About Memory, Interpretation Guidelines, and Clues to Diagnosis

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Report Interpretation Guidelines

Memory is a recording in one's brain of an experience —be it an interesting conversation or piece of information, a "memorable scene," or notable event. Specific brain areas activate these memories when one attempts to recall them. The amount of time that lapses between the experience and the time when one wishes to recall that experience, determines which part of the brain is accessed.

Types of Memory

Working memory resides in the frontal lobe and lasts less than a minute. This form of memory is commonly referred to as your attention span or working memory and lasts up to one minute before being erased.

Short-term memory resides in the temporal lobe and lasts between a few minutes and a few weeks. An area on the inside (medial) part of the temporal lobe called the hippocampus activates the brain areas that represent the memory so that the individual may retrieve it. This form of memory is commonly known as short-term or episodic memory, and lasts from a few minutes to a few weeks before being erased.

Not all of one's moment-to-moment experiences activate hippocampal short-term memory. Only those experiences that are novel, interesting or those that one intended to remember will sufficiently stimulate nerve cells in working memory. Once stimulated, these cells send electrical impulses to the hippocampus to activate short-term memory and retrieve the experience.

Long-term memory can last a lifetime. We are not certain which brain area activates memories older than a few weeks, such as your first love or the name of a school you went to as a child.

Report Interpretation Guidelines

These guidelines are designed to help physicians, other healthcare professionals and researchers interpret the test results presented in the MCI Screen report; they are not intended to supplant the physician's necessary role in diagnosing medical problems.

Overall Impression

This is the primary result of the MCI Screen.

There are three possible outcomes—Impaired, Normal or Borderline.

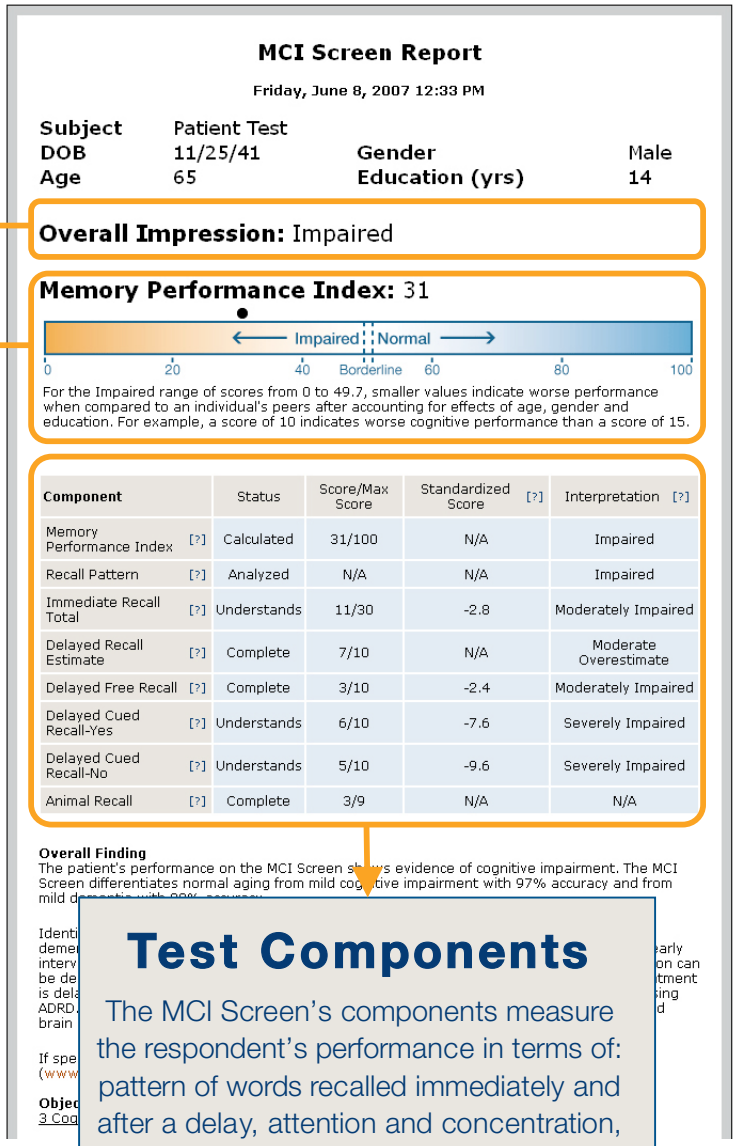
The Overall Impression may be "Impaired" even if most results in the column marked "Interpretation" are "Normal".

