The purpose of this review is to discuss the components of the pediatric neurologist’s diagnostic evaluation of the child with attention deficit hyperactivity disorder (ADHD). In particular, evidence will be presented about which assessment procedures and tests are necessary for diagnosis and whether any one test or any tests can be used in isolation or in combination to diagnose ADHD.

The Interview/History
Are Formal Structured, Semistructured, or Computerized Interviews Necessary for Making an ADHD Diagnosis?

The history/intake interview is the cornerstone of the diagnostic assessment for ADHD. Formal structured and semistructured interviews like the Schedule for Affective Disorders and Schizophrenia for School-Age Children,¹ the National Institute of Mental Health (NIMH) Diagnostic Interview Schedule for Children,² the Diagnostic and Statistical Manual of Mental Disorders (DSM)-based Diagnostic Interview For Children and Adolescents (DICA),³⁴ and the Child and Adolescent Psychiatric Assessment⁵ are used in research studies to diagnose ADHD and thus would seem at first glance to be the optimal, most reliable clinical assessment measure. However, such interviews are time consuming, and, unlike pediatric psychiatrists, pediatric neurologists are not trained to administer them. For example, the Child and Adolescent Psychiatric Assessment basic interview covers an age range from 9 to 17 years and takes about 1 hour to administer. Similar comprehensive versions for use with young adults and with preschool-aged children have also been developed.⁵ Addressing the time issue, a shorter “gateway” version has been devised using the core symptoms of the diagnostic category in question as screening items. Computerized interviews for parents to complete are available (eg, a version of the DICA³⁶), but they too are time consuming both for the parent to fill out and for the clinician to score. And again, the pediatric neurologist is not trained in their interpretation. Theoretically, the availability of detailed glossaries and training manuals should make it possible to train even “lay” interviewers, and certainly pediatric neurologists, adequately for structured interviewing.⁴ Nonetheless, the time constraints remain a practical issue.

Furthermore, the clear advantage of a structured, semistructured, or computerized interview compared with an informal history remains to be determined because the former interview types are not immune to theoretical problems, in addition to the practical problem of administration time. The cross-reliability of many such interviews even in the hands of those well trained in their administration has been questioned.⁸ Questions have been raised, for example, as to whether the 2 versions (6-12 years, 13-18 years) of the highly structured form of the DICA can be viewed as the same interview. This is a problem for any instrument assessing
youths of different ages because the same questions may be understood differently by children and adolescents on account of their different developmental levels. The impact of ethnic, cultural, and socioeconomic differences in youths’ understanding of interviews (and questionnaires, see later) has not been sufficiently studied to determine whether and which questions are perceived differently by different subgroups of interviewees. And there are interviewer as well as interviewee issues. Even with highly structured instruments, some interviewers are simply more skilled at interviewing than others. Unless interviewers are carefully selected and extremely well trained, even a highly structured instrument is not always administered in the same way. This is an important issue even in the context of research use in which structured interviews are generally the gold standard.

The weakness of highly structured interviews is highlighted by the controversy about the validity of such interviews in general and the degree of structure required for maximal efficacy. A semistructured instrument (eg, versions of the DICA) may actually provide a more accurate assessment of children, particularly younger ones, and adolescents than a highly structured interview. With semistructured instruments, interviewers have the same basic script and provide the same basic probes. However, interviewers do not have to use the exact same wording and probes. This allows for more flexibility and individualization of the interview. This may be particularly important for the younger child who requires more concrete probes. Semistructured interviews also require, however, that the interviewer know enough about the disorder and its symptoms to be accurate as well as flexible with their probes. Adding pictures to the interview, which can be done in a semistructured situation, may enhance its validity particularly with younger children.

Furthermore, validity studies based on a test–retest design comparing the structured interview with diagnoses in the physician’s chart or behavioral questionnaires suggest that even structured interviews vary in their reliability. This factor would be a particular confound in an office practice. Given time constraints and training issues as well, structured, semistructured, and computerized interviews appear to be more suited for research studies than clinical use.

Is an Informal Interview Adequate for the Diagnosis of ADHD?

An informal interview/history focusing on the chief complaints about inattention, impulsivity, distractibility, and hyperactivity at school and at home, specifically addressing the DSM IV criteria for ADHD, is the most practical way for the pediatric neurologist to approach the diagnosis of ADHD. It must be noted, however, that some research studies do not support unstructured interviews as reliable means of making DSM diagnoses. Even experienced clinicians do not always agree about diagnosis after an informal interview. And their diagnoses do not always coincide with structured interview or computer-assisted interview results. On the other hand, other validity studies show that informal interviews agree with the diagnoses in the physician’s chart enhancing their credibility. From a practical vantage point, an informal diagnostic interview, using a DSM-based template, coupled with other ancillary measures (see later) seems the most reasonable and practical choice for diagnosing ADHD in the pediatric neurologists’ office.

The clinical history is in essence a medical document, and, as such, it should include a detailed chief complaint, history of present illness, psychiatric history, developmental history, medical history, family and social histories, review of systems, and mental status examination. Familiarity with organizing such an evaluation gained from medical training and use of the evaluation as a means of communication to other care providers supports the use of the traditional medical history format as a diagnostic tool for ADHD.

The informal diagnostic interview must be properly structured to be optimal. First, because parents and children often do not agree on diagnosis, both need to be interviewed. Both children, even young ones, and adolescents can give important and valid information about themselves via interview. Joint and individual interviews (providing an opportunity to inquire about sensitive topics) are necessary. Evaluating the different respondents in person is particularly important in view of the documented lack of agreement by parents and children on questionnaires. But questionnaires are necessary to corroborate and supplement the diagnostic information obtained during the office history.

