Chapter One

OVERVIEW

INTRODUCTION

Memory is a fundamental aspect of cognition, and characterization of memory functioning is an essential component of clinical and neuropsychological evaluation. A thorough assessment of the various aspects of memory is particularly important in individuals with known or suspected cognitive impairment. Many neurological and psychiatric disorders involve disruption or impairment of memory processes (e.g., dementia, traumatic brain injury). In normally aging older adults, decline in some aspects of memory functioning is common (Rockey, 1997; Smith & Rush, 2006). However, memory disorders are more prevalent in older adults, and complaints of memory decline are a frequent reason for referral in this population. Therefore, comprehensive evaluation of memory ability is needed to differentiate normally aging individuals from those experiencing more pathological memory loss.

The Wechsler Memory Scale–Fourth Edition (WMS-IV; Wechsler, 2009) is the most recent revision of one of the most popular memory assessment instruments (Rabin, Barr, & Burton, 2005). This book provides an easy-to-use reference for individuals learning the essentials of administration, scoring, and interpretation of the WMS-IV. It maintains the direct, systematic approach to presenting material that is characteristic of the *Essentials* series. In addition, administrative and interpretive guidelines are provided for those who administer complete or partial WMS-IV batteries and want to integrate the results with other tests, such as the Wechsler Adult Intelligence Scale–Fourth Edition (WAIS-IV; Wechsler, 2008) and Advanced Clinical Solutions for the WAIS-IV and WMS-IV (ACS; Pearson, 2009). Throughout this book, the latest research on the WMS-IV and on memory processes is provided to assist in applying results obtained with the WMS-IV.

Essentials of WMS-IV Assessment covers topics that emphasize the appropriate administration, scoring, interpretation, and application of the WMS-IV. Each chapter includes several "Rapid Reference," "Caution," or "Don't Forget" boxes to highlight important points for easy reference and clarification. At the end of

each chapter, a short "Test Yourself" quiz is provided to help readers solidify what they have read. The information in this book is provided to help clinicians understand the nuances of the WMS-IV and become proficient users.

HISTORY AND DEVELOPMENT

The concept of memory and the assessment of memory ability have been widely researched. Early approaches viewed memory as a global skill, with emphasis in assessment placed on the ability to recall information, with scores generally reflecting overall memory ability. As research progressed, memory was broken down into subcomponents; short-term and long-term memory emerged as key concepts along with right- and left-hemisphere lateralization theories of memory. More recent conceptualizations of memory suggest even more memory components, as well as describe the influence of other cognitive abilities on memory functioning. The evolution of the Wechsler Memory Scale reflects this changing view of memory. Current research and theories on memory, as well as research on previous editions of the Wechsler Memory Scale, were utilized in the conceptualization and development of the WMS-IV. Therefore, it is important to review the previous editions to place the WMS-IV in context. Previous editions include the original Wechsler Memory Scale (WMS; Wechsler, 1945), Russell's adaptations of the WMS (Russell, 1975, 1988), Wechsler Memory Scale–Revised (WMS-R; Wechsler, 1987), Wechsler Memory Scale–Third Edition (WMS-III; Wechsler, 1997b), and Wechsler Memory Scale–Third Edition Abbreviated (WMS-IIIA; Wechsler, 2002b). Each of the editions reflects the knowledge and theories of memory at the time of its development. This section provides a brief history of the content and standardization of the Wechsler Memory Scales, while later chapters provide a review of the literature related to memory and research completed with the Wechsler Memory Scales.

VARIOUS EDITIONS OF THE WECHSLER MEMORY SCALE

The Original Wechsler Memory Scale (1945)

The Wechsler Memory Scale (WMS) was a brief survey of immediate memory skills. WMS included seven subtests: Personal and Current Information, Orientation, Mental Control, Digits Forward and Backward, Logical Memory, Associate Learning, and Visual Reproduction. For each subtest, the examinee recalled information immediately; no delayed conditions were included. This immediate recall only approach allowed for a quick 15- to 30-minute administration. A single composite score, the Memory Quotient (MQ), was derived and converted to a standard score metric that could be directly compared to a Full Scale IQ derived on the Wechsler

Adult Intelligence Scale (WAIS; Wechsler, 1955). The MQ reflected the examinee's overall memory performance. Although information was collected in visual and verbal modalities, no index level scores or comparisons were provided. Two forms were developed, allowing for an alternate form at retest; however, norms were developed only for Form I, so most research utilized Form I (Mitrushina, Boone, Razani, & D'Elia, 2005). Norms were based on 200 patients, ages 25 to 50, at Bellevue Hospital in New York; norms for younger and older individuals were extrapolated from this patient sample. Despite its problems, the WMS was widely used in practice and research (Erickson & Scott, 1977; Russell, 1981) and translations were developed and normed in five countries (Mitrushina et al., 2005).

Russell's Wechsler Memory Scale (1975, 1988)

In an attempt to improve the utility of the WMS, Russell adapted and renormed the scale. He administered the Logical Memory and Visual Reproduction subtests with a recall condition immediately after presentation *and* after a 30-minute delay filled with interference activities. His scale allowed for left (verbal)/right (visual) hemisphere and immediate and delayed memory comparisons. Russell's version gained some popularity and was utilized in several research studies (e.g., Brinkman, Largen, Gerganoff, & Pomara, 1983; Chlopan, Hagen, & Russell, 1990). He titled his revision the WMS-R, the same name given the later revision by the publisher. Although Russell's WMS-R improved upon the content coverage of the WMS, problems were noted with the normative sample and psychometric properties of the scale (Crosson, Hughes, Roth, & Monkowski, 1984; Curry, Logue, & Butler, 1986; Haaland, Linn, Hunt, & Goodwin, 1983).

