

The Computer Self Test (CST): A Computerized Internet Accessible Cognitive Screening Test for Dementia

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Abstract

Background: The CST is a recently developed interactive computerized instrument designed to assess functional cognitive domains impaired by Alzheimer's disease (AD); namely, orientation, visuospatial abilities, verbal fluency, memory, attention, and executive processing in approximately 10 minutes. The CST is accessible via the Internet and is easily self-administered with rudimentary computer skills. It can also be administered by a caregiver, family member or primary care physicians in the home or office settings. **Methods:** This study consisted of 101 total subjects (54 female; 47 male) with a mean age of 74.76, range 53 – 94, SD 8.20. The AD patients met all criteria set forth by NINCDS/ADRDA. All patients completed the CST prior to routine neurocognitive procedures. **Results:** There are significant differences between AD patients and controls in the mean total score for the CST and in the mean time of completion. The AD group shows deficits in memory, animal naming, orientation, and in clock-face construction. All patients identified as being demented on the MMSE were likewise identified on the CST. A more complete analysis comparing the MMSE and CST will be completed as larger numbers of cognitively impaired patients are examined. **Conclusions:** The data in this early CST study indicate that AD impacts verbal fluency, memory, orientation to day, month and year, as well as executive decisions necessary for correct completion of the clock construction task. These results suggest that the CST is sensitive to deficits in the numerous cognitive domains affected by AD. Early detection of combination deficits may provide primary care physicians, caregivers and the individual vital information for early diagnosis and intervention in AD. The CST and MMSE appear to detect cognitive deficits in an effective manner. The CST demonstrates the ability to effectively detect multiple cognitive deficits with a high degree of accuracy (93%) compared to MMSE (67%) in differentiating between Control, MCI and stages of AD.

Background

- As many as 5 million Americans are living with Alzheimer's Disease (AD) and by 2050, 10 million 'Baby Boomers' will develop AD.
- 60% of the patients with early indicators of AD may go undiagnosed in the primary care setting.
- Domain specific cognitive patterns (DSCP) offer promise in discriminating between Normal, MCI and stages of AD.
- Tracking several cognitive domains (DSCP) over time may prove superior to tracking a single specific domain alone (i.e. memory or attention).
- Unlike current dementia screening tests, the Computer Self Test (CST) is accessible via the internet and is easily self-administered with rudimentary computer skills. It can also be administered by a caregiver, family member or primary care physician in the home or office setting.
- This study is part of an ongoing research project.

Methods

- This study consisted of 101 total subjects (54 female; 47 male) with a mean age of 74.76, range 53 – 94, SD 8.20. We compared AD and Control (C) groups as well as diagnostic categories within the AD group; Mild Cognitive Impairment (MCI); Early AD; Mild to Moderate AD; Moderate to Severe AD.
- The AD patients met all criteria set forth by NINCDS/ADRDA. All subjects completed the CST prior to other routine neurocognitive measures; including, Mini Mental State Examination (MMSE), Test of Executive Functions (EF), Verbal Fluency (VF) and the Geriatric Depression Scale (GDS). Figures 1 through 3 show actual screens from the CST.
- For comparisons between groups we utilized the Kruskal-Wallis test. We employed Discriminant Analysis (DA) to determine the efficacy of the CST and MMSE in classification of the five experimental groups.
- The CST is scored on a scale of 30 possible points.



Figure 1: Clock Number Screen
Figure 2: Animal Naming Interface
Figure 3: Animal Naming and Memory for words interface

Table 1: Scoring scale and data range from this study for standardization. In the table from left to right are the group, the range, standard deviation, mean and 95% confidence intervals.

Group	Range	SD	Mean	95% CI
1- Normal	27.00 - 30.00	1.20	28.00	26.90 - 29.10
1-MCI	26.00 - 28.00	0.90	27.00	27.10 - 26.90
2-Early AD	20.00 - 25.00	0.92	23.00	24.40 - 21.60
3-Mild to Moderate	22.00 - 25.00	0.87	23.00	22.90 - 23.10
4-Moderate to Severe	19.00 - 22.00	0.90	19.50	17.40 - 21.60

Results

- Table 1 shows the scoring scale and data range from this study. In the table from left to right are the group, the range, standard deviation, mean and 95% confidence intervals.
- Figure 4 shows significant differences between AD and Control for all routine neurocognitive measures administered to patients presenting to the memory disorder clinic. Figure 5 shows the significant differences between AD and Control for domains within the CST. Figure 6 shows significant differences between AD and Control for domains within the MMSE.
- The total score for the CST correlates with the total score for the MMSE at significant levels $r(,668) **$.
- Figure 7 and 8 show the results of DA using the CST and MMSE for the same random sample. Figure 9 shows the results of DA for the CST for the entire sample. Fig 10 shows the plotted Chi-Square values for each diagnostic group compared to (C) illustrating the domain specific cognitive patterns (DSCP) for each group.
- Logistic regression procedures indicate both CST (97%) and MMSE (83%) detect cognitive deficits with significant accuracy; however, the CST classifies groups more accurately. The CST discriminates between Control, MCI and subtypes of AD with 93% accuracy while the MMSE shows only 67% accuracy in this respect.