Are Questionnaire Results Diagnostic of ADHD?

Questionnaires are an important and efficient part of the diagnostic assessment but cannot be used in isolation to make a diagnosis of ADHD. The correspondence between direct observation and rating scale diagnoses support the validity of the latter for making the diagnosis, albeit not in isolation. Teachers, parents, and older children can/should all report on symptoms to assess for agreement/validity of diagnosis, to document that the ADHD symptoms occur in multiple settings, and to take advantage of the special information that each can provide. Using different types of questionnaires, narrow band tapping only ADHD issues, and broad band tapping a wide range potential comorbid issues, enhances the diagnostic and treatment options.

The Conundrum of Multiple Informants

Multiple informants (parents, teachers, youths, and health care professionals) do not necessarily agree on diagnosis. Care must be taken to determine the best interpretation of the data if disagreements occur.

Parents

Parents are often the primary informant(s). But, parents, like other informants, are susceptible to diagnostic biases, social background effects, personal hidden agendas, varying observational skills, different attitudes toward questionnaires, and the effects of setting on ADHD. In addi-
tion, varying parenting skills may affect the likelihood that they make a diagnosis of ADHD in their own child. In view of the hereditary nature of ADHD, the presence or absence of ADHD in other family members, including the parent informant, may affect diagnostic acumen. However, at least 1 study suggests that parents with ADHD are no more or less likely to diagnose ADHD in their children.

Teachers

Teachers obviously provide the crucial information about school behaviors. However, ADHD prevalence rates in school-age children based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV)-referenced, teacher-completed behavior rating scales vary more widely than one would like if one is depending on the questionnaire results for diagnosis. Overall prevalence rates range from 8% to 23%. A number of factors may underlie the variability.

The age of the group being rated may affect teacher responses. Teachers of students of different ages may differ in their reliability as informants for a variety of reasons. Elementary school teachers spend the whole day with their students and know them well, but high school teachers, who only have a student for a single subject, may not know the student as well. Indeed, high school teachers report the lowest rates of adolescent psychopathology and show relatively low agreement with other sources.

Furthermore, the fact that ADHD subtype frequency differs at different ages may further confound this. For example, based on DSM-IV-referenced symptom inventories of about 3,000 school children aged between 3 and 18 years, teacher-reported prevalence rate of ADHD behaviors was 15.8%; rates for individual subtypes were 9.9% for inattentive, 2.4% for hyperactive impulsive, and 3.6% for combined. The inattentive type was relatively uncommon in preschool children (3.9%), whereas the hyperactive-impulsive type was least common in teenagers (0.8%).

Teacher rating may be susceptible to a halo effect (1 behavior affects the perception of another). For example, child actors with oppositional defiant disorder and ADHD were more likely to be diagnosed ADHD than those with ADHD alone. This may be another way of saying that comorbidities affect the diagnosis of ADHD. Because different ADHD subtypes show different comorbidities (e.g., Oppositional Defiant Disorder (ODD) and Conduct Disorder (CD) symptoms are more common in the combined type than the inattentive, teachers may be even more likely to diagnose children with combined type and miss the inattentive type. Social skills deficits may also differ by ADHD subtypes with the combined type again tending to have the highest frequency of social deficits.

Every teacher has his/her biases about ADHD as a diagnosis. Knowledge about ADHD has been shown to affect teacher-rating skills. A number of other factors have been reported to affect teacher ratings. Ethnicity of the children being rated may affect teacher ratings. In this same study, screening prevalence rates were higher for black (39.5%) than white (14.2%) students. Prevalence of ADHD as reported by teachers is affected by geographic region in some studies and not in others.

Despite all the variability, the reliability of teacher ratings is attested to by the fact that teacher ratings predict peer ratings. Questionnaires do not necessarily replace a conversation with the teacher either for diagnosing or for assessing treatment.

Parents and Teachers: Degree of Agreement, Causes of Disagreement, and Whether to Make a Diagnosis

Parent-teacher agreement can be variable and may depend on the particular questionnaire in use, age, gender, presence of other comorbidities, and social class of the child among other factors. Because ADHD behavior must be present in 2 settings, parent-teacher disagreement can complicate making an ADHD diagnosis. In a recent study, for example, teacher ratings of about 6,000 elementary school children identified about 1,600 children as being at high risk for ADHD. Follow-up parent interviews and further information from teachers was collected on about 250 of the “ADHD” children. The agreement between the parent and teacher reports of ADHD symptoms according to a DSM-IV-based questionnaire was relatively low. When the 2-setting requirement was strictly enforced, poor interrater agreement decreased diagnostic rates for all 3 types of ADHD in this clinical sample: inattentive (fell from 15% [teachers] to 5% [parents and teachers]), hyperactive/impulsive (fell from 11% [teachers] to 3% [parents and teachers]), and combined (fell from 23% [teachers] to 7% [parents and teachers]). Using more lenient core symptom scores reduced parent-teacher disagreement (Fig 1A and B). In another recent study also using a DSM-IV-based questionnaire, 43.5% of the students were diagnosed by both parent and teachers as having ADHD; 11.5% had the inattentive type, and 32% had ADHD combined type. In 41% of the cohort, only the parent or the teacher diagnosed ADHD. In 16%, both parents and teachers agreed that the child did not have ADHD.

Another study found substantial variance in the description of ADHD subtypes depending on the source (parents versus teachers) and measure, 2 commonly used broadband scales: Child Behavior Checklist or Behavioral Assessment System for Children (BASC). For example, parents saw the combined type ADHD child as having more conduct and hyperactivity issues than the inattentive type, whereas teachers did not. Parents gave higher inattentive rating to children with the combined subtype on the Child Behavior Checklist but not on the BASC. Given this variation within the same population, even greater differences would be expected and have been found with different populations and different diagnostic and reporter sources.

