31 Woodcock-Johnson III Tests of Cognitive Abilities

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INTRODUCTION, HISTORY, AND DEVELOPMENT

The Woodcock–Johnson III (Woodcock, McGrew, & Mather, 2001, 2007a) includes 31 cognitive tests that are published in two components. The Standard Battery (Tests 1–10) and the Extended Battery (Tests 11–20) are published in the *Woodcock-Johnson III Tests of Cognitive Abilities* (WJ III COG; Woodcock, McGrew, & Mather, 2001, 2007c). An additional 11 tests are published separately as the *Woodcock-Johnson III Diagnostic Supplement to the Tests of Cognitive Abilities* (DS; Woodcock, McGrew, Mather, & Schrank, 2003, 2007). The WJ III COG and DS are conormed with the *Woodcock-Johnson III Tests of Achievement* (WJ III ACH; Woodcock, McGrew, & Mather, 2001, 2007b). The *Woodcock-Johnson III Normative Update* (WJ III NU; Woodcock, McGrew, Schrank, & Mather, 2001, 2007) was published in 2007. It is a recalculation of the WJ III normative data on the basis of 2005 U.S. Census statistics (U.S. Census Bureau). A parallel, Spanish-language version of the WJ III COG is published as the *Batería III Woodcock-Muñoz: Pruebas de habilidades cognitivas* (Batería III COG; Muñoz-Sandoval, Woodcock, McGrew, & Mather, 2005, 2007a); the Spanish version of the WJ III COG DS is called the *Batería III Woodcock-Muñoz: Suplemento diagnóstico par alas pruebas de habilidades cognitivas* (Batería III COG DS; Muñoz-Sandoval, Woodcock, McGrew, Mather, & Schrank, 2005, 2007).

Different combinations of WJ III COG and DS tests form clusters for interpretive purposes. Some of the clusters are referred to as Cattell–Horn–Carroll (CHC) broad or narrow clusters, on the basis of an amalgamation of the research efforts of intelligence theory scholars Raymond Cattell, John Horn, John Carroll, and their associates. Table 31.1 includes an outline of the clusters and tests in the WJ III COG and DS.

The complete WJ III COG and DS is the most current evolution of a smaller number of cognitive tests that were originally published in the *Woodcock–Johnson Psycho-Educational Battery* (WJPEB; Woodcock & Johnson, 1977). The WJPEB began as one battery that consisted of three parts: Part 1—Tests of Cognitive Ability, Part 2—Tests of Achievement, and Part 3—Tests of Interest Level. The development of this battery of tests began as a number of controlled experiments for measuring differential learning capacities (Woodcock, 1958). For example, the Visual-Auditory Learning test was developed to measure an important cognitive process involved when learning to read (paired-associate encoding); performance on this task was shown to be highly related to reading achievement. Later, the Analysis–Synthesis test was developed to measure an important cognitive capacity involved in the ability to learn mathematics (algorithmic reasoning and deduction); performance on this task was shown to be highly related to mathematical achievement.

The idea of a complete battery of tests was developed more fully as part of Woodcock's neuropsychology postdoctoral research at the Tufts New England Medical Center in 1974–1975. At Tufts, Woodcock's plan was to use scientific-empirical methodology to construct a set of tests that would tap many different aspects of cognitive functioning defined by extant cognitive and neuroscience research. For example, the Concept Formation test was developed to measure inductive reasoning, involving the cognitive processes of rule-based categorization and rule-switching (R. W. Woodcock, personal communication, June 20, 2008).

The WJPEB differed from other cognitive and achievement measures of the era by the application of Rasch measurement technology for both test development and interpretive procedures. Woodcock had been introduced to the Rasch (Rasch, 1960) measurement technology in 1969 (R. W. Woodcock, personal communication, June 20, 2008). In addition to the technology's usefulness for the analysis of item–response data and scale construction, Woodcock used the technology to develop a unique interpretive scheme for the description of an individual's proficiency on the tests. The technology was also useful to predict how the individual would perform similar tasks in nontest, functional settings. These efforts foreshadowed the current trend for using test results to describe functional levels and limitations of individuals with neuropsychological impairments. At the time, neuropsychologists typically used cognitive tests to help determine the site of a lesion, rather than to determine the functional implications of test results.

Table 31.1 ■ WJ III NU COG and Diagnostic Supplement Broad and Narrow Abilities and Inferred Cognitive Processes

Primary broad CHC factor	Test	Narrow CHC abilities	Inferred cognitive process(es)
Comprehension-Knowledge (*Gc*)	1: Verbal Comprehension	Comprehension-Knowledge (*Gc*) Lexical knowledge Language development	Object recognition and reidentification; semantic activation, access, and matching; verbal analogical reasoning
	11: General Information	Comprehension-Knowledge (*Gc*) General (verbal) information	Semantic activation and access to declarative generic knowledge
	31: Bilingual Verbal Comprehension–English/Spanish	Comprehension-Knowledge (*Gc*) Lexical knowledge Language development	Object reidentification; semantic activation, access, and matching; verbal analogical reasoning
Long-Term Retrieval (*Glr*)	2: Visual-Auditory Learning	Long-Term Retrieval (*Glr*) Associative memory	Paired-associative encoding via directed spotlight attention; storage and retrieval
	12: Retrieval Fluency	Long-Term Retrieval (*Glr*) Ideational fluency Naming facility	Recognition, fluent retrieval, and oral production of examples of a semantic category
	10: Visual-Auditory Learning–Delayed	Long-Term Retrieval (*Glr*) Associative memory	Retrieval and reidentification; associative encoding (for relearning)
	21: Memory for Names	Long-Term Retrieval (*Glr*) Associative memory	Associative encoding via directed spotlight attention, storage, and retrieval
	30: Memory for Names–Delayed	Long-Term Retrieval (*Glr*) Associative memory	Reidentification
Visual-Spatial Thinking (*Gv*)	3: Spatial Relations	Visual-Spatial Thinking (*Gv*) Visualization Spatial relations	Visual feature detection; manipulation of visual images in space; matching
	13: Picture Recognition	Visual-Spatial Thinking (*Gv*) Visual memory	Formation of iconic memories and matching of visual stimuli to stored representations
	22: Visual Closure	Visual-Spatial Thinking (*Gv*) Closure speed	Object identification from a limited set of component geons
	28: Block Rotation	Visual-Spatial Thinking (*Gv*) Visualization Spatial relations	Visual matching using visual-spatial manipulation
Auditory Processing (*Ga*)	4: Sound Blending	Auditory Processing (*Ga*) Phonetic coding	Synthesis of acoustic, phonological elements in immediate awareness; matching the sequence of elements to stored lexical entries; lexical activation and access
	14: Auditory Attention	Auditory Processing (*Ga*) Speech-sound discrimination Resistance to auditory stimulus distortion	Selective auditory attention
	8: Incomplete Words	Auditory Processing (*Ga*) Phonetic coding	Analysis of a sequence of acoustic, phonological elements in immediate awareness; activation of a stored representation of the word from an incomplete set of phonological features
	23: Sound Patterns–Voice	Auditory Processing (*Ga*) Sound discrimination	Prelexical, perceptual analysis of auditory waveform patterns
	29: Sound Patterns–Music	Auditory Processing (*Ga*) Sound discrimination Musical discrimination Judgment	Prelexical, perceptual analysis of auditory waveform patterns
Fluid Reasoning (*Gf*)	5: Concept Formation	Fluid Reasoning (*Gf*) Induction	Rule-based categorization; rule-switching; induction/inference
	15: Analysis-Synthesis	Fluid Reasoning (*Gf*) General sequential reasoning Quantitative reasoning	Algorithmic reasoning; deduction
	19: Planning	Visual-Spatial Thinking (*Gv*) and Fluid Reasoning (*Gf*) Spatial scanning General sequential reasoning	Means-end analysis
	24: Number Series	Fluid Reasoning (*Gf*) Mathematics knowledge Quantitative reasoning	Representation and manipulation of points on a mental number line; identifying and applying an underlying rule/principle to complete a numerical sequence
	25: Number Matrices	Fluid Reasoning (*Gf*) Quantitative reasoning	Access to verbal-visual numeric codes; transcoding verbal and/or visual representations of numeric information into analogical representations; determining the relationship between/among numbers on the first part of the structure and mapping (projecting) the structure to complete the analogy

(*Contiuned*)

Table 31.1 ■ WJ III NU COG and Diagnostic Supplement Broad and Narrow Abilities and Inferred Cognitive Processes (*Continued*)

Primary broad CHC factor	Test	Narrow CHC abilities	Inferred cognitive process(es)
Processing Speed (*Gs*)	6: Visual Matching	Processing Speed (*Gs*) Perceptual speed	Speeded visual perception and matching
	16: Decision Speed	Processing Speed (*Gs*) Semantic processing speed	Object recognition and speeded symbolic/semantic comparisons
	18: Rapid Picture Naming	Processing Speed (*Gs*) Naming facility	Speed/fluency of retrieval and oral production of recognized objects
	20: Pair Cancellation	Processing Speed (*Gs*) Attention and concentration	Controlled, focal attention; vigilance
	26: Cross Out	Processing Speed (*Gs*) Perceptual speed	Speeded visual matching
Short-Term Memory (*Gsm*)	7: Numbers Reversed	Short-Term Memory (*Gsm*) Working memory	Span of apprehension and recoding in working memory
	17: Memory for Words	Short-Term Memory (*Gsm*) Auditory memory span	Formation of echoic memories and verbalizable span of echoic store
	9: Auditory Working Memory	Short-Term Memory (*Gsm*) Working memory	Recoding of acoustic, verbalizable stimuli held in immediate awareness
	27: Memory for Sentences	Short-Term Memory (*Gsm*) Auditory memory span Listening ability	Formation of echoic memories aided by a semantic, meaning-based code

WJ III NU COG, *Woodcock-Johnson III Normative Update Tests of Cognitive Abilities*.

