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1. **COGNIGRAM™ RECOMMENDATIONS FOR CLINICAL USE**

COGNIGRAM™ is a computer-based system that provides a brief, standardized, sensitive assessment of cognitive function to assist physicians in the detection and monitoring of subtle cognitive change over time.\(^1\)\(^-\)\(^3\) COGNIGRAM™ has been validated to assess subtle cognitive impairment and monitor cognitive change associated with concussion or possible mild cognitive impairment (MCI)/dementia.\(^2\)\(^,\)\(^4\)

Cognitive assessments such as COGNIGRAM™ may be appropriate for patients with suspected dementia, presenting with signs and symptoms of cognitive impairment and/or where patients or caregivers are raising concerns.

COGNIGRAM™ may also be appropriate for patients at least 10 years of age presenting with signs and symptoms of cognitive impairment following concussion. In order to assess and monitor cognitive change associated with concussion, it is preferable to proceed with a COGNIGRAM™ baseline assessment on an annual basis.

2. **LIMITATIONS OF COGNIGRAM™**

COGNIGRAM™ is not a medical device, and the results generated by COGNIGRAM™ are not intended to provide a medical diagnosis. COGNIGRAM™ is designed to provide a simple, sensitive, reliable measure of cognitive performance. COGNIGRAM™ could be used to assist physicians in measuring and assessing changes in cognitive function over time. Cognitive function can change for many reasons, including lack of sleep, substance abuse, neurodegenerative disease, and many other normal and abnormal conditions. COGNIGRAM™ is not designed to determine the cause of impairment or change in cognitive function and cannot be used solely to diagnose an injury or any other medical condition.

3. **COGNIGRAM™ DESIGN AND ASSESSMENT**

COGNIGRAM™ utilizes the CogState Brief Battery, a cognitive assessment that has been tested in numerous clinical groups to address the question of whether or not there has been change or impairment in cognitive function over both short (minutes) and long intervals of time (weeks, months).\(^3\)

**Cognitive Domains Assessed by COGNIGRAM™**

Using the 4 tasks from the CogState Brief Battery, COGNIGRAM™ was scientifically developed to broadly assess change using simple visual stimuli in 4 critical cognitive domains:\(^2\):

i. Psychomotor function

ii. Attention

iii. Learning and memory

iv. Working memory
Data on the CogState Brief Battery have been published in several international peer-reviewed journals. Clinical trials and research studies have demonstrated the suitable construct validity of these tests in measuring their assigned cognitive domains by showing that each task has a high correlation with conventional neuropsychological test measures of the same cognitive domain.\(^3\) The 4 tasks included in COGNIGRAM™ were selected because many neuropsychiatric disorders and neurological illnesses are characterized by impairment in 1 or more of the 4 cognitive domains assessed by COGNIGRAM™, measurement of these functions can provide the broadest opportunity for the detection of cognitive impairment or monitoring of cognitive change, irrespective of cause. Also, the four tasks together require approximately 8 to 10 minutes for administration, utilize very simple stimuli, and require simple decisions in response to simple rules.

Four COGNIGRAM™ Tasks

The 4 COGNIGRAM™ tasks are the Detection, Identification, One-Card Learning and One-Back tasks.\(^2\)

The Detection task is a simple reaction time assessment of general psychomotor function. During this task the participant must focus on a playing card shown in the center of the computer screen and respond to the question “Has the card turned over?” The participant is instructed to simply press the “Yes” button as soon as the card turns face up. The face of the card is always the same generic joker. The task ends after 35 correct responses. Trials during which anticipatory responses occur are excluded and another trial is then begun so that all participants complete the 35 trials. The performance measure for this task is reaction time in milliseconds (speed).
The **Identification task** is a choice reaction time task measuring visual attention. During this task the participant must pay attention to the card in the center of the computer screen and respond to the question “Is the card red?” The participant is then required to press the “Yes” button if the card is red or the “No” button if the card is black. The faces of the displayed cards are either red or black joker cards presented in the same numbers in a random order. These cards are distinct from the generic joker card used in the Detection task. The Identification task ends after 30 correct trials. Trials during which anticipatory responses occur are excluded and another trial is then begun so that all participants complete the 30 trials. Similar to the Detection task, the performance measure for this task is reaction time in milliseconds (speed).

The **One-Card Learning task** measures visual learning within a pattern separation model. The participant must pay attention to the card in the center of the screen and respond to the question “Have you seen this card before?” The participant is instructed to simply press the “Yes” button or the “No” button as appropriate. In this task normal playing cards are displayed without joker cards. Six cards are drawn at random from the deck and repeated throughout the task. These cards are interspersed with distractor, nonrepeating cards. The task ends after 80 trials, without rescheduling for postanticipatory correct trials. The primary performance measure for this task is the proportion of correct answers (accuracy).
The **One-Back task** is an assessment measure of working memory. The participant has to pay attention to the card in the center of the screen and respond to the question “Is this card the same as the previous card?” The participant is instructed to press the “Yes” or “No” button accordingly. The task ends after 30 correct trials. A correct but postanticipatory response leads to the scheduling of an extra trial. The primary performance measure for this task is the proportion of correct answers (accuracy).

**Patient Instructions**

i. Patients are instructed to respond as quickly and accurately as possible. At the beginning of each task, instructions are presented to the participant on the computer screen. It is recommended that a supervisor be present during the COGNIGRAM™ assessment to clarify instructions and/or address the patient’s unanswered questions.²

ii. The instructions are subsequently followed by an interactive demonstration in which patients practice the task. Once the practice trials are completed, the task begins.²

iii. On each trial of each task a single playing card stimulus is presented in the center of the computer screen.²

iv. At the presentation of each playing card stimulus patients are required to respond either “Yes” or “No” by pressing a “Yes” button, always placed on the right, or a “No” button, always placed on the left. These buttons are attached to the computer by means of a USB port. If no buttons are attached, patients can still undergo the assessment by pressing the “D” key for “No” and the “K” key for “Yes.”²
4. COGNIGRAM™ REPORT

COGNIGRAM™ provides an easy-to-interpret report, without the need for manual scoring. The administration of COGNIGRAM™ involves taking a measurement from a patient who can then be re-assessed periodically. On any single assessment a decision can be made as to whether the patient has cognitive function within the normal limits for their age. The purpose of the reassessments is to monitor cognitive change over time. Deterioration in performance can occur following concussion or in early dementia such as MCI or in Alzheimer’s disease. Any patients with scores deviating from normal variations can therefore be identified and oriented toward a full evaluation for diagnostic purposes.