Wechsler Memory Scale–Revised (1987)

The first revision of the test by the publisher, the Wechsler Memory Scale–Revised (WMS-R), expanded the original normative sample down to age 16 and up to age 74, added measures of delayed recall, and introduced a new visual memory task, Visual Paired Associates. The assessment of attention and concentration was also expanded in the WMS-R with the inclusion of Spatial Span. Eight subtests were included in the WMS-R: Information and Orientation, Mental Control, Digit Span, Visual Memory Span, Logical Memory, Verbal Paired Associates, Visual Reproduction, and Visual Paired Associates. The subtest scores were combined to form five index standard scores: Verbal Memory, Visual Memory, General Memory, Attention/Concentration, and Delayed Recall. The General Memory Index was comprised of the immediate recall conditions of both the verbal and visual memory subtests.

The WMS-R was a significant improvement over the original WMS, particularly with its larger normative sample (N = 316). It provided nine normative age groups, although norms for three of the age groups were interpolated from adjacent sampled groups. The normative sample for the WMS-R was also more diverse, reflecting the 1980 census. In addition, extensive reliability and validity data were collected. Similar to Russell's revision, the WMS-R allowed for evaluation of different aspects of memory through the new index scores, which were scaled on the same metric and thus were directly comparable. Finally, scoring procedures were improved through the provision of detailed scoring criteria, increasing reliability across examiners.

Despite these improvements, several problems were observed including low subtest and index reliability, floor and ceiling effects on several index scores, lack of an integrated theoretical foundation, a small normative sample and interpolated norms for three age groups, and lack of consistent factor analytic support for the index structure. In addition, the new visual memory tasks required other cognitive abilities beyond visual memory; one measured attention along with visual memory and one contained visual stimuli that were easily verbalized, confounding the visual memory task with verbal memory. Finally, the WMS-R did not include recognition memory tasks.

Wechsler Memory Scale–Third Edition (1997)

The WMS-III was developed with guidance from an advisory board of prominent memory researchers and neuropsychologists to address many of the criticisms of the WMS-R. A large representative sample of the population was collected to update the norms, and the age range was expanded to include ages 16 to 89. Each of the 13 normative age groups was sampled so no norms required interpolation, although weighting was used to increase the standardization sample from 1,032 actual test cases to the 1,250 cases used for norming. The WMS-III was conormed with the Wechsler Adult Intelligence Scale–Third Edition (WAIS-III; Wechsler, 1997a) and the Wechsler Test of Adult Reading (Wechsler, 2001). This conorming enabled the derivation of comparative statistics across the instruments.

In terms of content, delayed recognition trials were added for some of the subtests to assess for encoding versus retrieval deficits, the working memory tasks were updated, additional comparative scores were developed, and two new visual memory tasks (Faces and Family Pictures) were introduced. Also, several process scores were developed to examine individual skills utilized in subtest performance. For example, a copy condition was added to the Visual Reproduction subtest to enable clinicians to rule out psychomotor problems as a cause of impaired performance. Finally, scoring procedures and reliability were improved, and an upgrade to the scoring software provided demographic adjustments for the norms.

The WMS-III consisted of 11 subtests, six primary subtests required to derive index scores (Logical Memory, Verbal Paired Associates, Letter–Number Sequencing, Spatial Span, Faces, and Family Pictures) and five optional subtests that expanded the content areas assessed (Information and Orientation, Mental Control, Digit Span, Word Lists, and Visual Reproduction). The six primary subtests required an average of 42 minutes to administer (Axelrod, 2001) and were used to derive eight primary index scores (Auditory Immediate, Visual Immediate, Immediate Memory, Auditory Delayed, Auditory Recognition Delayed, Visual Delayed, Working Memory, and General Memory) and four auditory process composites (Single-Trial Learning, Learning Slope, Retention, and Retrieval). The General Memory Index was comprised of the auditory and visual delayed recall tasks and auditory recognition tasks. If all 11 subtests were administered, administration time increased to 100 minutes (Lichtenberger, Kaufman, & Lai, 2002).

The WMS-III resolved many of the problems observed in the earlier versions. However, several limitations were noted including:

- Increased length of testing (particularly for older adults)
- Inclusion of many more subtests in the standardized version compared to the final published version leading to questions about the effect of fatigue on the normative data (Doss, Chelune, & Naugle, 2000; Zhu & Tulsky, 2000)
- Poor quality of materials (e.g., the Visual Reproduction response booklet was produced on thin paper that was easily seen through)
- Lack of factor analytic support for the proposed index structure, particularly for the visual memory index (Burton, Ryan, Axelrod, Schellenberger, & Richards, 2003; Millis, Malina, Bowers, & Ricker, 1999; Price, Tulsky, Millis, & Weiss, 2002; Wechsler, 2002a; Wilde et al., 2003)
- Shared content between the WMS-III and WAIS-III, which created confusion when interpreting the two Working Memory Indexes as they were comprised of overlapping as well as distinct subtests
- Inclusion of potentially undiagnosed predementia cases in the normative sample, which may have reduced sensitivity in older adults in comparison to other memory measures
- Lack of clinical sensitivity in some subtests, particularly Faces and Word Lists (Glassmire et al., 2003; McDowell, Bayless, Moser, Meyers, & Paulsen, 2004)
- Problems with subtest score ranges, floors, or ceilings (Flanagan, McGrew, & Ortiz, 2000; Holdnack & Delis, 2004)
- Examiner difficulty tracking responses accurately on Spatial Span