Subsequent to the publication of the WJPEB, John Horn, a well-respected scholar–scientist in the field of the structure of human intellectual capacities, presented a synopsis of his work at a 1985 University of Illinois conference honoring one of his former teachers, Lloyd Humphreys. Horn's treatise inspired the theoretical foundation for the second edition of the cognitive tests that were contained in the *Woodcock-Johnson Psycho-Educational Battery–Revised* (WJ-R; Woodcock & Johnson, 1989). Dr. Woodcock (R. W. Woodcock, personal communication, February 10, 2009) described the effect of Horn's presentation on him as a type of intellectual epiphany—or moment of pivotal insight—that was characterized by the words "this is it!" (the answer to his quest for a theoretical foundation upon which a measurement model could be built). To more broadly measure the primary cognitive abilities articulated by Horn, 10 new cognitive tests were added to the battery. As a consequence, the WJ-R was described as an operational representation of Horn's *Gf–Gc* theory (Horn, 1991), measuring seven broad cognitive abilities: comprehension-knowledge (*Gc*), long-term retrieval (*Glr*), visual processing (*Gv*), auditory processing (*Ga*), fluid reasoning (*Gf*), processing speed (*Gs*), and short-term memory (*Gsm*).

Carroll's (1993) publication of *Human Cognitive Abilities: A Survey of Factor-Analytic Studies* provided a widely respected confirmation of Horn's (1965, 1988, 1989, 1991), Ekstrom, French, & Harmon's (1979), Horn and Stankov's (1982), and Cattell's (1941, 1943, 1950) contributions to the construct of differentiated broad and narrow cognitive abilities. Carroll's broad classifications of cognitive abilities were remarkably similar to those described by Horn and his associates.

John Horn and John Carroll served as consultants in the development of the WJ III; their research resulted in somewhat different contributions to the WJ III. Identification of the broad CHC abilities in the WJ III is historically and primarily linked to the *Gf–Gc* research of Cattell and Horn (see also Horn & Noll, 1997; Horn & Masunaga, 2000). Carroll contributed the idea that human cognitive abilities could be conceptualized in a three-stratum hierarchy. The specification of the narrow abilities and general intellectual ability (*g*) construct was heavily influenced by Carroll's (1993, 1997, 2003) research. As a result of the contributions of both Horn and Carroll, the WJ III COG and DS provide measures of seven broad and approximately 25 narrow CHC abilities.

ADMINISTRATION AND SCORING

The WJ III COG and DS were designed to be easy to administer and score; however, proper administration of the WJ III COG and DS requires knowledge of the exact administration and scoring procedures and an understanding of the importance of adhering to standardized procedures. The *Examiner's Manual* (Mather & Woodcock, 2001) provides guidelines for learning to administer and score the tests. The test books also contain instructions, test by test, for administration and item scoring. General instructions are found on the introductory page of each test (the first printed page after the Tab Page); additional instructions appear on the test pages as needed.

Some tests require use of audio recordings. Audio recordings help ensure standardized presentation of certain auditory and short-term memory tasks. The tests that utilize an audio recording include Sound Blending, Numbers Reversed, Incomplete Words, Auditory Working Memory, Auditory Attention, Memory for Words, Sound Patterns–Voice, Memory for Sentences, and Sound

Patterns–Music. Other tests require use of the subject response booklet or subject response pages. Decision Speed, Planning, and Pair Cancellation all require the use of the subject response booklet. Visual Matching (Version 2) and Cross Out each requires the subject to use test material that is located in the test record.

Examiners must establish a basal and a ceiling for several tests. Basal and ceiling criteria are included in the Test Book for each test requiring them. If a subject fails to meet the basal criterion for any test, examiners are directed to test backward, full page by full page, until the subject has met the basal criterion or until Item 1 has been administered. For some tests, subjects begin with Item 1 and test until they reach their ceiling level; these tests do not require a basal. During administration, examiners score individual items and calculate the raw score for each test. There are correct and incorrect keys in the Test Book. These are intended to be guides to demonstrate how certain responses are scored. Not all possible responses are included in the keys. In cases where the subject's response does not fall clearly in either the correct or incorrect category, examiners may need to write down the response and come back to it later to determine a score. Most tests use a 1 (correct) or 0 (incorrect) scoring rule for determining raw scores. Visual-Auditory Learning, Visual-Auditory Learning–Delayed, and Planning each has a different scoring procedure. In these tests, the raw scores are determined by counting the number of errors. Generally, raw scores are determined by adding the number of correctly completed items to the number of test items below the basal. Scores for sample or practice items should not be included when calculating raw scores.

Test and cluster scores are calculated by any one of three associated scoring and/or interpretive programs: the WJ III Normative Update Compuscore and Profiles Program (Compuscore; Schrank & Woodcock, 2007), the *Woodcock Interpretation and Instructional Interventions Program* (WIIIP: Schrank, Wendling, & Woodcock, 2008), or the *Dean-Woodcock Neuropsychological Report* (Dean, Schrank, & Woodcock, 2008).

INTERPRETATION

In addition to the general intellectual ability score options, the WJ III COG and DS provide measures of an extensive array of broad and narrow cognitive abilities. These are described in the first portion of this section (measurement of cognitive functions). The middle portion of this section (determination of functional levels) describes how an individual's abilities can be described in terms of functional levels, including severity of impairment. In the final portion of this section (performance of clinical samples), WJ III COG and DS test score data obtained from 2,648 children and adolescents in 10 special population groups are presented and discussed.

MEASUREMENT OF COGNITIVE FUNCTIONS

Test level interpretation may provide the most functional information for neuropsychological evaluations because the narrow abilities that are measured by each test closely correspond to intellectual functions, such as lexical (word) knowledge, visual memory, or memory span. Additionally, each test was constructed to contain an operational definition of an intellectual function. That is, each test explains "what the subject is to do" and "what the evaluator is to observe" to elicit evidence of the intellectual function (Schrank, 2006).

The tests are also organized into clusters for interpretive purposes. CHC theory (McGrew, 2005) provides the basis for interpretation of the seven broad cognitive abilities measured in the WJ III COG. The CHC broad ability terms comprehension-knowledge (*Gc*), long-term retrieval (*Glr*), visual-spatial thinking (*Gv*), auditory processing (*Ga*), fluid reasoning (*Gf*), short-term memory (*Gsm*), and processing speed (*Gs*) describe broad classes of narrow abilities, on the basis of two or more operational definitions of narrow abilities. Figure 31.1 outlines the broad cognitive abilities measured by the WJ III COG and DS tests. Several of the tests are combined into other logically derived clusters that provide another level of interpretive information about an individual's performance. Each of these clusters (verbal ability, thinking ability, and cognitive efficiency) represents a general category of broad cognitive abilities that influence, in a similar way, what may be observed in an individual's cognitive or academic performance. Several general intellectual ability clusters are available, depending on the tests that are administered.

Comprehension-Knowledge (*Gc*)

Cognitive psychologists often define some of the abilities that fall within the broad CHC domain of Comprehension-Knowledge (*Gc*) as declarative memory or "memories for facts and events that are recalled consciously" (Squire & Knowlton, 2000). Markowitsch (1992, 2000) described this as the knowledge system of context-free facts. Another definition of comprehension-knowledge is semantic memory (Tulving, 1972, 1983), "whose function is to mediate the acquisition and use of individuals' general knowledge of the world" (Tulving, 2000, p. 728). CHC theory suggests that Test 1: Verbal Comprehension primarily measures lexical (vocabulary) knowledge and language development (general development in spoken English language skills). Test 31: Bilingual Verbal Comprehension–English/Spanish provides a procedure for measuring aspects of lexical knowledge and language development in Spanish. Test 11: General Information primarily measures general verbal information; this test samples an individual's store of general knowledge, or information that can be readily accessed without any particular kind of integrative mental process. Hintzman

		Intellectual Ability						Cognitive Performance Model Clusters						Broad CHC Clusters									Narrow CHC Clusters										Clinical Clusters				
	Tests of Cognitive Abilities	**General Intellectual Ability–Std**	**General Intellectual Ability–Ext**	**General Intellectual Ability–EDev**	**General Intellectual Ability–Bil**	**Broad Cognitive Ability–Low Verbal**	**Brief Intellectual Ability**	**Verbal Ability–Std**	**Verbal Ability–Ext**	**Thinking Ability–Std**	**Thinking Ability–Ext**	**Cognitive Efficiency–Std**	**Cognitive Efficiency–Ext**	**Comprehension-Knowledge (*Gc*)**	**Long-Term Retrieval (*Glr*)**	**Visual-Spatial Thinking (*Gv*)**	**Visual-Spatial Thinking 3 (*Gv3*)**	**Auditory Processing (*Ga*)**	**Fluid Reasoning (*Gf*)**	**Fluid Reasoning 3 (*Gf3*)**	**Processing Speed (*Gs*)**	**Short-Term Memory (*Gsm*)**	**Phonemic Awareness (PC)**	**Phonemic Awareness 3**	**Working Memory (WM)**	**Numerical Reasoning (RQ)**	**Associative Memory (MA)**	**Associative Memory-Delayed**	**Visualization (Vz)**	**Sound Discrimination (U3)**	**Auditory Memory Span (MS)**	**Perceptual Speed (P)**	**Broad Attention**	**Cognitive Fluency**	**Executive Prcoesses**	**Delayed Recall**	**Knowledge**
Standard Battery	Test 1: Verbal Comprehension	■	■	■	■		■	■	■					■																							
	Test 2: Visual-Auditory Learning	■	■							■	■				■												■										
	Test 3: Spatial Relations	■	■		■	■				■	■					■	■												■								
	Test 4: Sound Blending	■	■							■	■							■					■	■													
	Test 5: Concept Formation	■	■		■	■	■			■	■								■	■															■		
	Test 6: Visual Matching	■	■	■	■	■	■					■	■								■											■					
	Test 7: Numbers Reversed	■	■		■	■						■	■									■			■								■				
	Test 8: Incomplete Words			■																			■	■													
	Test 9: Auditory Working Memory																								■								■				
	Test 10: Visual-Auditory Learning-Delayed		■						■					■														■								■[2]	
Extended Battery	Test 11: General Information		■								■				■																			■			■[3]
	Retrieval Fluency		■								■					■	■																				
	Test 13: Picture Recognition		■								■							■																			
	Test 14: Auditory Attention		■								■								■	■													■				
	Test 15: Analysis-Synthesis		■										■								■																
	Test 16: Decision Speed		■										■									■												■			
	Test 17: Memory for Words		■																												■						
	Test 18: Rapid Picture Naming																																	■			
	Test 19: Planning																																		■		
	Test 20: Pair Cancellation																																■		■		

