



# Artificial Intelligence (AI) based Cognitive Assessment Tool for Early Diagnosis of AD

Seyed-Mahdi Khaligh-Razavi<sup>1,2\*</sup>, Hadi Modarres<sup>1</sup>, Haniye Marefat<sup>3</sup>, Hamed Karimi<sup>4</sup>, Mahdiyeh Khanbagi<sup>2</sup>, Chris Kalafatis<sup>1,5,6</sup>, Zahra Vahabi<sup>7</sup>

<sup>1</sup>Cognetivity Ltd, London, UK  
<sup>2</sup>Department of Brain and Cognitive Sciences, Cell Science Research Center, Royan Institute for Stem Cell Biology and Technology, ACECR, Tehran, Iran  
<sup>3</sup>School of Cognitive Sciences, Institute for Research in Fundamental Sciences (IPM), Tehran, Iran  
<sup>4</sup>Amir Kabir University of Technology, Tehran, Iran  
<sup>5</sup>South London & Maudsley NHS Foundation Trust, London, UK  
<sup>6</sup>Department of Old Age Psychiatry, King's College London, London, UK  
<sup>7</sup>Tehran University of Medical Sciences, Tehran, Iran  
\*correspondence to [Seyed@Cognetivity.com](mailto:Seyed@Cognetivity.com)

