

# 学位論文の要旨

## Abstract of Thesis

研究科 School	ヘルスシステム統合科学研究科 Graduate School of Interdisciplinary Science and Engineering in Health Systems
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学位論文題目 Title of Thesis (学位論文題目が英語の場合は和訳を付記)

Study on audiovisual integration and cross-modal working memory training in young and older adults  
(若者と高齢者における視聴覚統合とクロスモーダルなワーキングメモリトレーニングに関する研究)

学位論文の要旨 Abstract of Thesis

Audiovisual integration refers to the phenomenon in which individuals effectively perceive visual and auditory information presented simultaneously as a unified and coherent perceptual experience. Audiovisual integration can enhance individuals' information recognition, resulting in more accurate and faster judgments of simultaneously presented audiovisual information. Neurologically, it is characterized by increased amplitudes and earlier latency. However, the topic of audiovisual integration in older and younger adults remains a subject of debate and requires further exploration. Additionally, early research primarily focused on the effects of audiovisual integration on detection tasks, while its impact on higher-level cognitive processes, such as working memory, requires further investigation. Due to differences in perceptual and cognitive abilities between older and younger adults, it is unclear whether audiovisual integration has different effects on working memory in these two groups. In addition, there is emerging evidence that working memory can be improved by training. Most working memory training tasks tend to be restricted to a single modality. However, the combined information from visual and auditory modalities could lead to audiovisual facilitation and enhance our ability to perceive the world. We also tested whether audiovisual working memory training led to training effects on working memory and transfer effects on perceptual processing. If audiovisual integration has a positive impact on working memory, can we improve working memory capacity through audiovisual working memory training and transfer those benefits

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to other related abilities across different age groups? This remains an open question.

This study consisted of three experiments. Experiment 1 aimed to investigate the neural and behavioral differences between older and younger individuals in the visual modality, auditory modality, and audiovisual modality by manipulating a simple detection task. Additionally, it sought to elucidate the differences in audiovisual integration between older and younger individuals. The results revealed that older adults exhibited significantly greater audiovisual integration than younger adults in terms of behavioral performance. Neurologically, older adults demonstrated earlier audiovisual integration in the early stages (110-140 ms, 140-170 ms) compared to younger adults (190-250 ms), but delayed integration in the later stages (350-380 ms) compared to younger adults (300-360 ms).

In Experiment 2, we compared the audiovisual n-back task to the visual n-back and auditory n-back tasks to determine whether working memory in the audiovisual condition could lead to better performance. The results showed that reaction time in the audiovisual condition was faster than that in the visual and auditory conditions across both younger and older adults, indicating that audiovisual integration has a positive impact on working memory.

In Experiment 3, we investigated whether audiovisual working memory training could induce training effects and transfer effects. For younger adults, we found that working memory performance improved, as reflected by accuracy and response time across the 1-back, 2-back, and 3-back levels after training. The ERP (event-related potential) results showed that the P300 component was enhanced in the frontal and central regions across all conditions. Additionally, the N200 component was also enhanced in the central region in the 3-back level. In terms of neural oscillations, alpha oscillations were enhanced after training at 250-300 ms. Transfer effects were also observed in younger adults, as reflected by greater audiovisual integration in the early stage (80-120 ms) in the training group. For older adults, the behavioral results showed that audiovisual n-back training led to a training effect on the 3-back level, which represents a relatively higher cognitive load. The ERP results showed that the N200 latency was earlier after training. In terms of neural oscillations, alpha oscillations were enhanced at 220-250 ms. For the transfer effect, greater audiovisual integration was found at 180-200 ms, indicating that audiovisual working memory training yielded transfer effects on audiovisual processing.