and the Children’s Auditory Verbal Learning Test-2 (CAVLT-2), and one designed for adults but has been used in pediatric application (Rey Auditory Verbal Learning Test, AVLT). The pediatric tests contain words that are semantically related (CVLT-C and CAVLT-2). However, unlike the adult literature, there exists as yet no research in children on the differing sensitivity of these different test batteries, nor is there research on whether inclusion of semantically related test items increases sensitivity in the child age group. Therefore, the absence of related words could not be used to help make the specific test selection. The CVLT-C was selected since it contains normative information covering a larger age range.

However, there will be cases in which older adolescents (e.g., ages 15-16 years) may wish to be followed longitudinally or be combined with young adults. In these cases, we suggest using the Rey AVLT (the recommended verbal learning test for adults) in order avoid introducing testing discontinuities in study design. Spanish versions of both the CVLT-C and AVLT are available.

Recommended Test: California Verbal Learning Test Children’s Version (CVLT-C) ([Click here for the Pearson Clinical website](http://psychcorp.com/)).

Alternative Test for Older Adolescents: Rey Auditory Verbal Learning Test (AVLT) ([Click here for the WPS website](http://portal.wpspublish.com/portal/page?_pageid=53,70251&_dad=portal&_schema=PORTAL).

### Visuospatial Testing (Optional)

Spatial skills are not typically a primary interest in most epilepsy studies. Other than improvement following contralateral/dominant hemisphere surgery, visuospatial performances tend to remain stable. In addition, there is greater variability in tests used to measure visual spatial abilities compared to language measures (e.g., Judgment of Line Orientation, Beery Visual Motor Integration, Rey-Osterreith Complex Figure copy).

Rather than recommend an additional test to the CDE neuropsychology protocol, the committee is cognizant of the fact that in most cases, Block Design will be administered as part of the Wechsler IQ testing. Consequently, when an individual visual spatial task is needed, performance on the Block Design subtest can be used.

For studies using the WISC-IV, the Perceptual Reasoning Index (PRI) derived from performances on Block Design, Matrix Reasoning, and Picture Concepts can be used. If the WASI has been used, then the PIQ, which is analogous to the WISC-IV PRI given the absence of tests of processing speed, can be reported.

Recommended Tests: Block Design, WISC-IV Perceptual Reasoning Index ([Click here for the WASI website](http://www.pearsonassessments.com/HAIWEB/Cultures/en-us/Productdetail.htm?Pid=015-8981-502)).

### Executive Function

Executive function refers to a diverse set of cognitive processes (e.g., sustained and divided attention, working memory, initiation, inhibition, planning, shifting of mental perspectives, or ‘sets’) that depend primarily on the functional integrity of the frontal lobes, although impairments on these tests may also be seen with lesions in other brain regions.

### Trail Making Test (Optional)

Trail Making assesses visual attention and mental flexibility, and consists of 2 separate components (Trails A and Trails B). Trails A requires the patient to required to draw lines between circles containing numbers from 1-25 in ascending (‘connect the dots’), and time to completion is recorded. Trails B requires the subject to alternate between numbered and lettered circles in ascending/alphabetical order (i.e., 1-A-2-B) with completion time being the primary dependent measure. For both Trails A and Trails B, the number of sequencing errors is often also recorded.

Trail Making is one of the most widely used neuropsychological tests and is well-accepted by the neuropsychological and neurologic community. It is a “double-duty” task, insofar as its processing speed demands make it sensitive to diffuse neurologic dysfunction and the effects of AEDs. The number of errors on Trails B successfully discriminated frontal and temporal lobe epilepsy patients in one study (Upton & Thompson, 1996), but no differences were found in another (Exner et al., 2002). Completion time was sensitive to the tapering of topiramate, a novel AED with known cognitive side effects (Kockelmann, Elger, & Helmstaedter, 2003).

Although Trails B is considered to be more sensitive to executive function deficits than Trails A due to its task alternation characteristics, Trials B should not be given alone without the administration of Trails A because that significantly alters the task demands without the practice effects associated with first completing Trails A.

