A novel Digital Cognitive Biomarker for Mild Cognitive Impairment and Alzheimer's disease

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Background

Recent evidence suggests that oculomotor behaviours linked to cognitive performance can be a biomarker of Alzheimer's disease (AD). Short-Term Memory Binding (STMB) declines in patients with AD dementia and in those at risk of dementia. STMB relies on brain regions relevant to visual processing which are known to support oculomotor behaviours. Viewmind is proposed as a novel "cognitive digital biomarker" with the potential of revealing phenotypic features of AD in the pre-dementia stage of the pathology. Viewmind applies artificial intelligence to analyse eye movements and pupil responses during the performance of STMBT.

Methods

A three-year longitudinal study involved 42 healthy older adults and 61 patients with Mild Cognitive Impairment (MCI). Patients and controls underwent assessment with the STMBT and a Neuropsychological battery (Table 1). The STMBT assesses the ability to temporarily hold bicoloured objects whose colours had to be remembered either as individual features (baseline) or integrated within unified representations (binding). Viewmind's technology powered by Artificial Intelligence was applied to data gathering during STMBT (Figure 1).

Figure 1. Viewmind technology combines cognitive and eye-tracking metrics obtained during the STMBT to yield a cognitive biomarker for AD

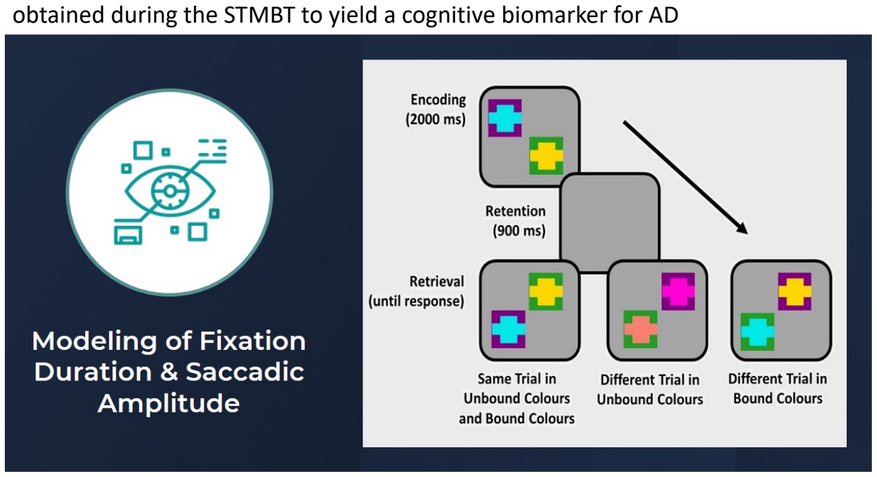


Table 1. Demographic and background neuropsychological assessment of healthy controls and MCI patients at baseline.

	MCI (n=61)	Controls (n=42)
Age	72 (SD=6.7)	73 (SD=6.1)
Education (Years)	12	12
MMSE	26.6 (SD=2.2)	29.7 (SD = 0.4)
ACE-R	78.3 (SD = 10.8)	93.2 (SD = 0.8)
IFS	18.4 (SD = 5.2)	27.0 (SD = 1.1)
GDS	8.5 (SD = 2.8)	
Pfeffer daily activity	6.1 (SD = 1.5)	
Hamilton's Anxiety Scale	16.3 (SD = 3.5)	

