BEMS Abstract 2014

Title: Threshold for magnetophosphenes perception and EEG response in humans exposed to 50 and 60 Hz MF up to 50,000 µT

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Short Abstract (500 characters max): 479 characters (72 words)

OBJECTIVE: Quantify human EEG response and magnetophosphene perception in 50 and 60 Hz MFs up to 50 mT.
METHODS: Magnetophosphene perception and EEG collected during 55 MF conditions at 50 and 60 Hz.
RESULTS: Magnetophosphene perception threshold between 10 and 30 mT depending on the exposure conditions.
CONCLUSIONS: Pilot results provide a preliminary estimate of magnetophosphene perception threshold at 50 and 60 Hz. Associated EEG changes will be presented at the conference.

Long Abstract (10,000 characters max): 7444 characters (1121 words)

INTRODUCTION

Guidelines from the International Commission for Non-Ionizing Radiation Protection (ICNIRP) and standards from the Institute of Electrical and Electronics Engineers (IEEE) are providing international recommendations regarding human exposure to Extremely Low Frequency Magnetic Fields (ELF MF, below 300 Hz, ICNIRP, 2010; IEEE, 2002). For power-frequency exposures, these recommendations are based on the extrapolation of existing experimental data on magnetophosphene perception thresholds, as reported by Lövsund in the early eighties (Lovsund et al., 1980). However, uncertainties persist regarding the threshold for magnetophosphene perception in humans at power-frequency (Kavet et al., 2008; Saunders and Jefferys, 2007). Indeed, this threshold is reported to be the lowest at 20 Hz (between 5 and 10 mT), and to increase with frequency (Lovsund et al., 1980; Silny, 1986). However, the threshold is only extrapolated at 60 Hz and no experimental data acquired in humans are actually available. The current project is therefore aiming to establish the thresholds for systematic acute, objective and quantifiable responses in humans exposed to 50/60 Hz MF of up to 50 mT. The selected outcomes include magnetophosphene perception and associated brain electrical activity as measured by electroencephalography (EEG).

MATERIAL AND METHODS

Two groups of healthy volunteers (to date, n = 23 at 60 Hz and n = 15 at 50 Hz) are each tested in 2 localized exposure conditions (eyeball and occipital cortex using a small coil) and 1 global head exposure condition. Each frequency group is scanned with 11 magnetic flux density conditions (from 0 to 50 mT, 5 mT increments) lasting five seconds each. Flux density conditions are each repeated 5 times and separated with five seconds without exposure. A computer program randomly assigns the order of presentation of the MF flux density conditions. During this protocol, the volunteers are sitting eyes closed in a dark room, and are asked to report magnetophosphene perception by button-press, while their occipital EEG activity is continuously recorded. Each experimental condition starts after 5 minutes of adaptation to the darkness. An MRI-compatible EEG system/cap/cable (Neuroscan-Compumedics Inc, Melbourne, Australia) is used, allowing EEG recording during 50 mT MF exposure. It is expected that magnetophosphene perception will be associated with a decrease in EEG alpha (8-12 Hz) spectral power in the visual/occipital cortex. This protocol is approved by the Health Sciences Research Ethics Board of Western University (HSREB #18882).

RESULTS

Pilot testing has begun for this project and so far, group results clearly show magnetophosphene perceptions both at 50 and 60 Hz (n=15 and 23 respectively) for retinal (Fig. 1, left panel) and global (Figure 1, right panel) exposures, starting to occur at flux densities below 50 mT. Separated repeated measures ANOVAs with a between-subjects factor testing for MF flux density (11 flux density modalities: 0 to 50 mT) and for MF frequency (2 frequency modalities: 50 and 60 Hz) effects were conducted on these preliminary data. Only results from the button-press detected magnetophosphenes in the retinal and global head exposure conditions are reported here (Figure 1). Results from the occipital exposure condition and from EEG analyses will be reported at the conference. Results showed a significant main flux density effect (**Retinal exposure** – Figure 1, *left panel*: F= 56.25, p<.001, Partial Eta^2=.61, Power=1 ; **Global exposure** – Figure 1, *right panel*: F=85.85, p<.001, Partial Eta^2=.71, Power=1) for both retinal and global exposure conditions, indicating a detection threshold occurring between 10 and 25 mT depending on the local *vs.* global exposure conditions. Interestingly, interaction effects confirmed the differential frequency response reported at lower frequencies (Losvund et al., 1980): the magnetophosphene threshold is lower in terms of flux density at 50 Hz than at 60 Hz both in **retinal** (Figure 1, *left panel:* F= 3.15, p<.05, Partial Eta^2=.08, Power=.62) and in **global** (Figure 1, *right panel*: F=3.37, p<.01, Partial Eta^2=.09, Power=.85) exposure settings.

