CHAPTER 14

Attention-Deficit/Hyperactivity Disorder

MARK D. RAPPORT, MICHAEL J. KOFLER, R. MATT ALDERSON, AND JOSEPH S. RAIKER

Attention-Deficit/Hyperactivity Disorder (ADHD) is a complex, chronic, and potentially debilitating disorder of brain, behavior, and development that affects between 3% and 7% of school-age children, or approximately 1.1 to 2.5 million children between 5 and 13 years of age in the United States, based on recent census estimates (U.S. Census Bureau, 2005). Accumulating evidence suggests that the core symptoms of ADHD—inattentiveness, severe impulsivity (both behavioral and cognitive), and overactivity—reflect dysfunction or dysregulation of cerebellar-striatal/adrenergic-prefrontal circuitry (Castellanos, 2001).

Near-, intermediate-, and long-term studies reveal a rather bleak picture of adverse outcomes associated with ADHD, ranging from scholastic underachievement and school failure to dysfunctional interpersonal and employment-related relationships. An overwhelming majority (>90%) of children with ADHD perform poorly in school and underachieve scholastically (i.e., 10 to 15 point deficits on standardized academic achievement batteries)—a fact highlighted by the estimated 10% to 70% with comorbid learning disabilities in reading, spelling, math, or handwriting (Barkley, 2006). They make more failing grades, have lower grade point averages (1.7 vs. 2.6), and are retained (42% vs. 13%), suspended (60% vs. 19%), and expelled (14% vs. 6%) more often from school relative to typically developing peers. An alarming 23% (3% to 7% prevalence estimates = 249,000 to 581,002) to 32% (3% to 7% prevalence estimates = 346,436 to 808,351) of children with ADHD fail to complete high school (for details, see Barkley, Fischer, Smallish, & Fletcher, 2006; Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1993), which translates into significantly fewer entering (22% vs. 77%) and completing (5% vs. 35%) college.

The elevated risk for adverse outcomes associated with ADHD continues throughout late adolescence. Those diagnosed with the disorder are sexually active at an earlier age, with a higher number of sexual partners, and are less likely to use contraceptives

relative to their peers—a collective set of behaviors that increases their risk for teenage pregnancy and contracting sexually transmitted diseases. The inattentive and impulsive components of the disorder also contribute to their poor driving records. They receive more speeding citations (4–5 vs. 1–2) and are involved in and at fault for more vehicular accidents (26% vs. 9% involved in 3 or more crashes) relative to same-age control children, particularly those causing serious injury (60% vs. 17%). Their poorer overall driving skills are highlighted by significantly higher rates of license suspensions and revocations (32% vs. 4%) relative to same-age peers (Barkley, 2006).

The impairing nature of the disorder continues into adulthood for many individuals. A surprising 90% of children previously diagnosed with ADHD are gainfully employed by their late 20s to early 30s; however, their overall socioeconomic status is significantly lower relative to controls followed over the same time frame (Manuzza et al., 1993). Moreover, young adults with ADHD are more likely to be fired from their job (55% vs. 23%), change jobs more frequently (2.6 vs. 1.3), evince more ADHD symptoms on the job, and earn lower employee work performance ratings relative to peers. Approximately 66% of those diagnosed with ADHD during childhood continue to experience significant symptoms of the disorder as adults, and some meet diagnostic criteria for Antisocial (11%–21%), Histrionic (12%), Passive Aggressive (18%), and Borderline (14%) Personality Disorder. The increased risk associated with the development of comorbid personality disorders in adulthood, however, appears to be conveyed by elevated Conduct Disorder (CD) symptoms during childhood and/or the expression of CD problems during adolescence.

Attention-Deficit/Hyperactivity Disorder is a controversial clinical disorder and is difficult to diagnose for several reasons. One of the core symptom clusters used to define the disorder—attentional problems—has poor specificity and occurs with high frequency in many other childhood disorders. Many of the disorder's core and secondary symptoms represent dimensional variants of normal temperament, and ADHD is presumed to reflect diverse factors or pathways that result in a similar developmental outcome, a phenomenon termed *equifinality*.

Despite the abundance of assessment instruments available today, none are uniquely sensitive and valid for diagnosing ADHD. This situation is due to two intertwined factors: the introduction of ADHD as a diagnostic category prior to developing appropriate tools to measure its core features and the failure to scrutinize core deficits or features of the disorder and their underlying assumptions prior to designing assessment instruments. The initial section on current assessment strategies highlights these issues, and the conceptualization section provides a detailed discussion of theoretical issues underlying the design of clinical assessment measures for ADHD. The ensuing two sections examine empirically based treatments for ADHD, followed by a detailed case description that illustrates the major topical issues discussed throughout the chapter.

ASSESSMENT

OVERVIEW

Expert guidelines in psychiatry (McClellan & Werry, 2000) and psychology (Barkley, 2006) recommend that a qualified clinician conduct a comprehensive diagnostic

evaluation utilizing multiple assessment instruments. These range from subjective measures such as ratings scales and clinical interviews to increasingly objective measures such as direct observation and sophisticated actigraphs. Aside from the handful of small *n* and uncontrolled case studies, self-report and self-monitoring instruments have been confined to assessing treatment-emergent effects (i.e., side effect rating scales) and co-occurring symptomatology (e.g., self-report depression and anxiety inventories) in ADHD. Clinicians interested in these specialty instruments can find detailed discussions throughout this book and elsewhere (cf. Mash & Terdal, 1997). The diagnostic process must also include a careful review of psychoeducational test data and the child's social-developmental, medical, educational, psychiatric, familial, and treatment histories, as discussed in the following sections.

Historical Information

Obtaining detailed and accurate historical information is essential to the assessment of ADHD. Information obtained concerning the onset, course, and duration of behavioral and emotional problems is one of the most valid means of separating ADHD from other childhood disorders, following the early methods of defining clinical syndromes used by Hippocrates (i.e., recognizing patterns or clusters of symptoms). A child with a relatively benign history of behavioral and academic problems, for example, whose academic performance is compromised beginning in fifth grade accompanied by an acute onset of behavioral and/or emotional difficulties, is unlikely to have ADHD based on our knowledge of the disorder. Alternative candidates, such as affective disorders, anxiety disorders, early-onset Schizophrenia, or abrupt environmental change represent more likely alternatives to explain the difficulties. Table 14.1 provides an overview of the differences in onset, course, and duration of problematic symptoms in childhood-onset disorders.

Questions concerning pre-, pari-, and postnatal development, early or continued ingestion of alcohol, drugs, and other toxins, length and course of pregnancy, delivery and birth complications, Apgar scores, and other information relevant to the child's early development are outlined in the University of Central Florida Children's Learning Clinic-IV (CLC-IV) clinical intake form shown in Table 14.2 (also available in pdf version from the author). The rationale for including this information derives from research suggesting slight elevations in pregnancy complications and physical abnormalities, general health problems, allergies, and accidental injuries and poisonings in children with ADHD (for a review, see Rapport, Timko, & Wolfe, 2006).

Detailed medical, educational, and child and family psychiatric, social, and developmental histories are required. Obtained historical information contributes to the diagnostic process by providing converging evidence of occurrences common to children with ADHD. For example, family psychiatric histories typically reflect a higher prevalence of ADHD in first-degree biological relatives of children with ADHD (25% to 37% average risk), particularly in fathers (44%) and brothers (39%; Biederman, Faraone, Keenan, Knee, & Tsuang, 1990).

The educational history associated with ADHD is typically characterized by an early onset and gradual worsening of behavioral, emotional, and academic difficulties. Teachers often invoke the term *immaturity* when describing 4- to 5-year-old children with ADHD. A laundry list of pejorative characteristics that reflect gradually impairing levels of inattentiveness, impulsivity-hyperactivity, and general classroom

Table 14.1
Onset, Course, and Duration of Major Clinical Disorders of Childhood

Clinical Disorder	*Onset*[a,b,c]	*Course*	*Duration*
Disruptive Behavior Disorders			
Attention-Deficit/Hyperactivity Disorder (ADHD)[g]	3.5[b]	Chronic	Adolescence–lifelong
Conduct Disorder (CD)	<10[c]	Variable	Adulthood[d]
	<16[c]	Variable	Early adulthood
Oppositional Defiant Disorder (ODD)	<8[c]	Variable	Remits or antecedent to CD
Pervasive Developmental Disorders			
Asperger's Disorder	3–6[c]	Chronic	Lifelong
Autistic Disorder[e]	<3[b]	Chronic	Lifelong
Childhood Disintegrative Disorder[e]	3–4[b] or [c]	Chronic	Lifelong
Rett's Disorder[e]	1–2 & <4[c]	Chronic	Lifelong or fatal
Mood Disorders			
Major Depressive Disorder[f]	5–19[b] or [c]	Variable	Remits or variable
Dysthymic Disorder	8.5[c]	Variable	Remits or variable
Manic Episode (In context of Bipolar Disorder)	5–14	Variable	Lifelong
Anxiety Disorders			
Acute Stress Disorder	Any age[h]	1 month	2 days to 1 month
Obsessive-Compulsive Disorder[i]	6–15(m)[c]	Chronic	Lifelong
	20–29(f)[c]	Chronic	Lifelong
Posttraumatic Stress Disorder	Acute or	Variable	2 months to
	Delayed[h]	Variable	2 years
Separation Anxiety Disorder[l]	9–13[b]or[c]	Variable	2 years–adolescence
Social Phobia[l]	Mid-teens[b] or [c]	Chronic	Remits by adulthood
Specific Phobia[j,l]	7–12[b] or [c]	Variable	Remits by adolescence
Other Clinical Disorders			
Tourette's Disorder	7[c]	Variable	Lifelong
Early-Onset Schizophrenia[l]	5–11[b] or [c]	Variable	Lifelong

[a]Age of onset indicates age in years at which symptoms are most frequently first reported in children; [b]Acute onset; [c]Insidious onset; [d]At risk for Antisocial Personality Disorder and Substance Abuse Disorder as adults; [e]Typically associated with mental retardation; [f] typically associated with an anxiety disorder; [g]Frequently associated with Conduct Disorder; [h]Onset immediately following a traumatic event; [i]Commonly associated with depression, other anxiety disorders, and/or Tourette's; [j]Slightly higher rates in females and dependent on the type of phobia; [k]Significantly higher number of males versus females prior to age 10; [l]Frequently continuous with adult anxiety disorder.