Introduction

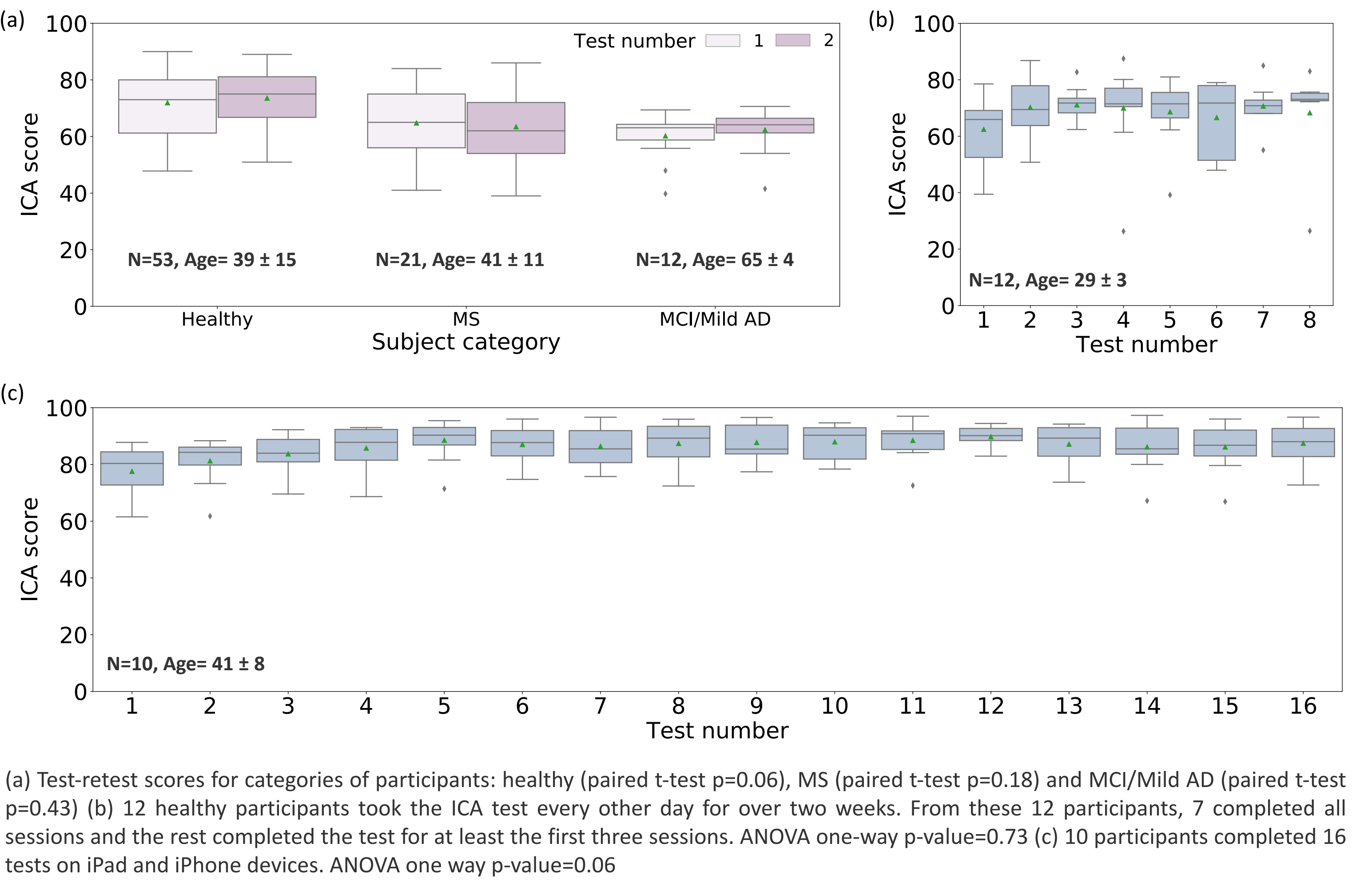
Task-based fMRI

Neurodegenerative disorders, such as Alzheimer’s Disease (AD), continue to present a major economic, social and healthcare burden. These diseases remain underdiagnosed or are diagnosed too late for meaningful interventions. The development of screening tests capable of detecting AD during early, preferably asymptomatic, stages has been a highly unmet need. Since such tests will be used for screening large populations of people, they should be non-invasive, inexpensive, and ideally independent of language, education, culture and practice.

Methods

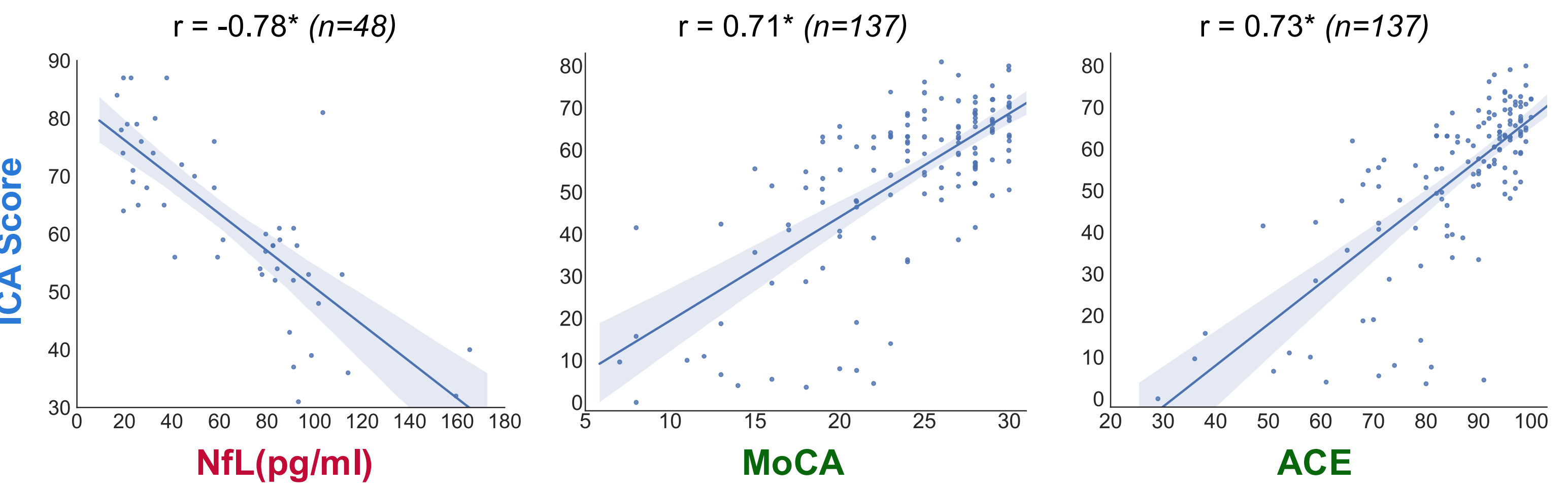
Taking advantage of new artificial intelligence (AI) and machine learning techniques, we have developed a 5-minute integrated cognitive assessment tool (ICA) that meets the above-mentioned criteria, and has the flexibility to learn from new data to improve its predictive power. The ICA is computerised, can be conducted without expert supervision, and is designed based on a rapid visual categorisation task, tracking participants’ response-patterns to natural stimuli to detect small changes in their cognitive performance.