(*Contiued*)

	Intellectual Ability					Cognitive Performance Model Clusters							Broad CHC Clusters								Narrow CHC Clusters											Clinical Clusters				
Tests of Cognitive Abilities	**General Intellectual Ability–Std**	**General Intellectual Ability–Ext**	**General Intellectual Ability–EDev**	**General Intellectual Ability–Bil**	**Broad Cognitive Ability–Low Verbal**	**Brief Intellectual Ability**	**Verbal Ability–Std**	**Verbal Ability–Ext**	**Thinking Ability–Std**	**Thinking Ability–Ext**	**Cognitive Efficiency–Std**	**Cognitive Efficiency–Ext**	**Comprehension-Knowledge (*Gc*)**	**Long-Term Retrieval (*Glr*)**	**Visual-Spatial Thinking (*Gv*)**	**Visual-Spatial Thinking 3 (*Gv3*)**	**Auditory Processing (*Ga*)**	**Fluid Reasoning (*Gf*)**	**Fluid Reasoning 3 (*Gf3*)**	**Processing Speed (*Gs*)**	**Short-Term Memory (*Gsm*)**	**Phonemic Awareness (PC)**	**Phonemic Awareness 3**	**Working Memory (WM)**	**Numerical Reasoning (RQ)**	**Associative Memory (MA)**	**Associative Memory-Delayed**	**Visualization (Vz)**	**Sound Discrimination (U3)**	**Auditory Memory Span (MS)**	**Perceptual Speed (P)**	**Broad Attention**	**Cognitive Fluency**	**Executive Prcoesses**	**Delayed Recall**	**Knowledge**
Test 21: Memory for Names			■	■	■																					■										
Test 22: Visual Closure			■													■																				
Test 23: Sound Patterns-Voice				■	■																								■							
Test 24: Number Series																									■											
Test 25: Number Matrices																			■						■											
Test 26: Cross Out																															■					
Test 27: Memory for Sentences			■																											■						
Test 28: Block Rotation																												■								
Test 29: Sound Patterns-Music																													■							
Test 30: Memory for Names-Delayed																											■									
Test 31: Bilingual Verbal Comprehension-English/Spanish				*[1]									*[1]																							

[1]Test 31: Bilingual Verbal Comprehension is not required for calculation of this cluster. If administered, items answered correctly on Test 31 are added to the raw score for Test 1: Verbal Comprehension.
[2]Also includes Test 12: Story Recall-Delayed from the WJ III NU Tests of Achievement.
[3]Also includes Test 19: Academic knowledge from the WJ III NU Tests of Achievement.
[4]Also includes Test 21: Sound Awareness from the WJ III NU Tests of Achievement.

Figure 31.1 ■ Complete *Woodcock-Johnson III Normative Update Tests of Cognitive Abilities* (WJ III NU COG) selective testing table (includes Diagnostic Supplement).

(1978) called this type of knowledge generic memory—information that can readily be accessed without any integrative mental processing.

Long-term Retrieval (*Glr*)

The CHC broad ability of long-term retrieval (*Glr*) involves the cognitive processes of acquiring, storing, and retrieving information. *Glr* reflects the efficiency with which information is initially stored and later retrieved. The two tests that compose the *Glr* cluster are Test 2: Visual-Auditory Learning and Test 12: Retrieval Fluency. Visual-Auditory Learning measures associative memory or paired-associate learning and Retrieval Fluency measures ideational fluency and naming facility. In Visual-Auditory Learning, the initial task requires associating a rebus (visual symbol) with a verbal label. The controlled-learning format of this test uses a concept from cognitive neuroscience research called directed spotlight attention (Gazzaniga, Ivry, & Mangun, 1998), a mental attention-focusing process that prepares the examinee to encode the stimulus. The retrieval phase requires the examinee to match a rebus presentation with its stored representation; this process is called identification. The Retrieval Fluency test requires fluent retrieval and oral production of examples of a semantic category. This task does not include the encoding and storage processes, but rather measures the rate or automaticity of retrieval.

Test 21: Memory for Names is another test of associative memory. An associative memory cluster score may also be obtained by Memory for Names and Visual-Auditory Learning. The narrow ability of associative memory may be particularly useful when the ability to store and retrieve associations is of interest. A delayed recall cluster representing the ability to recall previously learned associations may be obtained by administering Test 10: Visual-Auditory Learning–Delayed and Test 30: Memory for Names–Delayed.

Visual-Spatial Thinking (*Gv*)

Visual-spatial thinking (*Gv*) involves visual perception (the process of extracting features from visual stimuli) and includes the processes involved in generating, storing, retrieving, and transforming visual images. Test 3: Spatial Relations and Test 13: Picture Recognition are the two tests that create the *Gv* cluster. Spatial Relations measures the ability to use visualization (the ability to apprehend spatial forms or shapes, often by rotating or manipulating them in the imagination of the "mind's eye"). Picture Recognition is a visual memory task. A narrow ability visualization (Vz) cluster can be obtained by administering Test 28: Block Rotation in addition to Spatial Relations. Test 22: Visual Closure measures the narrow ability of closure speed (recognition of a visual stimulus that has been obscured in some way).

Auditory Processing (*Ga*)

Auditory processing (*Ga*) is a broad CHC ability that involves auditory perception (the process of extracting features from auditory stimuli) and includes a wide range of abilities that are needed to discriminate, analyze, synthesize, comprehend, and manipulate sounds. The two tests that compose the *Ga* cluster are Test 4: Sound Blending and Test 14: Auditory Attention. Sound Blending is a measure of phonetic coding and Auditory Attention measures speech–sound discrimination and resistance to auditory-stimulus distortion. A two-test phonetic coding cluster may be obtained by administering Test 8: Incomplete Words in conjunction with Sound Blending. This cluster is called phonemic awareness and measures the ability to attend to the sound structure of language through analyzing and synthesizing speech sounds. Test 23: Sound Patterns–Voice and Test 23: Sound Patterns–Music each measures the narrow ability of sound discrimination (the ability to discriminate tones or patterns of tones with respect to pitch, intensity, duration, and temporal relations); when both tests are administered, a sound discrimination cluster is obtained.

Fluid Reasoning (*Gf*)

Reasoning is a complex, hierarchical cognitive function that can rely on many other cognitive processes, depending on the nature and requirements of the task. Inductive and deductive reasoning are the hallmarks of this broad CHC ability. Reasoning also often relies on emergent properties; that is, those functions that cannot be predicted on the basis of simple interactions between other functions. Nevertheless, certain narrow abilities have been identified by CHC theory on the basis of different types of reasoning processes.

Test 5: Concept Formation, a measure of induction, or inference, and Test 15: Analysis-Synthesis, a measure of general sequential, or deductive reasoning, compose the *Gf* cluster. The Concept Formation test requires rule application and frequent switching from one rule to another. The ability to educe relations also requires flexibility in thinking. Analysis-Synthesis requires drawing correct conclusions from stated conditions or premises, often from a series of sequential steps. Because of its use of specific solution keys that, if followed correctly, furnish the correct answer to each test item, Analysis-Synthesis can be also described as a measure of algorithmic reasoning. In CHC theory, algorithmic reasoning is an aspect of quantitative reasoning. Test 19: Planning measures the narrow ability of spatial scanning (speed in visually surveying a complicated spatial field) and general sequential reasoning.

Two additional *Gf* tests are included in the DS. Test 24: Number Series measures the ability to identify and apply an analog or rule to complete a numerical sequence. The mental representations (or "number sense") that constitute this ability form the basis for the ability to learn symbols for numbers and perform simple calculations (Dehaene, 1997, 2000). Test 25: Number Matrices requires a foundation in mathematical knowledge (i.e., access to the category-specific verbal and visual code; for example, knowledge of the number line). However, in Number Matrices, the verbal and/or visual codes are transcoded into analogical representations between sets of numbers. The solution to each item is obtained by mapping the relationship implied from the first part of the item onto the latter part of the item, thereby completing the analogy. Number Series and Number Matrices combine to form a numerical reasoning cluster.

Processing Speed *(Gs)*

Efficiency of cognitive processing is based partly on the speed of mental activity. For many years, cognitive speediness, or mental quickness, has been considered an important aspect of intelligence (Vernon, 1983; Nettelbeck, 1994). Kail (1991) stated, "In the face of limited processing resources, the speed of processing is critical because it determines in part how rapidly limited resources can be reallocated to other cognitive tasks" (p. 152).

The two tests that compose the *Gs* cluster are Test 6: Visual Matching and Test 16: Decision Speed. Visual Matching is a perceptual speed measure and Decision Speed measures speed of semantic processing (i.e., the speed of mental manipulation of stimulus content). Perceptual speed involves making comparisons on the basis of rapid visual searches. Speed of semantic processing (i.e., the speed of mental manipulation of stimulus content) requires making symbolic comparisons of concepts. In contrast to decision making on the basis of physical comparisons, the semantic or acquired knowledge (rather than perceptual information) needed for the Decision Speed test influences the decision-making process. A two-test narrow ability perceptual speed cluster may be obtained by administering Test 26: Cross Out in conjunction with Visual Matching.

Test 18: Rapid Picture Naming measures the narrow ability of naming facility (speed of producing names for objects or certain attributes of objects; this test measures the speed of direct recall of names of pictured objects. Test 20: Pair Cancellation measures attention, concentration, and the ability to control interference.

Short-Term Memory (*Gsm*)

Short-term memory (*Gsm*) is the ability to apprehend and maintain awareness of elements of information in the immediate situation. This cluster represents a limited capacity system that includes both memory span and working memory. Test 7: Numbers Reversed (a measure of working memory) and Test 17: Memory for Words (a measure of memory span) are the two tests in the *Gsm* cluster. Numbers Reversed requires the ability to temporarily store and recode orally presented information (a subprocess of working memory). In this test, the individual is required to repeat a series of digits backward. Memory for Words measures the span of verbal (auditory) store by requiring the individual to repeat a series of unrelated words. Memory for Sentences also measures the span of verbal memory, but in this test, memory is aided by context (semantic, meaning-based code). A narrow ability working memory cluster may be obtained by administering Test 9: Auditory Working Memory in conjunction with Numbers Reversed.