From "Treating Children with Attention-Deficit/Hyperactivity Disorder (ADHD)" (pp. 65–107), by M. D. Rapport, in *Handbook of Psychological Treatment Protocols for Children and Adolescents*, V. B. Van Hasselt and M. Hersen (Eds.), 1998, New York: Erlbaum. Adapted with permission.

disruptiveness replaces the immaturity adjective invoked during the first and second grades. Intellectual development frequently lags behind same-age peers by as much as 7 to 15 points on standardized intelligence tests, and academic functioning is nearly always impaired except in high IQ ADHD children. This constellation of chronic and worsening behavioral, cognitive, and emotional problems results in more failing

Table 14.2
Children's Learning Clinic-IV Clinical Intake Form

Child's Name_____DOB_____Age_____

PREGNANCY

Prenatal history:

Planned_____Smoking_____ETOH_____Medications_____
_____Vitamins_____Other substances_____
(**Note:** Specify type, amount/dosage or number, and duration for each category)

Parinatal history:

Full term/other_____Medical complications (e.g., preeclampsia)_____
_____
Labor_____Delivery (e.g., natural, induced, C-section)_____
Delivery complications_____

Postnatal history:

APGAR score_____Height_____Weight_____Complications_____
_____Hospital stay_____

DEVELOPMENTAL HISTORY

Early temperament (describe child's reaction/interaction with caregivers and environment including eye contact, ability to be comforted, use and reaction to gestures, social bonding)_____
_____
Early development problems (e.g., colic, eating difficulties, sleep problems)_____

Developmental Milestones (in months):

Roll over_____Sit up_____crawl_____1st steps unassisted_____
Independent walking_____First words_____3-word sentences_____Toilet training_____

MEDICAL HISTORY

Diseases/chronic infections/febrile illnesses_____
(**Note:** Describe history, treatment, and outcome for each incident)

Chronic ear infections (otitis media)_____
Hospitalizations/ER visits_____
Head injuries/loss of consciousness_____
Surgeries/sutures (event and number)_____
Broken bones/other medical problems_____
Allergies_____Accidental poisonings_____
Medications (current/past)_____
Other medical problems (e.g., seizures, hearing loss, vision problems)_____
_____

Table 14.2
(*Continued*)

EDUCATIONAL HISTORY

Age (e.g., 4–5 Years)
School/facility_____Location_____
Teacher_____Grades/comments_____
Behavior_____
(**Note:** Complete above information for each grade/classroom placement)

Previous testing/assessments/special education staffing/placements_____
_____
Suspensions/expulsions/school-initiated punishments (include age/grade, event, outcome)
_____

SOCIAL FUNCTIONING

Peer relationships (friends—younger/older preference, home/school)_____
_____
Organized sports/activities (e.g., soccer, baseball, swimming, Scouts, karate)_____
_____
Other preferred activities (e.g., hobbies, computer/video games, art, music, bicycling, skateboarding, water sports)_____
Family relationships (with parents, siblings, other family members)_____
_____

FAMILY HISTORY

Paternal
Siblings_____
Parents_____
Grandparents_____

Maternal
Siblings_____
Parents_____
Grandparents_____

(**Note:** Describe all serious medical and psychiatric problems/diagnoses; include probes for school failure, learning problems, suicidal behavior/depression, anxiety, substance abuse, and treatments for unknown diagnoses.)

grades and grades failed, culminating in a 10 to 30 point lag on standardized academic achievement tests (Barkley, DuPaul, & McMurray, 1990).

Methods and assessment tools used in clinic, laboratory, and classroom settings to diagnose children with ADHD are reviewed in the ensuing sections, emphasizing their incremental validity for rendering diagnostic decisions.

Checklists and Rating Scales

Behavior checklists and rating scales play a prominent role in assessing children with ADHD. They serve as an important source of information concerning a child's behavior in different settings, how others judge behavior, and the extent to which behavior deviates from age- and sex-related norms. Information gleaned from rating scales contributes to the diagnostic process, and several scales serve as treatment efficacy measures. Specific psychometric properties of commonly used rating scales are provided in Table 14.3.

Limitations common to most rating scales include their reliance on subjective judgments and multiple threats to internal validity. These include halo effects, response bias, intensity and immediacy effects, and rater expectation bias (Harris & Lahey, 1982; McClellen & Werry, 2000). The underlying assumptions that Likert rating formats (e.g., 0–3 symptom severity rating) reflect interval level measurement and that all behavioral and emotional problems should be equally weighted (i.e., count equally toward a total score when endorsed at the same level) represent additional psychometric challenges to clinical rating scales.

Checklists and rating scales reviewed next are listed under *broad-band* and *narrow-band* categories. This distinction represents differences in scale development and the breadth of behavioral-emotional problems assessed by the instruments.

Broad-Band Rating Scales Broad-band rating scales provide for a rapid screening of the most common child clinical disorders and allow clinicians to compare obtained profile scores to scores based on sex and developmentally appropriate behavior. The severity of ADHD symptoms can be assessed, and patterns or presence of more general psychopathological dysfunction can be documented. Screening for other potential diagnoses is important for two reasons: Attentional difficulties are common to most child clinical disorders, and ADHD is highly comorbid with other disorders, particularly learning disabilities, Oppositional-Defiant Disorder, and Conduct Disorder. Converging evidence also indicates that ADHD without the presence of other disorders may be associated with a different developmental outcome (Fergusson, Lynskey, & Horwood, 1997; Rapport, Scanlan, & Denney, 1999).

Characteristics and psychometric properties of available broad-band rating scales are provided in Table 14.3. Most scales report separate sex norms for children ages 6 to 18, with some scales reporting norms for children as young as 2 years (e.g., CBCL, BASC-2). Scales that do not provide separate norms for boys and girls must be administered with caution, because sex differences in behavioral and cognitive symptoms are well documented in the literature. All scales use a Likert-type endorsement format, with response options indicating either frequency or severity of behavior. Completion time for scales is generally between 10 and 20 minutes, but may vary based on the respondent's reading level. The number of scale items ranges from 27–28 for the short forms of the Conners teacher and parent rating scales, respectively, to 160 for the parent version of the new Behavior Assessment System for Children, second edition (BASC-2). Scales with too few items may fail to assess important aspects of behavior, but increasing the number of items is beneficial only to the extent that added items are not redundant with existing items, as indicated by overly high internal consistency. Internal consistency estimates and test-retest reliability metrics are within recommended ranges for the broad-band scales listed in Table 14.3.

Table 14.3
Broadband and *DSM-IV* Rating Scales Used in Childhood Assessment of ADHD

Scale		No. of Items	Item Type	Comp. Time	Psychometric Properties: T-R	Psychometric Properties: Int. Con. (alpha)	Psychometric Properties: Validity Evidence: Conv/Div	Psychometric Properties: Validity Evidence: Criterion	Psychometric Properties: Validity Evidence: ROM	Norms: Age	Norms: Sex	Rating Period	Publisher/Cost
Broadband Scales													
BASC-2 Reynolds & Kamphaus, 2002	P	134–160	0–3 freq.	10–20	(1–10 wk) .65–.92 (7 mo.) .69	.72–.95 .73–.97	CBCL Attention (.66) Conners Parent (.71) Conners Teacher Inattention (.81) TRF Attention (.76)	BGD: With and without CD, behavior disorder, depression, emotional disturbance, ADHD, LD, Mild MR, and Autism.	*N/A*	2–21	Y	*NR*	American Guidance Services, Inc. Complete kit: $360/$500 (w/ or w/o software; manual, 25 of each form type, 25 DO forms) From 25 @ $30
	T	100–139											
CBCL Achenbach & Rescorla, 2001 Rater: Parent		118	0–2 freq.	15–20	(1 wk) .80–.94 (3 mo) M = .84	.63–.67	93 items identical b/t CBCL & TRF See manual for detailed validity information.	Discriminant analysis (referred vs. nonreferred: 80–88% correctly identified BGD: ADHD v. non-ADHD, LD	No sig. correlation with actometer (Aronen, Fjällberg, Paavonen, & Soininen, 2002)	2–18	Y	past 6 mo.	ASEBA Complete computer scoring kit: $325 (manual, software, 50 CBCL, TRF, & YSR forms) Forms 50 @ $25 (any type)

CBCL-TRF Achenbach & Rescorla, 2001 Rater: Teacher	118	0–2 freq.	15–20	(2 wk) .60–.96 (2 mo) .63–.88	.72–.95	Factor scores "correlate well" with equiv. CTRS scales Sig. corr. b/t scores and direct observations	Discriminant analysis (referred vs. nonreferred: 74–80% correctly identified BGD: ADHD vs. non-ADHD, LD	*NR*	5–18	Y	Past 2 mo.	see CBCL
CBRF-A Van Egeren, Frank, & Paul, 1999 Inpatient only	65	0–3 sev.	*NR*	(2 wk) .63–.76 (3 wk) .38 (OA)	*NR*	Overactivity Scale with: CBCL: .23–.28 (Externalizing, Aggressive Behavior) –.21 (Internalizing)	Overactivity scale did not predict length of hospital stay	*NR*	3–17	N	8-hour shift	Author Cost: *NR*
CBRSC Neeper, Lahey, & Frick, 1990 Rater: Teacher	70	0–5 freq.	10–15	Published norms based on earlier 81-item test—*NR* for available scale					6–14	Y	*NR*	Harcourt Assessment, Inc. Complete kit: S133 (contents unspecified) Forms: $29 (# unspecified)

(*continued*)

Table 14.3
(*Continued*)

