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Title of the doctoral thesis:

VISUAL SHORT-TERM MEMORY IN YOUNGER AND OLDER ADULTS – A COGNITIVE NEUROSCIENCE PERSPECTIVE

## ABSTRACT

**Background:** Deficits in cognitive functioning become more robust with aging, impacting an individual's ability to adapt to the environment. Taking into account the ever-growing number of older adults in modern societies, research focused on the mechanisms underlying those changes is needed. In particular, considering the crucial role of short-term memory in everyday functioning, the importance of studies regarding age-related differences in this area is highlighted. In the context of episodic memory, older adults, compared to younger adults, are more susceptible to false memories and are more confident of these erroneous responses. These differences are related to senescent changes in the hippocampus and frontal lobe activity. It is known that false memories may occur within a few seconds after encoding, but the knowledge about the age-related differences therein is limited. In particular, there is a lack of research that takes into account the differences in the subjective level of confidence and in the neural mechanisms underlying short-term false recognitions.

**Objectives:** The aim of this study was to analyze the age-related differences in false recognitions in the short-term memory, and in the neural mechanism underlying this phenomenon. The first goal of this work was to determine and compare the performance of younger and older adults, with regards to the rate of false recognitions of perceptually-related lures and the related confidence assessments. The second goal of this study was to identify the neural mechanisms of the observed age-differences.

**Methods:** The item based 'same'- 'different' recognition task, with following subjective confidence judgements and abstract objects used as targets, was developed to investigate the topic. Two experiments regarding false recognitions in the visual short-term memory were conducted – first a behavioral one, and then a neuroimaging one, with the use of functional magnetic resonance imaging technique (fMRI). Thirty-three younger adults (M 21.4, SD 1.84) and thirty-three older adults (M 60.2 SD 4.54) participated in the behavioral experiment. Next, the fMRI experiment was conducted in the 3T MR scanner Siemens Skyra. In this study twenty-five younger adults (M 24.2, SD 3.1) and twenty-six older adults (M 65.5, SD 4.6) participated.

**Results:** The behavioral results of the two experiments did not provide evidence for older adults' greater susceptibility to false recognitions in an item-based visual short-term memory. However, they indicate that, similar to the long-term/episodic memory, older adults are more confident of their erroneous responses. The fMRI results indicated that in younger adults the activity of the anterior cingulate cortex and frontal operculum/insular cortex is higher during false recognitions, compared to correct rejections, suggesting an

increased evaluation of errors and uncertainty. However, such pattern was not observed for older adults. The comparison of false alarms-related activity indicated the age-differences in activity of the visual cortex, the anterior cingulate cortex, the frontal operculum/insular cortex, and areas in the anterior prefrontal cortex and the medial frontal gyrus – the activity in these regions is higher in younger, compared to the older adults. In addition, only the differences in the visual cortex activity are independent of the individuals' metacognitive abilities. Also, an activity within both the frontal brain regions and the visual cortex is modulated by the individuals' performance. In particular, across both age groups better performance, measured by the sensitivity index, positively correlates with the activity of the anterior cingulate cortex.

**Conclusions:** To conclude, the obtained results indicate the age-related differences in the subjective level of confidence following erroneous recognitions, but do not show the age-related differences in the rate of false memories in an item-based visual short-term memory task. At the neural level, the results indicate the age-related differences in the activity of the visual cortex and frontal areas, suggesting older adults' less detailed memory representations and the age-related changes in the involvement of monitoring and cognitive control processes. The conducted research is novel and adds a new insight into the mechanisms of false recognitions in short-term memory in younger and older adults. To date, older adults' susceptibility to highly confident false recognitions was studied in the context of long-term/episodic memory. The obtained results shed light on the age-related differences in false recognitions in the visual short-term memory, including the related differences in the neural activity. Thus, this research stands as a basis for a new direction in the field of the neurocognitive aging. In addition, as the knowledge about neural bases of short-term false memories is still scarce, the current study also provides new information on the mechanisms underlying this phenomenon in the visual short-term memory.

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