Cognitive Category Clusters

These clusters organize cognitive abilities into functional categories: Each of the three categories is composed of abilities that contribute in a common way to performance, but contribute differently from the common contributions of the other categories.

Verbal Ability represents higher-order, language-based acquired knowledge, and the ability to communicate that knowledge. Thinking Ability represents a sampling of the different thinking processes (long-term retrieval, visual-spatial thinking, auditory processing, and fluid reasoning); these abilities are involved when information in short-term memory cannot be processed automatically. Cognitive Efficiency provides a sampling of two different automatic cognitive processes—processing speed and short-term memory, both of which are needed for complex cognitive functioning.

General Intellectual Ability *(g)*

In the WJ III COG, there are several *general intellectual ability* (GIA) scores available, including General Intellectual Ability–Standard (GIA–Std) and General Intellectual Ability–Extended (GIA–Ext). The GIA scores are measures of psychometric *g*. Each GIA score is an index of the common variance among the broad and narrow cognitive abilities measured by the component tests. Each is a distillate of several cognitive abilities and the primary source of variance that is common to all of the tests included in its calculation.

Two special-purpose GIA scores are also available, the GIA–Bilingual Scale (GIA–Bil) and the GIA–Early Development Scale (GIA–EDev). Each of these scales is also a first-principal component *g* measure. The tests that contribute to each scale were selected as the most appropriate for use given the purpose of the scale.

The GIA–Bil scale was designed to measure the construct of GIA in a language-reduced test format. The scale is intended for use with bilingual, though English-dominant, subjects. Tests representing the broad abilities of *Gv* (Spatial Relations), *Gf* (Concept Formation), *Gs* (Visual Matching), *Gsm* (Numbers Reversed), *Glr* (Memory for Names), and *Ga* (Sound Patterns–Voice) were selected for use in the scale as they require a relatively low level of English language ability. Additionally, the scale includes two tests of verbal ability: Verbal Comprehension and Bilingual Verbal Comprehension–English/

Spanish. Items answered incorrectly in English can be subsequently administered in Spanish (or vice versa for the Batería III). This procedure provides a measure of verbal comprehension in English and Spanish combined.

The GIA–EDev includes measures of six, rather than seven, broad cognitive abilities. This cluster does not include a measure of fluid reasoning (*Gf*). The six tests that compose the GIA–EDev cluster were selected on the basis of the developmental appropriateness of the task and adequacy of the test floors with young children. For example, testing may begin with Memory for Names which requires only a pointing response.

The GIA–EDev scale includes Verbal Comprehension (a measure of *Gc*), an early development form of Visual Matching (Version 1; a measure of *Gs*), Incomplete Words (a measure of *Ga*), Memory for Names (a measure of *Glr*), Visual Closure (a measure of *Gv*), and Memory for Sentences (a measure of *Gsm*). Items from Bilingual Verbal Comprehension–English/Spanish may also be administered to English-dominant Spanish-speaking subjects, providing an additional use for the scale for young, bilingual children. The scale is also useful for individuals of any age who function at a preschool level.

There are two other special-purpose intellectual ability clusters, but these clusters are not first-principal component *g* measures. The Broad Cognitive Ability–Low Verbal cluster is an alternative to "nonverbal" scales on other intelligence batteries. It includes all of the tests in the GIA–Bil cluster, with the exception of Verbal Comprehension and Bilingual Verbal Ability–English/Spanish. The brief intellectual ability cluster is intended as a screening measure. It includes Verbal Comprehension, Concept Formation, and Visual Matching.

DETERMINATION OF FUNCTIONAL LEVELS

Identification of both narrow and broad cognitive ability levels from performance on the WJ III COG can provide practical implications for differential diagnosis and treatment planning. The individual's performance on each of the WJ III COG tests and clusters can be interpreted in terms of the individual's functional level, or proficiency, on the narrow or broad ability measured.

The ability to measure proficiency levels is a result of a unique application of objective measurement called the W scale. The Rasch-derived W scale allows the professional to provide a criterion-referenced interpretation of an individual's level of actual task proficiency. On the W scale, item difficulties and ability scores are on the same scale (Woodcock & Dahl, 1971). The difference between an individual's ability and the ability of the average person at his or her age or grade is called the W Diff (difference). This difference provides a direct and quantifiable implication of performance for the task.

On the WJ III, the difference between an individual's ability on each scale and the difficulty of the task can be directly translated into a set of descriptive labels and probabilistic implications. Table 31.2 contains the descriptive labels and task implications corresponding to the W Diff. The W scale provides the basis for criterion-referenced interpretations of an individual's functional level of cognitive abilities, including the presence and severity of any impairment. This scale allows a neuropsychologist to describe broad categories of functional level ranging from "Very Advanced" to "Severely Impaired." More specifically, these labels describe how proficient an individual is with tasks that are of average difficulty for others of the same age or grade. Additionally, the interpretation system allows the neuropsychologist to make criterion-referenced, probabilistic statements about the ease or difficulty with which the individual will find similar tasks. These probabilities range from "impossible" for individuals whose functional level is "Severely Impaired" to "extremely easy" for individuals whose functional level is "Very Advanced."

Table 31.3 is an example of the Table of Scores from the WJ III NU Compuscore and Profiles Program (Schrank & Woodcock, 2007). This example shows the relationship between the W Diff scores and functional levels for selected clusters and tests. On the Compuscore, the W Diff is elected as a score option and the functional levels are elected as descriptors of the W Diff.

PERFORMANCE OF CLINICAL SAMPLES

This section presents selected WJ III NU test scores that were obtained from a pool of 2,248 children and

Table 31.2 ■ Proficiency, functional, and development labels corresponding to W Diff

W Diff	Proficiency	Functionality	Development	Implications
+31 and above	Very advanced	Very advanced	Very advanced	Extremely easy
+14 to +30	Advanced	Advanced	Advanced	Very easy
+7 to +13	Average to advanced	Within normal limits to advanced	Age-appropriate to advanced	Easy
6 to +6	Average	Within normal limits	Age-appropriate	Manageable
−13 to −7	Limited to average	Mildly impaired to within normal limits	Mildly delayed to age-appropriate	Difficult
−30 to −14	Limited	Mildly impaired	Mildly delayed	Very difficult
−50 to −31	Very limited	Moderately impaired	Moderately delayed	Extremely difficult
−51 and below	Negligible	Severely impaired	Severely delayed	Impossible

Table 31.3 ■ Example table of scores from the WJ III NU Compuscore and Profiles Program

CLUSTER/test	Raw	W	AE	Functional level	RPI	SS (68% band)	Wdiff
GIA (Std)	-	488	7–7	Mild impaired	34/90	66(63–68)	-26
Verbal Ability (Std)	-	507	11–4	Mild impaired-WNL	73/90	91(87–95)	-11
Thinking Ability (Std)	-	488	7–0	Mild impaired	47/90	68(65–71)	-21
COG Efficiency (Ext)	-	483	7–5	Mod impaired	22/90	58(54–62)	-32
Vis-Spatial Think (*Gv*)	-	495	8–2	Mild impaired-WNL	73/90	81(77–85)	-11
Fluid Reasoning (*Gf*)	-	472	6–4	Mod impaired	9/90	59(55–62)	-41
Process Speed (*Gs*)	-	481	7–4	Mod impaired	21/90	42(38–46)	-32
Short-Term Mem (*Gsm*)	-	485	7–7	Mod impaired	23/90	74(69–79)	-31
Verbal Comprehension	-	507	11–4	Mild impaired-WNL	73/90	91(87–95)	-11
Visual-Auditory Learning	45-E	479	5–6	Mild impaired	32/90	45(41–50)	-27
Spatial Relations	57-D	494	7–8	Mild impaired-WNL	70/90	82(78–87)	-12
Sound Blending	19	503	10–7	Mild impaired-WNL	78/90	91(85–97)	-9
Concept Formation	12-C	476	6–9	Mod impaired	13/90	68(64–72)	-37
Visual Matching	20–2	469	6–6	Mod impaired	4/90	31(26–35)	-48
Numbers Reversed	9	483	7–6	Mod impaired	16/90	73(68–79)	-35
Picture Recognition	44-D	496	8–7	Mild impaired-WNL	76/90	88(83–93)	-9
Analysis-Synthesis	9-B	467	6–0	Mod impaired	6/90	60(56–64)	-45
Decision Speed	25	494	9–0	Mild impaired	60/90	74(69–79)	-16
Memory for Words	15	487	7–7	Mild impaired	33/90	82(76–88)	-27

	Standard scores			Variation		Significant at
Variations	**Actual**	**Predicted**	**Difference**	**PR**	**SD**	**± or – 1.50 SD (SEE)**
Intra-Cognitive (Brief)						
Verbal Comprehension	91	68	23	98	+2.06	Yes
Visual-Auditory Learning	45	75	-30	1	-2.31	Yes
Spatial Relations	82	79	3	59	+0.22	No
Sound Blending	91	77	14	88	+1.18	No
Concept Formation	68	70	-2	44	-0.14	No
Visual Matching	31	84	-53	<0.1	-3.98	Yes
Numbers Reversed	73	76	-3	41	-0.23	No

SD, standard deviation; SS, standard scores; WJ III NU, *Woodcock-Johnson III Normative Update;* WNL, within normal limits.
Woodcock-Johnson III Normative Update Tests of Cognitive Abilities, WJ III NU Compuscore and Profiles Program, Version 3.1, Norms based on age 13–10.

adolescents (up to age 19) with various types of disabilities. Disability classifications are made on the basis of the *ICD-10: International Classification of Diseases and Related Health Problems* (World Health Organization, 1992). These children and adolescents were administered different combinations of WJ III COG and DS tests.