Scale			No. of Items	Item Type	Comp. Time	Psychometric Properties: T-R	Psychometric Properties: Int. Con. (alpha)	Validity Evidence: Conv/Div	Validity Evidence: Criterion	Validity Evidence: ROM	Norms: Age	Norms: Sex	Rating Period	Publisher/Cost
CRS-R Conners, Sitarenios, Parker, & Epstein, 1998 Rater: Parent, Teacher Self-report and ADHD *DSM-IV* Scale also available	Long	P	80	0–3 (not at all true to very much true)	15–20	(6–8 wk) .47–.85	.73–.94 .77–.96	Long: Short: .95–1.00 P:T: .12–.55 CDI: .40–.82 (teacher) .36–.79 (parent)	BGD: ADHD v. non-ADHD, emotional problems Sensitivity (.78–.92) Specificity (.91–.94) PPP (.85–1.0) NPP (.21– .61)	CPT: r = .33–.44	3–17	Y	Last month	Pearson Assessments Complete kit: $255 (manual, 25 of each form type) Forms: 25 @ $37/$40 (long/short)
		T	59			.47–.88	.86–.94							
	Short	P	25			.89–96	.88–.95							
		T	27			.72–.92								
CSI-4 Gadow & Sprafkin, 1994, 2002 Screens for *DSM* Disorders including ADHD	P		77	0–3 freq.	10–20	(2 wk) .66–.88 (P & T)	.74–.94 (both)	ADHD-HI & (C) vs: TRF-Externalizing: .69 (.53) IOWA-Conners-IO: .70 (.83)	ADHD category (6 studies): Mean sensitivity: .64 (.87 if using either teacher or parent) Mean specificity: .77 (.62 if using either teacher or parent)		3–18	Y	"Overall bx"	Checkmate Plus, Inc. Complete kit: $98/$358 (w/ or w/o software; manuals, 25 each form, plus scoring sheets, profiles) Forms: 50 @ $32
	T		99											

DSMD Naglieri, LeBuffe, & Pfeiffer, 1994 No attention subscale		111	1–5 freq.	15–20	.73–.94	.90–.95	CBCL Attention Subscale: .50	65–90% correctly classified across disorders	*N/A*	5–18	Y		PAR, Inc. Complete kit: $260 (manual, 25 each child and adolescent forms) Forms: 25 @ $85
MCBC Sines, 1986/1988 Activity level scale	Parent	77	T–F	10–15	(ukn) .49–.78	.58–.83	*NR*	*NR*	*NR*	9–14	Y	*NR*	Author: Cost: *NR*
	Teacher	68			*NR*	*NR*							
PBQ Behar & Stringfield, 1974		30	0–2 freq.	5–10	(3–4 mo.) .60–.94	*NR*	Sig. corr. w/DO of clsrm bx & interactions	BGD: Normal vs. hyperactive, emotionally disturbed preschool children	*NR*	3–6	*NR*	*NR*	Author: Cost: *NR*
RBPC Quay & Peterson, 1993		89	0–3 sever.	15–20	(2 mo.) .49–.83	.73–.94	Original BPS: .63–.97 CBCL: .43–.92 among alike scales ME not sig. correlated with DO of gross motor activity (r = 00; N = 34)	Discriminate clinical from nonclinical groups of children	*NR*	5–18	N	*NR*	PAR, Inc. Complete kit: $182 (manual, 50 forms & profile sheets) Forms: 25 @ $58 Software: $318

(*continued*)

Table 14.3
(*Continued*)

Scale		No. of Items	Item Type	Comp. Time	Psychometric Properties					Norms		Rating Period	Publisher/Cost
							Validity Evidence						
					T-R	Int. Con. (alpha)	Conv/Div	Criterion	ROM	Age	Sex		
Stand-alone scales													
WWPARS Werry, 1968 Rater: Parent		22	0–2 freq.	5	*NR*	*NR*	WWPARS rating at age 4.5 sig. related to CPRS rating at 6.5 years (Campbell et al., 1978)	Predicted some improvements in mother-child interactions in response to stimulant meds in hyperactive children (Barkley & Cunningham, 1979)	Actometer M = .65 Range: .24 (classroom) to .77 (woodshop); .67 during gym	2–9, N = 140	*NR*	*NR*	Free online
DSM-IV scales													
ACTeRS Ullmann, Sleator, & Sprague, 2000	Teacher	24	1–5 freq.	5–15	(2 wk) .68–.78	.92–.97	CPRS (.78–.90)	Hyperactivity scores medication sensitive in ADHD students; BGD: ADHD/non-ADHD	*NR*	5–14	N	*NR*	MetriTech, Inc. Complete kit: $62 (manual + 50 forms; parent OR teacher) Forms: 50 @ $43
	Parent	25				.78–.96	CBCL (.80–.81)						

ADDES-3 McCarney, 2004	Home School	46 60	0–5 freq.	12–15	(ukn) .87+	.99	Unavailable from publisher			5–18	Y	*NR*	Hawthorne Educational Services, Inc. Complete kit: $232 Forms: 50 @ $35 (either version) Software: $35
ADHD-SC-4 Gadow & Sprafkin, 1997	Parent Teacher	50	0–4 freq.	*NR*	(6 wk) .75–.82 .70–.89	.93–.95 .92–.95	CBCL (.48–.81) TRF (.45–.88)	Sensitivity .81–.85 Specificity .57–.94 Sensitivity .61–.89 Specificity .57–.94	*NR*	3–18	Y	*NR*	PAR, Inc. Complete kit: $69 (manual, 25 each version, scoring sheets) Forms: 50 @ $30
ADHD-IV DuPaul, Power, Anastopoulos, & Reid, 1998	Home School	18	0–3 freq.	10	(4 wk) .78–.86 .88–.90	.86–.92 .88–.96	CPRS-R: .10–.80 CRTS-R: .12–.41 ADHD Bx Code: .25–.26 AES: .36	Sensitivity .72–.84 Specificity .49–.86 PPP .54–.78 NPP .81–.81 BGD: ADHD-I, ADHD-C, and controls (parent and teacher)		5–18	Y	Last 6 mo.	Guilford Publications, Inc. Complete kit: $42 (book, manual, scale) Forms: photocopiable
ADHD-SRS Holland, Gimpel, & Merrell, 1998 Rater: Parent, teacher (same form; separate norms provided)		56	0–4 freq.	10–15	(2 wk) .93–.98	.92–.99	ADDES: .80–.95 CTRS: .64–.97 (like scales) ADHD-IV: .89–.93	BGD: ADHD vs. non-ADHD	*NR*	5–18	Y	*NR*	Wide Range, Inc. Complete kit: $85 (manual, 25 forms) Forms: 25 @ $38

(*continued*)

Table 14.3
(*Continued*)

Scale	No. of Items	Item Type	Comp. Time	Psychometric Properties					Norms		Rating Period	Publisher/Cost
						Validity Evidence						
				T-R	Int. Con. (alpha)	Conv/Div	Criterion	ROM	Age	Sex		
ADHDT Gilliam, 1995 Rater: Parent or Teacher	36	0–2 sev.	5–10	(1 wk) .85–.94 (2 wk) .85–.92	.91–.97	Compared to 7 other tests used to dx ADHD or bx concerns: "satisfactory" CTRS: .53–.72 ADDES-S: –.81 to –.88 ACTeRS: –.71 to –.78	BGD: ADHD vs. non-ADHD True positives/ negatives: 92% False positives: 7.7%	*NR*	3–23	Y	NR	Pro-Ed, Inc Complete kit: $110 (manual, 50 summary/ response forms) Forms: 50 @ $50
BADDS	50		10–20	(ukn.) .61–.93	.73–.89				3–18	Y	*NR*	Hawthorne Educational Services, Inc. Complete kit: $350/$195 (w/ or w/o software; manual, 5 of each form) Forms: 25 @ $59

BASC-M Kamphaus & Reynolds, 1998	Parent Teacher	47	0–3 freq.	5–10	(2–8 wk) .57–.90 .72–.93	.64–.83 .78–.93	CBCL: –.68 to .79 CTRS-R (–.36 to .62)	BGD: ADHD vs. non-ADHD & ADHD-I vs. ADHD-C (both versions)	*NR*	4–18	Y	*NR*	American Guidance Services, Inc. Complete kit: $129 (manual, 25 each form, scoring template) Forms: 25 @ $32
BHSQ-R DuPaul & Barkley, 1992	Home and School versions	20	9-point scale	5–10	(ukn.) .60–.89	.64–.66							Guilford Publications, Inc. Complete kit: $33 (book, manual, scale) Forms: photocopiable
CAAS Lambert, Hartsough, & Sandoval, 1990 Rater: Teacher or parent	Home School	31	1–4 freq.	2–5	(3 yr) .32–.44 .40–.82	.75–.81 .78–.94	*NR*	*NR*	*NR*	5–13	NR	*NR*	American Guidance Services, Inc. Complete kit: $155 (manual, 25 each form, scoring profile) Forms: 25 @ $50

(*continued*)

Table 14.3
(*Continued*)

Scale		No. of Items	Item Type	Comp. Time	Psychometric Properties					Norms		Rating Period	Publisher/Cost
					T-R	Int. Con. (alpha)	Validity Evidence: Conv/Div	Validity Evidence: Criterion	Validity Evidence: ROM	Age	Sex		
ECADDES McCarney & Johnson, 1995	Home	50	0–4 freq.	12–15	(1 mo.) .82–.89	.87–.97	CPRS-R: .41–.71 ADHDT: .46–.81	BGD: ADHD vs. non-ADHD	*NR*	2–6	Y	*NR*	Hawthorne Educational Services, Inc. Complete kit: $162 (technical and intervention manuals, parent's guide, 50 school, home, & *DSM-IV* forms) Forms: $35 per 50 forms (home or school); $22 per 50 *DSM-IV*
	School	56			.90–.98								
NICHQ VAS Wolraich et al., 1998/2003		P T	0–3 freq.	10–15	*N/R*	.90–.92	DISC-IV (.79)	BGD: ADHD vs. non-ADHD	*N/R*	5–12	N	6 mo.	NICHQ Free online: http://www.nichq.org

S-ADHD-RS Spadafore & Spadafore, 1997 Rater: Teacher	50	0–4 freq.	10	(2 wk – 1 mo.) .88–.90	NR	*NR*	Correctly identified: 50/50 ADHD Incorrectly identified 2/50 non-ADHD as ADHD	*NR*	5–19	Y		Complete kit: $80 (manual, 25 scoring protocols, 25 observation forms, 25 med tracking forms) Forms: 25 @ $25
SNAP-IV Swanson, 1992 Rater: Teacher or parent (same form)	90	0–3 freq.	10–15	(2 wk) .70–.90	.90+	*NR*	*NR*	*NR*	*NR*	Y	*NR*	Form and scoring guidelines are free online: http://www.adhd.net