Both Trails A and Trails B generally takes less than 10 minutes to administer and score. There is some variation in test administration, having to do with whether and how errors are corrected during performance, and this was a concern expressed by some committee members about making Trail Making a epilepsy CDE. . An intermediate version is available for use in children 9-14.

There was considerable discussion, too, whether this is a sufficiently sensitive measure to recommend. However, since Trailmaking is already part of the larger NIH CDE framework, it was decided to include Trailmaking as an optional test.

Recommended Test (Optional): Trails A and B

### Stroop Task (Not Recommended)

The Stroop Test assesses both processing speed and response inhibition. Multiple Stroop Test versions are available whose stimuli and procedures vary somewhat. All versions include an interference condition in which the subject has to inhibit a prepotent or dominant response to perform a dissonant one (e.g., say ‘blue’ when seeing the word ‘green’ printed in blue ink). Scores on versions of the Stroop have been shown to discriminate between patients with frontal and temporal lobe epilepsy (Helmstaedter, Kemper, & Elger, 1996; Upton et al., 1996).

After discussions of the advantages and disadvantages of various “Stroop” approaches, there was additional discussion of the frequency of selective impairment of the color/word inhibition tasks associated with executive dysfunction. Based upon the absence of consistent findings, and the variability of the approach used for assessment, the consensus of the group was to consider this task to be optional. In addition, because one version of the tests has not been shown to be clearly superior to others, a decision was made to not include any Stroop as a recommended over others. Finally, there are likely inherent difficulties in eliciting a true “Stroop” effect in young children because the assumption that reading is the prepotent/automatic response is not necessarily valid.

Recommendation: NOT RECOMMENDED

### Simple Attention

The WISC-IV Digit Span provides a separate assessment of span of apprehension (Digits Forward) and working memory (Digits Backward). It is a well-established and familiar measure of auditory attention that is often used informally by neurologists and neuropsychologists on bed-side mental status testing. Different elements of the test have discriminated between patients with frontal and temporal lobe epilepsy (Helmstaedter et al., 1996; Exner et al., 2002) and have been sensitive to the tapering of topiramate (Kockelmann et al., 2003).

Typical administration of forward and backward span takes 5-7 minutes and requires only a test form. Nationally-representative norms are available for ages 6-16 (WISC-IV). WISC-IV test booklets are copyrighted and can be purchased separately from the test publisher ([Click here for the Pearson Assessment website](http://psychcorp.com/)). Permission to photocopy single pages of the booklets for an annual fee can also be arranged with the publisher.

Recommended Test: WISC-IV Digit Span ([Click here for the Pearson Assessment website](http://psychcorp.com/)).

### Hypothesis Testing Ability

The WCST assesses abstraction ability and the ability to shift (or tendency to perseverate to) cognitive strategies in response to changing reinforcement conditions. The subject sorts cards with different designs to 4 target cards according to latent sorting principles that shift at various points during the procedure. There is an extensive literature documenting its sensitivity to frontal lobe structural lesions and frontal dysfunction in other conditions (e.g., schizophrenia). Versions of the WCST have been shown to discriminate between patients with frontal and temporal lobe epilepsy in some studies (Giovagnoli, 2001; Upton et al., 1996; Piazzini, Turner, Vignoli, Canger, & Canevini, 2008) but not all (Exner et al., 2002).

The WCST is recommended primarily for cross-sectional studies in which executive function is a focus of the study hypotheses. It is less sensitive to longitudinal change, due to substantial practice effects that develop after learning the task demands. For example, in normal samples, the number of perseverative errors and responses decreased by over half on retesting. Reliable change indices tend to exceed 1 SD (Strauss et al., 2006). It is also recommended as optional due to administrative burden (see below).

Multiple versions of the WCST have been developed and normed, although Heaton’s version remains the most commonly used. There is no clear consensus about the relative validity and responsiveness of the 64 and 128-card versions, although it has been suggested that the 128-card version may be more sensitive to subtler effects (Strauss et al., 2006). The test requires the card decks and test form. Copyrighted test materials and unlimited-use, computer administration and scoring programs are available from the publisher ([Click here for the PAR website](http://www4.parinc.com/)). Administration time is about 15-30 minutes. We have recommended the 64 card version since some centers prefer the shorter version due to time considerations and because a 64 card score can be calculated, even if the 128 card version is administered.