The cognitive tasks utilized in COGNIGRAM™ have been validated in numerous clinical groups, including patients with MCI, dementia of the Alzheimer’s type, and concussion. While qualitative distinctions have not been assessed among groups with these disorders, mild or severe cognitive changes were detected by COGNIGRAM™ in clinical trials.

Assessment of Cognitive Impairment and Monitoring of Cognitive Change Associated With Possible MCI/Dementia

For assessment of cognitive impairment and monitoring of cognitive change associated with possible MCI/dementia, 2 composite scores are automatically derived from the 4 individual tasks included in COGNIGRAM™ (Figure 1):

i. **Psychomotor function/attention composite score**: Computed by averaging the standardized scores from the Detection and Identification tasks.

ii. **Learning/working memory composite score**: Computed by averaging the standardized scores for the One-Card Learning and One-Back tasks.

**Figure 1.**

For assessment of cognitive impairment and monitoring of cognitive change associated with possible MCI/dementia, 2 composite scores are automatically derived from the 4 individual tasks. MCI = mild cognitive impairment.
Baseline Performance: Comparison with Normal Range

A patient’s baseline performance is compared with age-matched normative data. The normative data sample was acquired from over 2500 healthy individuals in the following age categories (18-34, 35-49, 50-59, 60-69, 70-79, 80-89, and 90-99 years). The scores from the individual tasks are standardized against the normative data and combined to produce a domain score that is presented on a linear scale in 1 of 3 categories (Figure 2). The range of the standardized score is 0–200 (mean = 100, standard deviation [SD] = 10) (Figure 3).

Figure 2.
Baseline performance for each of the 2 composite scores falls into 1 of 3 categories: abnormal, borderline, or normal.5

i. Abnormal: A performance score of 0–80 is considered abnormal. Abnormal scores are more than 2 SDs below those expected of a patient in his or her age group.

ii. Normal: A performance score of greater than 90 is considered normal for someone in the patient’s age group. That is, the performance score is equal to or above the mean for that age group (score ≥100) or is below average but less than 1.5 SDs below the average score for that age group.

iii. Borderline: A performance score of 81–90 is considered to be on the borderline of normal. This score falls 1.5 SDs below the expected performance score for the patient’s age group.

Figure 3.
The normative data are established from over 2500 healthy individuals in the following age categories (18-34, 35-49, 50-59, 60-69, 70-79, 80-89, and 90-99 years). The range of the standardized score is 0–200 (mean = 100, SD = 10). SD = standard deviation.
Change in Performance: Comparison Over Time

When COGNIGRAM™ is administered more than once following baseline, the difference in the composite scores can be compared, as demonstrated in the example in Figure 4. Positive and negative scores are indicative of improvement and decline in performance from baseline, respectively.5

A patient’s performance change over time can be classified in 1 of 3 ways5:

i. **Improvement in performance relative to baseline assessment**: A magnitude of change in composite scores greater than 1 SD above the baseline assessment is classified as a cognitive improvement.

ii. **Stability in performance relative to baseline assessment**: Performance on 1 or more assessments is within 1 SD of the baseline score.

iii. **Decline in performance relative to baseline assessment**: A magnitude of change that is greater than 1 SD below baseline is classified as a cognitive decline.

**Figure 4.**

Example of a patient’s change in the 2 composite scores over time. At the second assessment in May 2013, the COGNIGRAM™ report indicated that the patient’s cognitive function had not significantly changed from baseline taken in December 2012.
Refer to Appendix A for an example of an official COGNIGRAM™ report used to assess cognitive impairment and monitor cognitive change associated with possible MCI/dementia.

5. RECOMMENDATIONS FOR PATIENT MANAGEMENT

Early recognition of dementia is imperative to ensuring optimal patient management and outcomes. According to the Third Canadian Consensus Guidelines on the Diagnosis and Treatment of Dementia, primary care physicians are uniquely positioned to detect early cognitive decline and can adequately assess and manage most patients with dementia. Further, it is recommended that primary care physicians be familiar with the criteria for MCI and learn an approach to diagnosing the condition.

It is important for physicians to determine objective evidence of cognitive decline and, if present, the degree of this decline. Cognitive testing is optimal for objectively assessing the degree of cognitive impairment in an individual. Cognitive assessments such as COGNIGRAM™ might be appropriate for patients presenting with signs and symptoms of cognitive impairment and/or where patients or caregivers are raising concerns. Normal composite scores are indicative of normal cognitive function relative to an age-matched control group; monitoring over time, as needed, is recommended to detect any potential cognitive change. Clinical trials have demonstrated that scores on cognitive tests for individuals with MCI are typically 1 to 1.5 SDs below the mean of the age-matched control group.
Examples of mean performance scores on the 4 COGNIGRAM™ tasks in healthy controls and patients who met clinical criteria for MCI or mild-to-moderate Alzheimer’s disease (AD) are indicated in Table 1.\(^2\) When compared with healthy controls, patients with MCI or AD exhibit a larger impairment on the One-Card Learning and One-Back tasks relative to the Detection and Identification tasks. The presence of relatively greater impairment in learning and working memory with relatively subtle impairment in motor and attentional function is consistent with neuropsychological models of AD.\(^2\)

### Table 1.

**Group mean (SD) performance scores on the 4 COGNIGRAM™ tasks in healthy controls and patients who met clinical criteria for MCI or mild-to-moderate AD\(^2\)**

<table>
<thead>
<tr>
<th></th>
<th>HC (n=659)</th>
<th>MCI (n=107)</th>
<th>AD (n=51)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>69.5 (6.6)</td>
<td>75.7 (7.5)</td>
<td>79.3 (7.2)</td>
</tr>
<tr>
<td>Detection speed</td>
<td>100 (10.0)</td>
<td>94.26 (13.7)</td>
<td>91.72 (13.5)</td>
</tr>
<tr>
<td>Identification speed</td>
<td>100 (10.0)</td>
<td>87.62 (16.4)</td>
<td>84.12 (15.4)</td>
</tr>
<tr>
<td>One-Card Learning accuracy(^a)</td>
<td>100 (10.0)</td>
<td>83.74 (11.6)</td>
<td>78.42 (15.1)</td>
</tr>
<tr>
<td>One-Back accuracy(^a)</td>
<td>100 (10.0)</td>
<td>79.18 (13.1)</td>
<td>70.14 (16.3)</td>
</tr>
</tbody>
</table>

\(^a\) The mean and SD of the controls was used to standardize the data for each individual’s performance on each cognitive task. Mean score = 100, SD = 10. SD = standard deviation; MCI = mild cognitive impairment; AD = Alzheimer’s disease; HC = healthy controls. Adapted from Maruff P et al. manuscript submitted. 2013.