ICA shows no significant learning bias

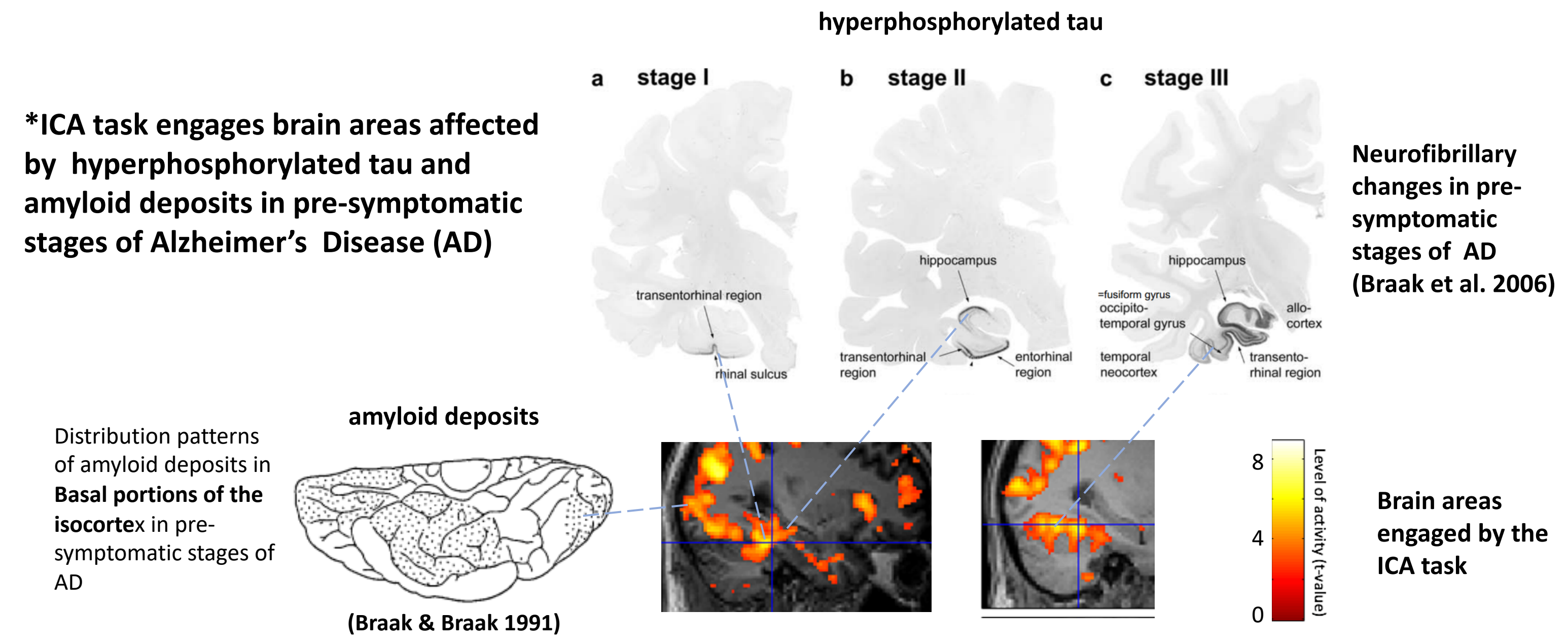


The ICA demonstrates no evidence of learning bias<sup>1</sup> (which affects standard cognitive assessments) for different demographics and platforms (Figure 1). Therefore the ICA test is suitable for frequent cognitive assessment or micro-monitoring of cognitive performance.

ICA correlation with MoCA, ACE and plasma biomarker (NfL)