ACTeRS = ADHD Comprehensive Teacher Rating Scale; ADDES-2 = Attention Deficit Disorders Evaluation Scale—Second Edition; ADDES-S = Attention Deficit Disorders Evaluation Scale—Secondary-Age Student; ADHD-IV = ADHD Rating Scale-IV; ADHD-SC-4 = ADHD Symptom Checklist—*DSM-IV* Edition; ADHD-SRS = ADHD Symptoms Rating Scale; ADHDT = ADHD Test; BADDS = Brown Attention Deficit Disorder Scale; BASC = Behavior Assessment System for Children; BASC-M = Behavior Assessment System for Children—Monitor for ADHD; BGD = Between-group differences; BHSQ-R = Barkley Home Situations Questionnaire—Revised; CADS = Conners' ADHD/DSM-IV Scales; CAAS = Children's Attention and Adjustment Survey; CBCL = Child Behavior Checklist; CBRF-A = Child Behavior Rating Form—Abbreviated; CBRSC = Comprehensive Behavior Rating Scale for Children; CDI = Children's Depression Inventory; CPRS-R = Conners' Parent Rating Scale—Revised; CPT = Continuous Performance Test; CRS-R = Conners' Rating Scales—Revised; CSI-4 = Child Symptom Inventory—Fourth Edition; CTRS = Conners' Teacher Rating Scale—Revised; ECADDES = Early Childhood Attention Deficit Disorders Evaluation Scale; M = Mean; MCBC = Missouri Children's Behavior Checklist; NICHQ VAS = National Institute for Children's Healthcare Quality Vanderbilt Assessment Scale; NPP = Negative Predictive Power; P = Parent; PBQ = Preschool Behavior Questionnaire; PPP = Positive Predictive Power; RBPC = Revised Behavior Problem Checklist; S-ADHD-RS = Spadafore ADHD Rating Scale; SNAP-IV = Swanson, Nolan, & Pelham Rating Scale—Version IV; T = Teacher; TRF = Teacher Report Form; WWPARS = Werry-Weiss-Peters Activity Rating Scale.

Note: Pricing information obtained from publishers' websites, accessed February, 2006.

Convergent and criterion validity data are available for many of the broad-band scales, providing inchoate evidence that the scales measure what they purport to measure. Validity evidence is generally limited to comparisons with other existing rating scales (which may be inflated due to shared source and item variance) and the scale's ability to statistically discriminate between ADHD and non-ADHD groups. The Achenbach (CBCL/TRF), Conners, and Child Symptom Inventory (CSI-IV) are exceptions, with recent versions demonstrating moderate to high *sensitivity* and *specificity* (the probability that a symptom is or is not present, given that a child has ADHD). Clinicians, however, are more interested in *positive* and *negative predictive power*—that is, the probability that a child does or does not have ADHD, given the presence of particular symptoms. The Conners and Achenbach parent and teacher rating scales (see Table 14.3) report moderate to high positive predictive power and low to moderate negative predictive power. Scale costs vary by test and publisher and are not necessarily correlated with scale quality.

Most broad- and narrow-band rating scales have not been compared to more objective measures such as precision actigraphs or direct observations of classroom behavior. The few studies that have examined these relationships tend to provide discouraging results. For example, Aronen and colleagues (2002) compared CBCL parent ratings of hyperactivity with high-precision actigraph measurements of activity level and failed to find a significant correlation. A similar study revealed that, when measured by step counter, nearly 64% of children rated as clinically hyperactive were less active than the most active child rated normal by the teacher (Tryon & Pinto, 1994).

Narrow-Band Rating Scales In contrast to broad-band scales, which are typically used early in the assessment process to quickly screen for several of the most common childhood disorders, narrow-band scales generally provide greater depth and breadth of specific symptoms relevant to situational characteristics associated with ADHD. Age and sex norms are available for some but not all scales—a serious limitation considering the well-documented developmental and sex differences in children's attention and activity level. Completing narrow-band scales typically requires significantly less time relative to broad-band scales because they are more focused and contain fewer items. Reliability and validity evidence is generally adequate when available, and these values are subject to the same concerns described in the section on broad-band scales. For example, the new ADDES-3 reports an internal consistency of .99, which indicates significant redundancy in the items and suggests that a shorter version of the scale could decrease administration time without negatively impacting reliability and validity. Emerging evidence suggests that scales with fewer items may also be equally sensitive for detecting treatment effects compared to longer rating scales.

Scale costs vary by test and publisher; however, there is no clear relationship between cost and diagnostic utility. Most scales require an initial investment, ranging from $33 to $350, for a starter kit containing the test manual and a requisite of forms. Additional packages cost between $30 and $59 for 25 to 50 forms. Two of the narrow-band scales, the ADHD-IV and the Barkley Home Situations Questionnaire (BHSQ), allow the user to freely photocopy the scale for unlimited use. One scale, the National Initiative for Children's Healthcare Quality Vanderbilt Assessment Scale (NICHQ VARS), is free online. Normative data and reliability and validity evidence for the parent version of this scale are based on a relatively small sample.

Structured/Semi-Structured Clinical Interviews

Overview The distinction between structured and semi-structured interviews lies in the degree of freedom granted to the clinician to stray from a given script and ask open-ended, probing questions in response to symptom endorsements made by the interviewee. Rutter and Graham (1968) are credited with pioneering the development and use of structured and semi-structured clinical interviews to aid clinical judgment. The development of these schedules represents the recognition of both the questionable reliability and validity of unaided clinical interviews and the frequent disagreement between parent and child reports of symptom endorsement and severity. To illustrate the potential problems associated with unaided diagnosis, consider the seminal study by Sleator and Ullmann (1981), which found that nearly 80% of children meeting formal diagnostic criteria for ADHD were misdiagnosed by their primary pediatricians. At 3-year follow-up, these children were no different from children correctly diagnosed with respect to continuing behavior problems, poor grades, and medication status. The fact that most children with ADHD fail to exhibit signs of hyperactivity in an office setting contributed to the high rate of misdiagnosis, and highlights the need for reliable and valid instruments for assessing childhood disorders in general, and ADHD in particular.

Structured and semi-structured clinical interviews result in decreased error compared to unstructured clinical interviews, both errors arising from internal (e.g., differential training level of clinicians, clinician biases) and external (e.g., discrepancies between informants) sources. Using the Hippocratic model, clinical diagnosis is based on the recognition of specific clusters of symptoms that characterize a particular disorder. Children with ADHD historically are poor informants, regarding both the presence and the severity of problematic symptoms. Information must thus be obtained from adult informants who are familiar with the child (e.g., parent or guardian, teachers).

Clinical Interviews Semi-structured clinical interviews provide unique information beyond the data gained from rating scales. They are currently the only assessment option that allows the clinician to probe for the onset, course, and duration of endorsed symptoms—a necessity for differential diagnosis—and are currently considered the gold standard for ADHD assessment and diagnosis. Strong convergent and discriminant validity is reported for most of the available semi-structured interviews, and test-retest reliability suggests stability of diagnosis over 1 to 3 years in clinical samples (Pelham, Fabiano, & Massetti, 2005). High sensitivity and specificity are typically reported for the semi-structured interviews, with only limited information available pertaining to positive (PPP) and negative (NPP) predictive power. The lack of PPP and NPP metrics is due in part to the use of semi-structured clinical interviews as the gold standard from which the predictive power of other measures (e.g., rating scales) is established.

Semi-structured clinical interviews typically require between 1 and 2 hours to complete, depending on a range of factors. These include the clinician's experience, the informant's ability to remain focused and recall historical information, and the severity, range, and duration of presenting problems (see Table 14.4). The time investment limits their practicality for repeated use (e.g., for assessing treatment effects). Financial investment varies significantly across interview schedules. Some are free and

Table 14.4
Clinical Child Diagnostic Interviews

Measures	*Age Range*	*Time (min.)*	*Test-Retest (Kappa)*	*Symptom History*	*Disorders Considered*	*Scoring Format*	*Instrument Cost*	*Training Required*
Structured Interviews								
Diagnostic Interview Schedule for Children-IV (DISC-IV)	6–17 (P) 9–17 (C)	90–120 (P) 45–90 (C)	0.79 (P) 0.42 (C)	4 weeks/ 12 months	All major Dx	Y/N	$150–$2,000	2–3 day training module
Diagnostic Interview for Children and Adolescents-IV (DICA-IV)	6–17	60–120	NR (P) 0.32 (C) 0.59 (A)	4 weeks/ 12 months	All major Dx	Y/N	$1,000	2–4 weeks
Children's Interview for Psychiatric Syndromes (CHiPS)	6–18	40	0.4	NR	All major Dx	Y/N	$115	NDR
Semi-structured Interviews								
Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS)	6–17	30–90	0.63	6 months/ Lifetime	All major Dx	0–3	Free online	CTR
Semi-structured Clinical Interview for Children and Adolescents (SCICA)	13–18	60–90	0.57 (Attention problems scale)	NR	Does not correspond with *DSM-IV*		$110–$295 $25 for 50	NDR
Child and Adolescent Psychiatric Assessment (CAPA)	9–17	20–210 M=66 (P) 22–150 M=59 (C)	NR for ADHD 0.55 for CD	3 months	All major Dx	0–3	$600 + $2,000 Fixed costs	BA
Interview Schedule for Children and Adolescents (ISCA)	8–17	120–150 (P) 45–90 (C)	Between 0.64 and 1.0	NR	All major Dx	0–3		CTR

Note: Properties are equivalent for parent and child/adolescent version unless otherwise indicated. A = Adolescent; BA = Bachelor's-level training; C = Child; CTR = Clinical training required; DX = Diagnosis; NDR = No degree requirements; P = Parent; NR = Not reported.

available online (e.g., K-SADS), whereas others have an initial cost of $600 in addition to $2,000 fixed training costs (e.g., CAPA). All but one of the semi-structured interviews covers all major *DSM-IV* diagnoses for school-age children through age 18. Some of the semi-structured interviews provide separate versions for parents, children, and adolescents. None of the available semi-structured interviews include a teacher version. Clinicians must use other instruments to obtain school-related information for purposes of establishing impairment across multiple settings.

The Child and Adolescent Psychiatric Assessment (CAPA) appears to be the most extensively developed of the clinical interviews, but requires up to 2 weeks of classroom instruction and an additional 1 to 2 weeks of practice to acquire the necessary certification (Angold & Costello, 2000). This training is estimated to cost $600, and there is an additional fixed cost of $2,000, which may limit widespread usage among clinicians, especially when schedules such as the K-SADS demonstrate adequate reliability and validity and are available online at no cost. The CAPA, however, may be superior to other available schedules due to several excellent features. The instrument provides for an intensity rating that varies by three symptom groupings: intrapsychic phenomena such as worrying, qualitatively different symptoms such as psychosis, and conduct disturbances. Training and coding are based on a detailed glossary, and thoroughly investigated symptoms are matched to appropriate glossary definitions and levels of severity. Formal rules are provided for the use of screening, mandatory, and discretionary questions.

The Diagnostic Interview for Children and Adolescents, *DSM-IV* edition, provides separate versions for children (ages 6–12) and adolescents (13–18) based on field testing of interview questions with different age, sex, and ethnic groups. Two to four weeks of training, at a cost of approximately $1,000, is required to reach the desired level of competence. The duration of training is based on clinician experience and includes topics such as age-appropriate probe questions and maintaining a child's interest through techniques such as tone of voice and appropriate nonverbal gestures. Reliability estimates corroborate research findings indicating that children are less reliable reporters of externalizing symptoms but more reliable reporters on internalizing symptoms relative to their parents. Computer versions are available, but initial research suggests poor reliability compared to the standard interview format.

The Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS) is currently the most widely used semi-structured clinical interview. The Present-Lifetime (PL) version collects information from the parent regarding current symptomatology as well as symptomatology at its most frequent and severe levels in the past. A separate interview is conducted with the child, and a third pair of ratings is generated based on integration of the parent and child reports with historical information and other data (e.g., rating scales). The K-SADS-PL focuses on chronology, treatment, impairment, and severity of symptoms. The initial screening interview consists of 82 items covering all major *DSM-IV* diagnostic categories. Cutoff scores are used to determine the need to administer the in-depth supplementary sections available for each diagnostic category, thus shortening administration time by allowing the clinician to skip supplementary sections based on negative endorsement of key screening questions. Interrater reliability estimates for the K-SADS are among the highest of any of the semi-structured clinical interviews. Extensive knowledge of diagnostic and symptom subtleties is required owing to lack of formal training requirements, and

clinicians must evoke clinician judgment to interject noncued verbal probes to clarify informant responses and elicit examples of problematic behavioral and emotional symptoms.

OBSERVATION METHODS

Natural Settings A recent meta-analytic review found that independent observations of on-task behavior in natural classroom settings resulted in statistically significant differences between ADHD and typically developing peer groups in 27 of 29 studies. After correcting for study methodology, best case estimation indicated that children with ADHD were on task in the classroom an average of 75% of the time across studies compared with 88% for typically developing children (Kofler, Rapport, & Alderson, in press). Direct observations are often considered the gold standard for experimental and outcome research; however, their use in clinical assessment is limited by several factors. No two research teams or commercially available observation systems define attention in exactly the same way, and research indicates that differences in observational schema can produce widely discrepant results in collected data.

Commercially available observation systems shown in Table 14.5 are available for school-age children and typically require between 10 and 30 minutes of observation. Multiple days of observation are required to produce representative and reliable data. Many systems offer software versions of their product, allowing the clinician to record behavior directly onto a personal digital assistant (PDA) or laptop computer. Although direct observations by independent observers can provide more objective and valid data than any of the other assessment methods discussed here, their relatively high temporal cost coupled with the general lack of norms suggests that their usefulness may be limited to situations where large discrepancies exist between teacher, parent, and other informant reports.

Relatively low-cost observations can be completed by classroom teachers. For example, desk checks ("Is the child prepared for class?"), teacher records of verbally intrusive behavior, and the percentage of daily academic assignments completed correctly discriminate between groups of children with and without ADHD (Pelham et al., 2005). These methods have the potential for objectivity that characterizes the independent observation methodologies, but they await critical evaluation to determine their utility for rendering diagnostic judgments at the individual level.

LABORATORY TASKS

A comprehensive review of laboratory- and clinic-based neuropsychological, cognitive, and behavioral tests, tasks, and experimental paradigms by Rapport, Chung, Shore, Denney, and Isaacs (2000) found that only five of 56 currently used measures reliably distinguished ADHD from non-ADHD groups. These tasks differ from unreliable measures in several important ways. Reliable tasks require recognition or recall memory of relevant stimuli, more rapid processing (measured in milliseconds or seconds for reliable tasks, versus minutes for most unreliable tasks), and place greater demands on phonological or visuospatial working memory compared to unreliable tasks. Specific tasks are not reviewed because none of them currently have diagnostically relevant psychometric properties (e.g., sensitivity, specificity, PPP, or NPP), most

Table 14.5
Mechanical and Observational Assessment Tools

Instrument/Distributor	*Age Range*	*Recording Length*	*Norms*	*Software Available*	*Cost*
Mechanical					
Actigraphs	Any	22 days per 32 Kilobytes of memory	N	Y	Starter: $1,000+ (w/ necessary software and reader interface); $500–$2,000 for each additional actigraph
Ambulatory monitoring MiniMitter MTI, Inc.					
Actometers[a] Model 108 Engineering Department Times Industries, Waterbury, CT 06720	Any	Variable	N	Y[b]	NR
Pedometers (available at sporting goods stores)	Any	Range: 99,999 steps (~5.25 miles) to 1,000 miles	N		
Stand-alone				N	$10–$40
With data downloadable to PC				Y	$125–$400+
Direct Observations					
ADHD BCS Barkley, 1990	NR	15 min.	N	N	NR
AET-SSBD Sopris West	School age	15 min.	Y	N	Kit: $108 (includes all 3 parts of SSBD)

(*continued*)

Table 14.5
(*Continued*)

Instrument/Distributor	*Age Range*	*Recording Length*	*Norms*	*Software Available*	*Cost*
ADHD-SOC Checkmate Plus, Ltd.	School age	16 min.	N	N	Kit: $25
BASC-2 SOS AGS, Inc.	School age	15 min.	N	Y	25 forms @ $33
BOSS Harcourt Assessment	School age	15 min.	N	Y	Kit: $120
COC Abikoff, 1977/1980	School age	32 min.	N	N	NR
DOF ASEBA	5–14	10 min.	Y	Y	50 forms @ $25
SECOS Saudargas, 1997	Grades 1–5	20 min.	Y	N	
Noldus Observer Noldus Information Technology	Any	Variable	N	Y	Observer Basic 5.0 $1,795 Observer Video Pro 5.0 $5,850

AET-SSBD = Academic Engaged Time Code of the SSBD; BCS = Behavior Coding System; BOSS = Behavioral Observation of Students in Schools; COC = Classroom Observation Code; DOF = Direct Observation Form; SECOS = State-Event Classroom Observation System; SOC = School Observation Code; SOS = Student Observation System. [a]Many studies report either using the Kaulins and Willis actometers (no longer manufactured) or enlisting a jeweler to modify a self-winding wristwatch as described by Schulman and Reisman (1959). [b]Eaton, McKeen, and Saudino (1996) provide SAS syntax for performing group-level data analysis based upon actometer readings.

are relatively insensitive to between-dose medication effects, and none provides incremental validity above classroom observations, rating scales, and academic efficiency measures.

Summary

A chief role of behavioral assessment is the identification of prominent behavioral, cognitive, affective, and physical signs and symptoms in the individual. Obtained information is used to formulate an initial diagnosis, select and evaluate response to treatment, and in some cases, portend long-term outcome. The complexity and multifaceted nature of ADHD, which includes broad-based behavioral and cognitive domains, eludes facile efforts at clarification and measurement. Many areas of dysfunction are apparent only under certain environmental conditions or situations (Douglas, 1988; Whalen & Henker, 1985). To complicate matters, children with ADHD frequently exhibit an inconsistent pattern of deficits from day to day, even when tasks and other parameters are constant. This phenomenon occurs in both field and highly controlled laboratory settings, to the dismay of researchers and clinicians alike (for reviews, see Castellanos et al., 2005; Rapport, 1990).

Eliciting information from single sources and limiting or relying exclusively on certain types of information to diagnose ADHD results in a high rate of misidentified cases. A desirable evaluation for children suspected of ADHD includes comprehensive history taking, parent (and, when appropriate, child) clinical interview, review of teacher and parent broad- and narrow-band rating scale data, psychoeducational test data, and behavioral observation. Direct observation of children functioning in an academic setting can be extraordinarily helpful, but is usually not feasible owing to time and cost constraints. By-products of the child's behavior in educational settings (i.e., permanent products), such as academic completion rates, may address this void (Pelham et al., 2005). Auxiliary neurocognitive assessment, coupled with behavioral observation during testing, provides valuable information but awaits psychometric validation. Objective measures of activity level, such as actigraphs, represent the sine qua non of behavioral assessment but are too costly for many clinical settings.

CONCEPTUALIZATION

DSM-IV Clinical Model

The appropriate design of assessment instruments for diagnosing children with ADHD and assessing treatment outcome rests on correctly specifying the core deficits associated with the disorder. Elucidation of core deficits, central processes, and the means by which these cause ADHD behavior problems inform us about the types (and content) of instruments to develop that will enable valid measurement. When developing neurocognitive instruments, hypothesized underlying mechanisms and processes guide the researcher in the design and manipulation of task parameters thought to challenge suspected systems.

Figure 14.1 illustrates the implicit and explicit causal assumptions underlying the current *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV-TR;* American Psychiatric Association, 2000) clinical model of ADHD. It presumes that biological influences (e.g., genetics, pre-, pari-, postnatal insults) give rise to individual differences in the functional properties of neurobiological systems (e.g.,

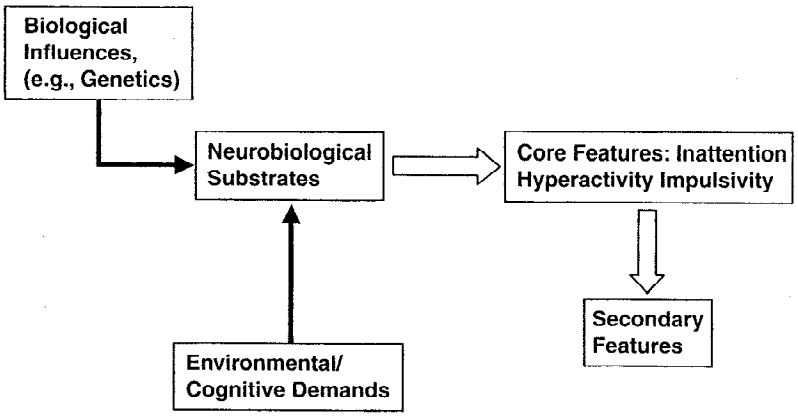

Figure 14.1 A visual schematic of the *DSM-IV* conceptual model of ADHD.

dopaminergic-noradrenergic neurotransmission in the frontal-striatal-cerebellar regions) that are etiologically responsible for the core psychological (i.e., cognitive and behavioral) features of ADHD. The *DSM-IV* clinical model conceptualizes inattention and hyperactivity-impulsivity as the core features of the disorder, and related behavioral and emotional problems as causal by-products of core symptoms. For example, academic underachievement represents a causal consequence of broader, more primary features of the disorder, such as chronic inattention and hyperactivity; children who cannot sit in their seat and pay attention are unable to complete academic assignments. Other secondary features common to ADHD, such as inadequate social skills and peer relationships, low frustration tolerance, and strained family relationships, are also by-products of core behavioral and cognitive influences to the extent that children rely on them for successful execution. Empirical validation of core processes can proceed at multiple levels but must eventually entail careful manipulation of discrete independent variables and observation of their effects to understand how underlying mechanisms and processes transcend to behavioral characteristics of ADHD.

ALTERNATIVE CONCEPTUAL MODELS

Theories of ADHD evolved from implied brain damage (Strauss & Lehtinen, 1947) and dysfunction (Cruickshank & Dolphin, 1951; Strauss & Kephart, 1955) to single-construct theories of sustained attention (Douglas, 1972), deficient rule-governed behavior (Barkley, 1989), cognitive-energetic dysregulation (Sergeant, Oosterlaan, & van der Meere, 1999), and delay aversion (Sonuga-Barke, 2002). Reviews of these models and their underlying psychological and neurobiological constructs and etiological factors are available (cf. Barkley, 2006; Castellanos & Tannock, 2002). Recent conceptualizations of ADHD include a comprehensive theory with behavioral inhibition as its core component, and an alternative model that postulates working memory dysfunction as a candidate endophenotype.

Behavioral Inhibition The most contemporary and ambitious theory of ADHD was proposed in 1997 by Dr. Russell Barkley, building on earlier theoretical models of

behavioral inhibition derived from Gray's (1982) theory of brain-behavior processes, wherein an underactive behavioral inhibition system fails to provide sufficient anxiety and fearfulness, resulting in the initiation or continuation of unwanted behavior (Quay, 1997). The central feature of the disorder is a developmental delay in behavioral inhibition. Disruption of this system affects children's ability to inhibit (a) previously reinforced behavior or responses, (b) ongoing behavior that should be stopped to permit consideration of more appropriate or adaptive responses, and (c) attention to task-irrelevant events (e.g., distractions). Poorly developed and inefficiently modulated behavioral inhibition processes subsequently impact the use and control of four higher order executive functions—working memory, internalization of speech/verbal working memory, self-regulation of affect/motivation/arousal, and reconstitution—that are necessary to direct and regulate the motor system and guide and provide control over current and future behavior (see Figure 14.2). Collectively, these deficiencies are causally related to the broad range of impairments observed in individuals with ADHD (for a comprehensive discussion, see Barkley, 2006).

Empirical evidence of executive function deficits in children with ADHD is incontrovertible (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005), providing strong support for the central portion of Barkley's (1997) model. Laboratory-based studies examining two of the hypothesized behavioral inhibition (BI) deficits by means of the stop-signal task, however, have produced mixed results. Recent meta-analytic reviews examining these studies suggest that previously reported BI differences between children with ADHD and normally developing controls appear to be due to deficiencies in central processing and attention rather than deficient behavioral inhibition (Alderson, Rapport, & Kofler, in press; Lijffijt, Kenemans, Verbaten, & van Engeland, 2005). Moreover, working memory's reliance on BI processes as a core executive function in the proposed model is difficult to defend because working memory processes must be invoked to evaluate stimuli (including situational cues) prior to the initiation of the inhibition process. Specifically, the central executive component of working memory regulates attentional resources, such as switching attention among competing stimuli, and phonological and visuospatial stimuli must be evaluated by working memory subsystems prior to BI activation. This suggests that behavioral inhibition is downstream of working memory processes. Competing models must recognize this conundrum and hypothesize a core role for working memory within a multilayered model.

Working Memory Recent conceptual models emphasize an endophenotypic approach, recognizing the probable involvement of multiple systems and levels in the pathophysiology of ADHD. Endophenotypes involve heritable traits that vary quantitatively and index a child's probability for developing the disorder. They follow a causal developmental model perspective and attempt to link etiological factors (e.g., candidate genes) to putative brain differences or abnormalities (e.g., catecholaminergic dysregulation, striatal lesions, EEG theta excess) to candidate endophenotypes (e.g., working memory deficits) to behavioral outcomes (e.g., delay aversion, scholastic underachievement, inattentiveness, disorganization). Recent empirical findings concerning potential candidate genes, underlying neurobiology and physiology, cognitive impairments, and associated behavioral outcomes support a multilayered, integrated model of ADHD.

Extant research provides growing support for working memory (WM) dysfunction as a candidate endophenotype. A visual schematic of the model is shown

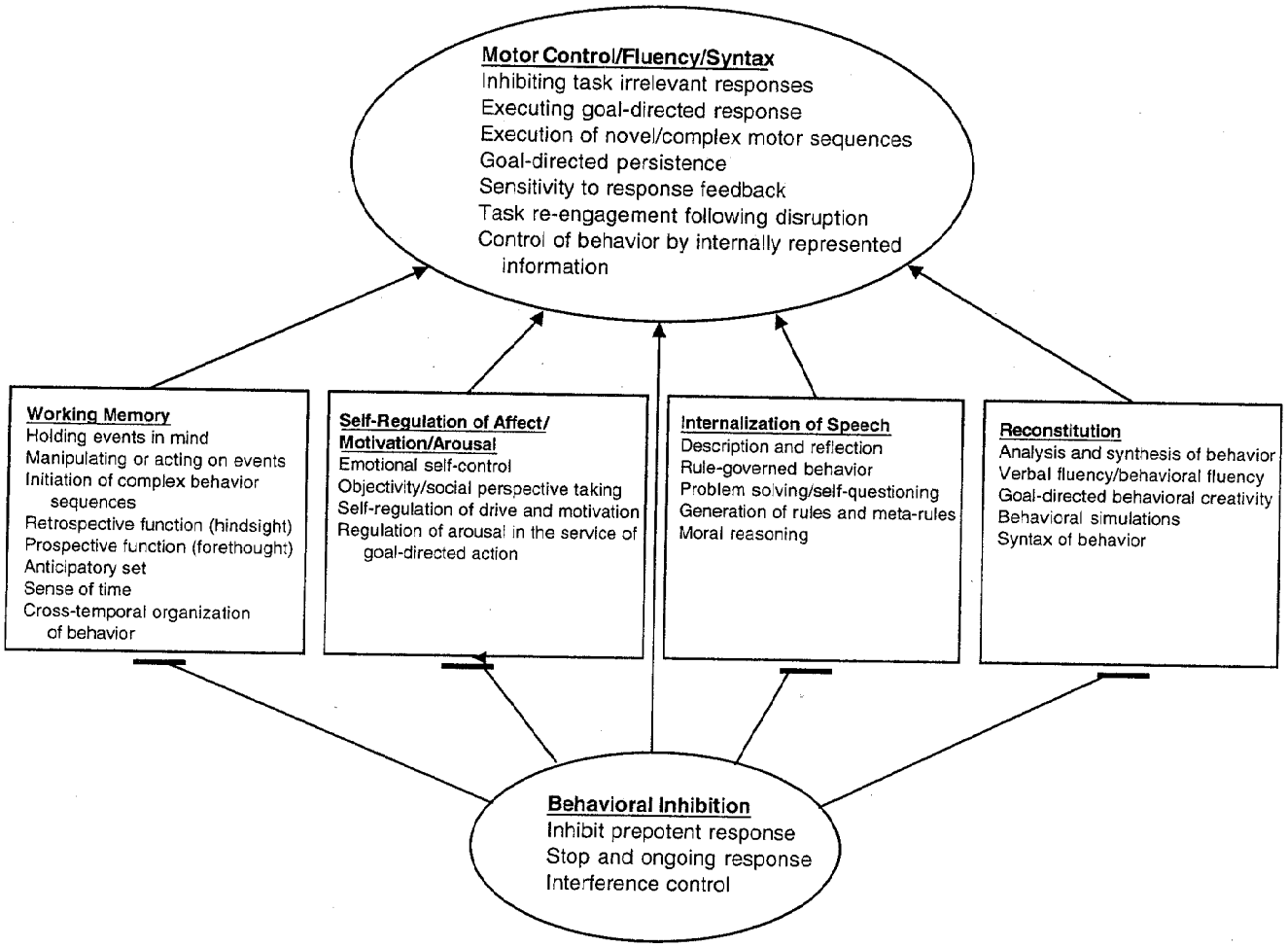

Figure 14.2 A visual schematic of Barkley's (1997) model of ADHD.