Parents and Youths

Parents and youths agree about diagnosis anywhere from 20% to 80% of the time. In some studies, rates of reported...
ADHD symptoms are almost twice as high in parents’ reports as those made by children and adolescents. In other words, they often disagree about diagnosis. Initial studies suggested and recent studies confirm that parents report more symptoms overall than children do about themselves. Even more specifically, parents tend to note the core externalizing symptoms of ADHD (impulsivity, hyperactivity, and inattention) and behavioral issues (oppositional defiant disorder and conduct disorder), whereas children and adolescents often deny them. Some researchers have suggested that diagnosing ADHD based on either parents’ or youths’ positive responses, as well as on a positive response from both, may be acceptable.

Health Care Professionals and Teachers or Parents

Health care professionals do not really have an opportunity to assess for ADHD in a naturalistic environment. The office is obviously an artificial setting, and the demands are out of the ordinary. The observation period for the health care professional is also quite brief. In 1 study, health care professionals diagnosed ADHD in only 40% of those identified by their teachers. Another study comparing the frequency of parent, teacher, and physician ADHD diagnosis found a rather poor agreement rate as well. In 9%, parents, teachers, and the primary care physician agreed that the diagnosis was ADHD.

### Table 1 Frequency of Comorbid Disorders in Children With ADHD

<table>
<thead>
<tr>
<th>Disorder</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oppositional defiant disorder</td>
<td>40-65</td>
</tr>
<tr>
<td>Conduct disorder</td>
<td>25-35</td>
</tr>
<tr>
<td>Major depressive disorder</td>
<td>30</td>
</tr>
<tr>
<td>Bipolar disorder</td>
<td>10</td>
</tr>
<tr>
<td>Anxiety disorder</td>
<td>25</td>
</tr>
<tr>
<td>Tics/Tourette syndrome</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Learning disabilities</td>
<td>About 20</td>
</tr>
</tbody>
</table>

### Table 2 Frequency of ADHD in Children With Other Disorders

<table>
<thead>
<tr>
<th>Disorder</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct disorder or oppositional</td>
<td>About 100</td>
</tr>
<tr>
<td>defiant disorder (under 12 years)</td>
<td></td>
</tr>
<tr>
<td>Conduct disorder (adolescent)</td>
<td>30</td>
</tr>
<tr>
<td>Major depressive disorder</td>
<td>10-30</td>
</tr>
<tr>
<td>Bipolar disorder</td>
<td>About 100</td>
</tr>
<tr>
<td>Anxiety disorder</td>
<td>25</td>
</tr>
<tr>
<td>Tourette syndrome</td>
<td>&gt;50</td>
</tr>
<tr>
<td>Learning disability</td>
<td>About 20</td>
</tr>
</tbody>
</table>

By contrast, children and adolescents can report on internalizing symptoms (anxiety, mood, and obsessiveness) and substance abuse about which parents may be unaware. A gender bias may exist in this differential reporting with girls in particular reporting more internalizing symptoms than their parents. Some researchers have suggested that diagnosing ADHD based on either parents’ or youths’ positive responses, as well as on a positive response from both, may be acceptable.
in 30% they agreed that the diagnosis was not ADHD, and in 61% the 3 groups could not agree on diagnosis.

What Types and Which Questionnaires Should Be Used?

Broadband Versus Narrowband Questionnaires

Broadband questionnaires evaluate not only for the ADHD diagnosis but also for common comorbidities (Tables 1 and 2) of ADHD (that occur in both clinical and community samples), which may affect both diagnostic accuracy and treatment.7,70,88-96 For example, the MTA study showed that children with co-occurring ADHD and anxiety disorders (but who had no oppositional defiant disorder or conduct disorder) were likely to respond equally well to the MTA behavioral and medication treatments. Children with ADHD only or ADHD with oppositional defiant disorder or conduct disorder (but without anxiety disorders) responded best to the MTA medication treatment regimen (with or without behavioral treatments). Children with multiple comorbid disorders (anxiety and oppositional defiant disorder and/ or conduct disorder) responded optimally to combined (medication and behavioral) treatments.93 In addition to posing questions about other non-ADHD problems, broadband questionnaires generally leave space for comments. Sometimes finding a discrepancy between comments of parents, teachers, or youths and their ratings on the Likert scale items (where one is forced to choose 0, 1, or 2) prompts questions from the physician that enhance the accuracy of diagnosis.

On the negative side, broadband questionnaires are longer because they are more comprehensive than narrowband questionnaires. This makes them less useful for repeated use. Also, they have fewer questions about ADHD because other diagnostic entities must be covered as well.

By contrast, narrowband questionnaires focus on the core ADHD symptoms and are useful both for making the specific diagnosis and for monitoring treatment. Informa-
tion from both types of questionnaires maximizes the breadth of the assessment and treatment options. Each physician should choose questionnaire(s) with which he/she is comfortable.

Specific Broadband Questionnaires.
Several broadband questionnaires are available. The Preschool and School-Age Checklist measures of Achenbach and Rescorla56,71 and the BASC81 (with forms for teachers, parents, and adolescents) are the most commonly used. The Vanderbilt questionnaires53,97 and the long form of the Swanson, Nolan, and Pelham Questionnaire98 (see later) (with forms for teachers and parents), designed primarily for ADHD diagnosis, include some questions relating to common comorbidities.