The WCST is considered to be an “optional” domain for several reasons. First, there is a significant practice effect associated with its use, thereby diminishing its sensitivity in longitudinal trial designs. The other reason is that it can be time intensive to administer and score without clearly established incremental benefit from other tests included in these recommendations. Since this is the most commonly used version, it will facilitate comparisons across studies.

Recommended Test: Wisconsin Card Sorting Test (64 card version) ([Click here for the Pearson Assessment website](http://psychcorp.com/))

### Speed

Psychomotor Speed

Slowing of cognitive and psychomotor speed is a commonly reported cognitive complication of epilepsy. Cognitive and psychomotor slowing has been reported in adults (Taylor et al., in press) and children with new onset epilepsy (Fastenau et al., in press, Hermann et al., 2006), it is a common complication of antiepilepsy medications (Loring et al., 2007), may worsen over time (Hermann et al., 2006), and persist after remission of epilepsy in children (Berg et al., 2008).

We have selected the PSI of the WISC-IV because these scores will be available whenever the full WISC-IV is administered, and well as multiple studies indicating that its components are sensitive to the factors listed above. The PSI is composed of two subtests (coding, symbol search). It is well-standardized, commercially available, used commonly in epilepsy research. It forms part of standard IQ assessment but it commonly used individually. This score is comprised of performance from the Coding and Symbol Search Wechsler subtests and administration time is extremely efficient. A disadvantage is cost.

Recommend Tests: Coding and Symbol Search, which form the Processing Speed Index. ([[Click here for the Pearson Assessment website](http://psychcorp.com/))](http://psychcorp.com/)).

Motor Speed

Motor speed may be assessed by a variety of procedures including measures of reaction time (Thompson & Trimble, 1983) or more conventional measures of motor speed used in clinical neuropsychological evaluations (Grooved Pegboard, Finger Tapping). While reaction time measures are perhaps extremely pure motor speed measures and have been used in epilepsy research (Thompson & Trimble, 1983), they are not widely used clinically and have limited normative data. More conventional clinical measures have the advantage of familiarity and strong normative databases and are brief and direct in administration time and directions.

Grooved Pegboard was selected due to its widespread use and its purported greater sensitivity to lateralized brain impairment than other motor speed measures such as finger tapping. Importantly, one of the reasons that finger tapping was not selected is that it has historically been given with various sets of instructions and the timing of each 10 second trial introduces significant measurement error. Grooved pegboard has been effectively used to characterize fine motor speed in multiple epilepsy studies.

Recommended Test: Grooved Pegboard

### Sustained Attention

Even though there was no recommendation for sustained attention in the adult tests, attentional disorders are common in pediatric populations and are a frequent co-morbidity in epilepsy. The two most common tests of sustained attention are the Continuous Performance Test-II (CPT-II) and the Tests of Variable of Attention (TOVA), and the committee felt as though there were clear advantages and disadvantages of each test. Because the CPT is shorter than the TOVA and has been used as a primary cognitive outcome in funded pediatric epilepsy trials (i.e., CAE trial), it was chosen as the recommended test.

There were important advantages associated with the TOVA, and the committee felt that if there were study-specific questions that the CPT-II did not fully address, then this would be an appropriate measure to include. The TOVA uses non-language visual targets and distractors. More importantly, unlike the CPT-II, there are two types of tasks. In addition to the condition that is analogous to the CPT-II that assess inhibitory processing containing a frequently occurring target, there is a condition which measures boredom in which the target occurs infrequently. The TOVA is longer than the CPT-II, requiring approximately 22 minutes to administer.

Recommended Test: Conners Continuous Performance Test (CPT)

Alternative Test: Test of Variables of Attention (TOVA)

### Executive Function Rating

Because one concern of neuropsychological testing is its relationship to real world function, and because of the multifaceted nature of the construct of “executive” abilities, the inclusion of the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) is recommended. The BRIEF a standardized parent questionnaire designed to assess real-world behaviors in children related to executive functioning in the home. The scale is increasingly being used to characterize executive function in both clinical and research settings. Despite the fact that this is a copyrighted test associated with ongoing expense in research applications, the committee felt that if filled an important need given its face and ecological validity. A Spanish version of the test is published.

Recommended Test: Behavior Rating Inventory of Executive Function ([Click here for the BRIEF website.](http://portal.wpspublish.com/portal/page?_pageid=53,69578&_dad=portal&_schema=PORTAL))

### Behavior Co-morbidity Rating

Behavior Rating

There is a high rate of behavioral and psychiatric comorbidity in epilepsy. Psychopathology occurs in 37% to 77% of children with epilepsy, with the most problematic areas being attention, internalizing disorders, and thought problems (Plioplys et al., 2007). The CBCL has been widely used in the research on these co-morbidities in pediatric epilepsy. In a recent consensus statement on the evaluation and treatment of affective disorders in epilepsy, the CBCL was recommended as a screening instrument in children (Barry et al., 2008).

Recommended Test: Child Behavior Checklist (CBCL) ([Click here for the ASEBA website.](http://www.aseba.org/))

References: Barry JJ, Ettinger AB, Friel P, Gilliam FG, Harden CL, Hermann B, Kanner AM, Caplan R, Plioplys S, Salpekar J, Dunn D, Austin J, Jones J. Consensus statement: The evaluation and treatment of people with epilepsy and affective disorders. Epilepsy & Behavior. 2008; 13: S1–S29.

Plioplys S, Dunn DW, Caplan R. 10-year research update review: psychiatric problems in children with epilepsy. J Am Acad Child Adolesc Psychiatry. 2007; 46(11): 1389-402.

### Adaptive Behavior Rating (Optional)

This domain is designed to characterize adaptive behavior delays and developmental level, which is important in pediatric epilepsy research because of the high base rate of cognitive delays in children who have intractable or catastrophic epilepsies (e.g., pediatric epilepsy surgery candidates; Lennox-Gastaut). In addition, adaptive rating scales provide an estimate of functional ability in otherwise untestable children whose levels are too low for standard neuropsychological and cognitive testing, and appear to be highly predictive of quality of life in children with epilepsy.

Although research does not clearly point to one scale over others for assessing this domain, the Scales of Independent Behavior-Revised (SIB-R) is recommended because of its ease of use (can be administered in questionnaire format rather than via interview) and availability of a short form; other scales such as the Vineland Adaptive Behavior Scales, Second Edition (Vineland-II) and Adaptive Behavior Assessment Scale (ABAS-II) may also be considered as well.

Recommended Test: Scale of Independent Behavior-Revised (SIB-R)

## Section III: Specific Test Recommendations (0-5 year olds)

### General Introduction

Neuropsychological testing in the youngest pediatric epilepsy patients poses unique challenges compared to adults and older pediatric cases, not only given the developmental trajectory that affects the normative/reference databases, but also with respect to the training and experience needed to successfully engage children at very young ages to produce valid measures of cognitive or motor function. In addition to the low ages, many of these children may have either significant cognitive or behavioral comorbidities placing further emphasis on the availability and training of skilled examiners in the age range.

The list of cognitive domains listed below is not exhaustive, but intended to capture relevant areas across a variety of pediatric epilepsy syndromes that are seen in the 0-5 year old age range. This is intended to facilitate direct comparisons across studies and potentially permit data pooling across studies or epilepsy centers. Compared to CDE for older children and adults, there are oftentimes few epilepsy studies on which to makes specific recommendations. However, tests are listed based upon either widespread clinical use in these ranges or use in diseases other than epilepsy, and intended to provide general guidance to facilitate test selections.

It is important to realize that for children age 2 years of age and younger, formal developmental assessment is less reliable that psychological testing in older subjects due both developmental and temperament issues of children this age. Consequently, development for this age range is primarily measured using rating scales (typically completed by parent/caregiver). When formal testing of the child is performed, specialized training in test administration and experience in this age range is essential.

