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）

Psychophysical Studies on Modulation Mechanism of Attentional Load in Audiovisual Integration
(視聴覚統合における注意負荷の調整メカニズムに関する心理物理学的研究)

学位論文の要旨 Abstract of Thesis

We live in a world, which is rich in information from many sensory modalities (e.g., auditory, visual, olfactory, and somatosensory). The brain can screen available information from multiple senses and integrate them to better perceive the external environment, thereby shaping and guiding our behaviors. Most of the information that humans use to recognize the world is derived from auditory and visual modalities. For example, when one tries to localize a singing bird flitting between the branches of a tree with luxuriant foliage, the combination of auditory and visual input information - as compared to using only auditory or visual information - will probably increase the accuracy and speed of the localization process. The phenomenon by which stimuli from visual and auditory sensory organs can be integrated into a coherent representation to better perceive information is called audiovisual integration (AVI). Although it is generally believed that attention plays a complex and multifaceted role in the integration of input from different sensory modalities, whether AVI is affected by top-down attentional load remains less clear. Additionally, stimulus congruency (e.g., semantic congruency, spatial congruency) may be proposed as a factor that determines the extent of attentional effects on AVI. Therefore, the main aim of this present thesis was to investigate how attentional load interact with stimulus congruency to influence AVI.

In part 1, we rigorously examine how semantic congruency interacts with attentional load to influence the AVI of common objects by applying a dual-task paradigm. Currently, many studies are beginning to use a dual-task paradigm in which a distracter task is adopted to modulate the levels of the endogenous attentional resources available for the secondary task to explore the effect of attentional load on AVI processing. In present study, we adopted a rapid serial visual presentation (RSVP) task as the distractor task to impose different levels of attentional load, namely, no load, low load, and high load. Specifically, participants were instructed to ignore the presented RSVP stream under no load condition, while participants simultaneously performed the AVI task and a distractor task that required them to search a central RSVP stream for either a yellow letter (low load) or a white digit (high load). The AVI was assessed by adopting an animal identification task using unisensory (animal images and sounds) and AV stimuli (semantically congruent AV stimuli and semantically incongruent AV stimuli). The results confirmed that attentional load did not attenuate the integration of semantically congruent AV stimuli. However, semantically incongruent animal sounds and images were not integrated (as there was no multisensory facilitation), and the interference effect produced by the semantically incongruent animal sounds and images was reduced by increased attentional load manipulations. We further observed an asymmetric cross-modal interference effect

supporting the visual dominance hypothesis; specifically, the auditory distractor effect was stronger than the visual distractor effect under all attentional load conditions. These findings highlight the critical role of semantic congruency in modulating the effect of attentional load on the AVI of common objects.

In part 2, to further clarify how the cross-modal interaction of AV stimuli is influenced by increased attentional load when attention is only focused on visual modality (selective attention to visual modality), and whether semantic association between AV stimuli modulates the effect of increased attentional load on the AVI of common objects. We manipulated the amount of available attentional resources by applying a dual-task paradigm and constructed three attentional load levels (no load, low load, and high load) by using a rapid serial visual presentation (RSVP) task. Additionally, individuals are instructed to ignore the auditory stimuli, and only response to visual target in the AVI task. And semantic associations between AV stimuli were composed of animal pictures presented concurrently with either semantically congruent, incongruent or unrelated auditory stimuli. The results showed that attentional load did not reliably alter the amount of the auditory enhancement effects caused by semantically congruent AV stimuli on this task. However, attentional load disrupt the auditory enhancement effects of the semantically unrelated and incongruent AV stimuli. These findings suggested that the strong semantic associations between AV stimuli played an important role in withstanding the effect of attentional load on AVI of modality-specific selective attention.

In part 3, we explored whether increased attentional loads would have different influence on the cross-modal interaction of simple and arbitrarily AV stimuli presented at the same or different spatial positions. We will adopt an RSVP stream as the distractor task to manipulate different attentional load: no load, low load, and high load. Specifically, participants simultaneously performed the AVI task and a distractor task that required them to search a central RSVP stream for either a red letter (low load) or two different coloured letters (high load) in a series of different coloured characters. Under no load condition, participants were only asked to response to AVI task. In the AVI task, participants were instructed to respond to a specific image (black‑white checkboard with two black dots) while ignoring all sounds (i.e., pure tone and white noise). And spatial congruency was controlled by presenting visual and auditory stimuli in the same or different locations. The results showed that significant audiovisual integration of spatial congruent AV stimuli occurred regardless of attentional load; however, increased attentional load reduced the integration of spatial incongruent AV stimuli. These findings highlight the critical role of spatial congruency in modulating the effect of attentional load on the integration of simple and arbitrarily AV stimuli.

In conclusion, we found that whether AVI is influenced by increased attentional load conditions depends on stimulus congruency between AV stimuli. Specifically, when using complex naturalistic common objects which corresponds to semantic content and operates on a higher level, our results show that semantic congruency plays a critical role in modulating the effect of attentional load on this AVI processing, whether or not in distributed audiovisual attention or focused visual attention settings. Further, when not using complex naturalistic common objects, but presenting simple and arbitrarily paired bimodal stimuli, we found that attentional load did not attenuate the integration of spatially congruent AV stimuli, but disrupted the integration of spatially incongruent AV stimuli. Thus, it seems that stimulus congruency plays a critical factor in modulating the effect of attentional load on the AVI. According to the current situation, future studies will focus on the neural mechanism of the effect of attentional load on the AVI for older adults and other special subjects. Based on the fact that the attentional statues of these special subjects will also alter greatly due to the increase of age and the development of some diseases, it is interesting to explore whether the decline of attention is an important factor that influence the automatic integration of semantically congruent AV stimuli.