LINKING ERP P300 COMPONENTS AND COGNITIVE RESERVE TO MEMORY TYPES IN OLDER ADULTS

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INTRODUCTION

- Alterations in **event-related potential (ERP) P300 components can be informative in early detection of cognitive impairment** in dementia, particularly in the initial stages of Alzheimer's disease and mild cognitive impairment (MCI).
- Alhough cognitive impairment in AD and MCI can occur in various cognitive domains, **initial deterioraton is characterized by progressive loss of memory** (Rossini et al., 2020).
- Studies indicate that ERP P300 elicited during working memory (WM) is affected in AD, MCI (Fraga et al., 2018) and in healthy older adults compared to younger adults (Speer & Soldan, 2015).
- Moreover, **cognitive reserve defined as the brain's ability to maintain cognitive function despite damage affects ERP P300 responses** associated with verbal WM in both younger and older populations (Speer & Soldan, 2015).
- However, it **remains unclear whether the relationship between P300 event-related potential components and different memory types persists after accounting for cognitive reserve** in older adults with varying levels of cognitive functioning—an association that may contribute to a better understanding of early markers of cognitive impairment in AD and MCI.

AIM OF THE PROJECT

This study aimed to examine whether **ERP P300 components correspond to different memory types**—verbal short-term and long-term memory, as well as visuo-spatial working memory—**irrespective of age, global cognitive functioning and cognitive reserve** in older adults.

MATERIALS AND METHODS

Participants:
Fifty-one native Latvian speaking older adults aged 56 to 84 (*M*=68.1 *SD*=7.04; 64% female) with no self-reported neurological or psychiatric disorders

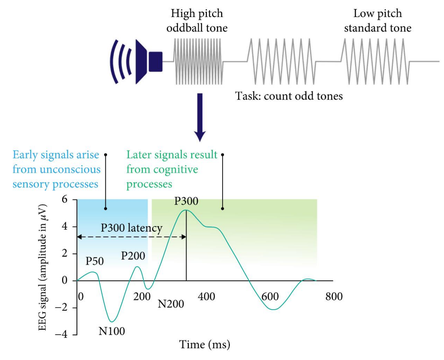


Figure 1. Auditory oddball paradigm – a rare target stimulus evokes P300 ERP (Olichney et al., 2022)

ERPs:

Participants completed an auditory Oddball task in PsychoPy program (Peirce et al., 2019) while EEG data was recorded using a g.tec g.Nautilus 32-channel EEG device and g.Recorder software. The brain activity was recorded using 10-20 EEG system with forehead ground and left earlobe electrode as reference.

Cognitive and behavioural measures:
1. *Verbal short-term memory (STM)* and *long-term memory (LTM)* – Luria's Ten Word Memory Task (Luria, 1976);
2. *Visuo-spatial STM* – Corsi block-tapping test (Corsi, 1972);
3. *Visuo-spatial working memory* – Backward Corsi task (Corsi, 1972);
4. *Cognitive reserve* – Cognitive reserve index questionnaire (CRIq, Nucci et al., 2012);
5. *Global cognitive functioning* –
Montreal Cognitive Assessment Test (MoCA; Nasreddine et al., 2005).

All cognitive tasks presented in Psytoolkit (Stoet, 2010; 2017), CRIq and MoCA administered in pencil and paper format.

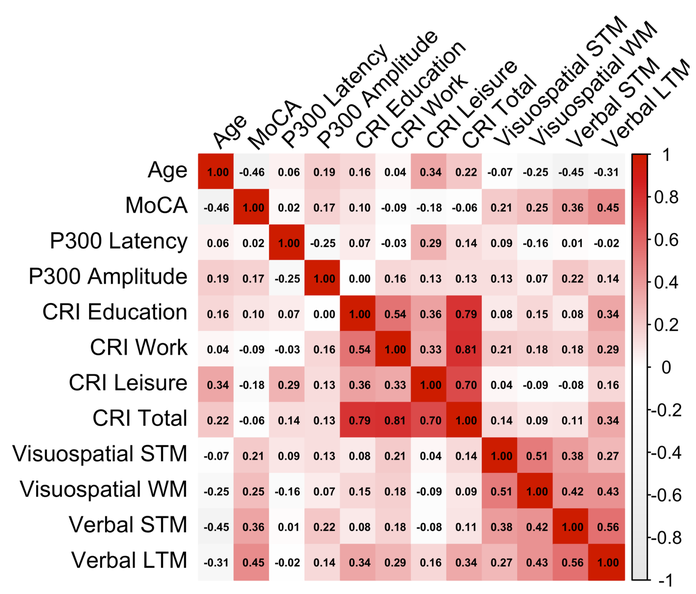
Data analytic strategy:
EEG data was processed in MATLAB (R2020a) EEGlab. The data was analyzed in Jamovi computer software (Version 2.6).
Spearman's rank correlation was performed among all of the study variables.