If the Overall Impression is "Normal" then the results in the column marked "Interpretation" are not shown.

The Overall Impression is 97.3%[1] accurate in distinguishing between mild cognitive impairment (MCI) and normal aging.

Memory Performance Index

The Memory Performance Index (MPI) is a quantitative measure of cognitive function.
The MPI scale ranges from 0 to 100.



MCI Screen Report

Friday, June 8, 2007 12:33 PM

Subject	Patient Test		
DOB	11/25/41	**Gender**	Male
Age	65	**Education (yrs)**	14

Overall Impression: Impaired

Memory Performance Index: 31

Impaired | Normal

0 20 40 Borderline 60 80 100

For the Impaired range of scores from 0 to 49.7, smaller values indicate worse performance when compared to an individual's peers after accounting for effects of age, gender and education. For example, a score of 10 indicates worse cognitive performance than a score of 15.

Component	Status	Score/Max Score	Standardized Score [?]	Interpretation [?]
Memory Performance Index [?]	Calculated	31/100	N/A	Impaired
Recall Pattern [?]	Analyzed	N/A	N/A	Impaired
Immediate Recall Total [?]	Understands	11/30	-2.8	Moderately Impaired
Delayed Recall Estimate [?]	Complete	7/10	N/A	Moderate Overestimate
Delayed Free Recall [?]	Complete	3/10	-2.4	Moderately Impaired
Delayed Cued Recall-Yes [?]	Understands	6/10	-7.6	Severely Impaired
Delayed Cued Recall-No [?]	Understands	5/10	-9.6	Severely Impaired
Animal Recall [?]	Complete	3/9	N/A	N/A

Overall Finding

Test Components

The MCI Screen's components measure the respondent's performance in terms of: pattern of words recalled immediately and after a delay, attention and concentration, judgment and reasoning, and short term memory. Each of the component test results is discussed in the following pages.

Report Interpretation Guidelines

Explanation of Test Components

The MCI Screen's components measure the respondent's performance in terms of: pattern of words recalled immediately and after a delay, attention and concentration, judgment and reasoning, and short term memory. Each of the component test results is discussed next.

Component	Status	Score/Max Score	Standardized Score	Interpretation
Memory Performance Index	Calculated	31/100	N/A	Impaired
Recall Pattern	Analyzed	N/A	N/A	Impaired
Immediate Recall Total	Understands	11/30	-2.8	Moderately Impaired
Delayed Recall Estimate	Complete	7/10	N/A	Moderate Overestimate
Delayed Free Recall	Complete	3/10	-2.4	Moderately Impaired
Delayed Cued Recall-Yes	Understands	6/10	-7.6	Severely Impaired
Delayed Cued Recall-No	Understands	5/10	-9.6	Severely Impaired
Animal Recall	Complete	3/9	N/A	N/A

1 **Status:** Reports whether or not the instructions were understood and/or whether or not the task was completed.

2 **Score/Max Score:** Reports the respondent's raw score for each task compared to the maximum score possible for that task.

3 **Standardized Score:** Indicates the number of standard deviations that the respondent's score deviated from the scores of their demographic peer group (their age, race, education and gender adjusted norm). In the above example of the 78-year old, white, male with 14 years of education, his Immediate Recall Total score was 1.2 standard deviations above the norm for his peer group. Standardized Scores are not meaningful for Recall Pattern, Delayed Recall Estimate and Animal Recall.

4 **Interpretation:** This is a qualitative interpretation of the respondent's performance based on the number of standard deviations between their performance and the mean performance for their demographic peer group. To avoid confusion, when the Overall Impression is "Normal", this column is not shown.