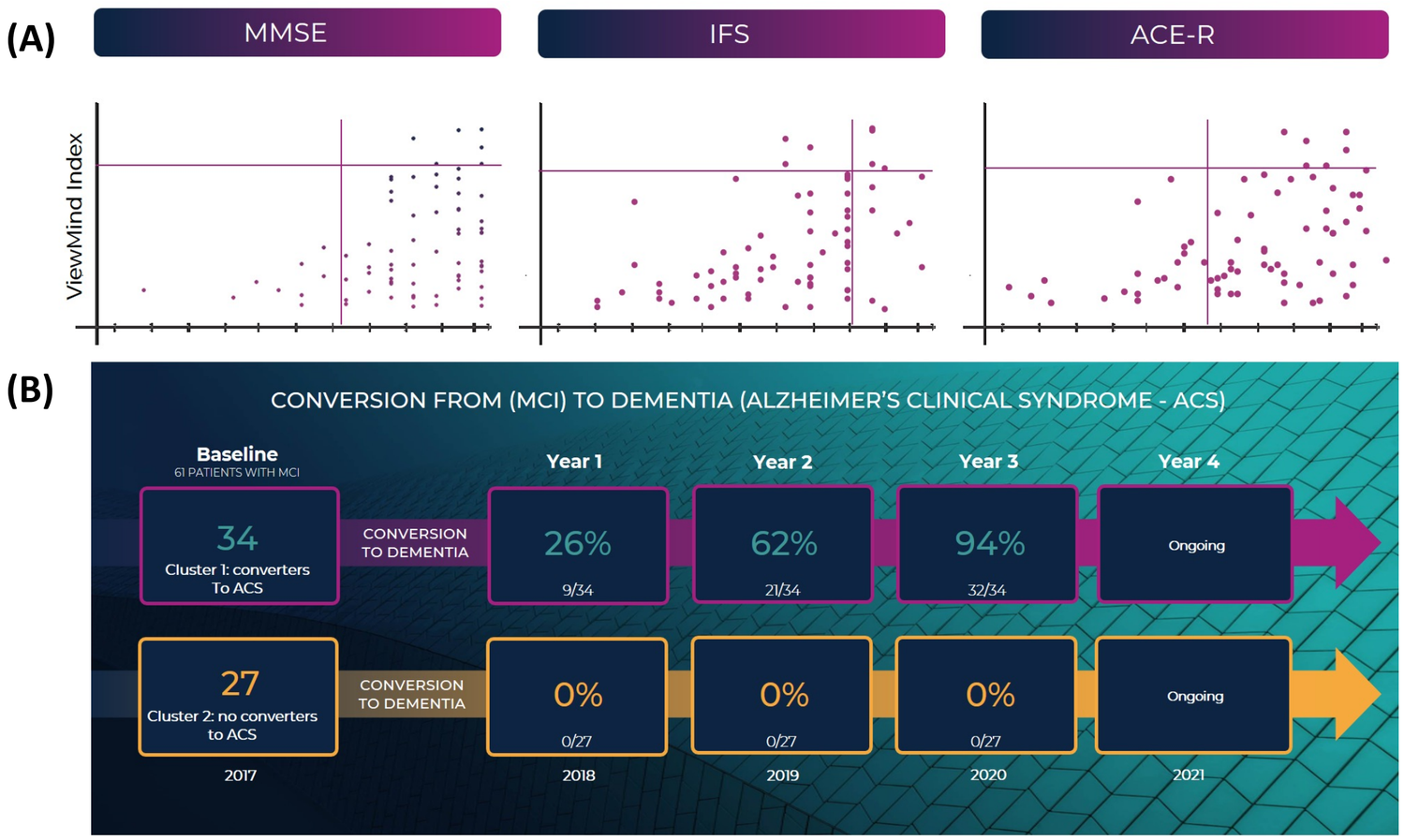
MMSE: Minimental State Examination, IFS: INECO Frontal Screening, ACE-R: The Addenbrooke's Cognitive Examination Revised, GDS: Global Depression Scale.

Results

The Viewmind Index drawn from oculomotor behaviours during STMBT significantly correlated with performance of MCI patients on cognitive screening stools such as the MMSE, IFS and ACE-R (Figure 2.A).

The Viewmind methodology identified two clusters of MCI patients from baseline data. Conversion to dementia (Alzheimer's Clinical Syndrome - ACS) was only observed in members of Cluster 1 (Figure 2.B). Retrospective analysis revealed that by Year 3, 94% of members of this cluster had developed the ACS while none of those from cluster two had. Those MCI patients from cluster two who progressed to dementia, developed Fronto-temporal or Parkinson's Disease dementia.

Figure 2. (A) The ViewMind Index significantly correlated with measures of diseases severity. **(B)** Baseline classification and retrospective analysis based on such an index identified a MCI phenotype (Cluster 1) that reliably informed about progression to AD dementia.



Discussion

Taken together, the results above suggest that Viewmind can (1) unveil novel features of the ACS unknown to date, and (2) provide a more sensitive tool which can detect and trace aspects of such a phenotype in people at risk, thus helping to ascertain the presence of the prodromal stages of AD.