- Excessive time required to score Visual Reproduction (Lichtenberger et al., 2002)
- Confounding of the Visual Memory Index as Family Pictures was easily verbally encoded
- Influence of guessing on scores on Faces (Levy, 2006)
- Failure to provide subtest recognition scores for primary subtests, in addition to the combined Auditory Recognition Delayed Index
- Inclusion of recognition memory in the General Memory Index, which affected the distribution of scores and interpretation of this index
- Lower reliability of supplemental index scores
- Lack of supplemental index scores for the visual domain
- Inclusion of only delayed memory tasks in the General Memory Index and therefore not representing global memory functioning

Wechsler Memory Scale–Third Edition Abbreviated (2002)

The WMS-IIIA was introduced as a screener for memory functioning, allowing a quick estimate of memory ability. It included the Logical Memory and Family Pictures subtests from the WMS-III, allowing assessment of both auditory and visual modalities. To maintain the brevity of the instrument, no recognition tasks were included. It took approximately 15–20 minutes to administer, although a 25- to 35-minute delay was required between the immediate and delayed conditions. Three composite scores were available, Immediate Memory, Delayed Memory, and Total Memory, and age- and education-corrected norms were available. The Total Memory Index included both immediate and delayed recall. Although the screener greatly reduced testing time, the content was directly lifted from the WMS-III. Thus, several of the problems with the WMS-III discussed previously also apply to the WMS-IIIA.

OVERVIEW AND ORGANIZATION OF THE WMS-IV

The development of the WMS-IV incorporated reviews of the psychometric properties of each WMS-III subtest and index to evaluate cultural and gender bias, reliability and stability, score range and distribution for floor and ceiling problems, and clinical utility. In addition, the content was reviewed to ensure appropriateness, thoroughness, and usability. Moreover, customer service data and research on the WMS-III were reviewed, surveys of WMS-III users were conducted, and a panel of prominent researchers and experts on memory and assessment was formed to provide feedback on the user's experiences with the WMS-III and potential areas for improvement. Detailed information on the modifications and improvements to the content, psychometric properties, and clinical utility

are described in the *WMS-IV Technical and Interpretive Manual* (Wechsler, 2009). An overview of the changes is provided in Rapid Reference 1.1.

The WMS-IV includes seven subtests, utilized in two different batteries: Brief Cognitive Status Exam, Logical Memory, Verbal Paired Associates, Designs, Visual Reproduction, Spatial Addition, and Symbol Span (see Figure 1.1). The Adult

Rapid Reference 1.1

Modifications from the WMS-III to the WMS-IV

Introduced two separate batteries for adults and older adults.

Norms reflect standardized version because the final battery was the same as the standardization battery.

Administration time for each battery is shorter than administration time for the entire WMS-III; the Adult battery has a longer administration time than the WMS-III primary subtests.

No overlap between WMS-IV and WAIS-IV.

Index structure simplified with supplemental indexes moved to ACS; General Memory Index dropped; and recognition memory removed from Delayed Memory Index.

Increased sample size from 1,250 to 1,400.

Fully sampled each age group (100 cases collected per age group), no weighting as was used in WMS-III.

Each normative age band had a mean WAIS-IV General Ability Index (GAI) score of 100.

Sample screened for cognitive impairment and effort.

Improved internal validity.

Improved subtest range, floors and ceilings.

Reduced impact of guessing on subtest and index scores.

Working Memory in visual modality only.

Modified and developed visual memory subtests to more accurately measure visual memory; Visual Reproduction scoring reflects memory ability.

California Verbal Learning Test–Second Edition (CVLT-II) score substitution developed.

Dropped supplemental subtests and cross-modality subtests: Family Pictures, Faces, Information and Orientation, Spatial Span, Word List, Letter–Number Sequencing, and Mental Control dropped.

Introduced contrast scaled scores.

Figure 1.1 WMS-IV Structure, by Battery

Domain Measured	Adult Battery	Older Adult Battery
Cognitive Status	Brief Cognitive Status Exam	Brief Cognitive Status Exam
Auditory Memory	Logical Memory I and II	Logical Memory I and II
	Verbal Paired Associates I and II	Verbal Paired Associates I and II
Visual Memory	Designs I and II	Visual Reproduction I and II
	Visual Reproduction I and II	
Visual Working Memory	Spatial Addition	Symbol Span
	Symbol Span	

battery is comprised of all seven subtests and is administered to individuals ages 16–69. The Older Adult battery contains five subtests (Designs and Spatial Addition are not included) and is administered to individuals ages 65–90. For individuals ages 65–69, examiners may administer either battery, depending on the needs of the individual being assessed. In addition to the different subtest composition, the content of Logical Memory and Verbal Paired Associates differs between the two batteries. Rapid Reference 1.2 lists the differences between the Adult and Older Adult batteries.

Three subtests were retained with modifications from the WMS-III (Logical Memory, Visual Reproduction, and Verbal Paired Associates), and four new subtests were added (Brief Cognitive Status Exam, Designs, Symbol Span, and Spatial Addition). Logical Memory, Verbal Paired Associates, Designs, and Visual Reproduction

Rapid Reference 1.2

Differences Between Adult and Older Adult Battery

Adult Battery	Older Adult battery
7 subtests	5 subtests
5 indexes	4 indexes
14 items in VPA	10 items in VPA
Story B and C in Logical Memory	Story A and B in Logical Memory

have both immediate and delayed conditions. Delayed conditions are administered 20–30 minutes after the immediate condition and include optional recognition tasks. Seven WMS-III subtests were dropped from the WMS-IV: Word List, Faces, Family Pictures, Letter–Number Sequencing, Spatial Span, Mental Control, and Information and Orientation. Detailed information on the new and retained subtests and rationale for dropping subtests is provided in the *WMS-IV Administration and Scoring Manual* and the *WMS-IV Technical and Interpretive Manual*. Of the seven subtests, only the Brief Cognitive Status Exam (BCSE) is considered optional. All other subtests are primary and required to obtain the index level scores, although not all conditions within a subtest are required. Examiners may administer a subset of the subtests or subtest conditions if all the index scores are not required. Scaled scores are derived from the subtest raw scores and have a mean of 10 and a standard deviation of 3. Subtest and index abbreviations are used throughout the WMS-IV manuals and this book. Rapid Reference 1.3 lists the abbreviations used for the WMS-IV subtests and indexes.