Cluster-level data on the performance of individuals with various neuropsychological disorders are presented in McGrew, Schrank, and Woodcock (2007). This section expands upon that information by presenting and discussing the performance of children and adolescents with neuropsychological disorders on selected WJ III NU COG and Diagnostic Supplement test scores.

Table 31.4 presents descriptive statistics for the selected tests by clinical group. Included in the descriptive statistics are standard scores (SSs) from a scale with a mean of 100 and a standard deviation (SD) of 15; the SD obtained from each subsample is also included. Finally, the median W Difficulty (W Diff) score for individuals in the subsample is provided.

Both SSs and W Difference scores are included in Table 31.4. The SS is a conventional metric used to compare results among tests or individuals. That metric, however, is often misinterpreted as an index of quality of performance when, in fact, it is only an ordinal index of position within a group. On the other hand, the W-Diff is used to define quality of performance (see Table 31.2).

Anxiety Spectrum Disorders

The median SSs, SDs, and median RPIs for 206 children and adolescents with anxiety spectrum disorders are presented in Table 31.4. Note that children with anxiety spectrum disorders scored relatively low on Visual-Auditory Learning and Visual-Auditory Learning—Delayed. Visual-Auditory Learning is a learning task requiring the paired-associate encoding (Kosslyn & Thompson, 2000), storage, and retrieval processes (Schacter & Tulving, 1994, Tulving, 1985, 2000). Retrieval and reidentification processes (Gazzaniga, et al., 1998) are also required in Visual-Auditory Learning—Delayed. These scores suggest that anxiety interferes with learning, specifically with paired-associate encoding. Visual-Auditory Learning—Delayed includes a relearning procedure. The relatively low performance of children and adolescents on Visual-Auditory Learning—Delayed suggests that children and adolescents with anxiety spectrum disorders also have difficulties retrieving information that was previously learned.

Also of note is the relatively low performance (median SS = 90.8) and proficiency (median W Diff = –11.9; mildly impaired to within normal limits) on Numbers Reversed. This suggests that anxiety interferes with cognitive efficiency and working memory.

Attention-Deficit/Hyperactivity Disorder

Children and adolescents in this sample included the predominately inattentive, predominately hyperactive-impulsive, and combined types of attention-deficit/hyperactivity disorder (ADHD), a neurobehavioral condition characterized by difficulty sustaining attention, overactivity, and impulsivity (American Psychiatric Association [APA], 2000). The performance of this group of 896 individuals diagnosed with ADHD is presented in Table 31.4. The lowest overall test score is Auditory Working Memory (median SS = 86.2; median W Diff = –14.9, mildly impaired). Auditory Working Memory requires the individual to hold a sequence of verbalized stimuli in immediate awareness and then recode the sequence (Gazzaniga et al., 1998) into two new sequences defined by numbers and names of objects. Recoding tasks that are manageable for age peers are difficult for children and adolescents with ADHD.

Autistic Spectrum Disorders

Table 31.4 presents data pertaining to the performance of 155 children and adolescents with autistic spectrum disorders, including autistic disorder and Asperger's disorder and unspecified pervasive developmental disorder. These disorders are often characterized by impaired social interaction or communication skills (APA, 2000). The data presented in Table 31.4 suggest that children and adolescents with autistic spectrum disorders will find age-level tasks on Auditory Working Memory to be extremely difficult. Perceptual speed tests (Visual Matching and Cross Out) are also relatively low for this group.

Depressive Spectrum Disorders

Individuals in this category include depressive spectrum disorders and bipolar disorders. An examination of the scores for this sample of 207 children and adolescents suggests that the depressive spectrum disorders may be associated with mildly impaired (W Diff = –14.8) cognitive proficiency on Numbers Reversed. Numbers Reversed is a measure of cognitive efficiency that requires recoding in working memory (Gazzaniga et al., 1998).

Head Injury

This sample includes scores from 123 children and adolescents with a number of different types of brain injury from an externally inflicted trauma, including traumatic brain injury, closed head injury, fractured skull, hematoma/hemorrhage, contusion, depressed skull fracture, and post-concussive disorder. The cognitive consequences of these injuries are broad and can vary by the severity of the injury. Some of the most persistent problems associated with head injury include memory impairments and difficulties in attention and concentration (National Institutes of Health, 1998); these problems are evident in the patterns of scores provided in Table 31.4. All test scores are lower than the mean of the standardization sample with the exception of Block Rotation. The data presented in Table 31.4 suggest that, on the WJ III COG, children and adolescents with head injury show lower performance on Visual Matching (a speed task) and Numbers Reversed (a recoding task).

Language Disorders

This sample includes 156 children and adolescents with articulation disorder, communication disorders, expressive language disorders, mixed receptive-expressive language disorders, and central auditory processing disorders. Data presented in Table 31.4 show that the presence of a language disorder is typically related to lower cognitive ability scores on the WJ III COG and DS. The Auditory Working Memory test is the lowest score (median SS = 77.9; median W Diff = –23.9, mildly impaired). Other tests that are sensitive indicators for children and adolescents with language disorders include Concept Formation (median SS = 81.8; median W Diff = –20.7, mildly impaired), Numbers Reversed (median SS = 87.9; median W Diff = –17.1, mildly impaired), Memory for Words (median SS = 88.6; median W Diff = –16.2, mildly impaired), Memory for Sentences (median SS = 85.5; median W Diff = –14.9, mildly impaired), and Number Matrices (median SS =81.5; median W Diff = –14.9, mildly impaired).

Mathematics Disorder

This sample is composed of 168 children and adolescents with mathematical ability that is substantially below an expectation on the basis of chronological age, general intellectual ability, and an age-appropriate educational history (APA, 2000). Sometimes referred to as dyscalculia, this specific type of learning disability significantly interferes with academic achievement or activities of daily living that require the application of mathematical skills. Table 31.4 shows the Auditory Working Memory and Number Series tests to be among the lowest for this sample of individuals. The Number Series test involves representation and manipulation of points on a mental number line. The functional ability involved in this test is sometimes called number sense and it requires identifying and applying an underlying rule or principle to complete a numerical sequence (Dehaene, 1997, 2000); this ability may be fundamental to mathematical competence.

The median performance of children and adolescents with mathematics disorder is nearly one SD below age peers (median SS = 85.6). Note, however, that the median

Table 31.4. ■ Selected WJ III NU COG and DS test scores by type of clinical sample—Children and adolescents age < 19

	Test 1	Test 3	Test 4	Test 5	Test 6	Test 7	Test 9	Test 10	Test 11	Test 12	Test 13	Test 14	Test 15	Test 16
	Verbal Comprehension	**Spatial Relations**	**Sound Blending**	**Concept Formation**	**Visual Matching**	**Numbers Reversed**	**Auditory Working Memory**	**Visual-Auditory Learning–Delayed**	**General Information**	**Retrieval Fluency**	**Picture Recognition**	**Auditory Attention**	**Analysis-Synthesis**	**Decision Speed**
Anxiety spectrum disorders														
n	116	98	192	183	206	100	10	50	36	20	163	16	172	66
Median (SS)	96.8	98.6	103.8	95.5	92.4	90.8	95.3	91.4	102.5	92.7	101.1	97.1	100.4	96.0
SD (SS)	16.1	11.7	13.1	15.0	16.0	16.5	21.7	19.6	15.1	17.2	12.4	15.5	16.0	17.7
Median (W Diff)	-3.3	-1.0	3.5	-5.0	-5.7	-11.9	-5.2	-4.7	2.4	-1.8	0.9	-1.5	0.3	-2.4
Attention-deficit/hyperactivity disorder														
n	650	373	856	844	896	347	143	55	243	250	733	213	795	294
Median (SS)	98.2	99.2	102.6	96.9	88.5	91.8	86.2	91.5	99.5	95.0	98.6	95.2	98.3	96.6
SD (SS)	13.7	38.2	14.6	15.9	17.7	16.6	17.1	20.2	15.4	15.9	12.0	21.1	16.1	18.0
Median (W Diff)	-1.7	-0.5	2.5	-3.6	-8.2	-10.7	-14.9	-4.7	-0.5	-1.3	-1.0	-2.1	-1.8	-2.0
Autistic spectrum disorders														
n	118	113	143	142	155	109	11	16	85	76	132	76	135	92
Median (SS)	96.2	103.4	97.6	92.4	83.7	90.6	70.9	81.8	99.1	93.6	95.9	98.0	94.3	90.9
SD (SS)	19.6	15.6	17.6	21.1	24.5	21.9	21.4	19.0	20.3	18.5	13.9	18.4	21.6	20.0
Median (W Diff)	-4.0	2.5	-1.8	-8.4	-11.2	-11.1	-30.6	-9.9	-0.9	-1.6	-3.1	-0.9	-7.0	-5.7
Depressive spectrum disorders														
n	105	93	187	182	207	83		39	28	14	164		175	53
Median (SS)	97.4	99.3	102.8	96.2	89.6	87.8		92.2	97.4	95.0	100.2		100.0	97.7
SD (SS)	13.8	11.8	12.4	15.1	18.6	16.6		16.7	13.0	14.7	12.0		17.1	19.7
Median (W Diff)	-2.9	-0.5	2.7	-4.4	-7.3	-14.8		-4.1	-2.6	-1.2	0.1		0.0	-1.5
Head injury														
n	73	58	101	97	123	65	13	19	30	17	97		103	33
Median (SS)	94.8	97.8	91.3	89.4	84.8	89.1	93.0	80.1	96.2	96.5	97.3		95.0	85.3
SD (SS)	17.2	13.6	15.2	18.0	22.5	20.8	19.2	20.3	14.5	10.8	16.7		16.4	15.8
Median (W Diff)	-5.3	-1.5	-7.5	-12.0	-11.1	-16.1	-7.4	-10.9	-3.8	-0.9	-2.2		-5.1	-9.4
Language disorders														
n	114	115	151	144	156	97	14	48	86	73	137	70	138	78
Median (SS)	88.0	94.0	92.8	81.8	88.8	87.9	77.9	91.2	90.4	97.6	97.5	99.6	89.4	91.7
SD (SS)	16.0	16.6	14.3	17.8	19.1	17.1	19.3	14.8	16.4	16.6	15.7	15.1	16.9	17.0
Median (W Diff)	-11.9	-4.0	-5.9	-20.7	-7.8	-17.1	-23.9	-4.8	-9.4	-0.6	-1.7	-0.1	-11.3	-5.1
Math disorders														
n	164	123	168	168	165	122	17	82	102	112	148	90	153	118
Median (SS)	94.0	97.8	102.0	95.0	88.3	89.8	82.0	93.1	96.5	98.3	98.0	102.8	94.7	98.9
SD (SS)	14.3	14.4	14.6	15.5	16.8	17.9	12.5	10.9	14.8	14.4	12.3	14.0	14.6	16.4
Median (W Diff)	-6.6	-1.5	2.2	-5.7	-8.1	-13.8	-19.0	-3.7	-3.6	-0.4	-1.6	1.2	-5.3	-0.7
Mental retardation														
n	125	133	154	139	146	112			56	35	153	35	127	36
Median (SS)	62.2	77.8	77.3	66.5	65.0	72.1			66.8	77.6	84.1	84.7	66.5	70.3
SD (SS)	12.0	13.2	14.1	12.8	17.0	15.4			14.1	16.8	16.8	18.7	15.6	19.0
Median (W Diff)	-37.6	-14.2	-19.3	-38.3	-24.7	-38.1			-33.8	-5.5	-12.7	-7.1	-33.0	-18.9
Reading disorders														
n	452	320	466	463	468	312	43	110	227	265	341	161	381	281
Median (SS)	94.0	98.0	102.0	99.4	86.3	89.1	82.6	92.4	97.2	96.7	100.9	98.9	100.2	97.6
SD (SS)	13.6	13.2	13.9	15.3	14.0	14.6	12.0	14.9	13.9	13.6	11.9	13.8	14.1	15.7
Median (W Diff)	-6.1	-1.3	2.0	-0.7	-9.4	-14.7	-18.6	-3.9	-2.6	-0.8	0.7	-0.5	0.1	-1.4
Written language disorders														
n	357	255	373	376	380	253	25	141	211	231	307	166	332	239
Median (SS)	98.2	98.9	102.4	101.1	89.3	91.6	84.3	97.7	101.8	98.2	100.0	98.5	102.7	99.7
SD (SS)	14.7	45.6	15.3	15.8	14.7	15.7	12.7	13.7	15.5	13.3	12.8	15.7	14.7	14.4
Median (W Diff)	-1.9	-0.8	2.4	1.2	-7.5	-11.1	-16.6	-1.1	1.6	-0.4	0.0	-0.7	2.5	-0.2
Total clinical sample														
n	1914	1565	2461	2406	2648	1478	259	469	1020	937	2156	774	2273	1070
Median (SS)	94.2	96.8	99.7	94.4	86.3	88.4	84.0	94.6	96.8	96.5	97.5	97.5	96.0	96.2
SD (SS)	17.1	23.1	16.0	18.3	19.0	18.0	17.6	15.8	17.4	15.8	14.6	17.7	18.2	17.9
Median (W Diff)	-5.9	-2.1	-0.3	-6.4	-9.5	-15.8	-16.9	-2.8	-3.1	-0.9	-1.9	-1.1	-4.1	-2.3

