

Influence of moving sight by turning over frequency

Shinya ISHIHARA* Keisuke SAWADA* Takayuki KINOSHITA* Tomohiro ISHIDA**
Keiko MOMOSE** Masato MAENO*** Kenji YANASHIMA*** Kazushige MAGATANI*
*Tokai University **Waseda University *** National Rehabilitation Center

Abstract— In late years, f-MRI (functional Magnetic Resonance Imaging) are used for analysis of a visual function. In case of the study for a visual function, the checker flag pattern consists of white square and black square is usually used for sight stimulation. In sight stimulation using this pattern, a color of square (black and white) changes alternately at constant frequency. It is usually called pattern reversal stimulation.

When this pattern is used for stimulation, the subject sometimes feels movement for the shown stimulation pattern. We think that this sensation of movement relates to spatial frequency (that means the size of a square of a stimulation pattern) of a stimulation image and a turning over frequency of a stimulation pattern strongly. Our objectives of this study are the following.

- 1) Clarify a part of the brain that is a cause of this moving sensation.
- 2) Investigate the relationship among the magnitude of this sensation, spatial frequency and turning over frequency.

Three normal adults were used for the subject. This time, turning over frequency was changed from 0Hz to 8 Hz by 1Hz step under fixed spatial frequency. Under this condition, we examined the state of activation of a V1 area. In addition, we examined whether BOLD effect varied with a change of a stimulation color. In this experiment, we used blue and yellow color instead of black and white for stimulation, and the reaction was examined.

Key word—fMRI visual cortex color V1 field MT field

1. INTRODUCTION

We studied about a reaction of the BOLD effect by using 8Hz pattern reversal visual stimulation. As for us, the activation as the reaction of the stimulation was observed in the MT and V1 area. MT area is also called a V5 area of a visual cortex. It is proved that all neuron of this area has the motion reactivity and the selectivity of a moving direction. And it is also known that destruction of the MT area of a monkey causes the ocular movement disorder. From these results, we think that MT area controls ocular movement and sight for movement of a person. And Beckers and Homberg reported that the reduction of an activity of occipital lobe while 30 or 40ms by short term magnetic stimulation to the head causes the lost of identification of a moving direction temporarily. And it is also reported that slight reduction of dynamic sight was observed from 70 or 80ms after stimulation by magnetic stimulation to the V1 area. This result means that information of the dynamic sight will transmit from V1 to V5 area and then the feedback information will transmit from V5 to V1, and finally we can realize the dynamic sight.

The MT area is also activated by the pattern reversal stimulation. And we think that the reaction in a V1 area will be also amplified by this pattern reversal stimulation. So, the reaction of V1 area and MT area that is caused by the change of turning over frequency is investigated using black and white pattern reversal stimulation.

We also investigated the reaction using another color pattern reversal. In this investigation, pattern reversal of blue and yellow is used for the sight stimulation. For example a pair of red and green, blue and yellow, black and white, and so on is called complementally color mutually. Fig.1 shows the hue circle. In this figure, one color and the opposite color is the pair of complementally color. And pair of the complementally color has the strong contrast. One pair of complementally color (blue and yellow) was used for the pattern reversal stimulation. Used colors were fixed based on their chromaticity. Before experiment, the chromaticity of stimulation color was measured and fixed by a chromaticity meter. In the pattern reversal stimulation that used a pair of complementally color, the change of turn over frequency causes the change of the contrast of stimulation pattern. In this experiment, we use the two types of contrast for the stimulation pattern. One is based on turning over frequency and the other is based on the brightness. And the results of activation from these stimulation were compared.



Fig.1 hue circle

2. MEASUREMENT SYSTEM

A f-MRI of Magnetom Vision Plus 1.5T (Siemens Co.) was used for measurement of f-MRI images. For visual stimulation and audio attention, STIM (Physio-Tech Co.) that works on IBM PC/AT clone and generates visual patterns for stimulation and sound for attention was used. A generated stimulation pattern was projected by a liquid crystal projector to the permeable screen that was set in front of the gantry of f-MRI. A f-MRI we used is shown in Fig.2. STIM on IBM PC/AT clone is shown in Fig.3 And a liquid crystal projector is also shown in Fig.4. A subject can see the pattern as a reflection image from the mirror that was set in front of his/her eyes. Fig.5 shows the schematic image of a condition of our experiment. And a generated sound for attention was given a subject by a headphone.



Fig.2 Magnetom-Vision-Plus1.5



Fig.3 STIM



Fig.4 liquid crystal projector

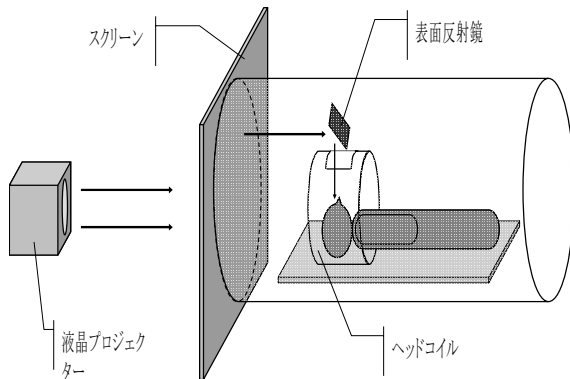


Fig.5 the image of MRI when we are taking image

3. EXPERIMENT METHOD

Fig.6 shows the sequence design of our experiment. Three normal subjects were tested by using this sequence.

For the first experiment we gave a black and white pattern reversal image with a fixation point that was indicated as a red circle on the center. An example of this stimulation pattern is shown in Fig.7. In our measurement system, external trigger for the scan was used, and a block paradigm was used for f-MRI measurement. As shown in Fig.6, the trigger interval was set at 3 seconds and 12 seconds of task period and 18 seconds of rest period were set in our experiment. Also we gave the subject the sound for attention, 0.4 second before the start point of task period. In this experiment, we wanted to know the change of magnitude of BOLD effect by the change of turning over frequency. Therefore, turning over frequency was changed from 0Hz to 8 Hz by 1Hz step under fixed spatial frequency. And in order to shorten measurement time, f-MRI image of 3 different frequency were measured at once. As shown in Fig.6, f-MRI using turning over frequency of 0Hz, 3Hz, and 6Hz were measured at first measurement. 1Hz, 4Hz, and 7Hz were at second measurement, and 2Hz, 5Hz and 8Hz were third. In this experiment, in order to obtain the difference among each frequency clearly, turning over frequency was shifted every 3Hz for one measurement.

For the second experiment, blue and yellow pattern reversal image were used. This image is shown in Fig.8. Sequence design of f-MRI measurement and some experimental condition were same as the first experiment. Only stimulation pattern was different. Before experiment, the chromaticity of stimulation color is measured and fixed in this experiment.

In both experiment, Z-score was used as the statistical evaluate of experimental results. In addition, ROI was decided by using Dr.View.

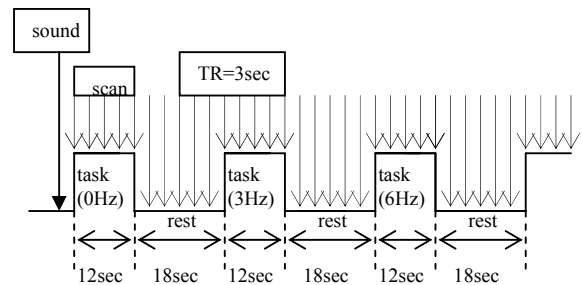


Fig.6 Sequence design Experiment

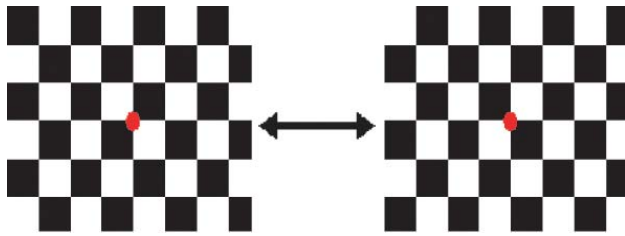


Fig.7 stimulation image for first experiment

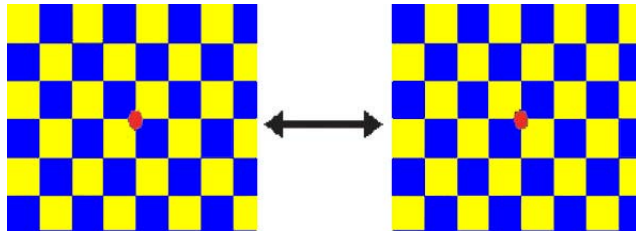


Fig.8 stimulation image for second experiment

4. RESULT

In this paper, the results of first experiment are shown. Fig.9 shows the ROI of the experiment. The trend of the intensity of BOLD effect for each turning over frequency at the V1 area are shown in Fig.10. And the trend of the same value at the MT area are shown in Fig.11. From these results, we can see the clear difference among the different stimulation frequency.

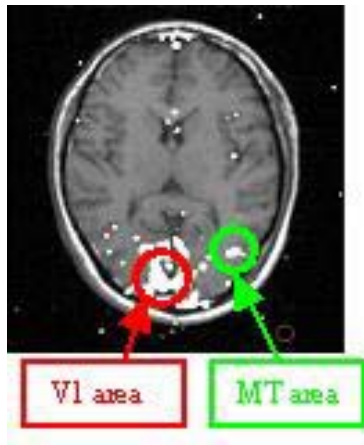


Fig.9 investigation area

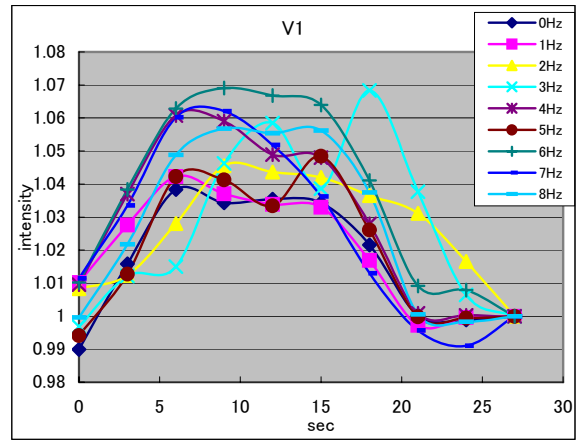


Fig.10 BOLD curve of frequency change in V1 area

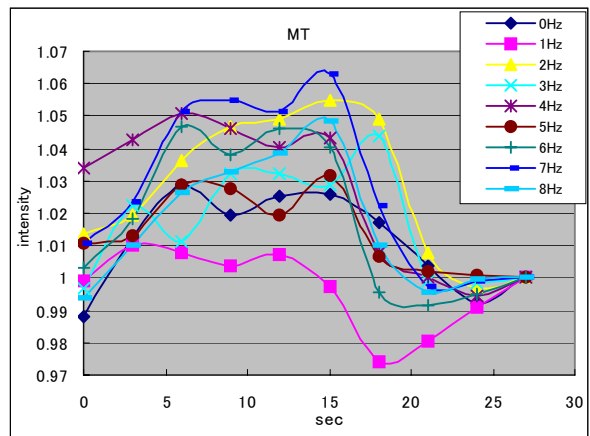


Fig.11 BOLD curve of frequency change in MT area

5. CONSIDERATION

As shown in Fig.10, the turning over frequency is concerned with the BOLD effect intensity strongly in the V1 area. As frequency increase, the intensity becomes increase. And as shown in Fig.11, the same tendency in V1 area is observed in MT area. In this area, as turning over frequency increase, the intensity becomes increase. Therefore, we think that a speed of the movement affects the activation of both V1 and MT area. And same tendency is observed by using colored pattern reversal stimulation. Therefore we concluded that the relationship between V1 area and MT area for dynamic sight becomes clear by continuously experiments using various stimulation frequency and stimulation color.

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