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Visual Attention and Detection of Auditory Stimuli

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Abstract

This study examines bimodal perception through modified inattentional blindness paradigm. It is a phenomenon of failure to notice a clearly distinguished stimulus when attention is focused on other stimuli. The main goal of this research is to test a cross-modal effect of this phenomenon. Two experiments were conducted. The visual attention was focused on estimating the length of the lines. In one trial, an auditory stimulus appeared unexpectedly and simultaneously with the visual task. The type of auditory stimulus was varied. The results show that focusing attention on the visual task does not limit the auditory perception. Failures in detection appear when additional sound, like a white noise, is included. The effect of white noise depends on the type of sound stimulus.

Keywords: visual attention, auditory stimuli, bimodal perception

Introduction

Visual perception is a process that enables us to get information about the environment that surrounds us. This process is largely determined by the attention. Visual attention is the first step in the processing of information because it provides their selection in space and time (Chun & Wolfe, 2001; Wolfe, 2000). But, when people are focused on the visual task, a certain amount of other information in the visual field remains unregistered. This phenomenon is known as *inattentional blindness* (Mack & Rock, 1998; 2000). It is not a result of damage of visual apparatus, neither is it a permanent state. During full involvement in a particular task, there is a temporary blindness to other content. Most of the research of this phenomenon has been focused on studying within one sensory modality – visual (Most et al., 2001; Simons & Chabris, 1999). But, within other sensory modalities, there is a certain type of „insensitivity". It was found that subjects cannot detect new tactile or olfactory stimuli if their attention is engaged in the task from the same modality (Dattel et al., 2013). Similar results are also obtained in auditory modality (Koreimann & Gula, 2014). Though many human activities involve the interaction of visual and auditory inputs, it raises the question about the effect of crossmodal attention in perception. Whether the engagement of the attention of a certain degree, regardless of a sensory modality, is a sufficient factor that limits the ability to detect prominent information in our surroundings?

The aim of this study is to examine the role of visual attention in detecting of stimuli that belongs to other sensory modality (auditory). This study also seeks to determine whether the type of auditory stimulus affects the efficiency of detection.

Considering that in everyday life we are not exposed to only one isolated sound source, this research also examined the effect of the white noise on noticing certain tones. The obtained results should contribute to understanding the importance of attention in a multisensory environment.

Experiment 1

Sample

44 participants participated in the experiment. 10 of a total number of participants participated in control trials that were conducted in order to test whether auditory stimuli can be heard at all with focused attention. These subjects correctly detected tones and their results were not included in further analysis. The final sample consisted of 34 participants, students of the University of Banja Luka (mean age of 20.9 years, range of 19 to 22). All subjects had normal or corrected to normal vision and normal hearing. They were tested individually. Although it is necessary to take measurements from a large sample of participants in order to obtain a reliable estimate of dependent variable, numerous researches of inattentional blindness were conducted on smaller samples (Furley & Memmert, 2010; Koivisto & Revonsuo, 2008; O'Shea & Fieo, 2015; Pěrez-Moreno, Conchillo & Recarte, 2011). Also, Schreiber et al. (2006) suggested that each parameter analyzed in the experiment should have at least 10 participants. Since there are only two categories of the independent variable in this experiment, the sample size may be considered acceptable.

Design and Procedure

The experiment consisted of four trials. Each trial began with the presentation of fixation point in the center of the computer screen for 500ms. After that, the cross was presented at the same location for 250ms. Subject's attention was focused on the visual task of estimating the length of the cross's lines. The same task was repeated through four trials. In the last trial, an unexpected auditory stimulus was presented simultaneously with the visual task. The type of auditory stimulus was varied. Two qualitatively different tones (Tone 1 – *Fizzaerosol*, Tone 2 – *Wooden ball bounce on ceramic tile*) were selected from the Laurie Heller's environmental sound events database[2]. Tones were 16-bit, 44.1 kHz. The

[2] A written permission was obtained for use

number of correct detections was measured when attention was engaged in a visual task.