SS, standard scores.

W Diff for this population (median W Diff = –18.1) suggests limited proficiency on Number Series. Children and adolescents at the median of this group would be described as mildly impaired in number sense. Children and adolescents at the median in this sample would likely find age-level number series tasks to be very difficult. When described as a developmental task, the median individual in this sample would be mildly delayed in terms of skill development (see Table 31.2).

The development of number sense (Griffin, 1998; Ginsburg, 1997) is suggested as an instructional intervention for limited proficiency on the Number Series test (Schrank et al., 2008), including seriation skills (High Scope Educational Research Foundation, 2003). Manipulatives can be used to make the transfer from concrete examples to internal representations of the number line (Butler, Miller, Crehan, Babbitt, Pierce, 2003; Cass, Cates, Smith, & Jackson, 2003; Siegler, 1988).

Test 17	Test 18	Test 19	Test 20	Test 21	Test 22	Test 23	Test 24	Test 25	Test 26	Test 27	Test 28	Test 29	Test 30
Memory for Words	**Rapid Picture Naming**	**Planning**	**Pair Cancellation**	**Memory for Names**	**Visual Closure**	**Sound Patterns– Voice**	**Number Series**	**Number Matrices**	**Cross Out**	**Memory for Sentences**	**Block Rotation**	**Sound Patterns– Music**	**Memory for Names– Delayed**
150	16	10		115	115				91	116			
96.2	93.9	99.2		101.7	101.0		.		94.1	98.0		.	
13.3	20.3	7.5		18.6	11.5		.	.	18.6	15.6	.	.	.
-5.3	-5.6	-0.2		1.3	0.9		.		-4.2	-2.0		.	
806	213	106	44	633	663	143	81	85	623	649	55		
94.7	93.3	97.4	97.5	97.9	100.5	101.5	97.1	96.9	93.2	98.0	102.8		
15.0	14.4	21.6	11.2	17.2	11.8	17.1	18.1	17.2	15.9	18.9	16.4		
-7.5	-6.1	-0.7	-3.0	-1.2	0.5	1.0	-4.4	-2.6	-5.0	-1.9	1.2		
127	12	12	10	61	60	12			42	61			
92.3	86.0	94.0	85.1	92.0	95.7	93.8			84.5	88.9			
18.2	15.8	8.4	11.3	16.2	19.0	15.4			19.6	30.9			
-11.3	-12.6	-1.6	-19.9	-4.2	-5.2	-4.8			-9.7	-10.9			
158	11			126	127	19			111	129			
95.0	87.9			101.8	100.9	96.4			95.6	97.7			
14.2	18.2			14.2	10.5	13.4			16.1	16.0			
-7.2	-11.1			1.4	0.8	-2.8			-3.4	-2.2			
86	15	12	12	89	89	30		11	69	90	11		11
93.7	86.7	97.2	93.9	97.2	97.7	92.3		97.6	92.3	93.2	100.6		91.0
16.2	16.0	9.2	10.1	18.4	16.1	11.8		11.0	18.1	18.3	12.0		9.2
-9.2	-11.4	-0.6	-8.1	-1.4	-3.0	-5.4		-2.0	-6.2	-7.2	0.3		-5.3
131	68	31	56	124	126	74	49	51	106	131	52	39	48
88.6	97.2	93.5	95.0	95.4	100.6	97.3	91.6	81.5	89.9	85.5	95.7	98.7	93.4
15.0	14.4	13.1	11.6	16.4	16.6	19.2	22.6	12.9	16.9	17.9	17.4	14.7	14.8
-16.2	-2.6	-1.2	-6.5	-2.6	0.6	-2.1	-12.9	-14.9	-7.2	-14.6	-1.9	-0.5	-3.9
155	102	67	81	130	131	82	81	81	130	130	79	61	74
100.0	97.7	96.0	99.0	99.4	99.6	99.9	85.6	90.7	95.9	99.4	97.4	100.8	95.2
16.4	15.1	15.4	10.9	14.6	14.1	14.2	19.6	16.1	17.8	18.2	17.4	15.8	15.0
-0.0	-2.2	-0.7	-1.2	-0.3	-0.5	-0.1	-18.1	-13.4	-3.2	-0.6	-1.1	0.3	-2.9
134				103	103				97	103			
72.1				77.3	89.5				64.7	65.6			
15.0				16.0	13.8				15.4	16.2			
-39.6				-12.0	-12.4				-25.4	-34.6			
403	235	48	89	238	236	83	68	69	246	253	66	59	61
94.5	90.6	98.6	98.2	92.1	99.9	97.9	100.0	98.2	94.5	98.4	102.7	97.6	97.4
14.7	13.2	16.4	8.1	13.9	11.6	15.8	17.4	16.2	14.7	15.8	17.6	16.4	15.1
-7.8	-8.7	-0.3	-2.3	-4.3	-0.1	-1.6	-0.4	-2.4	-3.8	-1.5	1.3	-0.9	-1.5
339	209	87	130	247	246	118	114	115	248	254	105	93	108
96.9	91.9	98.4	99.0	97.3	100.4	102.1	100.1	102.6	94.5	101.2	103.4	98.9	99.1
14.6	15.6	14.7	9.1	15.4	13.1	18.0	20.4	16.3	15.2	16.3	15.4	17.3	18.9
-4.4	-7.7	-0.3	-1.3	-1.4	0.3	1.4	0.2	3.9	-3.9	1.2	1.5	-0.4	-0.6
2205	756	400	414	1847	1906	581	423	451	1653	1877	376	253	321
93.1	92.9	97.6	97.5	95.5	99.2	99.1	95.3	95.8	91.9	95.3	101.0	98.9	97.3
16.6	14.8	16.7	10.3	16.7	13.8	16.6	19.9	16.4	18.1	20.1	16.9	16.3	16.4
-9.6	-6.6	-0.6	-3.0	-2.4	-1.0	-0.6	-6.7	-3.3	-6.0	-4.6	0.4	-0.4	-1.7

Mental Retardation

Table 31.4 provides information on a sample of 158 children and adolescents with mental retardation. Inspection of the median scores for children with mental retardation reveals that the pattern of cognitive test scores, although all low, is not uniform. Auditory Attention and Picture Recognition are among the highest scores. The Auditory Attention median SS (84.7) is approximately one SD below the mean for the general population. However, median proficiency with the underlying task (selective auditory attention) is limited to average (median W Diff = –7.1). Similarly, the Picture Recognition median SS (84.1) is also approximately one SD below the mean and the median proficiency with this task (visual memory) is also limited to average (median W Diff = 12.7). Both of these tasks have less complex cognitive processing requirements.

When compared to the general population of children and adolescents, the lowest test score is Visual-Auditory Learning (median SS = 56.3). This suggests that learning via paired-associate encoding is an area of weakness for children and adolescents with mental retardation; the median W Diff for this group (–22.1) suggests that age-level paired-associate learning tasks will be very difficult.

