Review

25 years of computerized cognitive assessments – where are we now?

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(List three to ten pertinent keywords specific to the article; yet reasonably common within the subject discipline.)

1. Introduction

The goal of this paper is to provide an overview of how computerized cognitive assessments started and how they have changed since they were first designed in the 80s with the advent of the internet and technologies like small, portable touch screens (iPads). The differences between the existing and commonly used paper-pencil test will be discussed with an emphasis on why computerized tests are particularly advantageous for assessing cognitive changes associated with aging.

2. Cognitive Assessment – Historically

Specify difference between cognitive tests for diagnostic purposes, and assessments for monitoring changes over time. In this paper we’re talking about the latter.

Paper and pencil cognitive tests need to be administered and interpreted by trained neuropsychologists/psychometrists. Requires highly trained professionals to be involved in routine assessments.

Computerized test batteries are highly consistent, reduce experimenter biases that might affect validity of test results, and ideally can be self-administered.

This leads into the importance of using computerized tests in assessing/following cognitive changes in aging and dementia over the long term. *(Citing Blackwell et al, Chapter 5 from Dementia textbook)*

Started with CANTAB

Describe work by Sahakian and Owen and others on the positive aspects of using computerized batteries in older adult populations/following dementia related cognitive declines

* Sahakian et al, 1988 *Brain;* 1990 *Neuropsychologia –* Computerized tests in Alzheimer’s & Dementia
* Sahakian & Owen 1992 *Royal Society of Medicine* – discussion of CANTAB
* Robbins et al 1994 *Dementia* – CANTAB in large group of older adults (n=787) factor analysis
* Blackwell et al 2003 *Dementia and Geriatric Cognitive Disorders* – specificity and reliability of computerized tests for detecting dementia/Alzheimer’s

3. Cognitive Assessment – In the internet age

The internet and proliferation of portable computers provides new opportunities for computerized cognitive assessments (more subjects, can be done at home, can be done without an administrator, etc). There are many different testing batteries:

* Wild, K et al 2008, *Alzheimers & Dementia* – systematic review of 11 computerized cognitive testing batteries appropriate for use in the elderly. Conclusion: batteries are not consistent and the utility of these batteries needs to be assessed on a case by case basis
* Zygouris & Tsolaki, 2015 *American Journal of Alzheimer’s Disease* – Review of computerized cognitive testing batteries appropriate for use in the elderly. Discusses inconsistencies in the research on utility of these batteries in dementia. Also discusses things that are missing from existing computerized cognitive testing batteries (e.g. Virtual reality, adaptability, length of tests)

An Illustrative Example of an online tool: Describe CBS as a comprehensive battery that is updated for modern technology

* Hampshire 2012 *Neuron –* CBS description
* Can cover a wide range of assessments in a short period of time
* Can be administered to thousands of people – 70 000 people have taken it (8 million test scores) – Figure from Conor showing hundreds of older adult scores on 12 different tests
* Quote CBS materials when describing the advantages to online testing: calculate scores on the fly, tests are adaptive to participant levels, feedback can be given immediately to participants or physicians (refer to example of CBS score report)
* Score reports can interpret scores for the reader of the report – meaningful change (a statistically significant increase in digit span translates to an increase in 0.7 digits – is that meaningful/useful?)

4. Online testing vs existing alternatives

Online testing vs in lab testing/MoCA/MMSE

* Show the unpublished results from young people and PD patients tested at home and in lab – at home testing is just as valid as in lab
* Summarize Brenkel data and our older adult CBS/Christie Gardens paper – computerized testing does better than existing ‘quick’ assessments

5. Relevance/Applications

* Clinical relevance: the importance of ease of interpretation (taken from Owen chapter in *Ageing and Dementia);* CBS meaningful change scores can be understood by non-physicians
  + Monitoring changes in cognition over time; Monitoring effects of drugs; postsurgical assessments;
* Relationship between imaging and cognition
  + Hampshire et al 2012 – CBS in scanner
  + neural validation of CANTAB work – Owen et al 1995 *Neuropsychologia* – CANTAB and temporal lobe excisions
  + Jacobson et al 2011 *Brain and Cognition* – neural correlates of Trail-Making test/set-shifting skills
  + Huntley et al, 2017 *British Journal of Psychiatry –* training adaptive working memory strategies (trained on digit span) improved general cognitive function (MMSE)– with MRI correlates

6. Conclusion/Summary

Computerized cognitive assessments have come a long way in the past 25 years. Proliferation of technology has made it cheaper and more accessible.

Provide an ‘ideal’ for what computerized cognitive assessments could look like: self-administered, self-monitoring, used by retirement homes/family physicians/other front-line health care workers to catch small changes in cognition early in order to identify early the supports that might be helpful (quality of life implications). *Using some of the keywords from previous reviews/papers*.

Working with physicians/health care providers to monitor early changes in aging/dementia will also create a large amount of data about what kinds of cognitive changes are happening during the aging process. Has broader implications for research that could impact the design of policies and health care support networks.

\*\*\* STORING OTHER THINGS HERE FOR NOW:  
Corbett et al 2015 - Computerized cognitive training in older adults to combat cognitive decline that occurs as a function of age. Test groups show some improvement in IADL than controls

Ferreira et al 2015 – playing leisure games like Sudoku has benefits for cognition

**Supplementary Materials:** The following are available online at www.mdpi.com/xxx/s1, Figure S1: title, Table S1: title, Video S1: title.

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**Conflicts of Interest:** The online cognitive tests (Cambridge Brain Sciences) discussed in this review are marketed by Cambridge Brain Sciences Inc, of which Dr. Owen is the unpaid Chief Scientific Officer. Under the terms of the existing licensing agreement, Dr. Owen and his collaborators are free to use the platform at no cost for their scientific studies and such research projects neither contribute to, nor are influenced by, the activities of the company. As such, there is no overlap between the current review and the activities of Cambridge Brain Sciences Inc, nor was there any cost to the authors, funding bodies or participants who were involved in the mentioned studies.

Appendix A

The appendix is an optional section that can contain details and data supplemental to the main text.

Appendix B

All appendix sections must be cited in the main text. In the appendixes, Figures, Tables, etc. should be labeled starting with ‘A’, e.g., Figure A1, Figure A2, etc.

References

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