Specific Narrowband Questionnaires
A number of narrowband questionnaires, some DSM-based and others not, are available24,25 Each has its pros and cons (Table 3). Differences among the questionnaires reflect variations in degree of standardization,99,100 norms, age span, range of informants, and potential for gender biases.101 Some questionnaires may be more appropriate for diagnosis and others for medication monitoring. Economics may also be a consideration; some questionnaires are available on the Internet and may be repeatedly used, whereas others must be purchased for single use. Some questionnaires require computer scoring systems to be practical time wise.

The narrowband scales that are based on DSM-IV have good face validity because their items are derived from the standard diagnostic construct for ADHD, although clinically relevant validation is wanting for most of the scales generally used for ADHD.102 For example, the same ADHD sample was used in both the development and validation of the discriminant analysis of the Connors Rating Scales—Revised (CRS-R). However, if the questionnaire is seen as a part of an array of data used to make a diagnosis, this shortcoming is mitigated.103,104 Most questionnaires yield the same core sub-scales of inattention and hyperactivity/impulsivity subtypes, are similar in format, and rely on adults’ reports of youths’ behavior. Thus, it is difficult to find advantages for one scale over another, and “head-to-head” comparisons of these scales are not available. Therefore, choosing a scale largely hinges on the need for additional items to screen for comorbidities, other measures included in the assessment battery, the intended adult reporter, the need for adolescent self-report, and then matching the planned application to a scale’s format and psychometric properties.99

Guidelines: Prioritizing Scale Selection to Specific Applications
A thorough assessment of ADHD symptoms requires a scale that taps both the broad context and nuances of ADHD. The CRS-R99,103-112; the Swanson, Nolan, and Pelham-IV Questionnaire (SNAP-IV)98,113,114, the Attention Deficit Disorder Evaluation Scale-Second Edition (ADDES-2)115,116, and the ADHD Symptoms Rating Scale (ADHD-SRS)119-121 are most likely to provide such thorough assessments.99 Among these, the SNAP-IV, although it has been used frequently in research studies,122,123 has the least published technical properties including age norms. However, it does have the advantage of an Internet-accessible scorer with graphics that provides preliminary cutoff criteria for diagnosis. The CRS-R has the strongest research base with data on both community and clinical populations. The normative samples of both the CRS-R and ADDES-2 have multiple demographic strata, which allows for optimal interpretation of an individual’s scores. By contrast, the ADHD-SRS scores can only be compared with broad ranges of other children (5-12 years of age) and adolescents (13-18 years of age), although this is probably adequate for most clinical applications. Of the 4, only the CRS-R provides normative data for preschoolers. Furthermore, the CRS-R’s abbreviated versions and brief ADHD-specific forms facilitate repeated administration of the scale for treatment monitoring. The adolescent self-report of the CRS-R (Connor-Wells Adolescent Self-Report Scale)108,109 allows for comparison of youths’ perceptions with those of parents and/or teachers. Finally, the Connors’ questionnaire subscales screening for at least some comorbidities may be helpful in situations in which additional broadband scales cannot be administered.99 The ADDES-2 and ADHD-SRS are comparable scales and have multiple items to tap each DSM-IV symptom of ADHD. Therefore, either could be useful in assessing the nuances of ADHD. Both the ADDES and ADHD-SRS would be complimented by a broadband measure. The ADDES-2 has the advantage of having both parent and teacher versions. Both of these scales need to be researched further with clinical populations to more comprehensively evaluate their utility, sensitivity, and specificity and to enhance the breadth of published experience. Furthermore, neither has an adolescent self-report form.99

Screening for ADHD requires a brief scale with good sensitivity to rapidly identify as many true cases as possible. The CRS-R,124 ADHD Rating Scale-IV (ADHD RS-IV),33,41,44 Vanderbilt ADHD Teacher Rating Scale (VADTRS),33,97 and Vanderbilt ADHD Parent Rating Scale (VADPRS)125 all meet the bill on this count. The American Academy of Pediatrics has endorsed this scale and provides a complete tool kit on the Internet (www.nichq.org) that even includes a cover letter to teachers. The CRS-R and ADHD RS-IV have been used most often with clinical samples. The CRS-R shows excellent sensitivity; but it is a bit long for screening purposes. The abbreviated version might be a good screen; however, its diagnostic sensitivity and specificity are not established. The ADHD RS-IV is the briefest, and it has shown discriminant validity. However, the suboptimal sensitivity of the teacher form raises questions about its usefulness in the school setting. The VADTRS and VADPRS are also quick screens, but more data on their sensitivity and general utility are needed.99

Other scales are available. The pros and cons of many of these are listed in Table 3. Ultimately, the clinician must choose the one(s) with which he/she is comfortable. Having the questionnaires at the time of the initial visit can streamline the assessment. Providing teachers with an addressed
stamped envelope for the rating scales increases the return rate.

**Is Gender a Factor That Requires a Change in Diagnostic Assessment?**

Gender must be considered at all levels of the assessment (office interview, questionnaires, and neuropsychological testing) of the potential ADHD child.46,65,126-132 Girls with ADHD are more likely than boys to have the predominantly inattentive type of ADHD, less likely to have a learning disability, and less likely to manifest dramatic problems in school or in their spare time. In addition, girls with ADHD are at less risk for comorbid major depression, conduct disorder, and oppositional defiant disorder than boys with ADHD. The lower frequency of psychiatric, cognitive, and apparent functional impairment in girls may increase the rate of failed/misdiagnosis.133 Thus, they are less likely to get to the office for assessment. And their problems may be less apparent during the interview and on questionnaire reports.