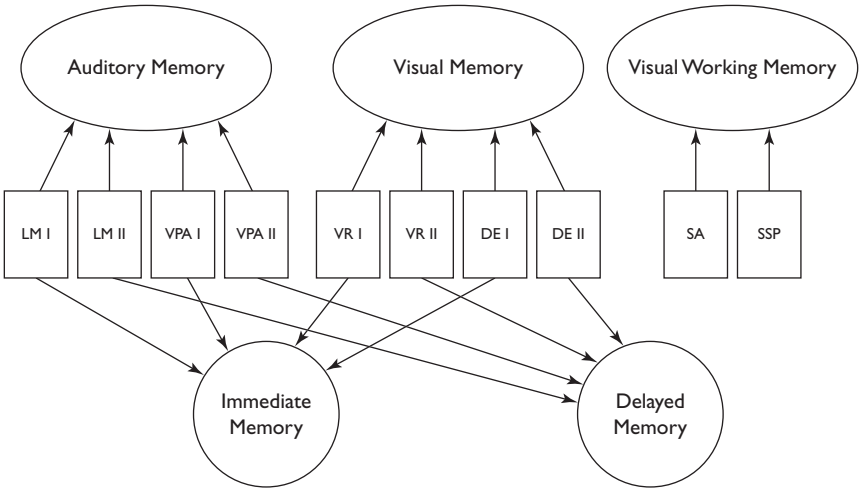
Five index scores can be obtained with the WMS-IV (Auditory Memory, Visual Memory, Visual Working Memory, Immediate Memory, and Delayed

Rapid Reference 1.3

WMS-IV Subtest and Index Abbreviations

Subtest/Index	Abbreviation
Brief Cognitive Status Exam	BCSE
Logical Memory	LM
Verbal Paired Associates	VPA
Designs	DE
Visual Reproduction	VR
Spatial Addition	SA
Symbol Span	SSP
Auditory Memory Index	AMI
Visual Memory Index	VMI
Visual Working Memory Index	VWMI
Immediate Memory Index	IMI
Delayed Memory Index	DMI

Figure 1.2 Organization of Subtests into Index Scores (Adult Battery)



Memory), each comprised of at least two conditions or subtests. Four index scores are available for the Older Adult battery; the Visual Working Memory Index is not available because Spatial Addition is not included in the Older Adult battery. Figures 1.2 and 1.3 depict the organization of the subtests into the index scores for the Adult and Older Adult batteries, respectively. Unlike the WMS-III, General Memory and Recognition Indexes are not derived in the WMS-IV, and Auditory Memory and Visual Memory are not divided into immediate and delayed index scores. The Working Memory Index of the WMS-III has been replaced by the Visual Working Memory Index and is comprised of two new subtests. Standard scores are derived for each of the five indexes, with a mean of 100 and a standard deviation of 15.

Scores from the CVLT-II (Delis, Kramer, Kaplan, & Ober, 2000) may be substituted for the VPA scores required for computing index scores. Both VPA and CVLT-II are list-learning tasks and measure auditory verbal memory. This substitution allows an alternative measure for individuals who have difficulty comprehending the pairing of unrelated words required for VPA. The substitution of CVLT-II reduces testing time across a battery of tests when both CVLT-II and WMS-IV are administered. Figure 1.4 illustrates the composition of the WMS-IV index scores when CVLT-II scores are substituted for VPA I (immediate) and II (delayed) scores.

Don't Forget

CVLT-II scores can be substituted for VPA scores in computing index scores, but the CVLT-II itself is not included in the WMS-IV kit.

Figure 1.3 Organization of Subtests into Index Scores (Older Adult Battery)

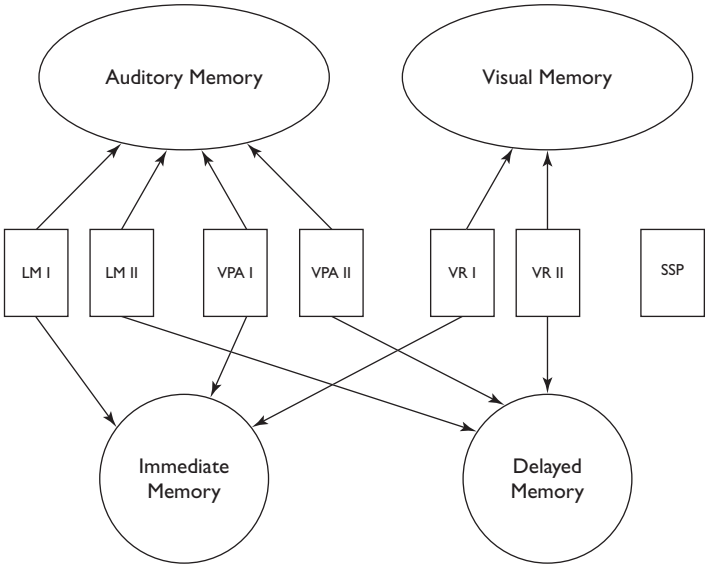


Figure 1.4 WMS-IV Index Structure with Substitution of CVLT-II for VPA, by Battery