Patterns of performance scores similar to those seen in clinical trials are not necessarily indicative of a diagnosis of MCI or AD. If a patient presents with persistent scores in the borderline or abnormal range or if scores are progressively declining with time relative to baseline assessment, it is recommended that they be closely monitored. Additional examinations (e.g., imaging, blood tests) are conducted prior to establishing a medical diagnosis.\(^9\) Reassessment of cognitive change using COGNIGRAM™ may be conducted at any time over days, weeks, or months following initial assessment.\(^3\)

Note that performance might vary between assessments. Changes between –1 and 1 SD are within the normal variation that can occur in patients over repeated assessments.\(^5\) However, it is recommended that patients demonstrating a trend of persistent decline in composite scores, even those that are within the range of normal variation, receive close attention and careful monitoring.
Assessment of Cognitive Impairment and Monitoring of Cognitive Change Associated With Concussion

As previously mentioned, COGNIGRAM™ has been validated in multiple clinical groups, including patients with concussion. The 4 COGNIGRAM™ tasks previously described and used in the assessment of cognitive impairment and monitoring of cognitive change associated with concussion, or possible MCI/dementia, are identical; however, the COGNIGRAM™ output report differs for concussion assessment. Details regarding the report output for COGNGIRAM™ and recommended patient management in concussion are included in the following section.

Baseline Performance: Comparison with Normal Range

For assessment of cognitive impairment and monitoring of cognitive change associated with concussion, 4 individual scores are derived from the 4 specific COGNIGRAM™ tasks described previously (Figure 5)\(^{12}\):

i. Psychomotor function

ii. Attention

iii. Learning

iv. Working memory

Figure 5.

For assessment of cognitive impairment and monitoring of cognitive change associated with concussion, 4 individual scores are automatically derived from the 4 COGNIGRAM™ tasks.\(^{12}\)
A patient’s performance is compared with age-matched normative data. The normative data sample was acquired from over 52,000 adolescents 10 to 21 years of age and adults in the following age categories (22-34, 35-49, 50-59, 60-69, 70-79, 80-89 and 90-99 years). The 4 scores from each of the individual tasks are standardized against the normative data and used to produce a domain score that is presented on a linear scale in 1 of 3 categories (Figure 6). The range of the standardized score is 0–200 (mean = 100, SD = 10) (Figure 7).

**Figure 6.**
*Baseline performance for each of the 4 tasks falls into 1 of 3 categories: normal, borderline, or abnormal.*

i. **Abnormal:** A performance score of 0–80 is considered abnormal. Abnormal scores are more than 2 SDs below those expected of a patient in his or her age group.

ii. **Normal:** A performance score of 91-200 is considered normal for someone in the patient’s age group. That is, the performance score is equal to or above the mean for that age group (score ≥100) or is below average but less than 1 SD below the average score for that age group.

iii. **Borderline:** A performance score of 81–90 is considered to be on the borderline of normal performance. This score falls 1 SD or more below the expected performance score for the patient’s age group.

**Figure 7.**
The normative data sample was acquired from over 52,000 adolescents 10 to 21 years of age and adults in the following age categories 22-34, 35-49, 50-59, 60-69, 70-79, 80-89 and 90-99 years (mean = 100, SD = 10). SD = standard deviation.
Change in performance: comparison over time

Each individual score—psychomotor function, attention, learning and memory, and working memory—is compared with the most recent valid baseline, and a change in score is computed for the difference between the current performance score and the baseline performance score (Figure 8). Positive scores indicate that performance has improved from the baseline assessment, while negative scores indicate that performance has declined from baseline. In the example illustrated in Figure 8 the patient’s baseline was assessed on September 3, 2013. The patient subsequently suffered a concussion approximately 5–7 days prior to their second COGNIGRAM™ assessment on November 14, 2013. At this time they demonstrated a cognitive impairment relative to baseline on all 4 tasks. However, they returned to their baseline performance at the subsequent assessment on November 18, 2013 and, as a result, were approved to return to play (Figure 8).

A patient’s change in performance can be classified in 1 of 3 categories:

i. Improvement in performance relative to baseline assessment: The magnitude of change in a score must be greater than 1.65 SDs above the baseline assessment.

ii. Stability in performance relative to baseline assessment: Performance on 1 or more assessments is within 1.65 SDs of the baseline score.

iii. Decline in performance relative to baseline assessment: The magnitude of decline must be more than 1.65 SDs below the baseline assessment.
Figure 8.

Example of a patient’s change in the 4 scores over time following concussion. At the third assessment, the COGNIGRAM™ report indicated that the patient’s cognitive function has returned to the same status as it was at baseline. SD = standard deviation.

Refer to Appendix B for an example of an official COGNIGRAM™ report used to assess cognitive impairment and monitor cognitive change associated with concussion.

Recommendations for Patient Management

Computerized cognitive assessments such as COGNIGRAM™ have been shown to be of clinical value and provide significant information in concussion evaluations.\textsuperscript{14-17} To assess and monitor concussion with COGNIGRAM™, it is preferable to proceed with a COGNIGRAM™ baseline assessment on an annual or biennial basis.\textsuperscript{18} This is especially important with children and adolescents due to the cognitive maturation that occurs during that period.\textsuperscript{19} A COGNIGRAM™ baseline assessment allows for comparison of an individual’s own premorbid scores with his or her post-injury assessment.
The majority (80%–90%) of concussion incidences resolve within a short period (7–10 days), although the recovery time might be longer for children and adolescents. In most cases, cognitive recovery largely overlaps with symptom resolution; however, it has been demonstrated that sole reliance on symptom assessments is unreliable in determining the persistence of impairment, as resolution of symptoms has been shown to precede cognitive recovery on computerized assessments such as COGNIGRAM™. Therefore, post-injury COGNIGRAM™ assessments are recommended after symptom resolution to allow for further evaluation and comparison with COGNIGRAM™ baseline scores. This approach will determine whether cognitive function has returned to the patient’s baseline score.

Assessment of cognitive function with neuropsychological tools like COGNIGRAM™ should be an important component in the overall management of concussion and, in particular, any return-to-play/return-to-school protocol. However, COGNIGRAM™ should not be the sole basis for management decisions as it is designed to aid the clinical decision-making process and be used in conjunction with a medical evaluation.

COGNIGRAM™ Task Completion and Accuracy/Speed Criteria for Assessment of Cognitive Impairment and Monitoring of Cognitive Change Associated With Concussion or Possible MCI/Dementia

To ensure high score reliability in each cognitive domain, tasks contributing to each cognitive domain need to satisfy predetermined task completion (Table 2) and accuracy/speed (Table 3) criteria based on the percentage of total trials completed and the percentage accuracy/speed for each task, respectively.

Task Completion Criteria

If a task fails the completion criteria, an outcome measure score cannot be calculated for that cognitive domain. If this occurs the data will not be shown in the graph indicating performance history.
Table 2.
COGNIGRAM™ task completion criteria for assessment of cognitive impairment and monitoring of cognitive change associated with MCI/dementia and concussion

<table>
<thead>
<tr>
<th>Task</th>
<th>Measure</th>
<th>Acceptable if</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET</td>
<td>Total trials presented</td>
<td>&gt;75% of 35</td>
</tr>
<tr>
<td>IDN</td>
<td>Total trials presented</td>
<td>&gt;75% of 30</td>
</tr>
<tr>
<td>OCL</td>
<td>Total trials presented</td>
<td>&gt;75% of 80</td>
</tr>
<tr>
<td>OBK</td>
<td>Total trials presented</td>
<td>&gt;75% of 31</td>
</tr>
<tr>
<td>DET, IDN, OCL, OBK</td>
<td>Total trials completed</td>
<td>No tasks were prematurely terminated by the user (as opposed to an error threshold being exceeded)</td>
</tr>
</tbody>
</table>

MCI = minor cognitive impairment; DET = Detection; IDN = Identification; OCL = One-Card Learning; OBK = One-Back.

Accuracy/Speed Criteria

For each task within a cognitive domain, an accuracy/speed criterion is applied. When a task is not performed at the expected level, the accuracy/speed criteria are compromised.

The accuracy/speed criteria for COGNIGRAM™ differ between MCI/dementia (Table 3) and concussion (Table 4) assessments.

Table 3.
Accuracy/speed criteria for COGNIGRAM™ assessment of cognitive impairment and monitoring of cognitive change associated with MCI/dementia

<table>
<thead>
<tr>
<th>Task</th>
<th>Measure</th>
<th>Acceptable if</th>
<th>Failure Invalidates</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET</td>
<td>Accuracy</td>
<td>&gt;80%</td>
<td>DET</td>
</tr>
<tr>
<td>IDN</td>
<td>Accuracy</td>
<td>&gt;80%</td>
<td>IDN</td>
</tr>
<tr>
<td>OCL</td>
<td>Accuracy</td>
<td>&gt;54%</td>
<td>OCL</td>
</tr>
<tr>
<td>OBK</td>
<td>Accuracy</td>
<td>&gt;53%</td>
<td>OBK</td>
</tr>
<tr>
<td>DET, IDN</td>
<td>Relative speed</td>
<td>DET faster than IDN</td>
<td>DET</td>
</tr>
</tbody>
</table>

MCI = minor cognitive impairment; DET = Detection; IDN = Identification; OCL = One-Card Learning; OBK = One-Back.
Table 4.

<table>
<thead>
<tr>
<th>Task</th>
<th>Measure</th>
<th>Acceptable if</th>
<th>Failure Invalidates</th>
</tr>
</thead>
<tbody>
<tr>
<td>DET</td>
<td>Accuracy</td>
<td>&gt;80%</td>
<td>DET</td>
</tr>
<tr>
<td>IDN</td>
<td>Accuracy</td>
<td>&gt;80%</td>
<td>IDN</td>
</tr>
<tr>
<td>OCL</td>
<td>Accuracy</td>
<td>&gt;53%</td>
<td>OCL</td>
</tr>
<tr>
<td>OBK</td>
<td>Accuracy</td>
<td>&gt;70%</td>
<td>OBK</td>
</tr>
<tr>
<td>DET, IDN</td>
<td>Relative speed</td>
<td>DET faster than IDN</td>
<td>DET</td>
</tr>
<tr>
<td>DET, OBK</td>
<td>Relative speed</td>
<td>DET faster than IDN</td>
<td>DET</td>
</tr>
</tbody>
</table>

DET = Detection; IDN = Identification; OCL = One-Card Learning; OBK = One-Back

In case of task completion or accuracy/speed criteria failure, a brief message indicating one or the other will appear in the “Results at a Glance” section of the COGNIGRAM™ output report for both concussion and MCI/dementia assessment.5,12

6. CLINICAL DATA

The CogState Brief Battery tests used in COGNIGRAM™ have been validated in multiple clinical groups across numerous clinical trials of concussion, MCI, and dementia of the Alzheimer’s type.

Features of COGNIGRAM™ validated in clinical trials include high sensitivity and specificity and test/retest reliability as well as resistance to practice effects, cultural and educational neutrality, and ability to track patient history over time.

Sensitivity and Specificity

The utility of COGNIGRAM™ in identifying the nature and magnitude of cognitive impairments was recently examined in a clinical trial of healthy controls (n=653) and adults who met clinical criteria for MCI (n=142) or AD (n=44). Differences in the 2 composite scores—learning/working memory and psychomotor function/attention—were examined among these 3 clinical groups. Sensitivity and specificity analyses were also conducted to determine optimal cutoff scores in these composite scores in identifying MCI- and AD-related cognitive impairment.2 For each composite score, Hedges’ g was used to quantify the magnitude of impairment in each of the 3 clinical groups relative to healthy controls. Results indicated that when compared with healthy controls, patients who met clinical criteria for MCI or AD exhibited a significantly larger impairment on the One-Card Learning and One-Back tasks relative to the Detection and Identification tasks (Figure 9A). Statistical analyses demonstrated significant group differences for the learning/working memory composite, F (2,769) =305.56, p<0.001, and the psychomotor
function/attention composite, $F(2,794) = 25.52, p< 0.001$. Post hoc analyses indicated that adults with MCI and AD demonstrated a significantly impaired learning/working memory composite score of large magnitude (Figure 9B). Patients with MCI and AD also exhibited a significantly impaired psychomotor function/attention composite score of moderate-to-large magnitude relative to healthy controls (Figure 9B).²

Figure 9.