### GENERAL FUNCTION

Formal Development

Purpose: To characterize level of cognitive development using formal assessment

Recommended Tests:

* Wechsler Preschool and Primary Scale of Intelligence (WPPSI-III) (Wechsler, 2002).
* Age Range: 2 years, 6 months –7 years, 3 months
* Mullen Scales of Early Learning (MSEL)
* Age Range: birth – 68 months
* Bayley Scales of Infant and Toddler Development (Bayley-III)
* Age Range: 1-42 months

Comment:

* WPPSI-III: The Wechsler scales are the most common tests of general cognitive abilities. The primary advantage of the WPPSI-III includes the comprehensiveness of the assessment, which includes measures of processing speed in addition to verbal and non-verbal measures. Thus, normative performances on domain-specific WPPSI-III subtests can be characterized relative to each other based upon formal difference scores derived from WPPSI-III normative sample. In addition, the tests and scale itself is a downward extension of the WISC, which is a CDE for older children. Thus, using tests in the same family facilitates longer term longitudinal studies in which children may cross age thresholds for test administration.
* There is no formal short form of the WPPSI-III. Researchers wishing a use short form may generate FSIQ estimates derived from either 2-subtest (Vocabulary, Matrix Reasoning) or 4-subtest (Vocabulary, Similarities, Block Design, Matrix Reasoning) combinations. This test selection corresponds to the 2- and 4-subtest combinations for the WASI. There is no Spanish version of the test.
* Mullen Scales of Early Learning (MSEL). The Mullen Scales provide information in 5 areas: Gross Motor, Visual Reception, Fine Motor, Expressive Language, and Receptive Language. There is no Spanish version of the test. This test has been widely employed in autism studies.
* Bayley-III. The Bayley assess the motor (fine and gross), language (receptive and expressive), and cognitive development of infants and toddlers. There is no Spanish version of the test.
* Time Estimate (Administration)
* WPPSI-III: 2-subtest WPPSI-III: 15 minutes; 4-subtest WPPSI: 30 minutes; Full WPPSI-III: ages 2:6-3:11, 30-35 minutes-4 core subtests; ages 4:0-7.3, 40-50 minutes (7 core subtests plus additional 5 minutes for Symbol Search)
* MSEL: 15 minutes (1 year); 25-35 minutes (3 years); 40-60 minutes 5 years
* Bayley-III: 30-90 minutes
* Time Estimate (Scoring)
* WPPSI-III: 2-subtest WPPSI-III: 5 minutes; 4-subtest WPPSI-III: 10 minutes; Full WPPSI-III: 30 minutes
* MSEL: 05 minutes
* Bayley-III: 25-35 minutes
* Primary Dependent Measures
* WPPSI: Complete WPPSI: FSIQ, VIQ, PIQ, and Processing Speed. For 4-subtest version: FSIQ, VIQ, PIQ. For 2-subtest versions: FSIQ
* MSEL: Early Learning Composite Score. Gross Motor, Visual Reception, Fine Motor, Expressive Language, and Receptive Language scores are reported separately.
* Bayley-III: Mental Scale, Motor Scale, Behavior rating scale.
* Vendors: [Click here for the Pearson Assessment website](http://psychcorp.com/)

