Arousal Effect of ELF Magnetic Stimulus on Car Driver's Spine Evaluated with Occipital Electro-encephalogram and Back Magneto-cardiogram

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Abstract— We found two positive effects in the human body activity induced with an extremely low frequency (ELF) distributed magnetic field stimulus at the spine position: (1) Increasing of the defined arousal index $(\alpha+\beta)/(\theta+\delta)$ up to around 3.0 in the occipital electro-encephalogram (O-EEG), and (2) Increasing of the energy concentration in the FFT frequency spectra for the back magneto-cardiogram (B-MCG) measured with the Pico-Tesla resolution magneto-impedance sensor.

Probable correlation between the arousal center in the brainstem and the aorta with the aorta corpuscle via the vagus nerve concerning a mutual activation is discussed on the basis of the phenomena.

1. INTRODUCTION

We have developed an effective and safe method for prevention of the drowsiness during car driving with the ELF distributed magnetic stimulus on the driver's body surface at the spine [1–3] and at the pit of the stomach [4] using the magnetized olivine sintered particle train. The ELF magnetic field is applied to the blood water when the blood flows through the periodic alternating pulse distributed magnetic field generated on the sintered magnetic particle train resulting the generation of the free protons and the ATP production is promoted in the bio cells for body activation due to the magneto-protonics principle [5].

Both magnetic stimuli resupply the bio-body energy ATP on the basis of the magneto-protonics and so are not accompanied with so-called the "rebound problem" inducing a deeper drowsiness after a tentative arousal with the sensory stimuli such as the flush light, the sound or voice, the perfume shot and so on.

Thus, we tentatively concluded that the ELF magnetic stimulus on the spine position is superior for the arousal than that on the pit of the stomach after in comparison the increasing rate of the arousal index $(\alpha+\beta)/(\theta+\delta)$ between them for eleven subjects in the driving simulator test. On the basis of the results, we investigated a dependency of the EEG with the head position concerning the arousal index change after application of the ELF magnetic stimulus at the spine position for three subjects and found a remarkable arousal effect occurred at the back of the head position for all subjects. We also measured the back magneto-cardiogram of the same subjects using the pico-Tesla resolution magneto-impedance sensor [6] and found a remarkable change in the FFT frequency spectrum for the heart stroke magnetic-field time series with application of the ELF magnetic stimulus. That is, a remarkable simplification of the frequency spectrum reflecting the heart stroke system energy concentration is induced with the ELF magnetic stimulus. Thus we may consider a relationship between the arousal effect and the heart stroke activation effect with the identical ELF magnetic stimulus on the basis of the physiology showing the vagus nerve connecting mutually the brain stem and the aorta with the aorta corpuscle [7]. We also found a possibility of a visual perception activation effect with the ELF magnetic stimulus on the basis of an experimental result of a 0.5 second displayed patterns recognition test.

2. EXPERIMENTAL PROCEDURE

We use a rubber coated 9 mm diameter olivine sintered magnetized particle train belt, as illustrated in Fig. 1, which generates the bio-activation magnetic field with around 2-cm period alternating pulse distributed train for the ELF magnetic stimulus. When the human blood water runs through the magnetic field with around 30 cm/s, the water is exposed to an ELF (around 15 Hz) magnetic field and generates free protons. The serotonin production rate at the medulla is promoted with the increased ATP due to the free protons and activates the arousal function.

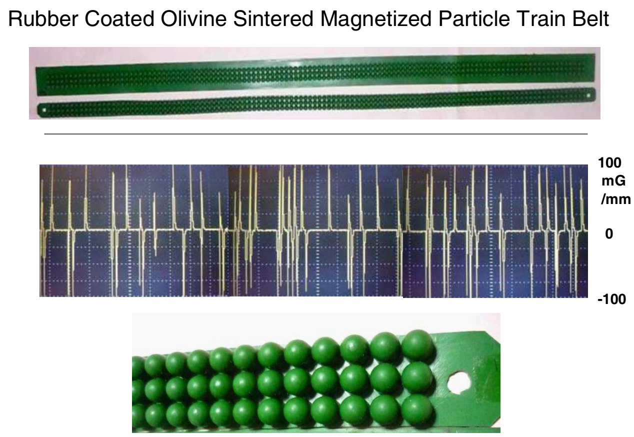


Figure 1: Rubber coated 9 mm diameter olivine sintered magnetized particle train belt generating bio-activation magnetic field with around 2-cm period alternating pulse distributed train.

3. EXPERIMENTAL RESULTS

3.1. Electro-encephalogram Measurements

Figure 2 represents measured results of the arousal index $(\alpha + \beta)/(\theta + \delta)$ for eleven subjects (22–28 years old) after 20-min. night time simple high-way driving in the driving simulator without magnetic stimulus, with the spine ELF magnetic stimulus, or with the pit of the stomach ELF magnetic stimulus. The EEG measurements were carried out for each subject in different three days in a week. Therefore, we tentatively concluded that the ELF magnetic stimulus at the spine position was the most effective for the arousal.

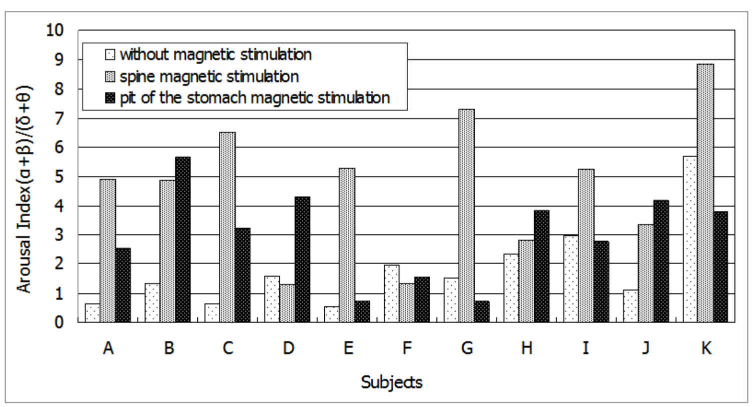
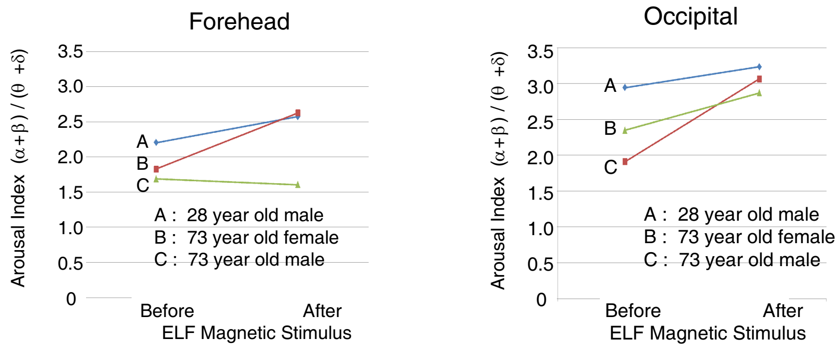


Figure 2: Arousal index of eleven subjects measured after 20-min. night time simple high-way driving in the driving simulator without magnetic stimulus, with the spine ELF magnetic stimulus, or with the pit of the stomach ELF magnetic stimulus.

Figure 3 shows the change of the arousal index for three subjects (28 year-old male (A), 73 year-old female (B), and 73 year-old male (C)) with the ELF magnetic stimulus applied to the spine position. The EEG measurement at the forehead and the occipital (back of the head) was carried out for each subject quietly sitting on a car driver's seat with closing eyes before the magnetic stimulus and after the 30-min. ELF magnetic stimulus with contacting the magnetized belt on one's spine position. We found that a remarkable arousal effect occurred in the occipital EEG with the ELF magnetic stimulus for all subjects, whilst the arousal was occurred for the two subjects and slightly decreased for the one subject in the forehead EEG.

3.2. Back Magneto-cardiogram

We detected the magneto-cardiogram at the left shoulder blade bottom position (Back-MCG) of the subject to which the amorphous wire head of the pico-Tesla resolution magneto-impedance sensor (PT-MI sensor) [6] is slightly touched via a cloth. We have found that the Back-MCG may reflect the activity of both the heart muscle and the aorta muscle referring the double-peak waveform in



(a) (b)

Figure 3: Change of the arousal index with application of the ELF magnetic stimulus at the spine: EEG measurement at (a) the forehead, and (b) the occipital (back of the head).

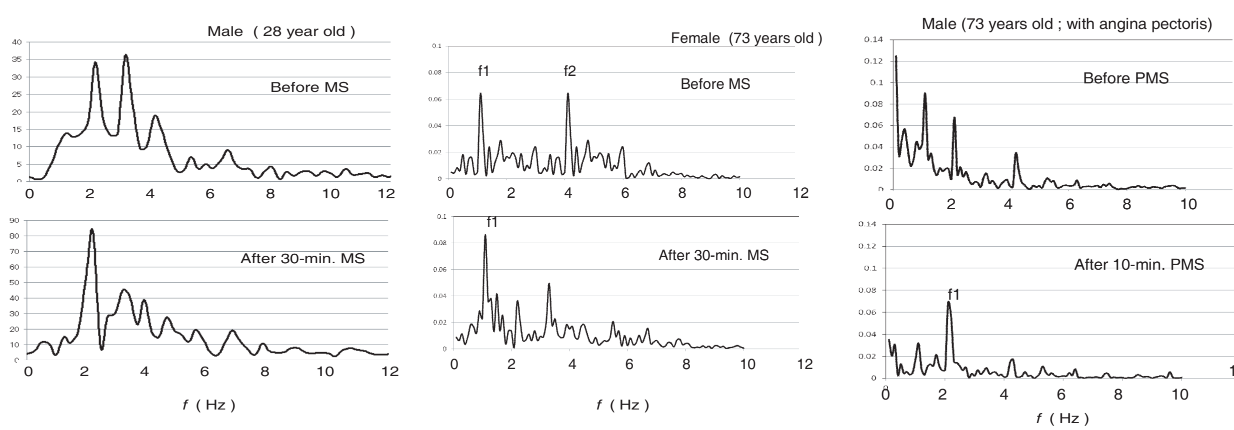
the Back-MCG, while the double-peak waveform does not appear in the Chest-MCG [8].

Figure 4 illustrates the FFT frequency spectra of the measured Back-MCG for three subjects same to the case of Figure 3 before and after application of the ELF magnetic stimulus: the 28 year-old male in (a), the 73 year-old female in (b), and 73 year-old male in (c). We found remarkable change in these spectra with the ELF magnetic stimulus showing energy concentration to the frequency f_1 which is considered as the basic heart stroke frequency of the heart-aorta blood flow system [8]. It is considered that the ELF magnetic stimulus may activate and increase the stability of the blood flow system.

Both experimental results of Figure 3 for the occipital EEG and Figure 4 for the Back-MCG suggest a relationship of the arousal center and the blood flow system and may support an activation model for the arousal center near the medulla in the brain stem and the blood flow system connected each other with the vagus nerve system with the spine ELF magnetic stimulus promoting the ATP production in the bio cells in the back of the human body.

The remarkable activation effect for the arousal in the area of the back of the head suggests a possibility of activation of the visual function. Therefore, we investigated an influence of the spine ELF magnetic stimulus for a flash displayed alphabet small characters visual recognition test as shown in Figure 5: A dotted line was before the ELF magnetic stimulus applied 30 min. at the spine and a real line was after the stimulus.

The subject (73 year-old male) has trained 7 days before the test and found almost no influence of the stimulus on the test in ordinary healthy condition. An influence appeared as in Figure 5 for the subject in a bad condition with such as a headache. The total point was improved from 73 to 91 points.



(a) (b) (c)

Figure 4: FFT frequency spectra of measured Back-Magnetocardiogram (Back-MCG) before and after application of the ELF magnetic stimulus: (a) the 28 year-old male, (b) the 73 year-old female, and (c) the 73 year-old male.

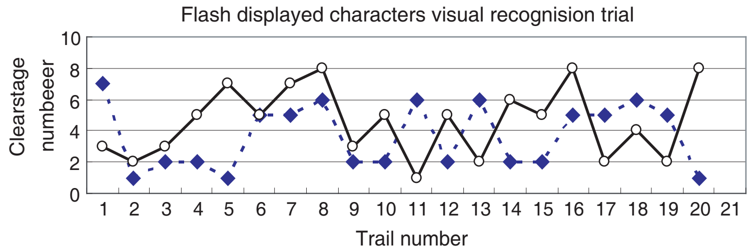


Figure 5: Improvement of a flush-displayed characters visual recognition ability with the spine ELF magnetic stimulus. The real line is after the spine ELF magnetic stimulus.

4. CONCLUSIONS

A remarkable arousal effect was obtained for the occipital EEG with the spine ELF magnetic stimulus.

Significant energy concentration appeared in the FFT frequency spectra with the spine ELF magnetic stimulus. Possible relation between them was discussed.

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