(A) Mean performance scores (SD) on the 4 COGNIGRAM™ tasks in healthy controls and patients who met clinical criteria for MCI or mild-to-moderate AD. (B) Post hoc analyses of the magnitude of impairment on learning/working memory and psychomotor function/attention composite scores relative to healthy controls.² SD = standard deviation; MCI = mild cognitive impairment; AD = Alzheimer’s disease; HC = healthy controls.
In this clinical trial, receiver operating characteristic (ROC) curves were also generated to illustrate the relationship between clinical sensitivity and the specificity of each composite score for the classification of MCI and AD patients from control subjects, as measured by the area under the curve (AUC). For classification of cognitive impairment in MCI and AD, the value for each composite that provided the optimal balance between sensitivity and specificity was determined by the ROC curve using Youden’s J statistic. This collective analysis indicated excellent classification accuracy in both MCI and AD for the learning/working memory domain (Figure 10). Accuracy of classification of both MCI (Figure 10A) and AD (Figure 10B) was lower for the psychomotor function/attention domain (Table 5, Figure 10). Results further demonstrated that a cutoff score of 90 (i.e., a change of –1 SD) for the learning/working memory composite results in optimal sensitivity (100% vs 80.4%) and specificity (84.7% vs 84.7%) in classifying AD- and MCI-related cognitive impairment, respectively. As expected, the psychomotor function/attention composite demonstrated lower levels of sensitivity, with only 53% of AD cases identified in the presence of the least conservative score level (i.e., a score of 90) (Table 5, Figure 10).

### Table 5.

<table>
<thead>
<tr>
<th>Composite</th>
<th>Clinical Group</th>
<th>Sensitivity (95% CI) Score &lt;90</th>
<th>Specificity (95% CI) Score &lt;90</th>
<th>Area Under ROC Curve (95% CI)</th>
<th>Standard Error</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychomotor function/Attention</td>
<td>AD</td>
<td>52.9% (38.5%, 67.1%)</td>
<td>85.7% (82.8%, 88.3%)</td>
<td>0.73 (0.64, 0.82)</td>
<td>0.05</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>MCI</td>
<td>AD</td>
<td>41.1% (31.7%, 51.1%)</td>
<td>85.7% (82.8%, 88.3%)</td>
<td>0.67 (0.61, 0.73)</td>
<td>0.03</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Learning/Working memory</td>
<td>AD</td>
<td>100.0% (91.5%, 100.0%)</td>
<td>84.7% (81.7%, 87.4%)</td>
<td>0.99 (0.98, 1.00)</td>
<td>0.01</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>MCI</td>
<td>AD</td>
<td>80.4% (71.6%, 87.4%)</td>
<td>84.7% (81.7%, 87.4%)</td>
<td>0.91 (0.87, 0.94)</td>
<td>0.02</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

MCI = mild cognitive impairment; AD = Alzheimer’s disease; ROC = receiver operating characteristic; CI = confidence interval.

Adapted from Maruff P et al. manuscript submitted. 2013.
Figure 10.

ROC curve for the psychomotor function/attention and learning/working memory composite score in the (A) MCI and (B) AD group relative to healthy controls. ROC = receiver operating characteristic; MCI = mild cognitive impairment; AD = Alzheimer’s disease; HC = healthy controls; AUC = area under the curve.

Adapted from Maruff P et al. manuscript submitted. 2013.
Clinical data have also indicated that COGNIGRAM™ tasks are sensitive to cognitive differences in healthy older adults who are genetically at risk for dementia. In 144 healthy older adults who had undergone apolipoprotein E4 (apoE Ɛ4) genotyping, measurement of cerebral amyloid beta (Aβ) with Pittsburgh Compound-B (PiB) neuroimaging, and assessment of cognitive functions in the Australian Imaging, Biomarkers, and Lifestyle Flagship Study of Ageing (AIBL), correlations were conducted to determine the magnitude of the relationship between cerebral Aβ and cognition in apoE Ɛ4 carriers (n=61) and noncarriers (n=83).²² Fisher’s Z was used to compare these correlations and Cohen’s q was used to determine the magnitude of difference between correlations. The CogState Brief Battery used in COGNIGRAM™ was one measure used to assess cognitive function in this study. Healthy older adults who were apoE Ɛ4 carriers, who exhibited a higher level of Aβ, demonstrated significant differences (p<0.001) on the One-Back task and the learning/working memory composite score at the 18-month assessment (Table 6).²²

### Table 6.

<table>
<thead>
<tr>
<th>Composite</th>
<th>Overall (n=144)</th>
<th>APOE Ɛ4 Carriers (n=61)</th>
<th>APOE Ɛ4 Noncarriers (n=83)</th>
<th>Fisher’s Z</th>
<th>Cohen’s q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection speed</td>
<td>-0.04 (-0.20, 0.12)</td>
<td>-0.11 (-0.32, 0.11)</td>
<td>0.04 (-0.21, 0.29)</td>
<td>-0.87</td>
<td>-0.15</td>
</tr>
<tr>
<td>Identification speed</td>
<td>0.08 (0.24, -0.08)</td>
<td>0.11 (-0.11, 0.32)</td>
<td>0.09 (-0.17, 0.33)</td>
<td>0.12</td>
<td>0.02</td>
</tr>
<tr>
<td>One-Back accuracy</td>
<td>-0.30 (-0.44, -0.14)</td>
<td>-0.37 (-0.54, -0.17)</td>
<td>-0.17 (-0.40, 0.09)</td>
<td>-1.26</td>
<td>0.22</td>
</tr>
<tr>
<td>One-Card learning accuracy</td>
<td>-0.13 (-0.29, 0.03)</td>
<td>-0.10 (-0.31, 0.12)</td>
<td>-0.06 (-0.31, 0.19)</td>
<td>-0.23</td>
<td>-0.04</td>
</tr>
<tr>
<td>Learning/Working memory composite</td>
<td>-0.29 (-0.43, -0.13)</td>
<td>-0.37 (-0.54, -0.17)</td>
<td>-0.13 (-0.37, 0.13)</td>
<td>-1.49</td>
<td>-0.26</td>
</tr>
<tr>
<td>Psychomotor function/Attention composite</td>
<td>0.02 (0.18, -0.14)</td>
<td>-0.01 (-0.23, 0.21)</td>
<td>0.08 (-0.18, 0.33)</td>
<td>-0.52</td>
<td>-0.09</td>
</tr>
</tbody>
</table>