However, the most difficult task for children and adolescents with mental retardation would invoke the inductive reasoning, rule-based categorization, and rule-switching (Smith & Jonides, 2000; Osherson, Smith, Wilkie, Lopez, & Shafir, 1990) processes involved in the Concept Formation test (median W Diff = –38.3, very limited). The median individual in this group would find similar age-level tasks extremely difficult. In terms of functional implications, the median child or adolescent with mental retardation would be moderately impaired in inductive reasoning. A similar profile is noted for the Analysis-Synthesis test (median SS = 66.5; median W Diff = –33.0, very limited). Analysis-Synthesis measures deductive reasoning. Notable proficiency limitations in Verbal Comprehension (median W Diff = –37.6, very limited) and General Information (median W Diff = –33.8, very limited) suggest that children and adolescents with mental retardation are moderately impaired in acquired knowledge.

A group of associated test scores suggests that children and adolescents with mental retardation have limitations in cognitive efficiency. Visual Matching, which measures speeded visual perception (Ashcraft, 2002), is very low (median SS = 65.0) and proficiency is very limited (median W Diff = –38.1). Similar scores exist for other tests of memory span, notably Memory for Words (median SS = 72.1; median W Diff = 39.6, very limited) and Memory for Sentences (median SS = 65.6; median W Diff = –34.6, very limited). Low performance is also evident on tests of perceptual speed such as Cross Out (median SS = 64.7; median W Diff = –25.4, limited).

Reading Disorders

Reading disorders are estimated to be involved in at least 80% of all learning disabilities (Shaywitz, 2003). Reading disorders are characterized by reading achievement (i.e., accuracy, speed, or comprehension) that falls substantially below an expectation on the basis of the individual's chronological age, general intellectual ability, and an age-appropriate educational history (APA, 2000). Sometimes referred to as dyslexia, this type of specific learning disability significantly interferes with academic achievement or activities of daily living that require the application of reading skills. Table 31.4 shows that the Auditory Working Memory and Numbers Reversed tests yield the lowest cognitive scores for this sample of 468 children and adolescents with reading disorders. Proficiency on both tests is limited (Auditory Working Memory W Diff = –18.6; Numbers Reversed W Diff = –14.7).

Written Expression Disorders

This sample is composed of 380 children and adolescents with writing ability that is substantially below an expectation on the basis of chronological age, general intellectual ability, and an age-appropriate educational history (APA, 2000). This type of specific learning disability significantly interferes with academic achievement or activities of daily living that require the application of writing skills. Table 31.3 shows that Auditory Working Memory is the lowest cognitive test score for this sample of individuals (median SS = 84.3; median W Diff = –16.6, limited).

Total Clinical Sample

Data for the combined clinical sample are presented in Table 31.4. This information is helpful for determining which WJ III COG and DS tests are the most useful across the entire rage of disorders. Regardless of diagnosis, the Auditory Working Memory and Numbers Reversed tests are likely to be sensitive in identifying individuals with disabilities. These two tests compose the working memory cluster on the WJ III. This suggests that limitations in span of apprehension and coding in working memory (Gazzaniga et al., 1998) are associated with various clinical disorders and that these two tests are particularly useful in determining the presence and severity of a cognitive disability.

PSYCHOMETRIC PROPERTIES

WJ III COG and DS Normative Update standardization data are derived from a nationally-representative sample of 8,782 individuals ranging in age from 2 to 102. The preschool sample was composed of 1,153 individuals aged 2 through 5 (who were not enrolled in kindergarten). The school age sample (kindergarten through 12th grade) was composed of 4,740 individuals. Children and adolescents from special education categories were included in the sample to the extent that they were present in the school population. Normative data are presented in month-by-month intervals through age 19, and then in 10-year intervals through 90+. More complete information on the reliability and validity of the WJ III COG and DS NU are described in the *Technical Manual* (McGrew et al., 2007).

RELIABILITY

Median reliability coefficients (r_{11}) and the standard errors of measurement (*SEM*) are reported for the WJ III COG and Diagnostic Supplement tests in Tables 31.5 and 31.6. The *SEM* values are in SS units. The reliabilities for all but the speeded tests and tests with multiple-point scoring systems were calculated using the split-half procedure (odd and even items) and corrected for length using the Spearman-Brown correction formula. The reliabilities for the speeded tests (Visual Matching, Retrieval Fluency, Decision Speed, Rapid Picture Naming, Pair Cancellation, and Cross Out) and tests with multiple-point scored items (Spatial Relations, Retrieval Fluency, Picture Recognition, and Planning) were calculated using Rasch analysis procedures. Most test reliabilities reported in Table 31.5 are 0.80 or higher. Table 31.6 reports median reliabilities and *SEM* for the WJ III COG and DS clusters across their range of intended use. Note that most reliabilities in this table are 0.90 or higher.

VALIDITY

The WJ III COG is supported by several sources of validity evidence as documented in the *Technical Manual* (McGrew et al., 2007), including a discussion of the relationship between the WJ III tests, CHC theory, and related cognitive processing research. However, as stated by Messick (1989), validation is an ongoing endeavor. Data and interpretation presented in this chapter on the performance of clinical samples add to the extant validity evidence for the WJ III COG and DS.

In addition, evidence based on test consequences evolves after using a test as part of a decision-making processes (Cizek, Rosenberg, & Koons, 2008). Children and adolescents with neuropsychological impairments often have exceptional educational needs, and the cognitive processes required for performance on the WJ III COG and DS tests may provide cues to interventions or accommodations that may enhance performance on similar educational tasks. Educational interventions or accommodations that address related cognitive limitations may be foundational to improved performance in academic areas where learning difficulties are manifested. The WJ III COG and DS tests have been linked to educational interventions and accommodations in the WIIIP. Research reviewed by Schrank et al. (2008) suggests theoretical and conceptual links between the tests and a number

Table 31.5 ■ WJ III NU COG and DS median test reliability statistics, ages 2–19

Test	Median *r11*	Median *SEM* (SS)
Standard battery		
1: Verbal Comprehension	0.90	4.74
2: Visual-Auditory Learning	0.86	5.61
3: Spatial Relations	0.81	6.54
4: Sound Blending	0.87	5.41
5: Concept Formation	0.94	3.67
6: Visual Matching	0.86	5.62
7: Numbers Reversed	0.87	5.41
8: Incomplete Words	0.78	7.12
9: Auditory Working Memory	0.88	5.08
10: Visual-Auditory Learning–Delayed	0.92	4.10
Extended battery		
11: General Information	0.88	5.20
12: Retrieval Fluency	0.82	6.54
13: Picture Recognition	0.73	7.80
14: Auditory Attention	0.88	5.20
15: Analysis-Synthesis	0.89	4.97
16: Decision Speed	0.87	5.38
17: Memory for Words	0.78	6.96
18: Rapid Picture Naming	0.97	2.51
19: Planning	0.74	7.72
20: Pair Cancellation	0.96	2.92
Diagnostic supplement		
21: Memory for Names	0.88	5.20
22: Visual Closure	0.80	6.62
23: Sound Patterns–Voice	0.94	3.67
24: Number Series	0.88	5.20
25: Number Matrices	0.90	4.74
26: Cross Out	0.71	8.08
27: Memory for Sentences	0.89	4.97
28: Block Rotation	0.81	6.54
29: Sound Patterns–Music	0.89	4.97
30: Memory for Names–Delayed	0.90	4.74
31: Bilingual Verbal Comprehension	0.90	4.74

DS, Woodcock-Johnson III Diagnostic Supplement to the Tests of Cognitive Abilities; SEM, standard errors of measurement; SS, standard scores; WJ III NU COG, Woodcock-Johnson III Normative Update Tests of Cognitive Abilities.

Table 31.6 ■ WJ III NU COG and DS median cluster reliability statistics, ages 2–19

Test	Median *r11*	Median *SEM* (SS)
Standard battery		
General Intellectual Ability–Std	0.97	2.60
Brief Intellectual Ability	0.96	3.00
Verbal Ability–Std	0.90	4.74
Thinking Ability–Std	0.95	3.35
Cognitive Efficiency–Std	0.89	4.97
Phonemic Awareness (PC)	0.88	5.08
Working Memory (WM)	0.90	4.67
Extended battery		
General Intellectual Ability–Ext	0.98	2.12
Verbal Ability–Ext	0.94	3.67
Thinking Ability–Ext	0.96	3.00
Cognitive Efficiency–Ext	0.91	4.50
Comprehension-Knowledge (*Gc*)	0.94	3.67
Long-Term Retrieval (*Glr*)	0.88	5.30
Visual-Spatial Thinking (*Gv*)	0.80	6.62
Auditory Processing (*Ga*)	0.89	4.97
Fluid Reasoning (*Gf*)	0.95	3.35
Processing Speed (*Gs*)	0.91	4.50
Short-Term Memory (*Gsm*)	0.88	5.30
Broad Attention	0.94	3.67
Cognitive Fluency	0.96	3.00
Executive Processes	0.96	3.00
Diagnostic supplement		
General Intellectual Ability–Bilingual	0.96	2.80
General Intellectual Ability–Early Development	0.94	3.67
Broad Cognitive Ability–Low Verbal	0.95	3.35
Visual-Spatial Thinking 3 (*Gv3*)	0.84	6.00
Fluid Reasoning 3 (*Gf3*)	0.96	3.00
Associative Memory (MA)	0.92	4.24
Associative Memory–Delayed (MA)	0.94	3.67
Visualization (Vz)	0.81	6.54
Sound Discrimination (U3)	0.96	3.00
Auditory Memory Span (MS)	0.88	5.30
Perceptual Speed (P)	0.87	5.41
Numerical Reasoning (RQ)	0.93	3.97