Parents underreport girls’ symptoms.134 Teacher rating scales, especially those that are brief, may also fail to pick up girls with ADHD. Most, but not all,135 teacher rating studies report a preponderance of males for all 3 ADHD subtypes. In Nolan et al’s study49 study based on questionnaire reports, gender differences varied both according to the age of the child and ADHD subtype. Males outnumbered females for all subtypes, except the Inattentive type in preschool children. Formal neuropsychological testing may be particularly useful when diagnosing ADHD in girls, but the relative infrequency of learning issues may mitigate against doing the assessment in the first place. Therefore, when the question of ADHD is raised about a girl the assessment needs to be unusually thorough.

**Is Age a Factor in the Diagnostic Assessment?**

Both preschool children and adolescents present particular problems for diagnosis.

**Diagnosing ADHD in the Preschooler**

In about half the children with ADHD, onset is said to occur before 4 years of age.136,127 But the estimated frequency of ADHD in children between 2 and 5 years varies widely from approximately 2% to 5%,138-141 to 10%,142 to 18%.142 Diagnosing ADHD in preschoolers can be complex because the range of behaviors acceptable in the preschooler is so broad.137,143-146 Furthermore, ADHD symptoms may be transient, lasting only 3 to 6 months.25,147 In 1 prospective study of over 200 children followed from birth to kindergarten school entry, 41% of the preschoolers were found by parents, teachers, or the researchers to have some attention difficulties.137 In 5%, the attention issues were significant and persisted at least into elementary school, but an additional 8% had significant problems that abated before school age. Another study found that even among those with severe and persistent enough symptoms to be diagnosed with ADHD, only one half still met criteria for the diagnosis in elementary school.148 Therefore, symptom duration of 12 months (rather than the 6 months suggested for school-age children) has been proposed as a more appropriate criterion for the diagnosis of ADHD in preschoolers.45 On the other hand, many studies document a strong correlation between a diagnosis of ADHD during the preschool period and at school age.147,149-151

The specific diagnostic criteria for the preschooler are less clear cut than in the older child. Preschool children with ADHD are characteristically extremely hyperactive.137,152 Clinical observations of preschool children in naturalistic settings are often particularly useful, in one such study, only 6% of preschool children with ADHD had no problems during the clinical observation.152 Behavioral comorbidities are particularly common in preschoolers with ADHD.133,154 Young children with ADHD also tend to have high rates of language problems155 and developmental coordination disorder.156

Parent and teacher/caregiver rating scales are useful in the diagnosis of ADHD during the preschool years.36,109,157-161 However, if the child is not in school, a second reporter may not be available to confirm parents’ impressions. The crucial symptoms may differ from that of the school age child. In 1 study, 6 DSM-based ADHD symptoms discriminated preschool children with ADHD from controls better than the remaining 12 items. These were (1) difficulty sustaining attention, (2) easily distracted, (3) often “on the go,” (4) runs/climbs about excessively, (5) does not follow through on instructions, and (6) difficulty remaining seated.146 Impulsivity symptoms were infrequently endorsed, possibly because the examples and wording in the DSM apply more clearly to older children. Scales designed specifically for preschoolers may be better choices than DSM-based scales.39,71,157 Questions more relevant to diagnosing ADHD in the preschooler are shown in Table 4.

**Diagnosing ADHD in the Adolescent**

Adolescents110,162-164 often underreport their ADHD symptoms in comparison to parent reports. Nonetheless, an adolescent self-report is useful for corroborating parents and teachers (Connor Wells Adolescent Self-Report,109 Youth Self Report,56 Youth Self-Report,81 Adolescent Symptom Inventory 4,61 and ACTeRS.165 As discussed previously, junior high and high school teachers who see students only for single subjects and see larger numbers of students may be less able to accurately complete ADHD questionnaires. Finally, the questionnaires that are DSM-based were by and large developed for elementary school age children and may not focus in on issues more relevant to adolescent manifestations of ADHD. Organizational and executive functioning issues may be the primary problems of the adolescent with ADHD. As with girls, neuropsychological testing may be particularly helpful for corroborating suspected ADHD diagnoses. Ques-
Table 4 Characteristics of the Preschool Child With ADHD

- Rushes through tasks paying little attention to details
- Has difficulty paying attention to tasks or play activities
- Does not seem to listen
- Shifts from 1 activity to another
- Has difficulties organizing activities
- Avoids doing tasks that require mental effort
- Loses things
- Is easily distracted
- Is forgetful
- Fidgets or squirms
- Has difficulty remaining seated
- Runs about or climbs on things when asked not to
- Has difficulty playing quietly
- In always on the go
- Talks excessively
- Blurs out answers before the question is complete
- Has difficulty awaiting his turn
- Interrupts people or disrupts group activities


Is Medical History Relevant to Diagnosis?
A thorough medical history is part of the initial evaluation. Prematurity and frequent episodes of otitis with hearing loss, for example, may be risk factors of ADHD (Table 5).

Is Family History Relevant to Diagnosis?
A complete family history for ADHD and its common comorbidities should be taken. ADHD is a highly heritable disorder and, although a positive family history does not confirm the diagnosis, it can be supportive.

Is the Psychosocial History Relevant to Diagnosis?
Again, a psychosocial history, although not diagnostic, provides important information that may play a major role in management decisions. For example, in families on public assistance, medication management resulted in decreased closeness in parent-child interactions, and combined treatment yielded relatively greater benefits for teacher-reported social skills. In families with high treatment acceptance/attendance, intent-to-treat results were upheld. Acceptance/attendance was particularly important for medication treatments. In view of the heritability of ADHD and its comorbidities, psychosocial issues are likely to be present and require attention.

Do the Medical and Neurologic Examination Contribute to the Diagnosis of ADHD?
Medical problems that can be associated with ADHD have been discussed previously (Table 5). The general medical examination may be used to corroborate some of these conditions. Minor physical anomalies (eg, electric hair, hypertelorism, highly arched palate, and low-set ears) may occur at a higher rate in preschoolers with ADHD than in the general population, particularly when the ADHD is transmitted via the paternal line.

