

EVENT-RELATED POTENTIAL P300 IN DETECTING EARLY SIGNS OF COGNITIVE IMPAIRMENT IN ELDERLY INDIVIDUALS

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INTRODUCTION

- Brain pathology associated with age-related cognitive impairment can begin decades before observable symptoms emerge (de Aquino, 2021).
- One promising early biomarker to detect cognitive impairment involves event-related potentials (ERPs) measured via electroencephalogram (EEG).
- ERP P300 components have shown potential for distinguishing between healthy controls, individuals with mild cognitive impairment (MCI), and Alzheimer's Disease (AD) patients (Paitel et al., 2021).
- However, it remains unclear whether alterations in P300 can be detected before cognitive impairment arises. Discrepancies in research findings exist, with some studies reporting null results (Tarawneh et al., 2023), while others highlight latency changes in MCI (Demirayak et al., 2023) and amplitude changes in AD (Pedroso et al., 2018).

AIM OF THE PROJECT

This study aimed to investigate the relationship between ERP P300 components and cognitive function domains in older adults, specifically focusing on verbal short-term and long-term memory, visuo-spatial working memory, and problem-solving abilities. Using the classical Oddball paradigm, the results of this study could help with understanding the cut-off points in P300 amplitude and latency that indicate optimal cognitive functioning levels.

MATERIALS AND METHODS

Participants:

Forty-seven native Latvian speaking older adults aged 56 to 84 ($M=68$, $SD=7.19$; 64% female) with no self-reported neurological or psychiatric disorders

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 program. The brain activity was recorded using 10-20 EEG system with forehead ground and left earlobe electrode as reference. Impedance was kept below 50k Ω .

Behavioural measures:

- Verbal short-term memory (STM) and long-term memory (LTM) – Luria's Memory Word Test;
- Visuo-spatial STM – Corsi block-tapping test (Corsi, 1972);
- Visuo-spatial working memory – Backward Corsi task (Corsi, 1972);
- Problem solving – Tower of Hanoi (Byrnes & Spitz, 1979);
- The level of cognitive functioning – Montreal Cognitive Assessment Test (MoCA; Nasreddine et al., 2005).

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

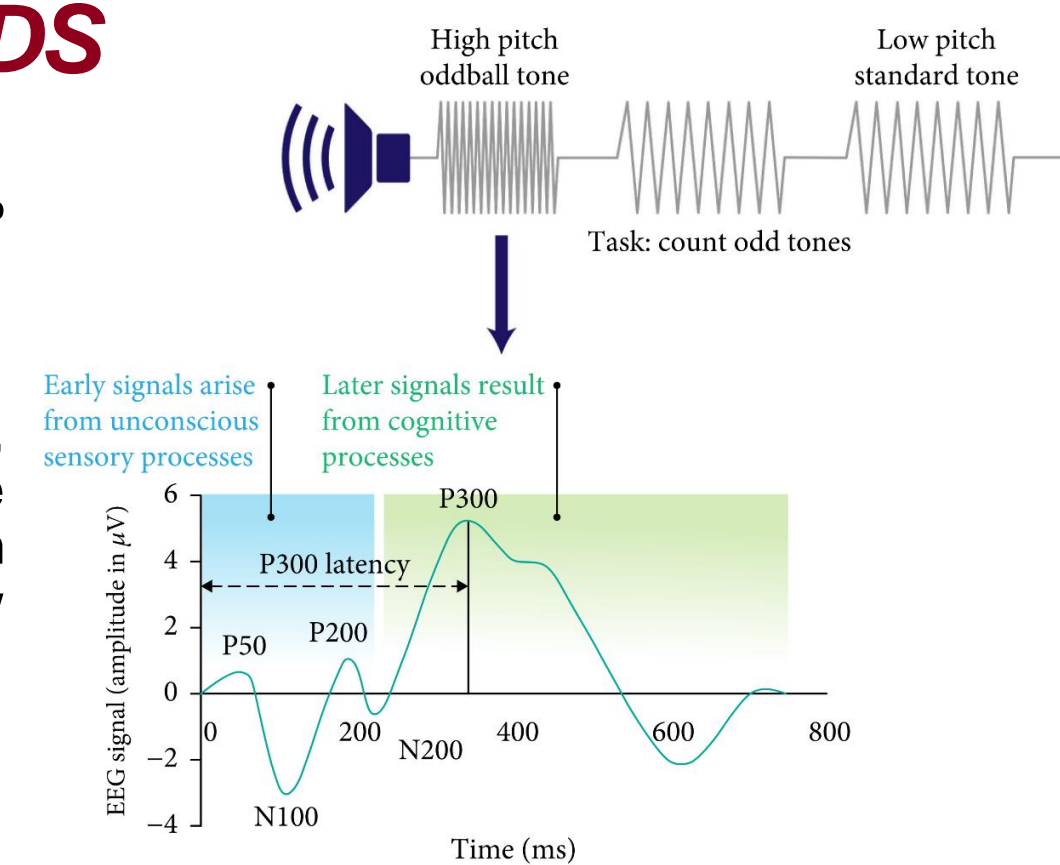


Figure 1. Auditory oddball paradigm – a rare target stimulus evokes P300 ERP (Olichney et al., 2022)

Data analytic strategy:

EEG data was processed in MATLAB (R2020a) EEGLab and Darbeliai packages. The data was analyzed in Jamovi computer software (Version 2.6).

Spearman's rank correlation was performed among all of the study variables.

RESULTS

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.

