PHYSIOLOGICAL AND NEURO-BEHAVIORAL EFFECTS OF AN EXPOSURE TO A 60 HZ MAGNETIC FIELD AT 1800 MICROTESLA

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Introduction

Extremely Low Frequency (ELF) magnetic fields (MF) effects on humans have been studied over the past 20 years, and it has been reported that they can affect brain electrical activity and human motor control. For example, recent results suggest an increase in occipital alpha rhythms of resting electroencephalographic activity (EEG) with exposure [1, 2]. Interestingly, other studies have demonstrated that human motor behaviour can be modulated by ELF MF, showing a reduction of standing balance amplitude and a decrease in physiological tremor intensity with exposure [3-7]. However, to establish a connection between these observations would require a project that, in one procedure, investigates physiological, neurophysiological and behavioural parameters. Thus, the main objective of the present work is to evaluate subtle effects of a 60 Hz MF exposure at 1800 μT on human EEG, electrocardiogram (ECG), peripheral blood perfusion, standing balance, performance in voluntary movements of the hands and physiological tremor in a single experimental procedure.

Methods

Ninety-three participants were involved in the study and seventy-three completed the entire experiment (UWO REB # 11956E). The study consisted of two counterbalanced exposure sessions given on two separate days (one active/real session and one control/sham session). A double blind procedure was insured by the use of a computer driven program (National Instrument Inc., USA) that controlled each variable so neither the participant nor the experimenter knew when the real or sham condition occurred. Each session included four blocks of testing (15 minutes each) with 15 minutes of rest in between them. Block 1 started 15 minutes prior to exposure, Block 2 began after 15 minutes of exposure, Block 3 started after 45 minutes of exposure, and Block 4 commenced 15 minutes after exposure ended. During each block, resting EEG (Siesta, Compumedics Inc., USA), physiological tremor (tip of the dominant index finger, Micro Laser Sensor, Matsushita Electronic Work, Ltd., Japan), voluntary movements of the hands (Liberty, Polhemus Inc., USA), and standing balance (OR6-7-1000, AMTI, USA) were sequentially recorded. Local blood perfusion (tip of the non-dominant middle finger) and systolic blood pressure (PF 5010 Laser Doppler Perfusion and blood pressure monitoring unit, Perimed, Sweden), as well as ECG (Siesta unit) were also collected. Specific indexes characterizing the above mentioned parameters were computed for each experimental condition and were used as variables in statistical analysis. Skin temperature was monitored throughout the experiment. After each block, the subject answered a Field Status Questionnaire to assess field detection ability.

Results

A repeated measures ANOVA, 2 (Sham/Real) x 4 (Block) x 2 (Eyes or Frequency), was conducted for every characteristic computed in each test (SPSS 16.0, USA). Probability values were corrected for lack of sphericity using the Greenhouse-Geisser epsilon. Bonferroni pairwise comparisons were conducted when main effect or interaction were found. Briefly, a MF effect has only been found with respect to standing balance (eyes closed condition only), showing, for example, a decrease in sway velocity- average velocity at which the body naturally oscillates while standing; $P < .05$, $F = 3.13$, $eta^2 = .05$. Detailed results will be reported on the poster.

Discussion

One hour of 60 Hz, 1800 μT MF exposure does not seem to modulate neurophysiological processes involved in EEG, physiological tremor, and voluntary rhythmic movement generation. However, as already reported by our group [7], results show a significantly decreased standing balance during exposure. Since this effect appears only during the eyes closed condition, it suggests that the exposure may act on proprioceptive and/or vestibular functions. Note that these results will be completed by those focusing on peripheral blood perfusion and ECG. The following phase of this project is beginning and focuses on cognitive function and brain activity during a 60 Hz MF exposure up to 3000 μT.

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References

1. Cook, C.M., Thomas, A.W., and Prato, F.S. "Resting EEG is affected by exposure to a pulsed ELF magnetic field", *Bioelectromagnetics*, **25(3)**, 2004, pp. 196-203.

2. Ghione, S., et al. "Effects of 50 Hz electromagnetic fields on electroencephalographic alpha activity, dental pain threshold and cardiovascular parameters in humans", *Neurosci Lett*, **382(1-2)**, 2005, pp. 112-7.

3. Legros, A. and Beuter, A. "Effect of a low intensity magnetic field on human motor behavior", *Bioelectromagnetics*, **26(8)**, 2005, pp. 657-69.

4. Legros, A. and Beuter, A. "Individual subject sensitivity to extremely low frequency magnetic field", *Neurotoxicology*, **27(4)**, 2006, pp. 534-46.

5. Legros, A., Gaillot, P., and Beuter, A. "Transient effect of low-intensity magnetic field on human motor control", *Med Eng Phys*, **28(8)**, 2006, pp. 827-36.

6. Pavlov, A.N., et al. "Using wavelet analysis to detect the influence of low frequency magnetic fields on human physiological tremor", *Physiol Meas*, **28(3)**, 2007, pp. 321-33.

7. Thomas, A.W., Drost, D.J., and Prato, F.S."Human subjects exposed to a specific pulsed (200 microT) magnetic field: effects on normal standing balance", *Neurosci Lett*, **297(2)**, 2001, pp. 121-4.