Title: Example of direct biophysical effects in the ELF range

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INTRODUCTION

Guidelines from the International Commission for Non-Ionizing Radiation Protection (ICNIRP) and standards from the Institute of Electrical and Electronics Engineers (IEEE) provide international recommendations regarding human exposure to Extremely Low Frequency Magnetic Fields (ELF MF, < 300 Hz [1,2]). For power-frequency exposures, these recommendations are based on extrapolations from a direct biophysical effect: the threshold for human magnetophosphene perception as reported by Lövsund [3]. This threshold is reported to be the lowest at 20 Hz (5-10 mT) and to increase with frequency [3,6], however at 60 Hz, this threshold has not been experimentally tested [4,5]. This current project is aiming to characterize the threshold for magnetophosphene perception and associated EEG responses in humans exposed to power-frequency magnetic fields of up to 50 mT.

MATERIAL AND METHODS

Two groups of healthy volunteers (targeted n = 30 at 60 Hz and 30 at 50 Hz) are tested in 2 localized exposure conditions (eyeball and occipital cortex) and 1 global head exposure condition. Each of the 2 tested frequencies (2 groups) undergoes 11 MF flux density conditions (from 0 to 50 mT, 5 mT increments, 5 s each). Flux density conditions are each repeated 5 times (random order, separated by 5 s without exposure). Tested volunteers are sitting eyes closed in a dark room, and are asked to report magnetophosphene perception by button-press, while occipital brain electrical activity (EEG) is recorded. An MRI-compatible EEG system/cap/cable (Neuroscan-Compumedics, Australia) is used to collect EEG during MF exposures. Magnetophosphene perception is expected to be associated with a decrease in EEG alpha (8-12 Hz) spectral power in the visual cortex. This protocol is approved by the Health Sciences Research Ethics Board of Western University (HSREB #18882).

RESULTS

Preliminary group results from our pilot testing indicate clear magnetophosphene perception, as reported by button-press, for retinal (Fig. 1, left;) and global (Fig. 1, right) exposures at both 50 and 60 Hz, but not for occipital exposure. The detection

threshold is between 10 and 30 mT depending on local/global – 50/60 Hz exposure conditions. Interestingly, the flux density threshold is lower at 50 Hz than at 60 Hz (Fig. 1). Statistical results and EEG responses will be reported at the workshop.

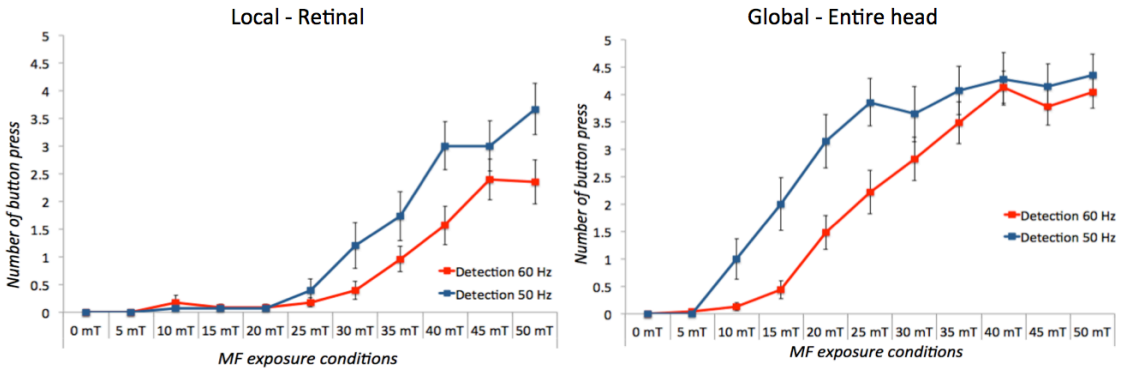

Figure 1: *Left panel* - Averaged number of button-press in the 50 Hz exposed group (n=15) and in the 60 Hz exposed group (n=23) as a function of MF flux density. *Right panel* - Averaged number of button-press in the 50 Hz exposed group (n=15) and in the 60 Hz exposed group (n=23) as a function of MF flux density.

CONCLUSIONS

Magnetophosphenes are the expression of a self-reported direct biophysical effect, and the associated EEG will provide objective information in terms of neurophysiological outcome (EEG). Based on our preliminary results, the detection threshold seems to be between 10 and 15 mT at 50 Hz, and between 25 and 30 mT at 60 Hz. The fact that the threshold is lower at 50 than at 60 Hz confirms the differential frequency-response previously reported at lower frequencies [3]. EEG data and results from occipital cortex exposure will be presented at the workshop. These results obtained in humans exposed to up to 50 mT will provide solid data useful to exposure guidelines, also offering opportunities for translational research.

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