	Adult Battery	Older Adult Battery
Auditory	Logical Memory I and II	Logical Memory I and II
	CVLT-II Trials 1–5 and Long Delay Free Recall	CVLT-II Trials 1–5 and Long Delay Free Recall
Visual	Designs I and II	Visual Reproduction I and II
	Visual Reproduction I and II	
Visual Working Memory	Spatial Addition	Symbol Span
	Symbol Span	(no index score available)
Immediate Memory	Logical Memory I	Logical Memory I
	CVLT-II Trials 1–5	CVLT-II Trials 1–5
	Designs I	Visual Reproduction I
	Visual Reproduction I	

(*continued*)

Figure 1.4 (Continued)

Delayed Memory	Logical Memory II	Logical Memory II
	CVLT-II Long Delay Free Recall	CVLT-II Long Delay Free Recall
	Designs II	Visual Reproduction II
	Visual Reproduction II	

Process scores provide additional information about WMS-IV performance and are provided as either scaled scores or cumulative percentages. Raw scores for all delayed recognition conditions and an optional copy condition for Visual Reproduction are converted to cumulative percentages presented in seven broad bands: ≤2, 3–9, 10–16, 17–25, 26–50, 51–75, and ≥75, reflecting the percentage of examinees in the standardization sample with the same or lower scores. Ranges are used in place of a specific cumulative percentage to account for measurement error in these scores. Separate content and spatial scores are provided for the Designs subtests and are converted to scaled scores. In addition, Word Recall, an optional free recall condition added to VPA, produces a scaled score.

Contrast scaled scores provide information about performance on one task adjusted for performance on another task. Similar to the manner in which demographic adjustments are derived for normative scores, one score is adjusted for performance on a separate score. For example, the Immediate Memory Index versus Delayed Memory Index Contrast Scaled Score adjusts the Delayed Memory Index for performance on immediate memory. The new score represents the examinee's performance on delayed memory in comparison to individuals of similar immediate memory ability. Contrast scaled scores are provided at the subtest and index level and are presented as scaled scores with a mean of 10 and a standard deviation of 3. Contrast scores are used to interpret scores in relation to similar ability peers; they do not replace subtest scaled scores and should not be substituted for subtest scores in reports or to compute index scores. Detailed information on the interpretation of contrast scaled scores is provided in Chapter Four.

Advanced Clinical Solutions (ACS) Additional WMS-IV Scores

Some of the scores available in the WMS-III were not used by the majority of users. Many of these scores were removed from the WMS-IV and included in the ACS to support ongoing research and clinicians who utilize the scores. This streamlined the WMS-IV for the general user. Additional process scores for the WMS-IV are provided in the ACS. The process scores in the WMS-IV and ACS describe the specific

cognitive skills utilized in memory functioning that are not evident in the subtest or index scores. The process approach to cognitive assessment, which requires quantifiable scores but emphasizes qualitative interpretation of performance (e.g., error analysis), was pioneered by Heinz Werner (1937) and popularized by Edith Kaplan (1988). The ACS scores do not require any additional administration beyond the normal administration of WMS-IV. However, they do require additional scoring. These scores are not required; they enhance the interpretation and application of WMS-IV results. See Figure 1.5 for a list of the additional scores. ACS scores are included in this book as they can be obtained without administration beyond the standard WMS–IV. The ACS scores are presented as subtest scaled scores, cumulative percentages, index standard scores, or contrast scaled scores.

Figure 1.5 Additional WMS-IV Scores in ACS

Additional Index Scores	Auditory Immediate Auditory Delayed Auditory Recognition Visual Immediate Visual Delayed Visual Recognition Designs Spatial Designs Content
Additional Subtest Scores	LM I Story A First Recall* LM I Story A Second Recall* LM I Story A* LM I Story B LM I Story C† LM II Story A* LM II Story B LM II Story C† LM II Cue Given LM II Story A Recognition* LM II Story B Recognition LM II Story C Recognition† VPA I Recall A VPA I Recall D VPA I Easy Items VPA I Hard Items VPA I Extra-List Intrusions VPA I Intra-List Intrusions VPA I Intrusions VPA II Easy Items VPA II Hard Items VPA II Extra-List Intrusions VPA II Intra-List Intrusions

(*continued*)

Figure 1.5 (Continued)

Additional Subtest Scores (continued)	VPA II Intrusions VPA II Recognition Easy Items VPA II Recognition Hard Items VPA II Recognition Hits VPA II Recognition False Positives VPA II Recognition Discriminability VPA II Word Recall Intrusions VPA II Word Recall Repetitions DE Rule Violation† VR I Average Completion Time VR I Additional Design Elements VR II Average Completion Time VR II Additional Design Elements
Additional Contrast Scaled Scores	Index-Level Auditory Immediate Index versus Auditory Delayed Index Auditory Recognition Index versus Auditory Delayed Index Visual Immediate Index versus Visual Delayed Index† Visual Recognition Index versus Visual Delayed Index† Designs Spatial Index versus Designs Content Index† Subtest-Level LM I Story A First Recall versus Story A Second Recall* LM Story A First Recall versus Story A Delayed Recall* LM Story B Immediate Recall versus Delayed Recall LM Story C Immediate Recall versus Delayed Recall† VPA I Recall A versus Recall D VPA I Easy Items versus Hard Items VR I Average Completion Time versus Immediate Recall VR II Average Completion Time versus Delayed Recall

*Score is available for ages 65–90 only. †Score is available for ages 16–69 only.

