学位論文の要旨

Abstract of Thesis

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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 Interaction in Visual Detection and Discrimination by Behavioral and Event-related Potential Experiments

（行動学と ERP による視覚検出と識別における視聴覚統合に関する研究）

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Sensory perception comprises the detection of salient events in space and time as well as their discrimination with regard to specific features or configural properties and recognition. In traditionally viewing, detecting the presence of an object is a different processing than identifying the object as a particular object. However, in the literature on visual categorization, researchers have reached controversial conclusions such as “as soon as you know it is there, you know what it is” or that “as soon as you know an object is there, you do not know what it is”. Additionally, people obtain dynamic effective information from the complex environment through multiple senses in everyday life. Audition also is one important sensory system that human use to perceive the environment. The brain handles multiple sensory signals (80% were vision and audition) automatically and effortlessly to provide a more accurate message in order to shape and guide our behavior. Therefore, it is important to study interaction across audiovisual sensory modalities. However, the neural mechanism of audiovisual interaction is not completely clear at all. Besides, how visual stimulus (feature of spatial frequency and contrast, or visual intensity) alter audiovisual interaction is also unknown. The aim of the present study was to clarify how our brain processes audiovisual information in different perception stage and whether the processing of different visual stimulus affect audiovisual interaction.

Firstly, to clarify whether visual detection and visual discrimination depend on same mechanism, a visual detection and visual orientation discrimination task were used to test the visual threshold with

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different spatial frequency. Our results showed that there were no significant different in threshold between visual detection and visual discrimination, whereas the response time for visual detection were faster than that for visual discrimination. These results suggesting that the perceptual of detection and perception might rely on partially separate mechanisms.

Secondly, to investigated whether audiovisual interaction is different for different perceptual processing, a visual detection and visual identification task with/without a task-irrelevant auditory stimulus were conducted to examine the effect of experimental task on audiovisual interaction, and the difference between different spatial frequency. The results confirmed that the response for visual discrimination was slowed, and task-irrelevant auditory stimulus speedup visual response in both visual detection and visual discrimination (so called “audiovisual interaction”), and the magnitude of audiovisual interaction were same for all spatial frequency in each task due to high contrast. However, audiovisual interaction in visual detection were larger than that for visual discrimination. Our results provided empirical evidence that complex of perceptual processing would affects audiovisual interaction.

Thirdly, to further clarify the effect of visual spatial frequency on audiovisual interaction, the visual detection task with/without a task-irrelevant auditory stimulus was performed. The results showed that spatial frequency modulates auditory facilitation of visual detection at low contrast (20%) but not at high contrast (100%). Moreover, the data revealed that audiovisual interaction was larger for low (0.54 cycles/degree) and high (6.46 cycles/degree) spatial frequencies than for a medial spatial frequency of 0.70 cycles/degree (all $p < 0.05$). However, when the visual stimulus was adjusted to the same perceived intensity for each spatial frequency by changing contrast, no significant difference was found among the different spatial frequencies ($p > 0.05$). The current results suggested that the stimulus intensity of a visual stimulus is the key factor for audiovisual interaction.

Lastly, to investigate the neural mechanism of visual intensity on audiovisual interaction, a visual orientation discrimination task with/without a task-irrelevant auditory stimulus were performed using event-related potential (ERP) method. Consisted with our previous study, behavioral results showed that task-irrelevant auditory stimulus facilitated visual discrimination, suggesting audiovisual interaction occurred. The ERP results showed that in the low intensity (3.47 c/d) condition existing the earliest integration (50-90 ms) in the left posterior region, and this audiovisual interaction was

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delayed from auditory cortex (50-90 ms) to visual cortex (70-90 ms), suggesting that auditory enhanced low intensity visual perception via direct or indirect connectivity from auditory cortex to visual cortex during early stage(cortico-cortical). Moreover, the audiovisual interaction over fronto-central area were delayed with decreasing visual intensity (230-260 ms, 240-300 ms and 280-320 ms for the intensity of 1.00, 1.86 and 3.47 c/d). In addition, audiovisual interaction over parietal-occipital area were delayed with decreasing visual intensity (310-500 ms, 390-500 ms and 480-500 ms for the intensity of 1.00, 1.86 and 3.47 c/d). These results suggested that the audiovisual interaction pattern was different with visual intensity, and further revealed a delayed audiovisual interaction resulting from the slowed visual processing.

According to the current situation, future studies will focus on special populations (e.g. older people, patients with Mild cognitive impairment, Alzheimer's disease, and Schizophrenia) to uncover the neural mechanism of audiovisual integration and to provide important basis for the early clinical detection and rehabilitation of special brain disease.