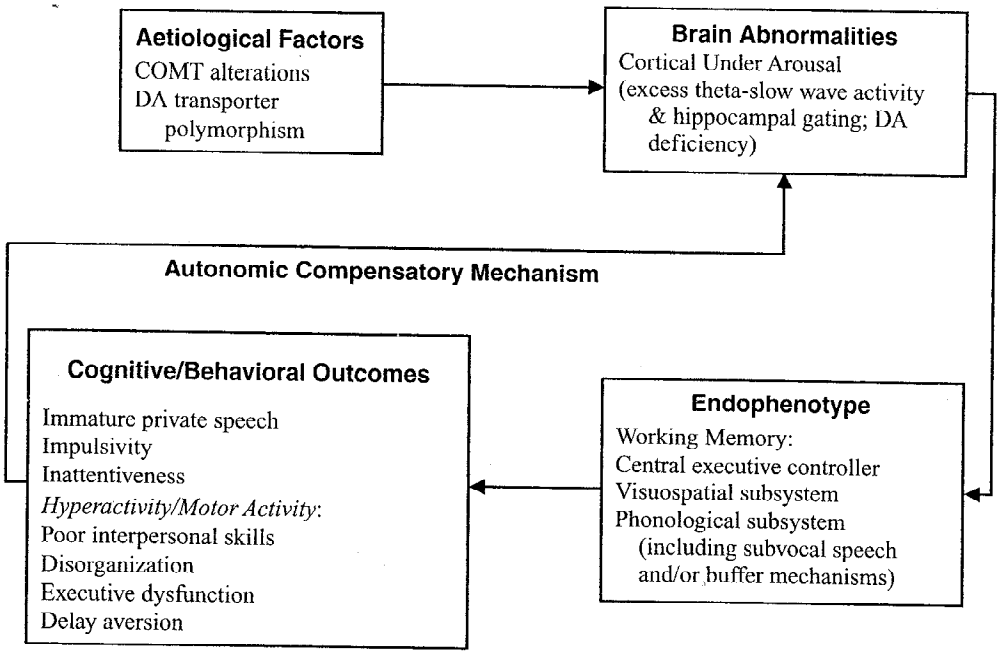

Figure 14.3 A visual schematic of Rapport et al.'s (2000) conceptual working memory model of ADHD. Biological influences underlie brain abnormalities (e.g., cortical underarousal) that adversely affect working memory processes and associated cognitive/behavioral outcomes.

in Figure 14.3. Hypothesized underlying etiological factors include alterations in catechol-O-methyl transferase (COMT) and genetic polymorphisms that influence dopaminergic and/or noradrenergic function (Castellanos & Tannock, 2002). These factors give rise to brain abnormalities, such as excess theta (slow wave, 4.0 to 7.5 hz) activity and decreased blood flow in frontal and prefrontal regions, which are associated with cortical underarousal during tasks that tax working memory processes. Motor movement serves three functions. The first is to increase *autonomic* arousal to help compensate for *cortical* underarousal (excess slow wave activity) while engaged in cognitive activities that rely on working memory. The second is to compensate for the rapid decline of WM representations by inputting new stimuli, which take the form of stimulation-seeking behavior. The third function of increased motor activity is to reduce the aversive nature of attending to tasks that tax working memory by means of escape behavior and, later, by means of avoidance behavior (e.g., out-of-seat behavior, behavior incompatible with homework completion). The three forms of motor activity vary significantly in topography and require sophisticated measurement to differentiate them from each other.

Evidence supporting the working memory model derives from multiple sources. Compelling evidence for heritability (reviewed later in the chapter) coupled with emerging evidence of cortical underarousal (including catecholaminergic dysregulation) in prefrontal regions provides an initial linkage of etiological factors and brain differences in ADHD (Beauchaine, Katkin, Strassberg, & Snarr, 2001; Ferguson & Pappas, 1979; Loo & Barkley, 2005). A central role for cortical hypoarousal as an

underlying physiological process in ADHD is also demonstrated by studies reporting increased slow wave (theta) and decreased fast wave (beta) activity in children with ADHD while performing academic (Mann, Lubar, Zimmerman, Miller, & Muenchen, 1992) and cognitive (Clarke, Barry, McCarthy, & Selikowitz, 1998; El-Sayed, Larsson, Persson, & Rydelius, 2002) tasks.

A comprehensive model of ADHD must include a convincing account of the excessive motor activity observed in children with ADHD, a feat thus far unaccomplished by extant models. Hyperactivity is traditionally viewed as a core clinical feature and *ubiquitous,* rather than serving a functional role as hypothesized by the working memory model. The WM model postulates that challenges to WM subsystems (phonological and visuospatial) will evoke increased activity level to compensate for cortical underarousal until WM systems are overloaded. When this occurs, children shift from task engagement to escape behavior or vacillate between these two states. Measured activity level is likely to show an overall reduction and change in topography under these circumstances, as children seek to reduce the aversive nature of impinging task demands (e.g., out-of-seat behavior, seeking alternative stimuli).

A recent study illustrates the hypothesized causal relationship between working memory and children's activity level (Rapport, Timko, Kofler, & Alderson, 2005). Children with ADHD and age- and IQ-matched normally developing control children completed computer-administered phonological and visuospatial working memory tasks under varying set sizes (i.e., number of stimuli) in a counterbalanced order once per week across a 4-week time span. Activity level was measured using sophisticated actigraphs placed on both ankles. Both groups of children were significantly more active while completing working memory tasks relative to baseline periods, and motor activity increased linearly as a function of increasing working memory demands except under the largest set size. Control children continued to show increased activity level when administered the largest set size (i.e., 6 stimuli), whereas children with ADHD exhibited a decrease in measured motor activity coupled with an increase in escape behavior (e.g., out-of-seat behavior, looking away from the computer screen). These results suggest that increases in motor activity serve an important purpose for all children—it increases autonomic arousal to facilitate cognitive functioning. The finding that children with ADHD exhibit significantly higher levels of motor movement relative to controls suggests a compensatory process, wherein higher levels of motor input (i.e., autonomic arousal) are needed to help compensate for chronic cortical underarousal (i.e., excess theta–slow wave activity) when WM systems are overwhelmed. Children with ADHD, and potentially all children, engage in escape behavior when WM is overwhelmed. Collectively, the WM model poses serious challenges to the notion of ubiquitous, purposeless activity level in ADHD.

OTHER CONCEPTUALIZATION FACTORS AND VARIABLES

Findings from family and twin studies reviewed next, coupled with accumulating evidence for working memory as a candidate endophenotype, provide compelling evidence that the majority of variation in the behavioral traits constituting ADHD results from genetic factors. Other factors discussed—including developmental issues, learning and modeling, parenting style, life events, peer influences, and culture—are best viewed as influencing the extent and diversity of impairments rather than causing the impairments.

Genetic Influences The field of behavior genetics is concerned with evaluating the extent to which behavioral similarities between individuals are correlated with degree of biological relationship. The strength of this relationship is quantified using heritability estimates derived from twin studies because these enable investigators to control for environmental influences that might otherwise confound genetic variation. Heritability refers to the proportion of phenotypic (i.e., observable) variation that is explained by genetic factors (i.e., after statistical control for environmental influences).

Studies employing behavioral genetic methodology provide compelling support for a heritable, biologically based etiology for ADHD. Most twin studies of ADHD have utilized scores on parental rating scales as dependent variables. Heritability estimates derived from these ratings indicate that approximately 65% of individual differences in attention are attributable to genetic variation (Gjone, Stevenson, & Sundet, 1996; Sherman, Iacono, & McGue, 1997). Similarly, 70% of individual differences in parent-rated impulsivity-hyperactivity are genetic in origin (Sherman et al., 1997; Silberg et al., 1996), and genetic differences account for 83% of observed variation in composite ratings of ADHD symptoms (Levy, Hay, McStephen, Wood, & Waldman, 1997; Nadder, Silberg, Eaves, Maes, & Meyer, 1998).

A small number of studies have computed heritability estimates based on discrete diagnostic categories derived from structured interviews or the application of cutoff scores to rating scales. The majority of these have used mothers as informants. The resulting heritability estimates have been very comparable to those based on continuous rating scale scores, ranging from .75 to .89 (Levy et al., 1997; Sherman et al., 1997; Thapar, Hervas, & McGuffin, 1995), with a median of .75. Thus, approximately 75% of observed variation in categorically diagnosed ADHD is genetically based. These data suggest that the heritability of ADHD is similar regardless of whether symptomatology is expressed categorically or in terms of continuous dimensions. This inference has been explicitly tested in two studies (Gjone et al., 1996; Levy et al., 1997). Both demonstrated that degree of heritability was constant across levels of symptomatic severity within their samples. These findings indicate that the features of ADHD are heritable and normally distributed in the population rather than representing a categorically distinct group.

Developmental Issues Key developmental issues that contribute to the conceptual understanding of ADHD center on three interrelated questions: What is the normal developmental trajectory of children's motor activity? Is there evidence of heterotypic continuity in ADHD; that is, do the types and forms of behavior problems change over time? Are there significant, sex-related behavioral or cognitive differences in ADHD that merit scrutiny?

Motor behavior frequency and intensity show an upward trajectory in toddlers and early preschoolers, but the changes are less pronounced and slower relative to those observed during infancy. Development of gross and fine motor behavior dominates this period as children explore and interact with their environment and acquire myriad skills, ranging from using scissors and crayons to riding a tricycle. Environmental, and particularly setting, effects can significantly influence children's activity level at this time. Some children attend nursery schools and day care facilities, whereas others have limited access to playgroups and other children. The stability of children's activity level over this period is remarkable despite differences in context and environment. For example, the test-retest correlation for a sample of 129 boys and girls assessed at

age 3 and again at age 4 was .44 and .43, respectively (Buss, Block, & Block, 1980). This finding indicates strong continuity in children's activity level at a time when development is proceeding rapidly.

The relationship between age and activity level changes rapidly in late preschool and early elementary school (age 5 to 10), but for the first time shows a *decline* after peaking at approximately 8 years of age (Eaton, McKeen, & Campbell, 2001). Children are expected to sit and engage in academic tasks and other cognitive activities for longer time intervals. Those able to do so are praised for their concentration abilities and tenacity, with accompanying high grades and test scores. Pejorative characteristics are conferred on those less able to regulate their activity level after entering elementary school; they are described as distractible, aggressive, restless, hyperactive, and impulsive. A majority of these children develop serious learning problems, make marginal or failing grades, exhibit a wide range of externalizing behavior problems, and experience impaired interpersonal relationships.

Evidence concerning the heterotypic continuity of ADHD is mixed. Symptoms of ADHD arise early in childhood; however, their presence does not necessarily portend a persistent pattern of ADHD beyond 3 years of age in an estimated 50% to 90% of children so characterized (Palfrey, Levine, Walker, & Sullivan, 1985). Continuation of early ADHD-like symptoms to 4 years of age, however, is highly predictive of clinical hyperactivity at 9 years of age (Campbell, 1990). Thus, the early onset, degree, and persistence of symptoms past 4 years of age is highly predictive of a clinical diagnosis (indicating continuing and worsening impairment) and continuing difficulties throughout adolescence and early adulthood. The stability of the diagnosis is also noteworthy. High percentages of children meeting formal diagnostic criteria in childhood continue to meet diagnostic criteria 8 to 10 years later as adolescents (70% to 80%: Barkley, Fischer, Edelbrock, & Smallish, 1990) and young adults (46% to 66%: Barkley, Fischer, Smallish, & Fletcher, 2002), although the level and topography of some core variables change with advancing age. Inattention problems tend to remain relatively stable between 7 and 11 years of age, whereas hyperactivity declines moderately (Hart, Lahey, Loeber, Applegate, & Frick, 1995). Fidgetiness tends to replace the excessive gross motor activity during adolescence, and most adolescents with ADHD report feeling more restless compared to age-matched controls (Weiss & Hechtman, 1993).

