Processing of novelty and familiarity in the aging brain

VI.7. Summary

Recognition memory is a form of episodic memory that promotes the discrimination of new items or experiences from previously encountered, familiar ones. Therefore, it has an essential role in record-keeping and updating the information we store about the environment. As such, it can effectively guide our behavior. Nevertheless, there is considerable debate in recent theories of memory about how the brain processes and stores new and familiar information. Some researchers argue for processing benefits of the former, while others argue for the mnemonic benefits of the latter. These mixed results can be attributed to differences in the experimental designs and the type of stimuli used. Therefore, this dissertation aimed to investigate further the processes underlying old/new recognition, such as pre-experimental stimulus familiarity, memory strength, and age. Throughout this dissertation, we used a three-phase old/new recognition memory paradigm (deep memorization, shallow memorization, and recognition) to test how the brain processes and responds to pre-experimentally unfamiliar abstract figures and non-words. Memory strength was manipulated as a function of the Levels of Processing. Strong memories were induced with deep encoding and repetition, while weak memories were achieved via shallow encoding without repetition. The included experiments' results were anticipated to reveal the factors that might influence effective recognition performance of stimuli without a pre-experimentally existing memory or meaning. Knowing how the brain processes these items can significantly improve our understanding of visual, lexical, and orthographic memory processing and contribute to designing relevant aging models.

In ***Chapter II,*** the role of memory strength and pre-experimental familiarity was tested using the above-described paradigm. To account for the effects of pre-experimental familiarity, we used pre-experimentally familiar and

unfamiliar visual and verbal materials (figures and words vs. abstract figures and non-words). The findings revealed that recognition performance primarily depends on experimentally induced memory strength as no differences were found between pre-experimental familiar and unfamiliar old item recognition accuracy. However, the new, unfamiliar figures were recognized better than the familiar ones, probably due to the more profound distinctiveness of the former. Regarding memory strength, we found that, independently of the stimulus being pre-experimentally familiar or unfamiliar, new item identification exceeded the correct old item recognition when the stimulus memory was weakly embedded but not when it was strongly embedded. Thus, this study indicates that while pre-experimental familiarity has a differential impact on visual and verbal materials, this is not the case for memory strength.

Chapter III reveals the underlying brain responses during old/new recognition of abstract figures and non-words using EEG. The results showed that successful new item identification was marked by a combination of the absence of familiarity (N400) and recollection (P600). For both the abstract figures and the non-words, the parietal P600 differentiated between the old and new items (late old/new effects). This study extends current knowledge on the processing of pre-experimentally unfamiliar visual and verbal items by showing that their discrimination depends on experimentally induced memory strength and that the underlying brain processes differ. Nevertheless, the P600, similarly to pre-experimentally familiar figures and words, likely reflects improved recognition memory of meaningless visual and verbal items.

In ***Chapter IV***, the above-described paradigm was tested in healthy young and elderly volunteers. It was found that older adults relative to the young showed impairment in the correct identification of new items. As indicated by the lower discriminability indexes, the elderly also had difficulties discriminating the strongly (drawn/semantically processed) and the weakly (studied) embedded

abstract figures but not the non-words. Age-related differences in reaction times were also only evident with the abstract figures. Finally, our results revealed that the recognition performance was equally affected by memory strength in both age groups. The current findings agree with previous research on age-related impairment in new item recognition, which can be attributed to misrecollection, decreased sensitivity to novelty, and less accurate novelty assessment in the elderly than the young. The detected age effects on the discriminability of the drawn and studied abstract figures agree with the age-related impairment in the perceptual encoding hypothesis and support the notion related to the need for environmental support to reduce age effects. The lack of age effects during the processing of the non-words indicates that age effects on discriminability appear to be stimulus-dependent. Thus, the current results support the notion that recognition memory in aging is only impaired under certain conditions and likely depends on the stimuli used.

The study in ***Chapter V*** investigated the effects of the muscarinic type 1 antagonist, biperiden, using the paradigm mentioned above with the aim to reveal whether this drug can be effective in modeling age-related memory impairments. The results of a double-blind, placebo-controlled, 2-way cross-over study are presented. It was found that 4 mg biperiden impaired recognition accuracy and prolonged reaction times of the drawn and the studied abstract figures. However, participants were biased towards 'old' responses in the placebo condition. The recognition of the new abstract figures was unaffected by the drug. Biperiden did not affect the recognition of the non-words. It was concluded that although biperiden may model age-related deficits in episodic memory, the current findings indicate that biperiden cannot mimic age-related deficits in recognition performance involving abstract figures and non-words.

Chapter VI includes the general discussion and reflections on the main findings of this dissertation, including the implications and directions for future research. Based on consistent findings presented in this dissertation, it can be said that the paradigm has reliably and consistently shown throughout all presented experiments the benefits of deeper Levels of Processing and repetition over shallow encoding without repetition. Additionally, experimentally induced memory strength has been found to affect old/new recognition. Namely, items with weak memory were less well recognized than the new ones. In contrast, items having strong memory representations were recognized better or just as well as the new ones. Furthermore, these findings were independent of pre-experimental familiarity, age, and pharmacological treatment with BIP, which suggests that experimentally induced memory strength is a stable and vital factor influencing old/new recognition. Regarding the underlying brain processes, the impact of age, and the blocking of the antimuscarinic receptors, it seems that there is a marked difference in the processing of pre-experimentally unfamiliar visual and verbal items. Therefore, further studies might benefit from including stimuli with both modalities to account for more accurate findings, especially considering the aging brain.