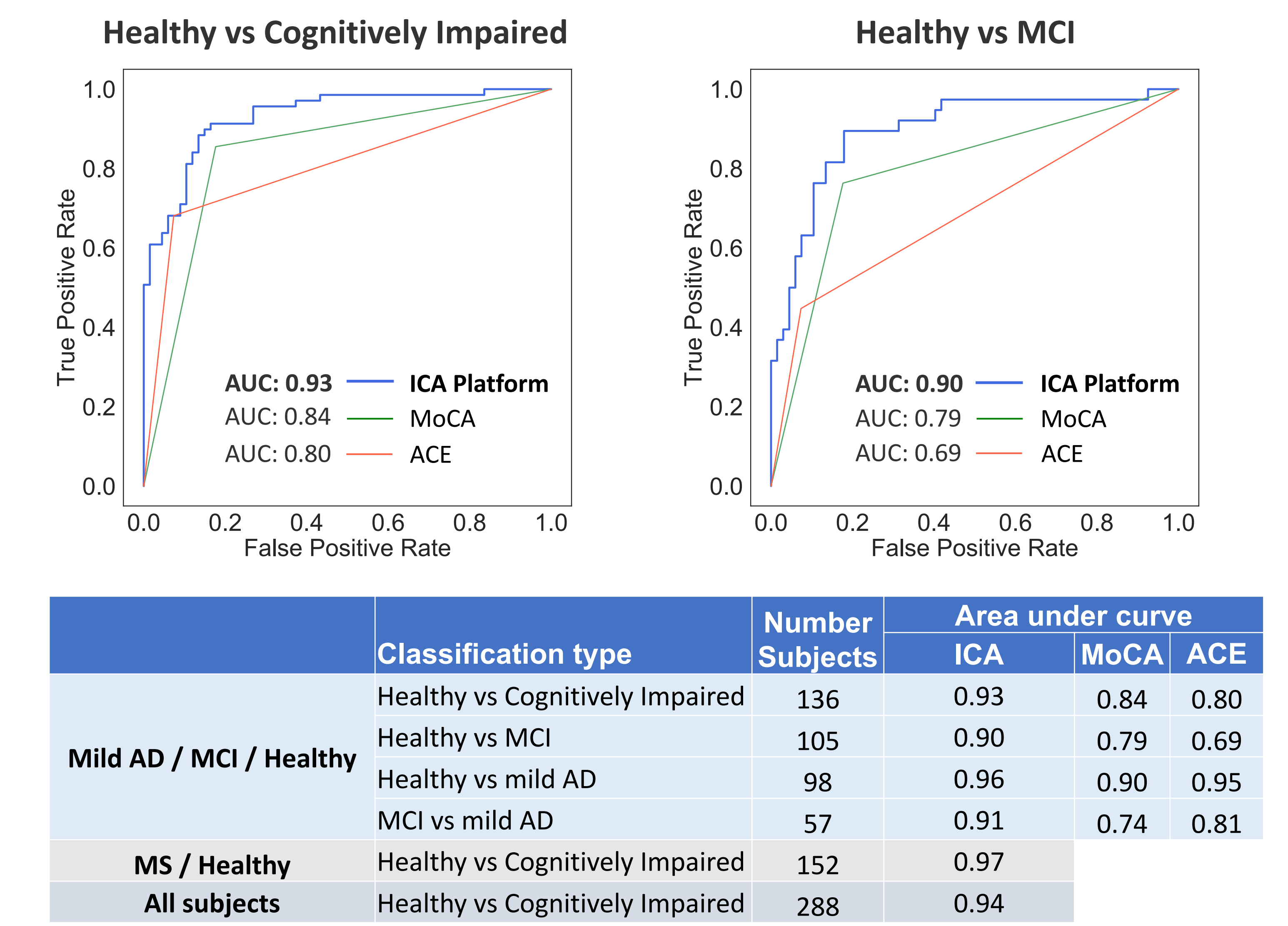


The ICA demonstrates convergent validity with MoCA and ACE and also shows a strong correlation with NfL and severity of cognitive impairment.



In a task-based fMRI investigation (30 participants), we find that the ICA task engages brain areas, such as transentorhinal, fusiform gyrus, inferior and middle temporal, that are anatomically identified among the earliest areas affected by tau-pathology and amyloid deposits in presymptomatic stages of AD, as shown by Braak and colleagues<sup>2,3</sup>, 1991 and 2006.

ICA accuracy in detecting cognitive impairment



Summary of ICA Platform performance and comparison with MoCA and ACE

Conclusions

- The ICA engages brain areas affected in early stages of AD, and shows high sensitivity in detecting cognitive impairment.
- The ICA is self administered and language independent, and as such the test can be used as an aid for early diagnosis of AD, ideally even in pre-symptomatic stages, and is appropriate for large-scale screening of cognitive impairment, and micro-monitoring of cognitive performance.
- The ICA has demonstrated to be free from a learning bias (i.e. practice effect).
- As an iPad test, the ICA has potential for integration with EHR and electronic medical record or research database integration.
- The above attributes yield significant clinical benefits in the day-to-day identification of MCI and AD in specialist clinical settings, in primary care and in remote cognitive monitoring.

References

(1) Khaligh-Razavi, S.-M. *et al.* Integrated Cognitive Assessment: Speed and Accuracy of Visual Processing as a Reliable Proxy to Cognitive Performance. *Sci. Rep.* **9**, 1102 (2019).  
(2) Braak, H. & Braak, E. Neuropathological staging of Alzheimer-related changes. *Acta Neuropathol.* **82**, 239–59 (1991).  
(3) Braak, H., Alafuzoff, I., Arzberger, T., Kretschmar, H. & Tredici, K. Staging of Alzheimer disease-associated neurofibrillary pathology using paraffin sections and immunocytochemistry. *Acta Neuropathol.* **112**, 389–404 (2006).