Report Interpretation Guidelines

Component	Status	Score/Max Score	Standardized Score	Interpretation
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Recall Pattern	Analyzed	N/A	N/A	Impaired
Immediate Recall Total	Understands	11/30	-2.8	Moderately Impaired
Delayed Recall Estimate	Complete	7/10	N/A	Moderate
Delayed Free Recall	Complete	3/10	-2.4	Moderately Impaired
Delayed Cued Recall-Yes	Understands	6/10	-7.6	Severely Impaired
Delayed Cued Recall-No	Understands	5/10	-9.6	Severely Impaired
Animal Recall	Complete	3/9	N/A	N/A

A

Memory Performance Index (MPI) The MPI scale ranges from 0 to 100. Approximately 1% of individuals tested will be classified as "Borderline" and will have scores that range from 49.7 and 50.3. For these individuals, their score cannot be clearly classified into a Normal or Impaired result. For the Normal range of scores ($50.3 \leq MPI \leq 100$), larger values indicate better performance when compared to an individual's peers after accounting for effects of age, gender and education. For example, a score of 93 indicates better cognitive performance than a score of 85. For the Impaired range of scores ($0 \leq MPI \leq 49.7$), smaller values indicate worse performance when compared to an individual's peers after accounting for effects of age, gender and education. For example, a score of 10 indicates worse cognitive performance than a score of 15.

B

Recall Pattern This is an analysis of the pattern of the specific words recalled during the three immediate and one delayed recall trials. The Recall Pattern is classified and analyzed by our proprietary algorithm and is the MCI Screen's most sensitive measure for distinguishing MCI from Normal Aging. The Recall pattern does not generate a numerical result so the "Score" and "Standardized Score" columns will always be "N/A".

C

Immediate Recall Total This is a test of working memory. The respondent is given three trials to learn a 10-word list. The score is the total number of words correctly recalled across the three learning trials (from 0 to 30). Impaired Immediate Recall performance usually indicates a disturbance of working memory, which is primarily controlled by the dorsolateral prefrontal cortex.

Measures: attention, concentration, working memory, information processing speed, comprehension

D

Delayed Recall Estimate This is a test of judgment. After the third immediate recall trial, the respondent is asked to estimate how many of the 10 words they will recall after a short delay. The Delayed Recall Estimate score is the respondent's estimate and must be compared to the actual number of words recalled in the Delayed Free Recall task to understand if there has been an over or under estimate. This provides insight into the respondent's judgment of their own short-term memory ability. Abnormal scores, if organic, indicate damage to the frontal or temporal lobes. A standardized score for the delayed recall estimate is not available.

Measures: judgment, awareness of memory loss, and information processing speed

Report Interpretation Guidelines

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Memory Performance Index	Calculated	31/100	N/A	Impaired
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Immediate Recall Total	Understands	11/30	-2.8	Moderately Impaired
Delayed Recall Estimate	Complete	7/10	N/A	Moderate Overestimate
Delayed Free Recall	Complete	3/10	-2.4	Moderately Impaired
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Animal Recall	Complete	3/9	N/A	N/A

E

Delayed Free Recall This is a test of short-term memory. The Delayed Free Recall score is the number of words recalled from the 10-word list after completing a brief interference task. Normal performance of this task requires intact function of both left and right entorhinal cortex and hippocampus and is influenced by the respondent's age, gender and education as well as by attentional factors measured during the three working memory trials.

Measures: short-term memory, false memory, and information processing speed

F

Delayed Cued Recall (Yes, No) This is a test of "aided" short term memory. After the Delayed Free Recall task, the respondent is read 20 words, one at a time, and asked to indicate which among them came from the list. The Delayed Cued Recall-Yes score is the number of words that are correctly recognized as coming from the list (from 0 to 10), while the Delayed Cued Recall-No score is the number of words correctly recognized as not coming from the list (from 0 to 10). Normal performance on these tasks requires intact entorhinal and hippocampal cortical function in the left medial temporal lobe only. Impaired performance of the Delayed Cued Recall-No part of the task may indicate a source memory problem, such as occurs in schizophrenics who cannot distinguish their hallucinations from reality.

Measures: short-term cued recall memory, source memory and information processing speed.

