Abstract

We employed Machine Learning principles to develop a novel, computerised cognitive assessment test that aims at screening for cognitive impairment in a way that can simplify and accelerate that diagnosis of Mild Cognitive Impairment (MCI) and Dementias. The test is primarily focused on rapid categorisation of natural images of varied statistical properties.

Methods

We conducted four different experiments, as summarized in Table 1. The first three experiments were designed to measure the ICA correlation with a wide range of routinely used reference cognitive tests. The goal was to investigate whether the speed and accuracy of visual processing in a rapid visual categorisation task is correlated with subject’s cognitive performance.

In the first and second experiments, we tested ICA’s ability in assessing cognitive performance in older adults. Therefore, we used MoCA and/or ACE-R as reference cognitive tests, both of which are routinely used to screen for Mild Cognitive Impairment (MCI) and dementia in older adults.

In the first experiment, 212 volunteers participated, MoCA was used as the reference cognitive test. The second experiment included 58 participants, the ICA was delivered and both MoCA and ACE-R were used as reference tests in this experiment.

The third experiment had SDMT, BVRT-II and CVLT-II as the reference cognitive tests, measuring speed of information processing, visuospatial memory and verbal learning, respectively. These three tests form the BiCOMS battery, which requires about 15 to 20 minutes to administer, and is primarily used to detect cognitive dysfunction in younger adults who suffer from Multiple Sclerosis. 166 participants took part in this experiment. Forty-four of them were selected for a re-test as part of a second visit to assess ICA test-retest reliability.

All the pen-and-paper cognitive tests were administered by a healthcare professional. The administration order for ICA vs. reference cognitive tests was randomized.

Finally, experiment 4 was designed to study whether the ICA test had a learning bias if taken multiple times in short intervals. 12 young volunteers participated in this study. For convenience, the ICA was delivered remotely via a web platform. Participants took the ICA every other day for two weeks.

Results

Figure 1: AIC score, test-retest scatter plot. Each blue dot shows the ICA score for an individual taken on two different days. The blue line indicates the linear curve fitted to the test-retest data. (Pearson’s r = 0.96, p<0.01).

Figure 2: AIC score, test-retest scatter plot. Each blue dot shows the ICA score for an individual taken on two different days. The blue line indicates the linear curve fitted to the test-retest data. (Pearson’s r = 0.96, p<0.01).

Figure 3: Dependency of standard-of-care cognitive tests on education. No significant effect of learning in repeated exposure to the ICA test. We find no learning bias when the test is taken multiple times. 12 healthy participants (age range = [20,35]) took the ICA test every other day for two weeks (ANOVA, F(7) = 0.62, P-value < 0.05). From these 12 participants, 7 of them completed all the sessions (8 days), and the rest did the test for at least the first three days.

Figure 4: No significant effect of learning in repeated exposure to the ICA test. We find no learning bias when the test is taken multiple times. 12 healthy participants (age range = [20,35]) took the ICA test every other day for two weeks (ANOVA, F(7) = 0.62, P-value < 0.05). From these 12 participants, 7 of them completed all the sessions (8 days), and the rest did the test for at least the first three days.

Conclusions

We established that the Integrated Cognitive Assessment correlation with MoCA is significant to determine construct validity. The ICA is independent of language and education while there is no discernible learning effect. The above attributes will yield more significant clinical benefits in the day-to-day identification of neurodegeneration both in primary care and specialist clinics.