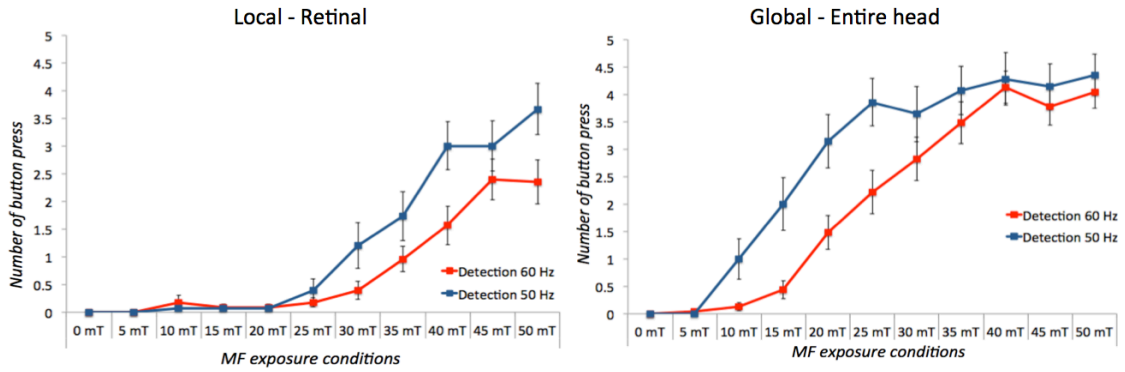

Figure 1: *Left panel:* Averaged number of button-press in the 50 Hz exposed group (n=15) and in the 60 Hz exposed group (n=23) as a function of MF flux density - retinal exposure, showing a magnetophosphene perception threshold between 25 and 30 mT depending on the frequency condition. Higher flux densities lead to a higher detection rate. *Right panel*: Averaged number of button-press in the 50 Hz exposed group (n=15) and in the 60 Hz exposed group (n=23) as a function of MF flux density - global head exposure, showing a magnetophosphene perception threshold between 10 and 15 mT depending on the frequency condition. Higher flux densities are associated with a higher detection rate.

CONCLUSIONS

This project allows the experimental testing of power-frequency MF exposures of up to 50 mT in humans. It investigates concomitantly a self-reported perception (magnetophosphenes) and an objective neurophysiological outcome (EEG), both acquired during the exposure. Based on preliminary data, the threshold for magnetophosphene perception is between 10 and 15 mT at 50 Hz, and between 25 and 30 mT at 60 Hz, Global head exposure seems more effective in generating magnetophosphene perception than local eye exposure. This might be mainly due to the inhomogeneity of the field produced by our local exposure system associated to potential small head movements produced by volunteers during experimental tests. The fact that the threshold is lower at 50 Hz than at 60 Hz confirms the differential frequency-response reported by Losvund et al. (1980) at lower frequencies, and deserves further investigation. The efficacy of an eye exposure to generate magnetophoshenes tends to confirm that the mechanism of action is originating in the retina. This is supported by our results from the occipital exposure condition (which will be presented at the conference) showing no associated magnetophosphene perception. When integrated, EEG results are expected to provide an objective insight related to the subjective perception. This is an ongoing experiment to reach a conclusive N-size (an attempt to increase the final group size is in process). This project will provide solid experimental data acquired in humans to refine exposure guidelines, which may also offer opportunities for translational research.

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