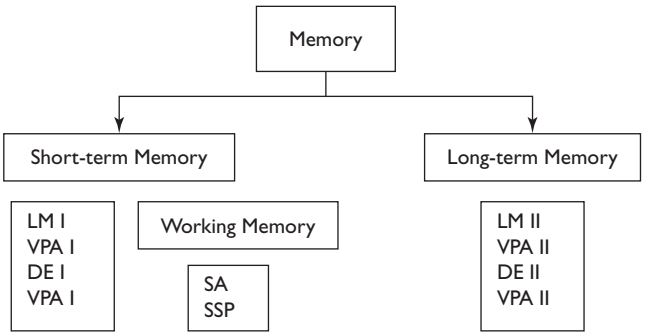
THEORETICAL AND RESEARCH FOUNDATION

The evolution of the WMS reflects the growing research on and theories of learning and memory, concepts that are closely intertwined. *Learning* is the process

through which new information is acquired, and *memory* is the persistence of learning so that it can be recalled at a later time (Squire, 1987). Learning and memory are frequently discussed in terms of encoding, storage or consolidation, and retrieval. *Encoding* is the transformation of external information into mental representations or memories. It represents the concept of *how* information is taken in to the memory system. *Consolidation* is the process through which information in immediate memory is solidified into long-term memory stores, and bringing this information from storage into conscious awareness is *retrieval*.

Many theories of memory divide the construct into short-term memory and long-term memory (e.g., Atkinson & Shiffrin, 1968). *Short-term memory* refers to brief, temporary storage of information, lasting from a few seconds to a few minutes. Permanent or long-lasting memories, from hours to years, are considered *long-term memory*. The WMS-IV measures both short- and long-term memory with the immediate and delayed conditions of LM, VPA, DE, and VR, respectively. More recent theories incorporate *working memory* into the concept of short-term memory. Working memory is a limited capacity system in which information is temporarily stored and manipulated. In the model proposed by Baddeley and Hitch (1974) and revised by Baddeley (2000, 2003), the working memory system is comprised of the *central executive*, a supervisory system that regulates two information activation/storage systems, the *phonological loop* and the *visuospatial sketchpad*. The phonological loop processes and temporarily stores auditory information while the visuospatial sketchpad does the same with visual information. Figure 1.6 ties the memory processes described to the measures included in the WMS-IV. In addition, the *episodic buffer*, regulated by the central executive, shuttles information into long-term memory and holds interrelated information in working memory. The central executive regulates the working memory system through controlling the flow

Figure 1.6 Memory Processes Measured in the WMS-IV



of information and the attention system, and engaging long-term memory as needed. It facilitates learning and other complex cognitive tasks by coordinating cognitive processes.

Long-term memory is often categorized as *implicit* (procedural) or *explicit* (declarative) memory. *Implicit* or procedural memory involves learning from experiences without the conscious awareness of learning, such as riding a bike or driving a car. *Explicit* or declarative memory is the conscious storage and retrieval of information, such as personal knowledge. Explicit memory is further divided into *semantic* and *episodic* memory. *Semantic memory* is the memory for facts and concepts, and *episodic memory* involves recollection of personal events and the contexts in which they occur. The WMS-IV is primarily a measure of declarative episodic memory as the "information presented is novel and contextually bound by the testing situation and requires the examinee to learn and retrieve information" (Wechsler, 2009, p. 2).

Brain Basis for Memory

A thorough examination of the literature on memory and neuroanatomy is beyond the scope of this book. This section provides a broad overview of theories on the brain and memory. For more comprehensive reviews, the reader is referred to other sources, such as Bauer (2008), Eichenbaum (2008), or Squire and Schacter (2002).

Multiple processes are involved in aspects of memory and must be intact for normal encoding, consolidation, and retrieval of information to be accomplished. Various injuries or disorders of the brain can affect different aspects of memory processes. In addition, problems with brain systems not directly associated with memory may also impact memory functioning. For example, attentional processes can impact normal memory functioning and should be considered when interpreting results. The brain systems that underlie episodic memory do not exclusively support episodic memory; they also activate during semantic and working memory tasks. The interdependence of abilities across systems and regions makes the specification of brain–memory relationships difficult.

A large volume of research has accumulated on the neuroanatomy of memory, implicating multiple regions and processes, particularly the structures within the medial temporal cortex. Memory circuitry in the brain involves the interaction of a number of brain regions; however, lesions in a specific region within the circuit may or may not produce complete amnesia. Dual systems hypotheses indicate

that parallel memory systems, one involving the hippocampus and the other the amygdala, are critical in understanding memory impairment (Bauer, 2008). Lesions involving both the hippocampus and the amygdala, or those involving both the perirhinal and parahippocampal gyri can produce a severe amnestic syndrome. Additional amnestic syndromes may occur in the presence of lesions including both antero- and dorsomedial thalamic nuclei or in lesions involving structures within the basal forebrain (Bauer, 2008). The observed memory impairments will vary, depending on which structures are damaged.

Encoding of novel information involves the medial temporal lobe, particularly the hippocampus, and midline diencephalon. Damage to the medial temporal lobe region, as exemplified by the case of H. M. (Scoville & Milner, 1957), results in the inability to form long-term memories or anterograde amnesia, although procedural memory and short-term memory remain intact. Neurologic conditions that produce amnesia affect the hippocampus, amygdala, and nearby areas (e.g., fornix, mamillary bodies of the hypothalamus, and/or medial thalamic nuclei) (Bauer, 2008; Cummings & Mega, 2003).

Information appears to be stored in the medial temporal lobe temporarily before being consolidated into long-term memory (Shimamura, 2002; Squire, Cohen, & Nadel, 1984). Research suggests longer term storage occurs in the posterior neocortex, although the hippocampus plays a role in the long-term storage of episodic memories (Nadel & Moscovitch, 1997; Shimamura & Wickens, 2009). The hippocampus interacts with cortical structures via circuits involving mamillary bodies, thalamic nuclei, and the posterior cingulate and also through projections from the perirhinal and parahippocampal cortex (Bauer, 2008). Interactions are observed during consolidation and retrieval of memory, reflecting involvement of the hippocampus and the neocortex (Kryukov, 2008; Takashima et al., 2009; Wang & Morris, 2010). The inferior parietal cortex and anterior prefrontal cortex are implicated in the retrieval process (Buckner, 2003).

The frontal lobes also influence memory, with impairments producing deficits in episodic memory due to poor screening of irrelevant information, poor encoding of information, failure to employ an appropriate strategy during learning, poor initiation of recall, and/or low productivity (Nyberg, 2008). Individuals with frontotemporal dementias frequently demonstrate retrieval deficits along with executive dysfunction (Cummings & Mega, 2003). When deeper processing of information is achieved during encoding or retrieval, the dorsolateral prefrontal cortex is activated. Imaging studies show the importance of the dorsolateral and ventrolateral prefrontal cortex during encoding and retrieval (Buckner &

Koutstaal, 1998; Ranganath & Blumenfeld, 2008). Damage to the dorsolateral prefrontal or medial frontal cortex can result in memory impairment. Finally, patients with damage to the basal ganglia also show memory impairments (Packard & Knowlton, 2002).

The utilization of working memory involves the complex interaction of multiple neurological systems. In general, the posterior brain regions seem to contribute storage functions to working memory, while rehearsal and executive functions are managed by prefrontal regions (Postle, Druzgal, & D'Esposito, 2003). Further, working memory appears to be processed in different regions depending on the type of memory involved. Spatial working memory, for example, activates the right prefrontal and parietal networks as well as the right dorsal stream of vision. Visual object working memory activates the left inferotemporal region and the left ventral stream of vision (Buchsbaum & D'Esposito, 2008).

STANDARDIZATION AND PSYCHOMETRIC PROPERTIES

The standardization sample for the WMS-IV was comprised of 1,400 individuals selected to form a representative sample of the U.S. population based on the 2005 U.S. Census data. It was stratified based on age, sex, race/ethnicity, education level, and geographic region. Sex was evenly sampled for ages 16–69 and representative of the population for ages 70–90. Fourteen normative age bands were created, each with a sample of 100 participants. Nine age bands were given the Adult battery and five were administered the Older Adult battery. Two groups were collected for individuals ages 65–69, one for each battery. The CVLT-II was completed by 380 individuals from the normative sample to allow for calculation of VPA I and II equivalent scaled scores.

Average split-half reliability coefficients for the index scores range from 0.93 for the VWMI to 0.96 for the VMI in the Adult battery and from 0.92 for DMI to 0.97 for VMI in the Older Adult battery. In a sample of 555 individuals diagnosed with a variety of clinical disorders, the average split-half reliability coefficients range from 0.93 for VWMI to 0.98 for VMI. Average subtest reliability coefficients for the normative samples range from 0.82 for LM I to 0.97 for VR II in the Adult battery and from 0.74 for VPA II to 0.96 for VR II in the Older Adult battery. In the clinical sample, the average split-half reliability coefficients range from 0.86 for LM I to 0.97 for VR II. Rapid Reference 1.4 provides the split-half reliability for all index and subtest scores in the normative sample. Sattler (2008) suggests that reliabilities should be above 0.80 for individual assessments. It is suggested that scores with reliabilities below this level be interpreted with caution, with greater care for those with reliabilities below 0.75.

Rapid Reference 1.4

Reliability and Stability Coefficients for Subtest and Index Scores

Average WMS-IV Index and Subtest Internal Consistency and Test–Retest Reliability Coefficients by Battery

	Adult Battery		Older Adult Battery	
	Average Reliability r_{xx}	Average Test–Retest r_{12}	Average Reliability r_{xx}	Average Test–Retest r_{12}
Index Scores				
Auditory Memory Index	0.95	0.81	0.95	0.82
Visual Memory Index	0.96	0.80	0.97	0.79
Visual Working Memory Index	0.93	0.82		
Immediate Memory Index	0.95	0.81	0.95	0.84
Delayed Memory Index	0.94	0.79	0.92	0.80
Subtest Scores				
Logical Memory I	0.82	0.72	0.86	0.77
Logical Memory II	0.85	0.67	0.87	0.71
Verbal Paired Associates I	0.94	0.76	0.93	0.76
Verbal Paired Associates II	0.85	0.76	0.74	0.77
Designs I	0.85	0.73		
Designs II	0.85	0.72		
Visual Reproduction I	0.93	0.62	0.93	0.79
Visual Reproduction II	0.97	0.59	0.96	0.64

(*continued*)

	Adult Battery		Older Adult Battery	
	Average Reliability r_{xx}	Average Test-Retest r_{12}	Average Reliability r_{xx}	Average Test-Retest r_{12}
Spatial Addition	0.91	0.74		
Symbol Span	0.88	0.72	0.84	0.69

Note. Average reliability coefficients were calculated with Fisher's z transformation.

The test–retest sample consisted of 244 individuals, 173 completed the Adult battery and 71 completed the Older Adult battery. Testings were an average of 23 days apart (range: 14–84). Memory and learning measures are particularly susceptible to practice effects that lower test–retest correlations (Strauss, Sherman, & Spreen, 2006) due to repeated exposure of the stimuli to be recalled. This is observed in the WMS-IV data. Test–retest reliabilities for all index and subtest scores are listed in Rapid Reference 1.4. Test–retest coefficients for the Adult battery ranged from 0.79 to 0.82 for the index standard scores and from 0.59 to 0.76 for the subtest scaled scores. For the Older Adult battery, test–retest coefficients ranged from 0.79 to 0.84 for the index standard scores and from 0.64 to 0.77 for the subtest scaled scores. The effect sizes ranged from 0.29 to 0.95 across the index scores and from 0.20 to 0.96 across the subtest scores, indicating small to large changes in performance across testing. The smallest changes were observed on the VWMI, while changes approaching 1 standard deviation were observed between testings on the AMI, IMI, and DMI. Given the high degree of change in these scores, it is suggested that WMS-IV memory subtests not be given a second time within a short time interval (e.g., 1–3 months). If a second administration is given within a short time frame, practice effects should be considered when interpreting differences between scores.

CAUTION

Memory and learning measures are particularly susceptible to practice effects, and changes approaching 1 standard deviation on some index scores may be observed if the WMS-IV is readministered after a short time interval (i.e., 1–3 months).

COMPREHENSIVE REFERENCES ON TEST

The most detailed and comprehensive information on the WMS-IV can be found in the *WMS-IV Administration and Scoring Manual* and *WMS-IV Technical and Interpretive Manual*. The *WMS-IV Administration and Scoring Manual* provides an overview of the test, descriptions of each subtest and score, and detailed information on subtest administration and scoring, calculating the index scores, and completing discrepancy analyses. Information on the theoretical underpinnings, development and standardization, reliability, validity, and interpretation is provided in the *WMS-IV Technical and Interpretive Manual*. Detailed information on the ACS Additional Scores can be found in the *ACS Administration and Scoring Manual* and the *ACS Clinical and Interpretive Manual*. In addition, the ACS manuals provide an overview of the use of demographic adjustments to WMS-IV norms, and information on premorbid memory prediction, effort assessment, and serial assessment with WMS-IV.

Tulsky et al. (2003) provide a thorough review of the Wechsler Memory Scales, the application and clinical use of the WMS–III, and related research in *Clinical Interpretation of the WAIS-III and WMS-III*. A chapter by Holdnack and Drozdick in *WAIS-IV Clinical Use and Interpretation: Scientist–Practitioner Perspectives* (Weiss, Saklofske, Coalson, & Raiford, 2010) is devoted to the use of the WMS-IV with WAIS-IV. Groth-Marnat (2009) devotes a chapter in *Handbook of Psychological Assessment–Fifth Edition* to the Wechsler Memory Scales, with a detailed overview of the WMS-IV and its clinical use. It is expected that more research on the WMS-IV will become available as the revision is more widely used. Rapid Reference 1.5 provides basic reference and publication information on the WMS-IV.

Rapid Reference 1.5

Publication Data for WMS-IV

Author: David Wechsler

Publication Date: 2009

What Test Measures: Auditory and Visual Memory, Visual Working Memory, Immediate and Delayed Memory, Cognitive Status

Age Range: 16–90

Administration Time:

Adult Battery: 90 minutes for complete battery

Older Adult Battery: 45 minutes for complete battery

(*continued*)

Qualification of Examiners: Graduate- or professional-level training in psychological assessment

Publisher: Pearson

19500 Bulverde Road

San Antonio, TX 78259

Order Phone Number: 1-800-211-8378

www.PsychCorp.com

Price: Complete Kit (as of June 2010): $699.00

TEST YOURSELF

1. **One of the biggest changes from the WMS-III to the WMS-IV is the introduction of different batteries for examinees based on age. The Older Adult battery is shorter than the Adult battery to decrease administration time and to lower the floor in older adults. Which index is not included in the Older Adult battery?**
   (a) Visual Memory Index
   (b) Visual Working Memory Index
   (c) Immediate Memory Index
   (d) Delayed Memory Index
2. **The General Memory Index (GMI) of the WMS-III was a measure of global delayed memory. This was replaced with the Delayed Memory Index (DMI) in the WMS-IV. What is the main difference between the WMS-IV DMI and the GMI of the WMS-III?**
   (a) Recognition tests were included in the GMI but were not included in the DMI.
   (b) The DMI is comprised of auditory memory only, while the GMI included both auditory and visual memory.
   (c) The GMI was comprised of visual memory only, while the DMI includes both auditory and visual memory.
   (d) The DMI includes recognition memory, but the GMI included only delayed recall memory.

3. **A new capability in the WMS-IV involves the substitution of scores from the CVLT-II for two subtest scores. For which subtest scores can scores from the CVLT-II be substituted?**
   (a) Logical Memory I and II
   (b) Visual Reproduction I and II
   (c) Verbal Paired Associates I and II
   (d) Symbol Span and Spatial Addition
4. **Auditory Immediate Index, Auditory Delayed Index, and Auditory Recognition Index are all part of the:**
   (a) Advanced Clinical Solutions for the WAIS-IV and WMS-IV
   (b) Auditory Memory Index of the WMS-IV
   (c) General Memory Index of the WMS-III
   (d) Delayed Memory Index of the WMS-IV
5. **Contrast scaled scores adjust one score for performance on another score. When should contrast scaled scores be used?**
   (a) To substitute for an invalid subtest scaled score
   (b) To compute index scaled scores for individuals at the extremes of the distribution
   (c) To contrast scores obtained on one subtest with those obtained on another unrelated subtest
   (d) To assist in interpretation of performance in relation to similar ability peers
6. **The ACS additional scores can be obtained with a standard WMS-IV administration.**
   True/False
7. **The WMS-IV is a measure of:**
   (a) Global memory ability
   (b) Declarative episodic memory and visual working memory
   (c) Implicit memory and working memory
   (d) Visual working memory and auditory working memory
8. **Systems utilized in episodic memory encoding, storage, and retrieval are exclusive to those functions.**
   True/False

Answers: 1. b, 2. a, 3. c, 4. a, 5. d, 6. True, 7. b, 8. False