A Preliminary Study on fNIRS-based RSVP Target Detection

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***Abstract*— Recently, functional infrared spectroscopy (fNIRS) has been widely used in the development of brain-computer interfaces (BCIs) due to its advantages of portability and noise resistance. In this study, we proposed a novel fNIRS-based BCI for target detection using rapid serial visual presentation (RSVP) paradigm. Despite the slow temporal resolution of fNIRS, it was possible to find a difference in the concentration of oxygenated hemoglobin depending on the inclusion of the target or not. Therefore, we could experimentally validate the feasibility of fNIRS-based BCI using the RSVP paradigm.**

Keywords—fNIRS, target detection, RSVP

I. Introduction

EEG has been most commonly used in the development of brain-computer interfaces (BCIs) especially using the rapid serial visual presentation (RSVP) task due to its high temporal resolution [1]. On the other hand, functional near infrared spectroscopy (fNIRS) was less used due to its low temporal resolution caused by the time delay of the hemodynamic response [2]. However, recently, as the advantages of portability and low sensitivity to noise have been highlighted, it has started to be used in BCI [3]. In this study, we report preliminary results for target detection in the RSVP paradigm using fNIRS-based BCI.

II. Method

A. Stimuli

The STL-10 dataset contains color images with 288×288 pixels of objects such as airplane, car, ship and truck [4]. In this study, we set the airplane class as a target, and the rest of transportation images were set as non-targets. We isolated an object of each image from the background and the background of the stimulus was set to black. In total, 94 target images and 720 non-target images were prepared for the experiment. We made 14 image sequences containing 20 images that were selected randomly. Target sequence contains a target image.

B. Experimental design

Six subjects (all females, 23.33 ±1.46 years) participated 14 RSVP trials that were 7 target and 7 non-target sequences in a random order. Fig. 1 shows the timeline of the experiment.

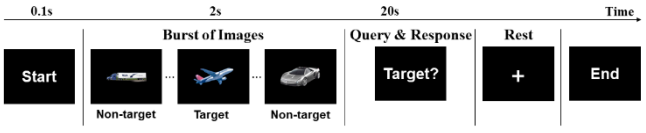

Fig. 1. Timeline of the experiment

Each sequence started with a 'Start' message. Subjects viewed a burst of 20 images for 2s with a 100ms presentation rate. They were then asked to press a key '1' (yes) or '0' (no) depending on the presence or absence of a target in the current sequence. The sequence ended with an 'End' message after 20s of the rest displaying a fixation cross. The fNIRS were recorded using 15-channel with the NIRSIT Lite (OBELAB Inc., Seoul, Republic of Korea).

III. Results

During the RSVP task, the average of the oxygenated hemoglobin concentration change (ΔHbO) was higher than the average of the de-oxygenated hemoglobin concentration change (ΔHbR). Further, we compared ΔHbO between target and non-target sequences. We could observe the prominent difference between target and non-target sequences in channels 1 and 2, as shown in Fig. 2 and Fig. 3.

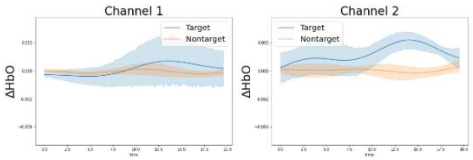

Fig. 2. The average ΔHbO in the 1st sequence

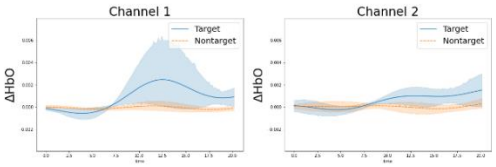

Fig. 3. The average ΔHbO in the 3rd sequence

IV. Discussion and Conclusions

In this paper, we experimentally verified the feasibility of fNIRS-based BCI using the RSVP paradigm. By adjusting experimental parameters, we will further extend this work to propose the robust BCI for the target detection.

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