

The Moderation Effect Of Cognitive Reserve On The Association Between Eye-tracking And Cognition: Data From The PREDICTOM Study



Alice Valcarenghi¹, Martin Pszeida², Lucas Paletta², Dag Aarsland^{3,4}, and the PREDICTOM Consortium

¹Department of Psychology, University “G. d’Annunzio” of Chieti-Pescara, Chieti, Italy; ²Joanneum Research FgesmbH, Graz, Austria; ³Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, United Kingdom; ⁴Centre for Age-Related Medicine, Stavanger University Hospital, Stavanger, Norway

INTRODUCTION

- Digital eye-tracking (ET) biomarkers may enable scalable detection of early cognitive vulnerability (Verón et al., 2026).
- Cognitive reserve (CR), i.e., the ability to cope with brain damage by utilizing preexisting or compensatory cognitive processes, has been associated with relatively preserved cognition despite neuropathology (Vockert et al., 2024).
- The role of CR in shaping oculomotor behaviour remains unexplored.

AIMS

AIM 1: ET-COGNITION ASSOCIATION

To evaluate the association between ET markers and cognitive performance across multiple domains in healthy older adults at increased risk of dementia.

AIM 2: ROLE of CR

To determine whether CR moderates the relationship between ET markers and cognitive performance.

METHODS

Data from PREDICTOM study - Level 1 home-based assessments (Brem et al., 2026).
ET feasibility: 80.6% completed all ET tasks, which required approximately 9 minutes.

	PARTICIPANTS (N = 378)	EYE-TRACKING TASKS	
Age	63.97 ± 8.39	(Pszeida et al., 2025) • MIRA → gamified antisaccade task • EMO → pairs game with emotional imagery • PVT → psychomotor vigilance task	
Sex	70% female		
Ethnicity	93% White/Caucasian		
Education	75% more than 12 years		
Employment status	48% retired		
Handedness	91% right	PROTECT cognitive test system (Brooker et al., 2020) • Speed of attention • Accuracy of attention • Memory • Executive functioning • Global cognition	
Country	14% United Kingdom 11% Norway 24% Switzerland 49% Spain 2% Germany		
STATISTICAL ANALYSES			COGNITIVE RESERVE (Pappalettera et al., 2024) CR proxy was operationalized as a sociobehavioural composite score derived from years of education, cognitive lifestyle activities, and social engagement.
• Multiple linear regression model adjusted for age, sex, and education (the latter only for ET-cognition associations). • Moderation analyses tested ET x CR interaction terms. • Only significant ET-cognition associations identified in Aim 1 were further explored in moderation analyses (Aim 2).			

