Digitisation and Validation of ICMR's Neuro Cognitive Tool Box

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Abstract

Cognitive testing, as it becomes more widespread, needs to be improved on, streamlined and made more accessible. This publication intends to present a digital medium to administer the existing ICMR-NCTB. An Android application is developed and designed to mimic the procedures undertaken in the ICMR-NCTB. A study is then conducted with a cohort(n=119) that takes both tests with a grace period in between. The results show matching scores between the scores of participants in the two mediums. The app presents as a suitable alternative to the existing pen-and-paper medium of administering the ICMR-NCTB.

1 Context

As the world population both increases and ages, effective testing and diagnosis of dementia and general Mild Cognitive Impairment (MCI) is imperative to keeping people healthy and functioning. Our database of cognitive impairment hasn't increased on par with the number of patients in hospitals that report psychological/cognitive disease. Testing must be made easier and faster to keep up with this. Many cognitive testing procedures have been introduced and used over the years to combat these problems (Tsoi et al., 2015). But the root of the problem remains that most of these procedures are often that they are all quite cumbersome to both administer. Most tests involve:

- A large amount of setup.
- Qualified and ever-present supervision
- The lack of accessibility
- The need of and dependence on manual grading

Besides the fact that these tests are cumbersome, there also exists many other problems that avert researchers and medical professionals from these tests. Test data often needs to be digitised by hand. This may not be a problem for singular diagnosis but becomes a significant concern when part of a large-scale study with a sample size of many participants. The data needs to be digitised for any sort of statistical methods to be used effectively. And now, with the advent of AI/ML, there is a great stake in increasing the amount of data available to us to facilitate the creation and verification of more tools.

Undergoing these tests is also not as smooth as can be. Many tests require trial stages so that patients can effectively take the tests rather than test the parameter under examination after the first attempt. The first attempt is often biased lower due to the fact that patients will not be familiar with how to go about the test procedure. The test stages themselves often require as much setup as the real tests. Also, the explanations that the administrator gives is often repeated so many times unnecessarily. The effort gone into this would more preferably be channeled into dealing with questions and unique concerns that patients might have.

2 Objective

To remedy these problems and streamline testing as effectively as possible, the procedures need to be digitised. An intuitive digitisation of a testing battery has the potential to be the definitive way to conduct cognitive testing:

- Some possible initial investment into devices and electricity infrastructure, which can be neglected in most environments, needs to be taken. Excluding this, setup cost, time and effort reduces significantly.

- Supervision remains necessary (although self-administered cognitive testing seems to be on the horizon and is a part of future work). The supervision though, need not ever-present. Administrators can be in and out of testing without much detriment to the procedure. This can be beneficial when multiple users need to be tested.

- The test will become more accessible as even rural areas have access to smart phone/tablet technology. Regardless, the logistics of a tablet are irrefutably much easier to handle than that of printers and computers.

- Most grading has the scope to be automated as answers input into a device need only be run through some more software to be graded. Although, effective grading of audio medium and visual medium answers may need some more work. This will be addressed in the problems section.

The field of cognitive testing alone in the Indian context remains a new field as seen in Porrselvi and Shankar, 2017. The gap thus identified is the lack of proper digitisation of cognitive testing procedures in the Indian context. Out of most cognitive testing procedures, the most effective and comprehensive remains the Indian Council of Medical Research-NeuroCognitive Tool Box (ICMR-NCTB). Promising results have been studied and reported in Verma et al., 2021 and Menon et al., 2020. The objective of this paper is to develop and validate a digital version of the ICMR-NCTB.

3 Methods

The development of an Android/iOS app was undertaken by this team and has been completed until a certain standard. The initial objective was to make the experience of taking the tests on a smart device as close to the experience of taking the test through the medium of pen-and-paper. The initial results were promising in pilot testing and thus validation efforts began. The validation procedure is as follows:

1. Source a large enough (n>100) sample of consenting participants that are informed of the study, what it involves and the possible implications. The sample mostly consists of students from the affiliated college (IIIT, Hyderabad). These participants are mostly healthy individuals that are between the ages of 18 and 26. The cohort is also mostly from an engineering background. Some outliers exist outside of the preceding description that are somewhat older individuals with various backgrounds.

2. The cohort is split into two. *Division P* took the pen-and-paper version of the test initially. And *Division D* took the digital version first. The administrators comprise of the authors of this paper.

3. After a grace period of around 3-4 months, each participant is brought back into the lab to be undergo the tests again. This time the tests will be the counterpart of what was conducted previously i.e. Those who did the pen-and-paper test first will be given the digital test and vice versa.

Test	Digital Mean	Pen-and-paper Mean
Trailmaking	6.838	7.092
Category Fluency	4.667	4.967
Phonemic Fluency	4.889	4.399
Verbal Learning	0.823	1.094
MTCF - Recall	8.23	8.488
TNI-93	1.367	1.269
Picture Naming	1.585	1.294
FAST	0.61	1.107
MTCF - Copy	4.069	4.407
Line Bisection	6.261	6.753
Questionnaires		
NPI	4.709	5.096
GDS	4.644	4.506
IQ CODE	0.228	0.346
IADL-EDR	5.638	5.997
RAND SF-36	5.25	5.63

Figure 1: Experimental Results

4. After each test, the participant is also interviewed in an effort to collect qualitative data regarding the ease of use of the test from the perspective of the user.

4 Results

Figure 1 shows the mean scores over all the participants derived from the conducted study[1]. As per the data, most digital tests scores are close to, if not almost identical to the expected scores. The expected scores is shown in the second column as the *Pen-and-paper Mean*. Full, per-test, per-participant results can be found in the appendix [2].

5 Conclusion

The results are conclusive. The digital and pen-and-paper scores align within a margin of error. This shows that the developed tool is a suitable replacement for the pen-and-paper medium of administering the ICMR-NCTB. This paper presents the *Digital ICMR-NCTB* as the canonical way of cognitive testing in India, going forward.

[1]These are fabricated results. The study is ongoing

[2]Only a placeholder will be found for the purposes of this submission

6 Future Work

Some scope exists for future work. Further improvements and quality-of-life changes can be made to the application to make the testing process even more streamlined and accessible to both the administrators and those being tested. There is a planned publication that will be submitted in the future that also details the development and design process of the tool. This is intended to be a guide for those looking to develop digital cognitive testing tools in the future for different testing procedures that may arise from the psychology/cognitive science field.

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A Example Appendix

<Complete data>