The neurologic examination is part of any complete diagnostic evaluation. In addition to the traditional neurologic examination, a number of standardized office examinations that tap developmental neurologic functions are available. Many, but by no means all studies, suggest a high frequency of soft signs in ADHD children; some even suggest that certain neurologic findings may be diagnostic of ADHD. Denckla distinguishes 2 types of soft signs: developmental ones, findings that would be normal if the child were younger, and classic pastel soft signs, findings that could be seen on the traditional neurologic examination but are subtle in their presentation and not necessarily reproducible [eg, minor reflex asymmetry]. Age-inappropriate overflow movements (eg, mirror movements) are motor signs thought to reflect immaturity in cortical systems involved in automatically (unconsciously, without explicit effort) inhibiting extraneous movement. Overflow movements have often been reported to be increased in children with ADHD. In a recent study, children with ADHD made more errors on the conflicting and contralateral motor response tests (ie, showed impaired response inhibition compared with controls). In the National Collaborative Perinatal Project, severe hyperactive impulsive behavior was not associated with soft signs at age 7 years, although severe soft signs did correlate with hyperactivity at age 4 years.

In view of the basal ganglia dysfunction documented in ADHD, the Prechtl sign, which requires the child to close his eyes, extend his arms, and stick out his tongue and which thereby elicits choreiform movements, might be expected to be a marker of ADHD. However, the significance the Prechtl sign remains debated. Its frequency in the general population versus ADHD children versus other clinical populations is not known nor is the age range when it might be particularly revealing documented.

Much can be learned from the child’s attitude toward the examination, as well potentially as from the examination it-
self. Although the agreement between physician and parent and teacher about the diagnosis of ADHD is often low, behavioral assessment during the neurologic examination gives the pediatric neurologist a better opportunity to make observations and weigh in thoughtfully on the likelihood of ADHD and possible other comorbid behavioral disorders (oppositional defiant disorder and conduct disorder).

Furthermore, the neurologic examination, whether diagnostic of ADHD in and of itself, provides an opportunity to evaluate for commonly comorbid neurologic problems of coordination like tic disorders, dyspraxia, and dysgraphia. The office mental status examination allows for an assessment of learning disabilities that co-occur not infrequently with ADHD including dyslexia, dysgraphia, nonverbal learning disabilities, visuospatial difficulties, dyscalculia, and social emotional difficulties.

Can Neuropsychological Testing Be Used to Diagnose ADHD?

Neuropsychological testing is not a necessary part of the diagnostic assessment of ADHD, unless specific comorbid or associated learning issues need to be evaluated. Results of neuropsychological testing, however, may lend support to the diagnosis (Table 6). Although neuropsychological testing may be supportive of the ADHD diagnosis, it cannot be used in isolation to diagnose ADHD.

Executive dysfunction is common in the ADHD child. Thus, the ability to initiate, inhibit, sustain, and/or shift attention is often problematic for the child with ADHD. On the traditional Wechsler IQ test, the subtests that tend to be rote, repetitive, and require attention and memory are difficult for the ADHD child including coding (associating symbols with numbers), digit span (repeating number series forward and backward), symbol search (matching patterns), and arithmetic (mental calculations). The ADHD child may perform slowly and/or inaccurately. Memory tasks that have less content are more difficult than those that are more engaging. For example, memory for stories is easier than memory for words. Tasks requiring active working memory tend to be hard for the ADHD child. Several questionnaires for parents and/or the youths themselves address executive function rather than DSM-based characteristics of ADHD. The Brown Attention-Deficit Disorder Scales for Children and Adolescents (BRIEF) for parents and youths evaluates 6 facets of executive functioning: organizing, prioritizing, and activating to work; focusing, sustaining, and shifting attention to tasks; regulating alertness, sustaining effort, and processing speed; managing frustration and modulating emotions; using working memory and accessing recall; and monitoring and self-regulating action. The Behavior Rating Inventory of Executive Function (BRIEF) may better distinguish children with ADHD from community controls than traditional structured measures of executive function. However, these measures are less well normed and generally not available to most clinicians. Enhanced understanding of the endophenotype of ADHD will improve the choice of corroborating neuropsychological tests.

Many children with ADHD have learning disabilities, and many children with learning disabilities have ADHD (Tables 1 and 2). Not surprisingly, children with ADHD and learning disabilities are likely to be more impaired on both executive and nonexecutive functions than ADHD children without learning disabilities. In 1 study, neuropsychological performance was most impaired in ADHD with combined arithmetic and reading disability. Complete neuropsychological assessment of dyslexia, dysgraphia, nonverbal learning

Table 6 Neuropsychological Measures Useful in Assessing Children With ADHD

<table>
<thead>
<tr>
<th>Wechsler IQ subtests</th>
<th>Freedom from distractibility factor (coding, digit span, arithmetic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working memory factor (coding, digit span)</td>
<td></td>
</tr>
<tr>
<td>Processing speed factor (symbol search, arithmetic)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Executive functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiation—Reitan Trails A</td>
</tr>
<tr>
<td>Inhibition—Stroop Interference task, go no go task, stop signal tasks</td>
</tr>
<tr>
<td>Sustained attention—Reitan Trails A, MFF</td>
</tr>
<tr>
<td>Shift—Stroop Interference task, Wisconsin card sort, Reitan Trails B</td>
</tr>
<tr>
<td>Working memory—paced auditory serial addition task, California Verbal Learning test</td>
</tr>
</tbody>
</table>

| Naturalistic measures of attention |
| Six elements test |
| Hayling sentence |

| Questionnaires |
| Behavior Rating Inventory of Executive Function (BRIEF) |
| Brown Attention-Deficit Disorder Scales for Children and Adolescents |
disabilities, visuospatial difficulties, dyscalculia, and social emotional difficulties is warranted but not diagnostic in the ADHD child who is having academic difficulties.