RESULTS

AIM 1: ET-COGNITION ASSOCIATION

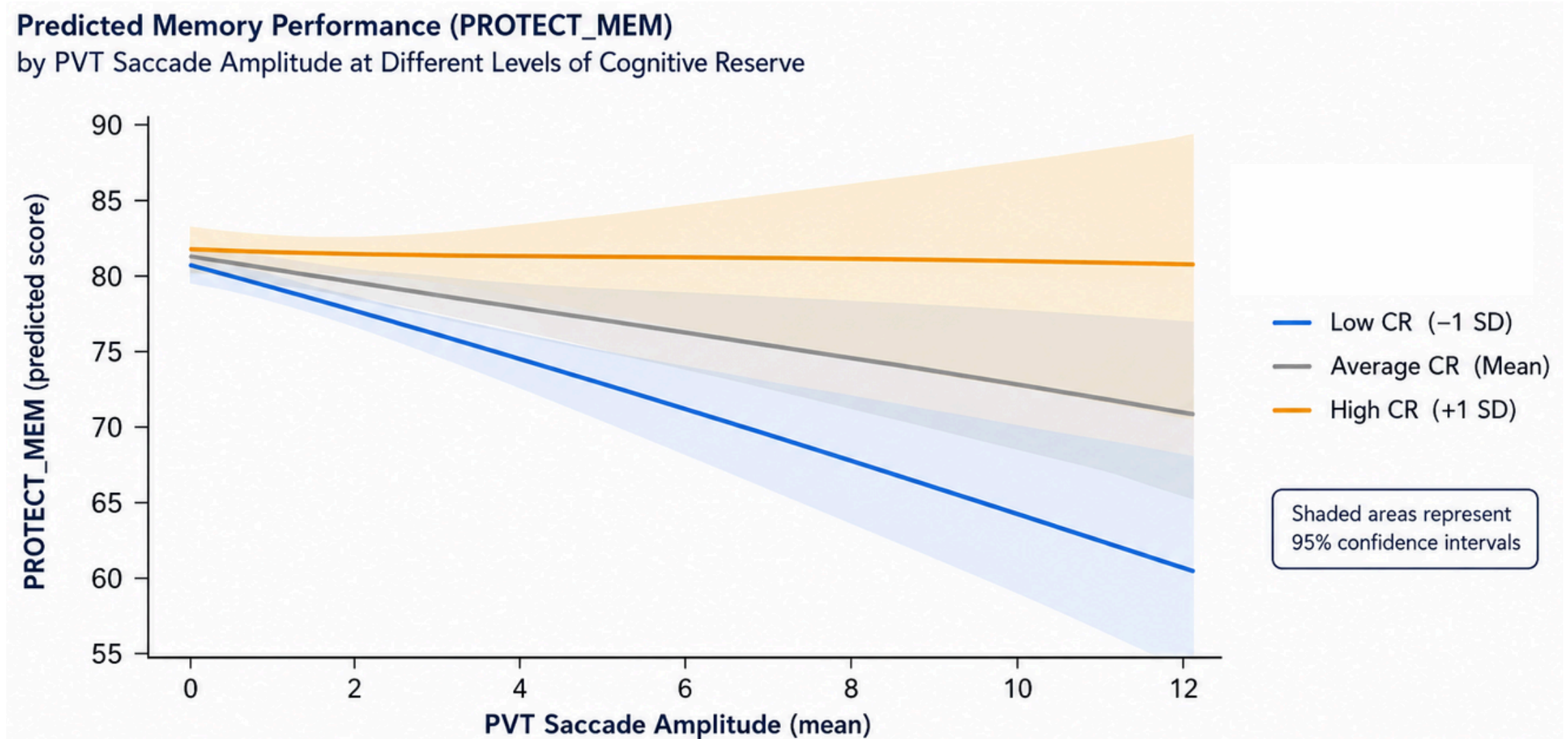
Distinct ET paradigms showed complementary associations with cognitive performance. PVT saccade amplitude and the MIRA antisaccade score were associated with all cognitive domains, whereas EMO fixation duration was specifically associated with attention accuracy, memory, and global cognition (Table 1). Together, these results indicate that different ET tasks capture complementary cognitive processes, supporting a task-specific rather than a universal approach to digital ET biomarkers.

COGNITION	PVT Saccade Amplitude β (<i>p</i> -value)	EMO Fixation Duration β (<i>p</i> -value)	MIRA Score β (<i>p</i> -value)
Speed of attention	-.257 (<.001)	ns	.178 (<.001)
Accuracy of attention	-.137 (.007)	.126 (.013)	.106 (.042)
Memory	-.171 (<.001)	.119 (.016)	.169 (<.001)
Executive functioning	-.195 (<.001)	ns	.196 (<.001)
Global cognition	-.247 (<.001)	.127 (.010)	.213 (<.001)

Table 1. Associations between selected eye-tracking metrics and cognitive performance.
Note. Values are standarized β coefficients from linear regression models adjusted for age, sex, and education; ns = not significant.

AIM 2: ROLE of CR

Among the ET-cognition associations identified in Aim 1, the only significant interaction was PVT Saccade Amplitude x CR proxy → memory (β = .113; *p* = .024). Higher CR attenuates the negative association between altered oculomotor behaviour during the PVT and memory performance.



Low CR (-1 SD) Strong negative association	Average CR (Mean) Moderate negative association	High CR (+1 SD) No significant association
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KEY FINDINGS

- Different ET paradigms capture distinct cognitive processes.
- CR independently contributes to cognitive performance.
- CR moderates the association between PVT saccade amplitude and memory, attenuating the negative impact of altered oculomotor behaviour.
- ET and CR provide complementary information on cognitive functioning.

CONCLUSIONS

- Home-based ET paradigms provide meaningful digital biomarkers of cognitive functioning in older adults at increased risk of dementia.
- Cognitive reserve independently contributes to cognitive performance and selectively moderates the association between PVT saccade amplitude and memory, suggesting a mechanism-specific buffering effect.
- Integrating ET biomarkers with CR measures may improve early risk stratification and guide personalized prevention strategies.

FUTURE DIRECTIONS

- Longitudinal validation of ET markers as predictors of cognitive decline and disease progression.
- Investigating the relationship between ET biomarkers and Alzheimer’s disease pathology (e.g., amyloid and tau biomarkers).
- Examining whether CR moderates ET-cognition associations across different stages of the neurodegenerative continuum, given evidence that its protective effects are time-sensitive (Guo et al., 2025).

Learn more about the PREDICTOM study

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CONTACT:
alice.valcarenghi@phd.unich.it