G

Animal Recall This is a test of short term memory. After the Delayed Cued Recall task, the respondent is asked to recall as many of the 9 animals that were used in the triadic comparisons interference task as they are able (from 0 to 9). Since they had not been asked to remember the animals when making the comparisons, the respondent is unlikely to experience the test anxiety that may occur when asked to learn the 10-word list. Furthermore, the act of comparing the animals in the earlier task more effectively encodes them into short-term memory than the Delayed Free Recall task. As such, the Animal Recall task can measure short-term memory capacity without confound from attentional or other non-short-term memory deficits. When the Animal Recall score is significantly higher than the Delayed Free Recall score (e.g., by 4 or more words) and Delayed Free Recall is in the impaired range, test anxiety may explain the impairment. Standardized score and interpretation for this component are not available, thus the N/A reference.

Measures: short-term memory, false memory, and information processing speed

Clues to Diagnosis

Using the MCI Screen to Assist with Differential Diagnosis

The pattern of impairment shown by the MCI Screen test results can assist in differentially diagnosing the patient's underlying cause of mild cognitive impairment or dementia.

The following patterns of MCI Screen impairment help narrow the differential diagnosis:

1) **Impaired Immediate Recall:** Disorders of the frontal lobe as well as systemic disorders that are not well controlled produce disturbances of attention, concentration and/or working memory. The primary disorders producing impaired immediate recall include cerebrovascular disease, psychiatric disorders, frontal-temporal lobe degenerative disease, Attention Deficit disorder, Parkinson's disease, Lewy body disease, and traumatic brain injury.
2) **Impaired Delayed Free Recall and Impaired Delayed Cued Recall—Yes/No:** This pattern is produced by bilateral hippocampal damage, which can be best seen with coronal views of a brain MRI, and most commonly occurs in disorders affecting the cerebral cortex. The primary disorders producing this pattern on the MCI Screen are Alzheimer's disease, frontal temporal lobe degenerative disease, traumatic brain injury involving loss of consciousness for days or longer, and severe alcohol abuse (4 or more drinks daily for years).
3) **Impaired Delayed Free Recall with Relatively Preserved Delayed Cued Recall—Yes/No:** Scores of the Yes and No parts of Delayed Cued Recall that add up to 18—20 are considered "relatively preserved" during MCI to mild dementia (FAST stages 3 or 4), while corresponding scores of 17—20 are considered "relatively preserved" during moderate to severe dementia (FAST stages 5—7). The pattern of impaired delayed free recall and relatively preserved delayed cued recall usually indicates unilateral damage to the left hippocampus, which can be seen with coronal views of a brain MRI, and most commonly occurs in disorders that primarily damage sub-cortical structures. The primary disorders producing this pattern on the MCI Screen are cerebrovascular disease, Lewy body disease, Parkinson's disease, multiple sclerosis, Attention Deficit disorder, poorly controlled medical conditions (*e.g.,* diabetes, cardiovascular disease, lupus, estrogen or testosterone deficiency), cancer, chemotherapy or radiation therapy, poorly controlled psychiatric conditions (*e.g.,* depression, bipolar disorder, generalized anxiety disorder, obsessive-compulsive disorder, schizophrenia), and certain medications (*e.g.,* anticholinergics, some antibiotics, anticonvulsants, antipsychotics, sedatives and tranquilizers, beta blockers, memantine).
4) **High Delayed Recall Estimate:** High Delayed Recall Estimate scores (an overestimate) indicate overconfidence or unawareness of true short-term memory capacity, such as is seen with damage to the inferior frontal lobes. Such lack of awareness is a common feature of Alzheimer's disease by the time a patient becomes mildly demented, but is much less often seen in Lewy body disease, depression, and cerebrovascular disease.
5) **Low Delayed Recall Estimate:** Low Delayed Recall Estimate scores (underestimate) indicate lack of confidence in memory capacity or low self esteem, such as is seen with damage to the frontal and temporal lobes, particularly in the left hemisphere. Such low confidence—if organic—is a common feature of depression, generalized anxiety disorder, cerebrovascular disease, Parkinson's or Lewy body disease.

Reference

1. Shankle WR, Romney AK, Hara J, Fortier D, Dick MB, Chen JM, Chan T, Sun X. Methods to improve the detection of mild cognitive impairment. Proc Natl Acad Sci U S A 102: 4919-24, 2005.