Table 1

Spearman's rank correlation heatmap

	P300 latency	P300 amplitude	Problem solving Score	Problem solving RT	Corsi STM	Working memory	Short term memory	Long-term memory
P300 latency	1.00	-0.32	0.09	0.15	0.14	0.13	0.28	0.15
P300 amplitude	-0.32	1.00	-0.15	-0.14	0.20	-0.01	0.00	-0.08
Problem solving Score	0.09	-0.15	1.00	0.74	-0.19	-0.17	-0.17	-0.08
Problem solving RT	0.15	-0.14	0.74	1.00	-0.14	-0.33	-0.24	-0.15
Corsi STM	0.14	0.20	-0.19	-0.14	1.00	0.53	0.36	0.23
Working memory	0.13	-0.01	-0.17	-0.33	0.53	1.00	0.40	0.41
Short term memory	0.28	0.00	-0.17	-0.24	0.36	0.40	1.00	0.50
Long-term memory	0.15	-0.08	-0.08	-0.15	0.23	0.41	0.50	1.00

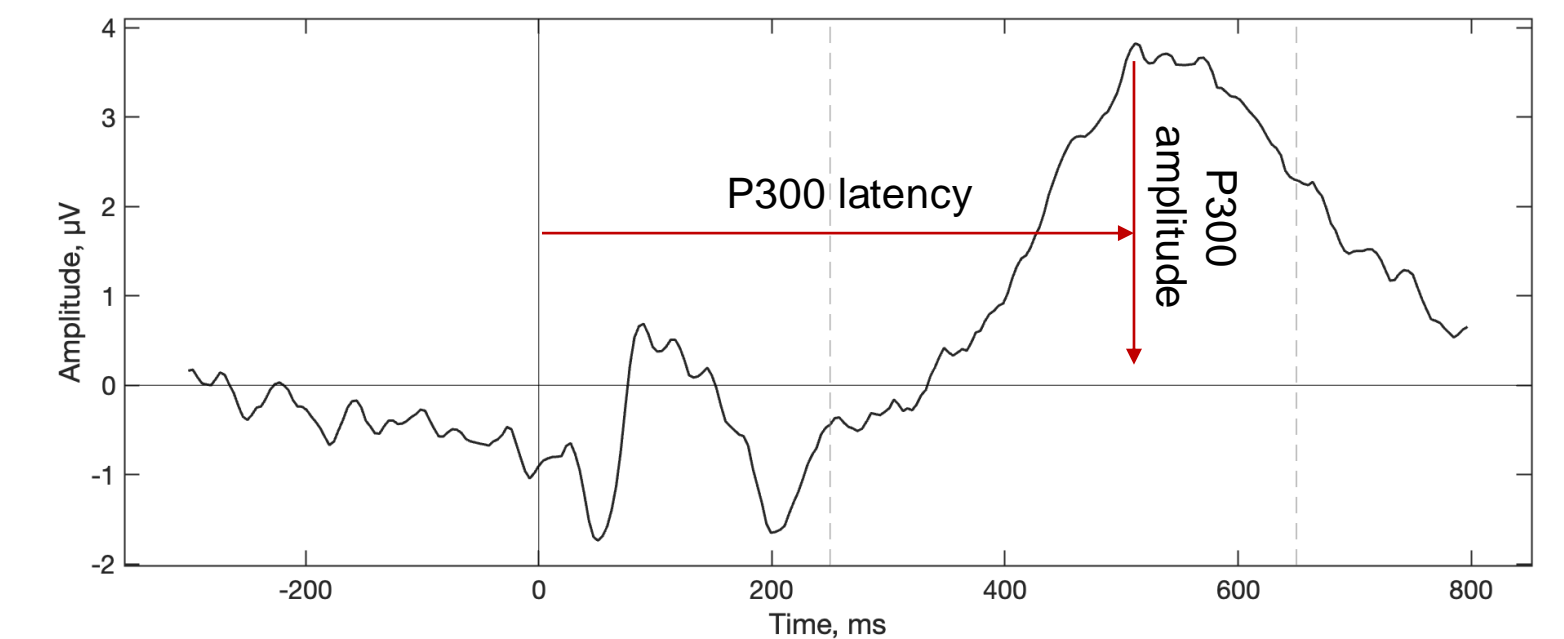


Figure 2. Grand average ERP time-locked to target stimulus onset

The accuracy of performance in Oddball task was high - $M=299$ ($SD=1.46$), which allowed to compute ERP P300 for the correct responses only.

Table 1 presents Spearman's rank correlations between ERP P300 components and cognitive function measures. As expected, STM, LTM, and WM measures were positively correlated, as were Tower of Hanoi response time and score. However, memory variables did not correlate with problem solving.

Importantly, ERP P300 amplitude and latency did not correlate with any cognitive function measures, contradicting the study's initial expectations.

CONCLUSIONS

The study anticipated correlations between ERP P300 components and verbal short-term and long-term memory, visuo-spatial working memory, and problem-solving abilities. However, no associations were found, possibly due to several factors:

- Variations in cognitive functioning levels within the sample, as indicated by MoCA test scores, may have obscured potential differences in cognitive performance.;
- Perhaps P300 components are related to other cognitive processes and not with those investigated in the study. In addition, studies that report P300 components differences in older adults in relation to a specific cognitive process evoke ERPs with a task engaging the same cognitive domain;
- The study focused solely on the Pz electrode, necessitating exploration of other parieto-temporal electrodes known to exhibit ERP P300;
- The classical Oddball task may not have been cognitively engaging enough. ERPs represent energy resources spent to process a stimulus. It is possible that auditory tone discrimination does not require great amount of energy resources to consistently show predictable variations in P300 components.

These factors are currently under investigation within the same research project.

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References:

