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Analysis of Cerebral Activation in Users Induced by Visual Stimulus Variation

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Abstract. This study presents the analysis of the changes in cerebral activation state induced by the visual stimuli delivered through the combination of colors, and derived significant results associated with the changes in cerebral activation state in relation to concentration index, psychological index, etc., based on the variation of stimulation. The results of this study may provide basis for building the efficient visual stimulating interfaces necessary for achieving the goals in various application in medical, educational fields, robotics, functional game sectors, and many more.

Keywords: We would like to encourage you to list your keywords in this section.

1 Introduction

The method for measuring the cerebral activation includes the Positron Emission Tomography(PET), functional Magnetic Resonance Image(fMRI), and the method using the electrocorticography (ECoG) apparatus. The functional Magnetic Resonance Image(fMRI) measures the cerebral activation by using the blood oxygenation level dependent(BOLD) signal. BOLD has the advantage of strong and excellent signal and can measure the entire brain, but has the time-consuming and costly problem [1-3]. Although the electrocorticography(ECoG) apparatus can measure only local regions of the brain, it can resolve the problem of time and cost and has been used increasingly more for the advantage that it is harmless to human body and provides convenience.

Amid such trends, researches have been conducted vigorously to analyze the state of human cerebral activation state induced by color stimulus using the colors or images. The visual stimuli used in these researches include the and pictures with combination of various colors, interior design, color light changes, flashing color light, etc[4,5]. However, there are problems that the method involving the color stimuli is not systematic and dependent on the reaction alone. Therefore, in this study, we selected the 6 colors of red, yellow, green, cyan, blue, and purple colors, using the CMYK color code and educational 20 color wheel designated by the Ministry of

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Education, in order to resolve such problems. Moreover, the visual images were produced by dividing the colors into background color and character color to analyze the cerebral activation state of user.

2 Analysis of cerebral activation state based on the changes in visual stimuli

In this study, an experiment was conducted to investigate into the cerebral activation state of the user for visual stimuli. The experiment was carried out by minimizing the external factors (light, noise, etc) in a booth with a holding capacity of 1 person to ensure stable extraction of brain waves from the subjects. 50 subjects in their 20s and 30s (comprised of 25 men and 25 women) were selected for this experiment who were healthy without any neurological or mental illness, color-blindness and cognitive impairment

2.1 Color stimulation method

In this experiment, we selected the 6 color groups comprised of A. red, B. yellow, C. green, D. cyan, E. blue, and F. purple colors, using the educational 20 color wheel designated by the Ministry of Education as shown in Fig 1 and CMYK color code in Fig. 2 as the background color and character colors.

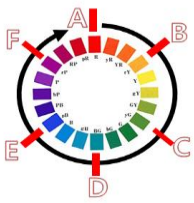

Fig 1. 20 color wheel designated by the Ministry of Education

Fig 2. CMYK color code

Table 1. Example of color group placement table

	Main Colors	**Background Colors**
Image Type 1	Character A	Background A
Image Type 2	Character A	Background B
Image Type 3	Character A	Background C
• • •	• • •	• • • •
Image Type 36	Character F	Background F

In Table 1, the colors were divided into the color groups comprised of 6 representative colors of A, B, C, D, E, and F designated in Fig. 2 and 3. If one of the main colors in characters are selected, the color wheel turns clockwise based on the color group where the concerned main color belongs. By combining the color groups of the background in the order of A, B, C, D, E, and F, the color group consisting of 36 colors is selected. In case that the character color and background color are same, the intensity of the concerned character color is lowered by one step based on CMYK color code for color group combination.

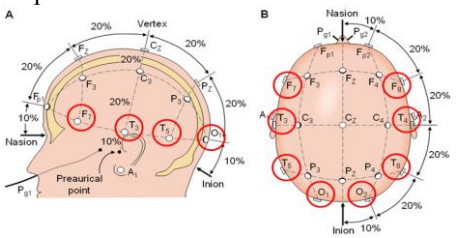

Fig. 2. 10·20 Montage using the electrode placement method

Fig. 2 shows the montage used in this experiment. Using the montage, a total of 10 positions were selected, including F7 and F8(related to cognitive domains in brain structure), T3, T4, T5, and T6(responsible auditory and visual information), 8 points of O1 and O2 (responsible for visual area) , earlobe A1, and A2-based electrode.

3 Experimental Results and Conclusions

This study presented the experiment investigating into the visual stimulus-induced cerebral activation state of the user to analyze the changes in cerebral activation state of human responding to the color stimuli. By applying such results, various application services are expected to be developed. For example, the cerebral activation in delta band of certain user might be considered necessary to achieve specific functional goals. If this user watches video images, the functional goal may be achieved by the exposure to stimulus delivered through combination of colors including the cold colors such as green, cyan, blue, and purple colors. If this user is taking a rest without being exposed to the stimulus of video images, the colors combining the green, cyan, and blue colors which were used prior to the resting time can be presented to reinforce the cerebral activation state in delta band of the user. The findings of this study suggests that the changes in cerebral activation state of subjects were concurrent with the manifestation of various characteristics, depending on the presented type of colors providing visual stimulus, and the results were statistically significant. The results of this study can be applied to select the color stimuli capable of inducing effective changes in cerebral activation state based on the goals of application, and provide basis for building efficient visual stimulation interfaces in sectors such as medical, educational fields, robotics, functional game, and advertising sectors, etc.

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