Sex predicts *DSM-IV* diagnostic subtype in many studies of children with ADHD, with females likely to exhibit more inattentive symptoms and males likely to display more hyperactive-impulsive behavior (Abikoff et al., 2002; Biederman & Faraone, 2004; Graetz, Sawyer, & Baghurst, 2005). These findings, however, may reflect differences in referral source. Few sex differences emerge in clinic-based samples, whereas lower levels of aggression and fewer internalizing symptoms are reported in community-based samples of girls relative to boys (Gaub & Carlson, 1997). Girls also appear to have a lower risk for comorbid externalizing disorders (ODD, CD) and depression than boys (Biederman et al., 2002).

Parental Factors Considerable research has been devoted to studying parents of children with ADHD. Much of the early research focused on understanding whether there were particular parental attributes that contributed to the disorder's development, that is, whether parents were causally responsible for the myriad behavioral problems displayed by their children. Information gleaned from this research failed to support a causal role for faulty parenting.

Second-generation observational studies conducted in child research clinics generated considerably more information concerning the interactions of children with their parents. This advance was achieved by having parents and their children follow prearranged scripts, engage in games, participate in discussions, and attempt specific child management techniques under close observation. Collectively, these studies indicate that children with ADHD are more defiant and demanding, more talkative, more negative, and less likely to comply with parent requests. They also place heavier demands on their parents' attention and supervisory responsibilities due to their inability to play and work independently, and higher activity level relative to typically developing children (DuPaul, McGoey, Eckert, & VanBrakle, 2001). The collective result is a significantly higher level of intrafamily conflict.

Studies of specific styles and interaction patterns associated with parents of children with ADHD suggest a general parenting approach characterized by a more lax but overreactive, coercive, and acrimonious interaction pattern, coupled with higher levels of emotional expression and lower parenting efficacy. Mothers of ADHD children tend to be less responsive to their children's requests for attention, more negative and directing, and less rewarding of appropriate behavior relative to control families (DuPaul et al., 2001). This identified interaction and commanding style of child management by mothers of children with preschool hyperactivity is highly correlated with the persistence of ADHD symptomatology throughout childhood (Campbell, 1990). Barkley and Cunningham (1979) reported an interesting finding that supports the bidirectional and interactional, rather than causal, nature of parent–ADHD child interactions. Mothers of children with ADHD were significantly less controlling and more positive when their children were receiving psychostimulant treatment relative to no medication or placebo. This finding strongly suggests that the parents' negative reactions and aversive managerial style are elicited to a considerable degree by the overly demanding, noncompliant, impulsive, and defiant nature of their children.

Life Events and Physical Factors Extant research is relatively consistent in demonstrating that children with ADHD—as a group—experience significantly more adverse life events compared to typically developing children. These findings contribute to the supposition that ADHD may reflect a broad spectrum of early insults that manifest themselves as a final common pathway.

A higher incidence of pre-, pari-, and postnatal incidents, as well as brain trauma—once considered idiopathic of ADHD—remains unproven based on systematic intake data collected in recent years. Research concerning other adverse life events, including general health problems, sleep disturbance, accidental injuries, minor physical anomalies, and motor coordination problems, suggests that they occur at higher rates in ADHD children relative to the general population.

A greater incidence of general health problems is common for children with ADHD, particularly allergies and recurring upper respiratory infections. Sleep disturbance is also common. An estimated 56% of children with ADHD experience difficulty falling asleep, and up to 39% experience sleep continuity disturbance, often beginning in infancy, based on parent report (Corkum, Tannock, & Moldofsky, 1998).

Accidental injuries are common in children with ADHD, and recent studies suggest that these are associated with their higher levels of hyperactivity and aggression. For example, a study of 10,394 British children reported that overactivity and aggression uniquely contributed to the incidence of accidental injuries in children with ADHD (Bijur, Golding, Haslum, & Kurzon, 1988); however, a recent study examining 6,000

children in England reported that hyperactivity alone predicted increased accidental injuries after controlling for demographic and socioeconomic factors (Lalloo, Sheiham, & Nazroo, 2003). Collectively, their higher rate of accidental injuries results in greater use of outpatient medical care facilities, particularly emergency medical services (Leibson, Katusic, Barbaresi, Falissard, & O'Brian, 2001), and are associated with 3 times the annual health costs of typical children (Swenson et al., 2003).

Children with ADHD experience significantly higher rates of motor coordination problems relative to typically developing children (Barkley, DuPaul, et al., 1990) and many meet diagnostic criteria for Developmental Coordination Disorder. Problems with gross motor coordination, motor overflow, sluggish gross motor movements, fine motor coordination (balance, paper mazes, handwriting), and motor preparedness (Oosterlaan & Sergeant, 1995) are the most commonly documented difficulties. A higher incidence of minor physical anomalies in ADHD is also common. These slight deviations in outward appearance (e.g., hair whorls on the back of the head, index finger longer than middle finger), however, are inconsistently related to behavior problems.

Peer Influences The chronic and pervasive peer difficulties associated with ADHD are well documented. A majority of children with ADHD experience significant problems in social relationships with other children (Pelham & Bender, 1982). These findings are not particularly surprising given the core symptoms of the disorder (inattentive, impulsive, excessive motor activity) and broad range of expected impairments. Children with ADHD overwhelm peers with their unbridled enthusiasm and are viewed as overly talkative, loud, intrusive, domineering, impulsive, and emotionally reactive. Their inability to hold information sufficiently long to thoroughly process and use it for social interactions (i.e., working memory deficits) contributes to their preference for immediate gratification, deficient delay skills, difficulty understanding instructions and rules, immature speech, and verbal communication deficits. These deficient social and peer interaction patterns are so discerning that they are rejected by non-ADHD peers within 20 to 30 minutes, particularly children with ADHD who display higher levels of emotional reactivity, aggression, and sensation-seeking behavior (DuPaul et al., 2001; Mikami & Hinshaw, 2003). They also are more likely to bully and be bullied by other children relative to their peers (Unnever & Cornell, 2003). The collective impact of these behaviors, coupled with deficient knowledge concerning social interactions, portends poorly for the development of desired social interactions and relations throughout adolescence and into adulthood (Barkley et al., 2006). To make matters worse, they possess limited understanding or appreciation of their problems, which, in turn, contributes to an inflated perception of their abilities, accomplishments, and the extent to which others like them (Diener & Milich, 1997). Some peer interaction and social behaviors show moderate improvement with treatment; however, maintenance and generalization of treatment effects are the exception rather than the rule.

Cultural and Diversity Issues ADHD prevalence rates for other countries are similar to U.S. averages when estimates are derived using identical diagnostic criteria (e.g., *DSM-III-R, DSM-IV*). U.S. estimates derived from studies published since 2000 typically range from 1.5% to 9.9% (mean = 7.7%), with higher estimates reported from studies using *DSM-IV* criteria (7.4% to 9.9%). The increase in prevalence rates over previous years may reflect increased awareness and improved diagnostic practices

to some degree, but more likely represents changes in diagnostic subtyping, that is, the addition of *primarily inattentive* and *primarily hyperactive-impulsive* subtypes to the *combined* subtype.

Cultural and diversity factors play important roles in understanding ADHD because of their influence on observations, perceptions, and reports of child symptoms. For example, a study examining teacher perceptions found that Thai teachers reported higher rates of off-task behavior in same-age elementary school children relative to U.S. teachers. Direct observations of the children, however, showed the opposite result: U.S. children were off-task significantly more often than were Thai children (Weisz, Chaiyasit, Weiss, Eastman, & Jackson, 1995). Differences in child ratings also occur among teachers from mainland China, Hong Kong, and the United Kingdom (Alban-Metcalfe, Cheng-Lai, & Ma, 2002) and may reflect different expectations for children from different cultural backgrounds. de Ramirez and Shapiro (2005) reported an interesting example of this phenomenon. Hispanic teachers rated Hispanic children higher than Caucasian children on a hyperactivity-impulsivity scale, whereas Caucasian and Hispanic teacher ratings of Caucasian students were not significantly different. Mexican mothers are also less likely than both Mexican American and Puerto Rican mothers to report impulsive behavior in their children (Schmitz & Velez, 2003). Collectively, these findings suggest that differences in cultural expectations of children's behavior may significantly affect adult ratings and require due consideration when obtaining information from parents and teachers.

MEDICAL TREATMENT

Treatment of attention deficits traditionally involves using behavior or pharmacological therapy alone or in combination. Pharmacological interventions (particularly the psychostimulants), however, are considered more cost-effective and have the added benefit of affecting both behavioral and cognitive domains throughout the day without the specific programming and oversight required by behavior therapy. Table 14.6 displays the most frequently prescribed psychostimulants and their corresponding properties. A low dose is usually prescribed initially, with dosage gradually titrated upward on a biweekly basis until clinical improvement is optimized, while minimizing potential emergent symptoms. Second- and third-tier interventions typically include antidepressants, selective serotonin reuptake inhibitors (SSRIs), clonidine, and, less frequently, atypical antipsychotics for the treatment of highly aggressive children with ADHD. Combined regimens, such as stimulants and antidepressants, are prescribed with increasing frequency to treat the comorbid conditions (e.g., mood disturbance) that often accompany ADHD. Pemoline, once considered a viable treatment for ADHD, is rarely prescribed because of elevated risk for hepatic failure.

Basic Clinical Properties and Prescription Practices

Understanding the basic clinical properties of psychostimulants is essential for assessing outcome. Some physicians continue to prescribe psychostimulants based on children's body weight (i.e., on a mg/kg basis), despite compelling evidence that methylphenidate (MPH) dosage titrated to gross body weight or body mass is unrelated to treatment response (Rapport & Denney, 1997). This practice frequently results in overdosing low-weight and underdosing high-weight children. Knowledge of the behavioral time-response course of these agents is equally important because of the