RESULTS

Table 1
Descriptive statistics of study variables

	M (SD)	*Mdn (Q1-Q3)*	*SW*
Age	68.1 (7.0)	67 (62.5-73.0)	0.970
MoCA	23.8 (3.2)	25 (22.0-26.0)	0.924*
CRI_{total}	134 (24.6)	133 (120-149)	0.940*
$CRI_{education}$	122 (22.3)	120 (104-133)	0.936*
CRI_{work}	131 (26.8)	126 (117-148)	0.936*
$CRI_{leisure}$	127 (20.1)	124 (112-138)	0.975
P300 latency	507 (74.7)	508 (455-551)	0.984
P300 amplitude	4.68 (2.31)	4.32 (2.99-6.19)	0.946*
Verbal STM	5.35 (1.16)	5 (5.0-6.0)	0.929*
Verbal LTM	5.73 (2.51)	7 (4.0-8.0)	0.904**
Visuospatial STM	3.04 (2.14)	4 (0.0-5.0)	0.848**
Visuospatial WM	3.39 (1.84)	4 (3.0-5.0)	0.907**

Table 2
Spearman's rank correlation heatmap



After **controlling for age**, but not CRI Total or global cognitive functioning, there was **a positive correlation between P300 amplitude and verbal STM** (r_p=0.34, p = 0.01).

The sample was divided into two age groups: participants younger than 70 years (n = 30, M = 63.2, SD = 3.82) and those aged 70 years and older (n = 21, M = 75.0, SD = 3.96). There was a significant difference between groups in verbal STM (U=174, p<0.01, r=0.45), but not in P300 amplitude (U=223, p=0.12, r=0.26).

Strongest correlations were found between CRI Total (r_s = 0.452, p = .002), CRI Education (r_s = 0.36, p = .01), CRI Work (r_s = 0.39, p = .007), and CRI Leisure activities (r_s = 0.30, p = .04) with long-term memory, which persisted after controlling for age and global cognitive functioning.

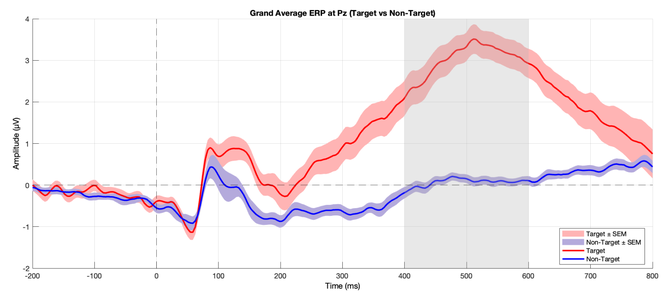


Figure 2. Grand average ERP at Pz electrode, time-locked to target stimulus onset. Shaded region indicates 400–600 ms P300 window

EEG preprocessing:
Bandpass filter used - 0.3 to 40Hz, data downsampled to 256, re-referenced to average, data epoched and ERP P300 components extracted from Pz electrode for each participant.

CONCLUSIONS

After controlling for age, a significant association emerged between P300 amplitude and verbal STM, suggesting age may obscure underlying brain–behavior relationships. This highlights the importance of accounting for age-related variability when examining cognitive and neural correlates in older adults.

The result also supports the idea that **P300 amplitude reflects cognitive processing resources** associated with memory performance, and its predictive value becomes clearer when age-related decline is statistically isolated.

These findings suggest that, in this sample, the decline in verbal short-term memory may precede alterations in P300 amplitude.

The classical Oddball task may not have been cognitively engaging enough may not have been sufficiently demanding to engage cognitive reserve mechanisms.

References:

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Acknowledgements:
This work is supported by Riga Stradins University/Administration and Development Department/Development and Projects Department/Project "Internal consolidation of RSU and external consolidation of RSU with LSPA", No. 5.2.1.1.i.0/2/24/I/CFLA/005/Grant "Modifiable bio and life-style markers in predicting cognitive decline(MOBILE-COG)", No. RSU-PAG-2024/1-0014.