Chapter 10

Effects of Stimulus Complexity on Bisensory Audiovisual Integration

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ABSTRACT

With the rapid increase in the number of elderly people, the number of people with dementia is also increasing. The most common form of dementia is Alzheimer’s disease, which accounts for 50-70% of all dementia cases. Until the present time, however, there was no effective early detection method for Alzheimer’s disease. A recent study showed that brain glucose metabolism in healthy volunteers was different than glucose metabolism in Alzheimer’s patients during the response to passive audiovisual stimulation. This result suggested that the mechanism of audiovisual integration in patients with Alzheimer’s disease was influenced by the disease. In the present study, the authors investigated the effects of modality-specific selective attention on audiovisual integration using simple visual and auditory stimuli in healthy human subjects. Three different attentional instructions were accessed: (1)
visual selective attention, in which subjects were instructed to focus their attention on visual stimuli; 
(2) auditory selective attention, in which subjects were instructed to focus their attention on auditory 
stimuli; and (3) audiovisual divided attention, in which subjects were instructed to focus their attention on both visual and auditory stimuli. The results showed that significant bimodal enhancement was present only in the divided attention condition, which is similar to the results of a previous study using complex semantic stimuli. Therefore, the authors conclude that stimulus complexity does not influence the modality-specific selective attention effects of audiovisual integration. A future study will examine the mechanism of audiovisual integration in patients with Alzheimer’s disease using the same experimental design (using simple stimuli), which will hopefully help find a new method for the early detection of Alzheimer’s disease.

INTRODUCTION

Audiovisual Integration

Humans are constantly bombarded with information from multiple sensory organs. For instance, when driving a car, we are surrounded by visual (road, roadside billboards, signaling lamps, etc.), auditory (car engine, music from vehicle CD player, etc.), and somatosensory (feeling the steering wheel, etc.) information. Some of this information is task-relevant (road, signal lamp, car engine, feeling the steering wheel), while other information is task-irrelevant (roadside billboard, music from vehicle CD player). To focus on the relevant information and ignore the irrelevant information, the human brain is equipped with a selection mechanism known as attention. The attention system allows us to dynamically select and enhance the processing of objects and events that are the most relevant at each moment. The brain can then combine the task-relevant information from anatomically different sensory pathways to form unified percepts.

Atypical example of the audiovisual interaction is the McGurk effect, which was first described in a paper by McGurk and MacDonald in 1976. When a video of one phoneme production is dubbed onto a sound recording of a different phoneme that is spoken, the perceived phoneme is a third, intermediate phoneme. For example, a visual /ga/ combined with an audio /ba/ is often heard as /da/.

The McGurk effect demonstrates an interaction between hearing and vision in speech perception (McGurk & MacDonald, 1996).

Alzheimer’s Disease and Audiovisual Integration

The population of elderly people is increasing rapidly, and the number of people with dementia is increasing accordingly. It is estimated that there are currently approximately 18 million people worldwide with Alzheimer’s disease (AD). This number is expected to nearly double by 2025 to 34 million. Unfortunately, we currently have no effective early detection method for Alzheimer’s disease. AD is a progressive, degenerative brain disorder, and a recent study showed that brain glucose metabolism in healthy volunteers differed from glucose metabolism in Alzheimer patients during their response to passive audiovisual stimulation (Pietrini et al., 2000). This result suggested that the mechanism of audiovisual integration was altered in AD patients. Therefore, it might be possible to detect Alzheimer’s disease at an early stage by observing a patient’s audiovisual integration.

Previous Studies Regarding Audiovisual Integration

Many studies have investigated the bimodal audiovisual integration in healthy individuals
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