* < .05, ** < .01

Results

Comparisons between AD and Control Groups

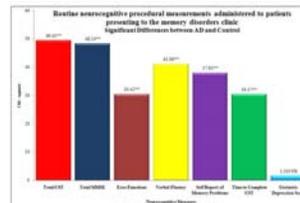


Fig 4: The AD group shows significant deficits in most routine neurocognitive measures except for the GDS. The AD group scores lower than controls on CST, MMSE, and tests of executive functions and verbal fluency. The AD group self-reports memory problems to a higher degree than controls and takes significantly more time to complete the CST.

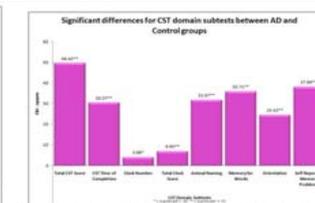


Fig 5: The AD group shows significant deficits in numerous cognitive domains as measured by CST including, verbal fluency, visuo-spatial construction, memory, generating speed, orientation, executive functions and the total score. The AD group self-reports memory problems significantly higher than controls.

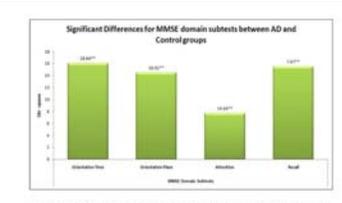


Fig 6: The AD group shows significant deficits in orientation to time and place, attention and recall. The listed domains show the only significant differences between groups.

Discriminant Analysis CST / MMSE

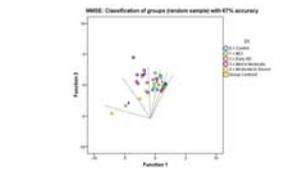


Figure 7: Results of discriminant analysis on random sample of 42 subjects (20 AD and 22 controls). The first two functions account for 90.4% of the variance with Eigenvalues of (3.399 and 0.123) and Wilks' Lambda (0.73, $p = .000$ and $0.14, p = .025$). The MMSE classifies 67% of the groups accurately.

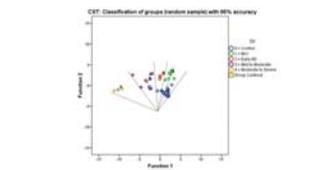


Figure 8: Results of discriminant analysis on random sample of 42 subjects (20 AD and 22 controls). The first two functions account for 91.4% of the variance with Eigenvalues of (3.109 and 0.385) and Wilks' Lambda (0.66, $p = .000$ and $0.16, p = .000$). The CST classifies 95% of the groups accurately.

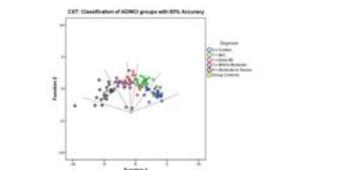


Fig 9: Results of Discriminant analysis for the entire sample for CST. The first two of four discriminant functions are shown. These functions account for 97.3% of the variance with Eigenvalues of (2.360 and 0.470) and Wilks' Lambda (0.48, $p = .000$ and $0.04, p = .002$). These functions accurately classify 93.1 percent of the groups.

Domain Specific Cognitive Patterns (DSCP)

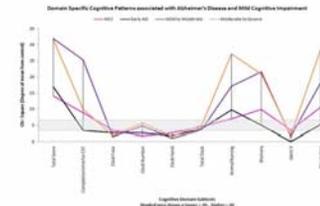


Fig 10: Results of comparison between stages of AD, MCI and controls for CST domain subtests. Plotting the degree of each groups' difference from the mean of the control group illustrates Domain Specific Cognitive Patterns associated with MCI and each stage of AD.

Conclusions

- The CST and MMSE both exhibit sensitivity to cognitive deficits. The CST appears more sensitive to deficits in numerous cognitive domains within MCI and diagnostic categories of AD as compared to MMSE. These domain specific cognitive patterns offer the possibility to detect AD or MCI earlier and more efficiently.
- The CST shows superior ability to discriminate between the normal and AD groups in addition to the AD/MCI groups as compared to MMSE.
- The CST, unlike the MMSE and other assessment instruments does not require professional administration which allows for continuous monitoring by self, caregiver, family member or primary care physician.
- The CST may also prove important in differentiating between AD and other types of dementias; including vascular dementia, diffuse Lewy body disease, and dementia associated with Parkinson's disease.
- The CST is easily accessible via the internet and offers an objective, standardized, rapid and reliable assessment of verbal fluency, memory, attention, orientation, executive functions and visual-spatial construction without a high demand on motor functions (i.e., writing and drawing)
- Further research is planned to confirm and expand on the results of this study.

Acknowledgments and Personnel

- ¹Medical Director, Cole Neuroscience Center, Memory Disorder Clinic; University of Tennessee Medical Center
- ²Director, Cognitive Neuroscience Laboratory, Cole Neuroscience Center
- ³Scientific Advisor, Computer Programming and Internet services
- ⁴Research Assistant, Cole Neuroscience Center
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