Additional data from AIBL further supported COGNIGRAM™’s high sensitivity in the assessment of cognitive change in patients with MCI and AD (Figure 11).²³ These clinical data demonstrated that when compared with results in healthy controls (n=653), the performance on COGNIGRAM™ tasks was abnormal in adults clinically diagnosed with MCI (n=68) and AD (n=44). When compared to controls, performance impairments were greater in the AD group than in the MCI group (p<0.001), with the magnitude of impairment in working memory and visual learning exceeding that of psychomotor function and attention for both groups.
In patients with concussion, the high sensitivity of COGNIGRAM™ in detecting cognitive change has also been demonstrated. In a prospective study of 615 male Australian rules football players who completed baseline testing before the start of the season, the performance of symptomatic players (n=25) 11 days following a concussion declined on the Detection (simple reaction time) and Identification (choice reaction) tasks of COGNIGRAM™ relative to asymptomatic (n=36) and control groups (n=84) (Table 7). These findings are consistent with previous reports of impaired performance on computerized tests of simple and choice reaction times in the days following injury. However, the symptomatic group displayed no change at reassessment on the paper-and-pencil tests [Digit Symbol Substitution Test (DSST) and Trail Making Test (TMT)] on day 11 (Table 7). These results demonstrated that COGNIGRAM™ uses tasks that have an enhanced sensitivity to detect impaired psychomotor and attentional domains in symptomatic athletes following concussion, a sensitivity that was not observed with paper-and-pencil assessments.
### Table 7.

**Performance on tasks of COGNIGRAM™ in concussed and control athletes**

<table>
<thead>
<tr>
<th></th>
<th>Control Baseline</th>
<th>Follow up</th>
<th>z score</th>
<th>Asymptomatic Baseline</th>
<th>Follow up</th>
<th>z score</th>
<th>Indice z</th>
<th>Symptomatic Baseline</th>
<th>Follow up</th>
<th>z score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N&lt;sub&gt;0&lt;/sub&gt; of athletes</strong></td>
<td>84</td>
<td>84</td>
<td></td>
<td>86</td>
<td>86</td>
<td></td>
<td>86</td>
<td>25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Simple RT speed</td>
<td>2.41 (0.09)</td>
<td>2.42 (0.09)</td>
<td>-19.0</td>
<td>2.43 (0.07)</td>
<td>2.45 (0.06)</td>
<td>-30</td>
<td>2.41 (0.06)</td>
<td>2.46 (0.06)</td>
<td>-0.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Choice RT speed</td>
<td>2.92 (0.09)</td>
<td>2.94 (0.09)</td>
<td>-0.33</td>
<td>2.94 (0.10)</td>
<td>2.85 (0.06)</td>
<td>-0.07</td>
<td>2.63 (0.08)</td>
<td>2.67 (0.07)</td>
<td>-0.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>DSST</td>
<td>69.17 (11.23)</td>
<td>68.85 (11.37)</td>
<td>0.52&lt;sup&gt;b&lt;/sup&gt;</td>
<td>66.42 (12.34)</td>
<td>71.10 (12.03)</td>
<td>0.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>61.00 (6.10)</td>
<td>62.41 (0.15)</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Trail Making Test–part B</td>
<td>52.92 (16.34)</td>
<td>48.33 (15.26)</td>
<td>0.40&lt;sup&gt;b&lt;/sup&gt;</td>
<td>50.94 (19.55)</td>
<td>48.52 (14.51)</td>
<td>0.70&lt;sup&gt;b&lt;/sup&gt;</td>
<td>59.81 (12.71)</td>
<td>52.41 (15.02)</td>
<td>0.15</td>
<td></td>
</tr>
</tbody>
</table>

Z: change score calculated by dividing the group mean difference score by the within subjects standard deviation (WSD) of the control group.

<sup>a</sup>Significant deterioration in performance from baseline (p<0.01);  
<sup>b</sup>Significant improvement in performance from baseline (p<0.01).


### Test/Retest Reliability

The test/retest reliability and stability of COGNIGRAM™ was assessed in a subgroup of participants from AIBL who had consented to serial computerized cognitive assessments.<sup>2</sup> The average measure intraclass correlation coefficients (ICCs) were used to compute the test/retest reliability of the psychomotor function/attention and learning/working memory composites in patients with a clinical diagnosis of MCI or AD, or healthy controls. The ICCs for both composites demonstrated high (r>0.70) test/retest reliability over a 4-month assessment period for all clinical groups. Estimates were also equivalent between the groups (Table 8).<sup>2</sup>

### Table 8.

**Test/retest reliability and group mean of each clinical group over a 4-month assessment period**

<table>
<thead>
<tr>
<th>Composite</th>
<th>ICC (95% CI)</th>
<th>P</th>
<th>Month 1 Mean</th>
<th>SD</th>
<th>Month 2 Mean</th>
<th>SD</th>
<th>Month 3 Mean</th>
<th>SD</th>
<th>Month 4 Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychomotor function/Attention</td>
<td>0.90 (0.87, 0.93)</td>
<td>0.00</td>
<td>163.54</td>
<td>11.97</td>
<td>150.34</td>
<td>15.65</td>
<td>104.94</td>
<td>11.44</td>
<td>102.63</td>
<td>14.75</td>
</tr>
<tr>
<td>Learning/Working memory</td>
<td>0.95 (0.93, 0.96)</td>
<td>0.00</td>
<td>69.04</td>
<td>14.06</td>
<td>94.16</td>
<td>13.39</td>
<td>65.17</td>
<td>14.46</td>
<td>66.36</td>
<td>14.75</td>
</tr>
<tr>
<td><strong>HC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychomotor function/Attention</td>
<td>0.94 (0.92, 0.95)</td>
<td>0.00</td>
<td>160.00</td>
<td>8.85</td>
<td>101.44</td>
<td>5.08</td>
<td>100.64</td>
<td>5.15</td>
<td>98.73</td>
<td>7.29</td>
</tr>
<tr>
<td>Learning/Working memory</td>
<td>0.76 (0.70, 0.83)</td>
<td>0.00</td>
<td>59.92</td>
<td>8.09</td>
<td>100.73</td>
<td>8.37</td>
<td>100.61</td>
<td>8.86</td>
<td>104.57</td>
<td>7.39</td>
</tr>
<tr>
<td><strong>MCI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychomotor function/Attention</td>
<td>0.94 (0.90, 0.97)</td>
<td>0.00</td>
<td>164.51</td>
<td>11.73</td>
<td>105.34</td>
<td>11.56</td>
<td>100.15</td>
<td>12.53</td>
<td>104.58</td>
<td>11.33</td>
</tr>
<tr>
<td>Learning/Working memory</td>
<td>0.86 (0.78, 0.93)</td>
<td>0.00</td>
<td>65.15</td>
<td>10.58</td>
<td>50.16</td>
<td>9.51</td>
<td>60.55</td>
<td>11.03</td>
<td>53.85</td>
<td>10.02</td>
</tr>
<tr>
<td><strong>AD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychomotor function/Attention</td>
<td>0.77 (0.68, 0.86)</td>
<td>0.00</td>
<td>113.24</td>
<td>14.63</td>
<td>111.04</td>
<td>28.53</td>
<td>113.44</td>
<td>19.86</td>
<td>111.95</td>
<td>14.65</td>
</tr>
<tr>
<td>Learning/Working memory</td>
<td>0.91 (0.84, 0.96)</td>
<td>0.00</td>
<td>73.40</td>
<td>12.07</td>
<td>73.95</td>
<td>12.26</td>
<td>75.10</td>
<td>13.11</td>
<td>75.76</td>
<td>12.46</td>
</tr>
</tbody>
</table>