DS, *Woodcock-Johnson III Diagnostic Supplement to the Tests of Cognitive Abilities;* SEM, standard errors of measurement; SS, standard scores; WJ III NU COG, *Woodcock-Johnson III Normative Update Tests of Cognitive Abilities.*

of evidence-based instructional interventions. Adams, 1990; Anders & Bos, 1986; Anderson, 1996;Anderson, Hiebert, Scott, & Wilkinson, 1985;Anderson & Nagy, 1992; Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003; Baumann, Kame'enui, & Ash, 2003; Beck & McKeown, 2001; Beck, McKeown, & Kucan, 2002; Bellis, 2003; Blachowicz & Fisher, 2000; Carlisle, 2004; Cunningham & Stanovich, 1991; Davidson, Elcock, & Noyes, 1996; Geary & Brown, 1990; Glazer, 1989; Graves, Juel, & Graves, 2004; Graves & Watts-Taffe, 2002; Greanleaf & Wells-Papanek, 2005; Gunn, Simmons, & Kame'enui, 1995; Hardiman, 2003; Hart & Risley, 2003; Hayes, Hynd, & Wisenbaker, 1986; Herman, Anderson, Pearson, & Nagy, 1987; Johnson & Pearson, 1984; Klauer, Willmes, & Phye, 2002; Kroesbergen & Van Luit, 2003; Manning & Payne, 1996; Marzano, Pickering, & Pollock, 2001; Meichenbaum,

Table 31.7 ■ Example instructional interventions related to the WJ III COG and DS tests

Test	Example instructional interventions
1: Verbal Comprehension	Creating a vocabulary-rich learning environment (Hart & Risley, 2003; Gunn, Simmons, Kame'enui, 1995), reading aloud to a young child (Adams, 1990), discussing new words and associating key words to prior knowledge; (Graves & Watts-Taffe, 2002; Nagy & Scott, 2000; Anderson & Nagy, 1992); text talks (Beck & McKeown, 2001); directed vocabulary thinking activities and explicit teaching of specific words (Carlisle, 2004; Graves, Juel, & Graves, 2004; Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003; Baumann, Kame'enui, & Ash, 2003; Hart & Risley, 2003; Beck, McKeown, & Kucan, 2002; Blachowicz & Fisher, 2000; Graves, 2000; National Reading Panel, 2000; Gunn et al., 1995; Anglin, 1993), semantic feature analysis (Pittelman, Heimlich, Berglund, & French, 1991; Anders & Bos, 1986); semantic maps (Sinatra, Berg, & Dunn, 1985; Johnson & Pearson, 1984); use of computer technology to develop word knowledge (Davidson, Elcock, & Noyes, 1996); reading for a variety of purposes (National Reading Panel, 2000; Stahl, 1999; Anderson, 1996; Cunningham & Stanovich, 1991; Herman, Anderson, Pearson, & Nagy, 1987)
2: Visual-Auditory Learning	Active, successful learning experiences (Marzano, Pickering, & Pollock, 2001) including activities that illustrate or visualize content (Greenleaf & Wells-Papanek, 2005); rehearsal and overlearning (Squire & Schacter, 2003); mnemonics (Wolfe, 2001)
3: Spatial Relations	Multi-sensory teaching techniques (Williams, Richman, & Yarbrough, 1992); private speech (Meichenbaum, 1977)
4: Sound Blending	Early exposure to language sounds (Strickland, 1991; Glazer, 1989); promoting phonological awareness (Adams, 1990); direct instruction in sound blending and practice blending sounds into words (National Reading Panel, 2000)
5: Concept Formation	Categorize using real objects (Quinn, 2004); develop skills in drawing conclusions (Klauer, Willmes, & Phye, 2002)
6: Visual Matching	Emphasize speediness and build cognitive speed via repetition, speed drills, use of technology (Tallal, Miller, Bedi, Byma, Wang, Nagarajan, Schreiner, Jenkins, & Merzenich, 1996); extended time, reducing the quantity of work required (breaking large assignments into two or more component assignments), eliminating or limiting copying activities, and increasing "wait" times after questions are asked as well as after responses are given (Geary & Brown, 1990; Hayes, Hynd, & Wisenbaker, 1986; Ofiesh, 2000; Shaywitz, 2003; Wolff, Michel, Ovrut, & Drake, 1990)
7: Numbers Reversed	Chunking strategies (Hardiman, 2003); rehearsal (Squire & Schacter, 2003)
8: Incomplete Words	Promote phonological awareness, including read aloud (Adams, 1990; Anderson, Hiebert, Scott, & Wilkinson, 1985)
9: Auditory Working Memory	Rehearsal and active learning (Squire & Schacter, 2003)
10: Visual-Auditory Learning–Delayed	Active, successful learning experiences (Marzano, Pickering, & Pollock, 2001); rehearsal and overlearning (Squire & Schacter, 2003; mnemonics (Wolfe, 2001)
11: General Information	Text talks (Beck & McKeown, 2001); semantic maps (Sinatra, Berg, & Dunn, 1985; Johnson & Pearson, 1984); see also interventions for Test 1: Verbal Comprehension
12: Retrieval Fluency	Oral elaboration (Wolf, Bowers, & Biddle, 2000; Wolfe, 2001)
13: Picture Recognition	Activities designed to discriminate/match visual features and recall visual informaton (Greenleaf & Wells-Papanek, 2005)
14: Auditory Attention	Reduce distracting noise (Bellis, 2003); modifications to listening environment, such as seating the student close to the primary channels of auditory information (Zentall, 1983)
15: Analysis-Synthesis	Deductive reasoning using concrete objects (Quinn, 2004); hands-on problem solving tasks (Klauer, Willmes, & Phye, 2002); metacognitive strategies (Manning & Payne, 1996; Pressley, 1990)
16: Decision Speed	Emphasize speediness and build cognitive speed via repetition (Tallal, Miller, Bedi, Byma, Wang, Nagarajan, Schreiner, Jenkins, & Merzenich, 1996)
17: Memory for Words	Rehearsal (Squire & Schacter, 2003)
18: Rapid Picture Naming	Increase fluency through self-competition (Tallal, Miller, Bedi, Byma, Wang, Nagarajan, Schreiner, Jenkins, & Merzenich, 1996)
19: Planning	Private speech (Meichenbaum, 1977)
20: Pair Cancellation	Emphasize speediness and build cognitive speed via repetition (Tallal, Miller, Bedi, Byma, Wang, Nagarajan, Schreiner, Jenkins, & Merzenich, 1996)
21: Memory for Names	Active, successful learning experiences (Marzano, Pickering, & Pollock, 2001) including activities that illustrate or visualize content (Greenleaf & Wells-Papanek, 2005); rehearsal and overlearning (Squire & Schacter, 2003); mnemonics (Wolfe, 2001)
22: Visual Closure	
23: Sound Patterns–Voice	Auditory training (Bellis, 2003); enhancements/modifications to listening environment (Zentall, 1983)
24: Number Series	Develop number sense (Griffin, 1998; Ginsburg, 1997); seriation (High Scope Educational Research Foundation, 2003); use of manipulatives (Butler, Miller, Crehan, Babbitt, & Pierce, 2003; Cass, Cates, Smith & Jackson, 2003; Siegler, 1988)
25: Number Matrices	Seriation; patterns; explicit instruction in number reasoning skills (Kroesbergen & Van Luit, 2003; High Scope Educational Research Foundation, 2003)

(Continued)

Table 31.7 ■ Example instructional interventions related to the WJ III COG and DS tests (*Continued*)

Test	Example instructional interventions
26: Cross Out	Emphasize speediness and build cognitive speed via repetition (Tallal, Miller, Bedi, Byma, Wang, Nagarajan, Schreiner, Jenkins, & Merzenich, 1996)
27: Memory for Sentences	Rehearsal (Squire & Schacter, 2003)
28: Block Rotation	Multi-sensory teaching techniques (Williams, Richman, & Yarbrough, 1992); private speech (Meichenbaum, 1977)
29: Sound Patterns–Music	Auditory training (Bellis, 2003); enhancements/modifications to listening environment (Zentall, 1983)
30: Memory for Names–Delayed	Mnemonics (Wolfe, 2001)
31: Bilingual Verbal Comprehension–English/Spanish	See Test 1: Verbal Comprehension

DS, *Woodcock-Johnson III Diagnostic Supplement to the Tests of Cognitive Abilities;* WJ III COG, *Woodcock-Johnson III Tests of Cognitive Abilities*.

1977; Nagy & Scott, 2000; Ofiesh, 2000; Pittelman et al., 1991; Pressley, 1990; Squire & Schacter, 2003; Stahl, 1999; Strickland, 1991; Tallal et al., 1996; Williams, Richman, & Yarbrough, 1992; Wolf, Bowers, & Biddle, 2000; Wolfe, 2001; Wolff et al., 1990; Zentall, 1983. These interventions, and their correspondence to performance on the WJ III COG and DS tests, are outlined in Table 31.7. The relationship of the WJ III COG and DS to educational interventions and accommodations provides additional evidence about the practical utility, or consequences, of test use.

SUMMARY

The WJ III COG (Woodcock, McGrew, & Mather, 2001, 2007a) and the DS (Woodcock, McGrew, Mather, et al., 2003, 2007) provide measures of 7 broad and 25 narrow cognitive abilities as defined by CHC theory. The WJ III NU (Woodcock, McGrew, Schrank, et al., 2001, 2007) was published in 2007. A complete Spanish version of the WJ III COG and DS are available.

Each of the 31 WJ III COG or DS tests measures one or more narrow, or specific, cognitive abilities; two or more tests combine to form a broad cognitive ability cluster. Identification of both narrow and broad cognitive ability levels from performance on the WJ III COG can provide practical implications for differential diagnosis and treatment planning. The individual's performance on each of the WJ III COG tests and clusters can be interpreted in terms of the individual's functional level, or proficiency, on the narrow or broad ability measured.

This chapter presents and discusses selected WJ III NU test scores that were obtained from a pool of 2,248 children and adolescents (up to age 19) with various types of disabilities. Disability classifications are on the basis of the *ICD-10: International Classification of Diseases and Related Health Problems* (World Health Organization, 1992). These data are useful for determining which WJ III COG and DS tests are sensitive indicators to neuropsychological disorders, including anxiety spectrum disorders, attention-deficit/hyperactivity disorder, autistic spectrum disorders, depressive spectrum disorders, head injury, language disorders, mental retardation, and mathematics, reading, and written language disorders.

The WJ III COG and DS tests meet professional standards of reliability and validity for their intended purposes (Cizek, 2003). Children and adolescents with neuropsychological impairments often have exceptional educational needs; consequently, the WJ III COG and DS tests have been linked to educational interventions and accommodations that address any cognitive limitations that are identified as part of a neuropsychological evaluation.

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