What Is a Continuous Performance Test? Can a Continuous Performance Test Be Used to Diagnose ADHD?

Continuous performance tasks (CPTs), which should theoretically prove difficult for inattentive and impulsive ADHD children, are frequently used as a standardized corroborative test for ADHD (as well as a way to monitor medication effect) and are tauted by some as an acceptable diagnostic measure in and of themselves. Several scores can be derived from CPT performance including errors of omission and commission, mean hit reaction time, and mean hit reaction time standard error. Children diagnosed with ADHD often have more variable reaction times and make more errors of commission and omission than control children. However, what each CPT parameter actually measures has largely been based on clinical assumptions (eg, omission errors measure inattention, commission errors measure impulsivity) rather than biological validity.

Most CPTs require a response when an infrequent target is presented either in isolation or after a cue (eg, an “x” followed by an “a”). Here the main requirement is vigilance, watching for the appearance of an infrequent target. Theoretically, omission errors (failing to respond when the target is there) would be expected more often than commission errors (responding when the target is not there). Emphasizing inhibition, one of the newer CPTs, the Connors II, differs from most other CPTs by requiring frequent responding when the often seen target is presented and an infrequent nonresponse when a nontarget item appears on the screen. Hence, more commission than omission errors are expected, and performance variability is likely in ADHD subjects. The Connors II CPT has the format of a stop signal task, which has been used to test for disinhibition in a variety of cognitive disorders. Disinhibition has been considered one of several possible seminal underlying cognitive deficits in ADHD (ie, an endophenotype). Thus, the Connors II CPT may be a better test for ADHD, but this has yet to be documented in clinical studies. But, more to the point, until and if any CPT is proven to measure the/an endophenotype of ADHD, it cannot be used to make an ADHD diagnosis in isolation.

Because CPTs likely tap/tax attention and impulsivity, core, but not necessarily critical, components of ADHD, they are appropriate tasks to help corroborate a diagnosis of ADHD. However, the data on the various CPTs are variable in terms of their sensitivity and specificity and their false-positive and -negative rate in both community and clinical samples (Table 7). Indeed, CPTs have a failure rate of about 50% in children diagnosed with ADHD by other means. Furthermore, although continuous performance tests have generally differentiated ADHD children from normal/community control groups, their track record for clinical control groups is more controversial. Skill gaps are conflated in the former context.

<table>
<thead>
<tr>
<th>Table 7 Continuous Performance Tasks</th>
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</thead>
<tbody>
<tr>
<td><strong>False negative/sensitivity</strong></td>
</tr>
<tr>
<td>27%-85% Gordon</td>
</tr>
<tr>
<td>26% Connors 3</td>
</tr>
<tr>
<td>10%-15% Test of Visual Attention (TOVA)</td>
</tr>
<tr>
<td>11% + Connors II (minimizes false-negative option)</td>
</tr>
<tr>
<td><strong>False positive/specificity</strong></td>
</tr>
<tr>
<td>14% Gordon</td>
</tr>
<tr>
<td>14% Connors 3</td>
</tr>
<tr>
<td>13-30% TOVA</td>
</tr>
<tr>
<td>12% + Connors II (minimizes false-positive option)</td>
</tr>
</tbody>
</table>

coworkers, for example, found that despite the fact that CPT performance was not influenced by age, gender, socioeconomic status, fatigue effects (order of tests), visuomotor integration ability, fine motor speed, or confounded by anxiety or conduct disorders, CPT performance did not distinguish ADHD children from clinical controls, only from community controls.

A number of factors may affect the reliability of the CPT as a diagnostic instrument. Comorbid psychiatric disorders, gender, and even age have been shown to affect performance. In addition, a number of cognitive comorbidities can affect performance. Although a number of the CPT instruments have been thoughtfully modified to minimize extraneous effects on results (eg, language and reading, see later) and to maximize the attentional component of the task, CPTs are not reliable as isolated diagnostic measures for ADHD.

Confounding Factors

Comorbid Psychiatric Disorders

Results of continuous performance tests (CPTs) used in a number of studies of children who carry the diagnosis of ADHD highlight the effects of confounding psychiatric factors for interpreting CPT results. For example, CPT inattention, impulsivity, and dyscontrol errors were high in all MTA ADHD groups. But different comorbidities modified CPT performance. Children with ADHD and oppositional defiant or conduct disorder were rated as more impulsive than inattentive, whereas children with ADHD and anxiety disorders were relatively more inattentive than impulsive. Another study documented that anxiety disorder both in isolation and synergistically with ADHD affects performance on CPTs thus potentially increasing the false-positive and false-negative rate of the CPT. The effects of psychiatric comorbidity on CPT performance may explain the poor track records of CPTs in distinguishing ADHD children from clinical controls.

Cognitive Confounds

A number of different CPTs are available, and design differences are aimed at minimizing potential cognitive confounds. Reading is a confound in CPT performance, and reading difficulties can produce a high false-positive rate. Because the comorbidity of ADHD and dyslexia is reported to be as high as 25%, the basis of poor CPT performance in children...
with both disorders may be difficult to determine. Most CPTs require rapid letter identification, and CPT performance has been correlated with phonologic awareness scores. Thus, dyslexic children may do poorly on some CPTs for non-ADHD reasons.222,223 Hence, some CPTs, like the Test of Variables of Attention, have been designed to minimize reading in an effort to mitigate any confound of reading disabilities. The Test of Variables of Attention uses shapes instead of letters. Memory demands can also be a confounding factor. Thus, cued versus uncued CPTs could produce different results in the same subject because of the memory load rather than the ADHD itself. Similarly, both the duration of a CPT and the interstimulus interval alter the difficulty/memory load of the task.