WPPSI-III: Pearson/PsychCorp, P.O. Box 599700, San Antonio, TX 78259

Product Code: 015-8989-317 $1009.00

Mullen: Pearson/PsychCorp, P.O. Box 599700, San Antonio, TX 78259

Product Code: 11150 $785.00

Bayley-III :Pearson/PsychCorp, P.O. Box 599700, San Antonio, TX 78259

Product Code: 978 0 15802 724 1 $2155.15

### LEARNING/MEMORY

1. Verbal Memory
   1. Purpose: To assess verbal learning and memory.
   2. Recommended Test: California Verbal Learning Test Children’s Version (CVLT-C)
   3. Comment: The California Verbal Learning Test for Children (CVLT-C) is a serial word list learning task containing words that have semantic (category) associations. Verbal learning is tested using 5 learning trials of 15 words. A second list of 15 words is presented next for a single trial (distractor trial), followed by a free recall trial of the initial word list. Delayed recall and recognition are also obtained. The two primary dependent measures include the learning score (sum across 5 learning trials) and delayed free recall.
   4. Although the CVLT-II (adult version) is not a recommended test for Adult Neuropsychology CDEs because the semantic associations among the words decreases its sensitivity to subtle verbal memory impairment, it is not yet known how the inclusion of semantic associations in word-list memory paradigms affect memory test sensitivity in children with epilepsy.
   5. Designed for children 5 years of age and older, extended norms for the CVLT-C are available for children as young as 4 years of age (Goodman, Delis, & Mattson, 1999).
   6. Time Estimate: 25 minutes (learning trials=20 min, delayed memory=5 min).
   7. Scoring Estimate: (10 minutes)
   8. Alternative Language: A Spanish language version of the CVLT-C can be used for Spanish speaking children (Rosselli, Ardila, Bateman, & Guzman, 2001).
   9. Primary Dependent Measures: 5 Trial Learning Sum, Delayed Free Recall
   10. Secondary Dependent Measures: Delayed Recognition Memory
   11. Vendor: Pearson/PsychCorp, P.O. Box 599700, San Antonio, TX 78259
   12. [Click here for the Pearson Assessment website](http://psychcorp.com/)
   13. CVLT-C ISBN: 015-8033-957
   14. Unit Price: $199
2. Visual Memory
   1. Purpose: To assess non-verbal learning and memory
   2. Recommended Test: None

Comment: There is no recommended visual memory CDE.

1. Language
   1. Purpose: To assess receptive vocabulary.
   2. Recommended Test: Peabody Picture Vocabulary Test-4. Parallel forms are available.
   3. Alternative Language: A Spanish version is reportedly under development, but is presently not available.
   4. Ages: 2 years, 6 months to 90+ years
   5. Administration Time: 10-20 minutes
   6. Scoring Time: 5 minutes
   7. Primary Dependent Measure: Overall Standard Score (mean=100, SD=15)
   8. Vendor: Pearson/PsychCorp, P.O. Box 599700, San Antonio, TX 78259
   9. [Click here for the Pearson Assessment website](http://psychcorp.com/)

Product Code: 30700

PPVT-4 Complete Hand Scoring Kit (Forma A and B)

$407

Product Code: 30701

PPVT-4 Complete Hand Scoring Kit (Form A)

$220

VISUOSPATIAL (optional domain)

General Visuospatial Function

Purpose: To assess non-verbal spatial perception and reasoning.

Recommended Test: WPPSI-III Block Design

Comment: This test is administered for studies that use the WPPSI-III.

Time Estimate: 15 minutes

Scoring Estimate: 5 minutes

Primary Dependent Measure: Age-adjusted Scaled Score

Vendor: Pearson/PsychCorp, P.O. Box 599700, San Antonio, TX 78259

http://psychcorp.com/

### EXECUTIVE FUNCTION

Executive function” refers to a diverse set of cognitive processes (e.g., working memory, initiation, inhibition, planning, shifting of mental perspectives, or “sets”).

### Executive Function Rating

Purpose/Rationale: Problems with executive functioning are common in children with epilepsy seen in tertiary centers, and may significantly impact quality of life. However, by virtue of being administered in a structured, novel, quiet, one-on-one testing environment, standard tests of executive functioning do not always allow executive deficits to emerge during test administration. Specialized questionnaires completed by family members are therefore a useful alternative to cognitive testing for assessing executive functions in children. The only executive functioning scale for use with children in the 2.5 to 5 year range is the Behavior Rating Inventory of Executive Function and BRIEF-Preschool Version (BRIEF-P; Gioia, Isquith, Guy & Kenworthy, 2000).