ICC = intraclass correlation coefficient; SD = standard deviation; HC = healthy controls; MCI = mild cognitive impairment; AD = Alzheimer’s disease. Adapted from Maruff P et al. manuscript submitted. 2013.
A prospective serial investigation of cognitive function with the battery tests (CogSport) used in COGNIGRAM™ assessed the repeatability of the cognitive test among 60 young adults. Participants were tested serially at 1-hour and 1-week test/retest intervals. CogSport speed indices displayed a high to very high (0.69–0.90) ICC coefficient at these test/retest intervals, indicating that true variance in CogSport speed scores accounts for most of the variance between testing times. CogSport accuracy indices displayed lower and more variable (0.08–0.51) ICC coefficients, indicating that true variance in CogSport accuracy scores accounts for less of the variance between testing times (Table 9).7 The results also suggested that in healthy young adults measures of response speed are more reliable than measures of response accuracy. This may have occurred because the accuracy of athletes’ performance was close to optimum at both the baseline and repeat assessments.7 Taken together, these findings indicate that the Brief Battery tests used in COGNIGRAM™ are ideal for repeated assessment of cognition.

Table 9.

Test/retest ICC coefficients for CogSport performance measures administered to 60 healthy young individuals7a

<table>
<thead>
<tr>
<th></th>
<th>1 hour interval</th>
<th>1 week interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Psychomotor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>0.90</td>
<td>0.76</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.20</td>
<td>0.31</td>
</tr>
<tr>
<td><strong>Decision Making</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>0.69</td>
<td>0.69</td>
</tr>
<tr>
<td>Accuracy</td>
<td>-0.08</td>
<td>0.51</td>
</tr>
<tr>
<td><strong>Working Memory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>0.76</td>
<td>0.72</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.24</td>
<td>0.51</td>
</tr>
<tr>
<td><strong>Learning</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>0.83</td>
<td>0.82</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.45</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Note: Intra-class correlations are values between 0 and 1 with higher values indicating higher test-retest correlation.
7a The ICC is defined as the ratio of true variance in an observation (score) relative to the total variance in an observation (true variance and random error). ICC = intraclass correlation. Adapted from Collie A et al. Clin J Sport Med. 2003.
Resistance to Practice Effects

In multiple clinical trials of healthy adults, COGNIGRAM™ tasks have been shown to be resistant to practice effects, even when administered at very brief 1-month test/retest intervals.⁷,¹⁷ A clinical trial of 45 healthy individuals 18 to 40 years of age (group 1, mean age = 21.64±3.80 years), and 55 healthy participants (group 2, mean age = 32.69±9.62 years) was conducted to investigate whether the tasks used in COGNIGRAM™ when administered at brief test/retest intervals are resistant to practice effects in younger adults.⁷ Results from this clinical trial demonstrated that performance generally improved from the first to the second assessment on tasks used in COGNIGRAM™. As a result, a short practice session has been incorporated before each COGNIGRAM™ assessment. Following the second assessment, performance in both groups stabilized and did not further improve on any of the cognitive tasks. More importantly, the task performance did not worsen over the first 4 assessments, which would have occurred had the individuals become fatigued or lost motivation due to repeated assessments.⁷ No significant practice effects were observed, and the magnitude of change on all measures was small at 1-month test/retest intervals.

Cultural and Educational Neutrality with Minimal Language Requirements

COGNIGRAM™ utilizes non-verbal playing-card stimuli in order to minimize language, educational and cultural biases affecting performance.²⁸ A clinical trial of healthy male participants 18 to 55 years of age recruited from 2 different sites in Brussels (n=12) and Singapore (n=16) demonstrated no between-site differences in cognitive outcome on tasks utilized in COGNIGRAM™, despite qualitative differences in the language and culture of the participants. An additional serial assessment of cognition among 40 healthy Indigenous Australian adolescents (mean age =15.25 years) with poor English literacy from a wide range of communities and language groups, reported no practice effects and adequate retest reliabilities for both accuracy and speed on tests of psychomotor function, attention, and working memory.²⁹ Together, these findings suggest that the test stimuli and mode of administration aid in minimizing potential cultural biases.²⁸
Tracking Patient History for up to 36 Months Following Baseline

Additional analyses from AIBL have demonstrated COGNIGRAM™’s capability of tracking patient history over a long period of time. All healthy participants from AIBL underwent an extensive medical, psychiatric, and neuropsychological assessment upon enrollment. The same assessments were repeated 18 months later. In this study, the authors reported Pittsburgh Compound-B (PiB) neuroimaging and apoE Ɛ4 genotyping data obtained at baseline and neuropsychological data obtained at baseline and 18 months to examine the rate of cognitive change in relation to cerebral Aβ load and apoE Ɛ4 status.30 The magnitude of the difference in adjusted means between low and high standardized uptake value ratio (SUVR) groups and between apoE Ɛ4 carrier and noncarrier groups at the 18-month assessment was expressed for each task and composite score using Cohen’s d (Figure 12). Healthy older adults who were apoE Ɛ4 carriers demonstrated significantly diminished scores on the One-Card Learning task (Figure 12A).