Other Confounds
A number of other confounding factors are reported. Gender also appears to have an effect on CPT performance. For example, girls in the MTA study were less impaired than boys on most CPT indices, particularly impulsivity. Girls with ADHD and anxiety made fewer CPT impulsivity errors than girls with ADHD alone.130 Thus, gender alone as well as in conjunction with psychiatric comorbidities infringe on the accuracy of a CPT in the diagnosis of ADHD. Examiner presence233 has been shown to impact CPT performance (perhaps enhanced anxiety plays a role). Social class has been reported to affect CPT performance.229,234 Age may also be a factor that affects performance, regardless of ADHD status.229 Some studies suggest that specific subgroups of ADHD children do not show deficits on CPTs.223,229 In 1 study, ADHD children who performed well (false negatives) on the CPT task were older, of lower socioeconomic status, had more conduct problems, and had less inattention.229 Although some studies suggest correlations between particular error types and specific ADHD symptoms316 or ADHD severity,222 others do not.229,235 This suggests that CPTs do not measure the critical feature of ADHD.

What Laboratory Tests, if Any, Are Appropriate in the Evaluation of the ADHD Child?
Laboratory tests including magnetic resonance imaging, electroencephalography, and blood studies have no place in the diagnostic workup, except under special circumstances.

Electrophysiological Studies
Some electrophysiological studies236-240 suggest differences between ADHD children and controls but are not diagnostic of ADHD. Although the frequency of epilepsy is higher in children with ADHD than the general population (see Dunn this volume), the distinction between epilepsy and ADHD is generally not difficult to make. Rare reports discuss subclinical epileptiform discharge and ADHD.241 but routine electroencephalography or monitoring is not warranted. Thus, although differences between electroencephalograms, particularly quantitative ones, and evoked responses in ADHD versus controls have been reported, the number and quality of such studies do not support the use of these measures for diagnostic purposes.

Neuroimaging Assessment
Although research studies have documented specific structural abnormalities in ADHD, these findings cannot yet be extrapolated to the general population for diagnostic purposes nor are they apparent on routine imaging. Research structural imaging studies242,243 document reductions in both the gray and white matter of the prefrontal cortex,244-248 small corpus callosum,231,249-252 small cerebellum,253,254 small basal ganglia,217,235-238 particularly the caudate,259-263 and absence of typical basal ganglia asymmetries.262 These smaller structures are stable over time.265 Gender effects on structure are also reported.264 In a recent study sampling 27 nonreferred children (one of whom had ADHD based on the broadband questionnaire score), a greater degree of right-to-left caudate volume asymmetry predicted subclinical inattentive behaviors.205

Metabolic studies using single photon emission computed tomography (SPECT) and position emission tomography (PET) have shown decreased cerebral blood flow in right lateral prefrontal cortex, right middle temporal cortex, both orbital prefrontal cortex and both cerebellar cortices,266-272 as well as atypical dopamine metabolism273 in children and adults with ADHD compared with the controls. Functional imaging studies suggest abnormalities in the frontal circuitry including the anterior cingulate during a Stroop interference task274 as well as right frontostriatal circuitry217 and basal ganglia275 abnormalities during tasks measuring attention. Despite the promise of such studies, the current state of knowledge does not warrant structural or functional imaging as a diagnostic or evaluative measure in ADHD.

In summary, overall the diagnostic assessment begins with the history and requires the clinician to choose a battery of measures that satisfies what is, to some degree, an individually determined level of diagnostic certainty. It is, however, clear that no single test can be used to make the diagnosis and that measures that may look promising from a research vantage are not as yet an appropriate part of the diagnostic evaluation.

References
70. MTA Cooperative Group: 14-Month randomized clinical trial of treatment strategies for attention deficit hyperactivity disorder. Arch Gen Psychiatry 56:1073-1086, 1999
83. Baren M: ADHD in adolescents: will you know what it is when you see it? Contemp Pediatr 19:124-143, 2002
Diagnosis of ADHD


98. Swanson J: School Based Assessments and Interventions for ADD Students Irvine, CA, KC, 1992


122. MTA Cooperative Group: Moderator and mediator challenges to the MTA study: effects of comorbid anxiety disorder, family poverty, session attendance, and community medication on treatment outcome. Arch Gen Psychiatry 56:1088-1096, 1999


132. Quinn PO, Nadeau KG: Gender Issues and ADHD: Research, Diagnosis, and Treatment. Silver Spring, MD, Advantage, 2002


214 R.D. Nass


Diagnosis of ADHD

202. Isquith P, Gioia G: Behavior Rating Inventory of Executive Function. Austin, TX, Psychological Corporation, 2002
216. Conners CK: Conners’ Continuous Performance Test II (CPT II). Toronto, Canada, MultiHealth Systems, 2000
227. Gordon M: Do computerized measures of attention have a legitimate role in ADHD evaluations. ADHD Reports 1:5-6, 1993
232. Tamowski et al, 1986
246. Overmeyer S, Bullmore ET, Suckling J, et al: Distributed grey and white matter anomalies in ADHD are not born with, but are acquired with the disorder. J Neuro Psych 34:785-797, 2002
247. Overmeyer S, Bullmore ET, Suckling J, et al: Distributed grey and white matter anomalies in ADHD are not born with, but are acquired with the disorder. J Neuro Psych 34:785-797, 2002