Comment: The BRIEF-P is completed by raters who have observed a child in different settings (i.e., parents and teachers). It yields the following scores: Inhibit Shift, Emotional Control, Working Memory, and Plan/Organize. The clinical scales form three broad indexes (Inhibitory Self-Control, Flexibility, and Emergent Metacognition) and one composite score (Global Executive Composite). The BRIEF-P also provides two validity scales (Inconsistency and Negativity).

Primary Dependent Measures: The Global Executive Composite (GEC), which is a standard score (M = 100, SD = 15), from parent rating.

Secondary Dependent Measures: Inhibitory Self-Control, Flexibility, and Emergent Metacognition.

Time Estimate: 10-15 minutes

Scoring Estimate: 5 minutes

Vendor: Psychological Assessment Resources Inc. (PAR; www.parinc.com). An Introductory Kit (Professional Manual, 25 Rating Forms, and 25 Scoring/Summary Forms) retails for $145 USD for the BRIEF. Scoring and interpretive software is also available for the BRIEF (BRIEF Software Portfolio, or BRIEF-SP) for $355 USD. [Click here for the WPS website.](http://portal.wpspublish.com/portal/page?_pageid=53,69604&_dad=portal&_schema=PORTAL)

### SPEED

Processing Speed

Purpose: Measure graphomotor and psychomotor speed. Note: the lower limit of these subtests is age 4.0 years.

Recommended Tests: WPPSI-III Coding and Symbol Search to generate the Processing Speed Quotient

Alternative Language: These are primarily non-linguistic tests that can be administered using Spanish directions.

Comment: These are timed tasks that measure the ability to rapidly transcribe symbols that are paired with numbers (Coding) and to rapidly scan a series of symbols to identify the presence or absence of a target (Symbol Search).

Time Estimate Coding: 5 minutes

Time Estimate Symbol Search: 5 minutes

Total Time (Coding and Symbol Search): 10 minutes

Scoring Estimate: 5-7 minutes (both)

Primary Dependent Measure: Processing Speed Quotient

Secondary Dependent Measure: Coding Scaled Score

Secondary Dependent Measure: Symbol Search Scaled Score

Optional Secondary Dependent Measure: Coding Raw Score

Vendor: Pearson/PsychCorp, P.O. Box 599700, San Antonio, TX 78259

[Click here for the Pearson Assessment website](http://psychcorp.com/)

Motor Speed

Purpose: Assess fine motor speed

Recommended Test: Purdue Pegboard

Ages: 2 years, 6 months and older

Alternative Language: This is a non-linguistic test that can be administered using Spanish directions.

Comment: Formal assessment of motor function is a common component of neuropsychological testing, and is sensitive to the presence of epilepsy independent of AED induced motor slowing. Although the Grooved Pegboard is the recommended CDE for older children and adults, the Purdue Pegboard is the recommended test for children 5 years of age and younger. This is due to an absence of adequate normative information in this age range for the Grooved Pegboard Test, and recognition that there is less of a fine motor component to the Purdue Pegboard Test since it does not require the subject to rotate slotted pegs to fit into a the pegboard (pegs for the Purdue Pegboard are round).

Time to completion is obtained for both dominant and non-dominant hands. Normative data can be found in Baron (2004) and Strauss et al. (2006). Raw scores should also be reported. Unless there is a goal of lateral asymmetries, the dominant hand speed should be considered primary and the non-dominant hand speed should be considered secondary.

Unlike the Grooved Pegboard, the Purdue Pegboard as an additional administration condition in which pegs are inserted using both hands simultaneously.

Primary Dependent Measure: Dominant hand time to completion.

Optional Secondary Measures: Nondominant hand time to completion, Time to completion for both hands simultaneously.

Optional Secondary Measure: Number of peg drops

Time Estimate: 5-10 minutes

Scoring Estimate: < 5 minutes

Vendors: Lafayette Instrument Co., PO Box 5729, Lafayette, IN 47903 (Model 32020, $120)

Psychological Assessment Resources (PAR), 16130 North Florida Avenue, Lutz, FL 33549 (WW-1743-EQ, $135)

Normative References: Baron, IS. Neuropsychological evaluation of the child. New York: Oxford University Press, 2004.

### Sustained Attention

Purpose: Assess sustained visual attention and inhibition of impulsivity over time.