Similarly, healthy older adults with a high amyloid load had significantly greater decline over 18 months in the One-Card Learning task, One-Back task, and the learning and working memory cognitive composite score (Figure 12B).

**Figure 12.** Magnitude of decline in baseline-adjusted performance between (A) healthy older adults who were apoE Ɛ4 carriers and noncarriers and (B) healthy older adults with high (≥1.5) or low (<1.5) SUVR for COGNIGRAM™ tasks and composite scores, from baseline to 18-month assessment.30 SUVR = standardized uptake value ratio; apoE Ɛ4 = apolipoprotein E4; DET = Detection; IDN = Identification; OCL = One-Card Learning; OBK = One-Back. Error bars represent 95% confidence intervals. *p<0.05.
Follow-up assessments from AIBL have demonstrated the capability of COGNIGRAM™ in the assessment of change in cognitive function in individuals with MCI and healthy individuals with varying degrees of Aβ load at even longer intervals of 36 months following initial assessment.\(^6\) The cognitive function of healthy older adults (n=177) and adults with MCI (n=48) from AIBL were included in this analysis. Patients underwent standard PiB positron emission tomography neuroimaging at baseline, 18 months, and 36 months to be examined for the rate of cognitive change in relation to Aβ load at the beginning of the study.\(^6\) A post hoc comparison of slopes over 36 months for each group indicated that, relative to the healthy control PiB-negative group, the healthy control PiB-positive group and the MCI PiB-positive group showed significantly greater rates of decline over 36 months on the learning/working memory composite score (Figure 13). The magnitude of difference in slopes relative to the healthy control PiB-negative group was moderate.
Figure 13.

Linear trend of performance on the learning/working memory composite (OCL-OBK) for HC PiB-positive (n=55), HC PiB-negative (n=122), MCI PiB-negative (n=16), and MCI PiB-positive (n=32) groups from baseline to 36 months. PiB- referred to those with low AB level and PiB+ those with high AB level. HC = healthy controls; MCI = mild cognitive impairment; PiB = Pittsburgh Compound-B; OCL = One-Card Learning; OBK = One-back.

Adapted from Lim et al. in press.

7. OTHER CLINICAL USES OF COGNIGRAM™

Data from several clinical trials worldwide have demonstrated that the CogState Brief Battery included in COGNIGRAM™ has suitable construct validity and is sensitive to detecting subtle cognitive impairment in additional clinical groups, including patients with mild traumatic brain injury (mTBI), schizophrenia, and AIDS dementia complex. Cognitive tasks from the CogState Brief Battery have demonstrated sensitivity to the facilitatory effects of cognitive enhancers and to the negative effects of sedative drugs in healthy participants. They have also been shown to be sensitive to cognitive changes in depression and attention deficit hyperactivity disorder.
8. PATIENT INFORMATION

☐ COGNIGRAM™ helps you and your physician track changes in cognition, such as your reaction time, attention, and memory. The results from COGNIGRAM™ can help your physician determine if you need follow-up visits to closely monitor changes in these functions or whether treatment or lifestyle changes are required.
☐ You may have to complete the COGNIGRAM™ enrollment form and sign the consent form prior to referral by your physician.
☐ This form can be faxed by your physician’s office to the assessment center or medical clinic.
☐ The assessment center will contact you to schedule an appointment for the test within 5 business days of the referral.
☐ Consider the following before you go to the assessment center or medical clinic:
  - If you need hearing devices or glasses, wear them or bring them with you.
  - Do not drink alcohol on the day of your appointment.
  - Tell your physician about your current medications, especially if any of them make you feel sleepy or groggy, as these medications may affect your performance on the assessment.
☐ When you arrive at the assessment center or medical clinic, inform the administrator if 1 or more of the following conditions is present:
  - You have trouble seeing or hearing, even with your glasses and/or hearing aid.
  - You have physical problems that may affect your ability to press the response buttons.
  - You are feeling unusually nervous or distracted.
☐ Once the assessment has been completed, the physician will receive your report by fax or secure-link e-mail.

9. SUMMARY

☐ COGNIGRAM™ provides a brief sensitive standardized assessment of cognitive function to assist physicians in the assessment of cognitive impairment and monitoring of cognitive change over time.
☐ The CogState Brief Battery used in COGNIGRAM™ has been validated in numerous trials and clinical groups, including patients with concussion, MCI, and dementia of the Alzheimer’s type.
☐ COGNIGRAM™ clinical data have demonstrated:
  - Its sensitivity and specificity.
  - Its capacity to track patient history over long periods of time.
  - Its resistance to practice effects and test/retest reliability.
  - Its cultural and educational neutrality.
☐ Data from several clinical trials worldwide have demonstrated that the CogState Brief Battery is sensitive to the detection of subtle cognitive impairment in additional clinical groups such as patients with mTBI, schizophrenia, and AIDS dementia complex.
10. APPENDIX

**Patient Information**
- **Patient Name:** Allison Smith
- **Date of Birth:** 01 Jan 1953
- **Gender:** Female
- **Referred By:** Dr. CogState Physician
- **Reason for Test:** Memory Concerns

**Test Information**
- **Test ID:** 000000079
- **Test Date:** 11 Jun 2013 @ 9:00 PM AST
- **Test Centre:** CogState Distributor
- **Supervisor Name:** Jamie Lanns

**Results at a Glance**
All cognition is within normal limits and has not changed from baseline.

**Attention and Psychomotor Function**
Attention and psychomotor function is a measure of the speed with which the individual can make simple reflexive decisions.

**Performance as of 11 Jun 2013 Compared to the Age-Based Normal Range (Mean = 100, SD = 10)**

- **Abnormal:** 0 to 39
- **Subnormal:** 40 to 69
- **Normal:** 70 to 100

**History - change in performance from baseline over time**
Learning and Working Memory Function

Learning and working memory function is a measure of the accuracy with which this individual can learn, use, and remember new information.

Performance as of 11 Jun 2013 compared to the Age-Based Normal Range (Mean = 100, SD = 10)

- Abnormal: 60 to 69
- Baseline: 70 to 79
- Normal: 80 and over

History - change in performance from baseline over time
11. REFERENCES

5. Data on File. COGNIGRAM™ Brief Interpretation Guide For Dementia.