Results and Discussion

Eighteen out of nineteen subjects (94%) detected Tone 1 and fourteen out of fifteen subjects (93%) detected Tone 2. The results showed that subjects achieved great accuracy in reporting of hearing the unexpected stimulus. Test of proportion is not statistically significant ($z = .1727$, $p = .86$), so it can be concluded that accuracy did not depend on the type of auditory stimulus. Such findings suggest that the stimulus detection in one sensory modality is relatively independent of attention engagement in another sensory modality.

Experiment 2

Sample

44 new participants participated in this experiment. Ten subjects were included in control trials in order to test the stimulus detectability with focused attention and accompanying by white noise. All ten subjects responded correctly and these results were not included in further analysis. The final sample consisted of 34 first-year and second-year students of the University of Banja Luka.

Design and Procedure

The stimuli and procedure were the same as in Experiment 1. The only difference was a white noise that was played through all four trials.

Results and Discussion

Ten of eighteen subjects (55%) detected Tone 1 and thirteen of sixteen (81%) detected Tone 2. The number of detections is higher for Tone 2, but the test of proportions is at the border of statistical significance ($z = -1.599$, $p = .055$).

Since the experimental procedure was the same as in Experiment 1, the results were compared to determine the differences between "silent" and "noisy" conditions. Figure 1 displays the detection results for two experiments.

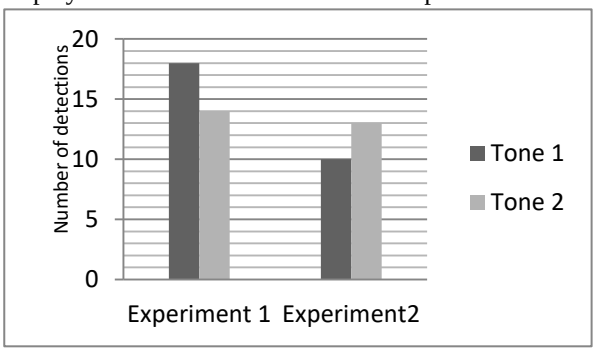

Figure 1. Results of tone detections in two experiments (with different conditions – silent and noisy)

The presence of white noise significantly reduced the ability to detect auditory stimulus when attention was focused on the visual task ($\chi^2(1,68) = 7.703$, $p < .01$). There is also a difference in detecting one type of auditory stimulus in the presence and absence of white noise ($\chi^2(1, 37) = 7.709$, $p < .01$). This finding suggests that failures in the detection of stimulus in one sensory system do not depend on the available resources of the different sensory system, but this effect is not the same for various unattended stimuli.

General discussion and conclusion

Attention has a major role in perception because it provides information selection and speeds up their processing. But, attention has limited capacity, so it often happens that a strong focus on one sensory input occupies all the available resources of attention and other sensory inputs remain unregistered. This research examines whether the same phenomenon occurs when inputs belong to different sensory modalities. Considering that many human activities involve concurrent reception of information from ear and eye, this study of bimodal perception has focused on the role of visual attention in the detection of auditory stimuli.

The findings of this study show that focusing attention on the visual task does not limit the auditory perception. Participants have registered exposed tone with high accuracy. Sinet et al. (2006) found the same results suggesting that there are separate attention resources in each of these sensory systems. The detection of auditory stimuli without an active focus on them is highly adaptive because warning and alarm signals are often unexpected and unannounced. Dalton and Lavie (2004) stated that auditory stimuli receive high processing priority and can be depicted as an early warning system. When additional sound, like a white noise, is included in the experiment the detection of isolated tones in the absence of focused attention significantly decreases. These results clearly show that detection of auditory stimulus does not depend on the engagement of visual attention, but depends on the additional load of the auditory sensory system. The presence of irrelevant sound consumes most of the auditory attention capacity and leaves less available resources for noticing other information from the same modality.

This study also shows that the effect of white noise depends on the type of sound stimulus. One type of stimulus is easier to detect in the presence and absence of white noise. It is possible that one tone is blending with background noise due to their similarity.

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