Recommended Test: Conners Kiddie CPT, ages 4-5

Comment: This is a computerized measure of attention and impulsivity commonly used in the assessment of attention-deficit hyperactivity disorder (ADHD). The Kiddie CPT uses pictures rather than letters, which are used in the Conners CPT. For a test that uses a more tradition continuous performance paradigm to assess primarily vigilance (as opposed to inhibitory control), the T.O.V.A may also be considered (Test of Variables of Attention; Greenberg, 2000). The test involves the subject pressing the space bar to one of two simple geometric forms on the screen; as such, it does not require familiarity with letters and may be more suitable for low functioning or pre-literate children.

Time Estimate: 7.5 minutes (KIDDIE CPT); 10.9 minutes (T.O.V.A.)

Scoring Estimate: automatic computer scored

Primary Dependent Measures: It was the consensus of the CDE Neuropsychology Committee that there is presently insufficient empirical support to recommend one dependent measure as primary.

Vendor: Multi-Health Systems, Inc. (MHS), PO. Box 950, North Towanda, NY, 14120-0950

Cost: $677, unlimited use on single computer

### BEHAVIORAL RATING SCALES

Behavior Co-morbidity Rating

Purpose: To characterize behavioral and emotional problems, as well as assessing ratings of language development.

Recommended Test: Child Behavior Checklist (CBCL/1 ½-5). This version of the CBCL is appropriate for children as young as age 18 months.

Comment: The CBCL/1 ½-5 obtains reports from parents regarding children’s competencies and behavioral/emotional problems.

Time Estimate: 10-15 minutes

Scoring Estimate: 10 minutes

Alternative Language: A Spanish form of this test is available.

Primary Dependent Measures: Total Problems composite score (T score)

Vendor: Achenbach System of Empirically Based Assessment (ASEBA), 1 South Prospect Street, St. Joseph's Wing (3rd Floor, Room# 3207), Burlington, VT 05401 (www.aseba.org)

Price: $295 (includes 50 forms, manual, and computer scoring software).

Adaptive Behavior Rating (Optional)

Purpose: To characterize adaptive behavior delays and developmental level, which is important in pediatric epilepsy research because of the high base rate of cognitive delays in children who have intractable or catastrophic epilepsies (e.g., pediatric epilepsy surgery candidates; Lennox-Gastaut). In addition, adaptive rating scales provide an estimate of functional ability in otherwise untestable children whose levels are too low for standard neuropsychological and cognitive testing, and appear to be highly predictive of quality of life in children with epilepsy.

Recommended Test: Although research does not clearly point to one scale over others for assessing this domain, the Scales of Independent Behavior-Revised (SIB-R) is recommended because of its ease of use (can be administered in questionnaire format rather than via interview) and availability of a short form; other scales such as the Vineland Adaptive Behavior Scales, Second Edition (Vineland-II) and Adaptive Behavior Assessment Scale Infant and Preschool Kit (birth to age 5) may also be considered as well.

Comment: The SIB-R provides information on developmental level and ability to function independently at home and in the community. Parents rate their children on several critical developmental domains including motor skills, social interaction, communication skills, personal living skills, and community living skills.

Each SIB-R adaptive behavior item is a statement of a task, and the behavior is rated on a 4-point scale (0—never or rarely performs the task (even if asked); 1—does the task but not well or about 25 percent of the time (may need to be asked); 2—does the task fairly well or about 75 percent of the time (may need to be asked); 3—does the task very well always or almost always (without being asked).

Primary Dependent Measure: The Broad Independence standard score (M = 100; SD = 15).

Secondary Dependent Measures: Standard scores for each of the adaptive domains (i.e., Motor Skills, Social/Communication Skills, Personal Living, Community Living; mean = 100, SD = 15),

Time: 20 minutes for Full Scale (rating scale, not interview format) 10 minutes for Short Form

Vendor: Riverside Publishing, 3800 Golf Road, Suite 100, Rolling Meadows, IL 60008

Item number: Y21922944

Cost: $271

\*Recommended as Core