Effects of a 60 Hz, 3000 MicroTesla Magnetic Field on Human Cognitive Processing

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AIM OF WORK

Health effects from human exposure to Extremely Low Frequency (ELF, < 300 Hz) Magnetic Fields (MF) have been actively studied; however, no consensus has been reached. The most recent cognitive studies have not found (or replicated previous) MF-induced effects [1]. However exposure intensities were different than in past studies that reported cognitive effects from exposure to an ELF MF. In these studies changes generally appeared in higher level cognitive processes, such as attention, learning, and memory [2, 3]. The majority of these studies with MF-induced changes indicate an influence on the accuracy and precision of cognitive mechanisms rather than the velocity of execution [2, 3]. Psychometric testing allows for the quantification of performance in specific cognitive functions such as mental imagery, processing speed, selective attention, spatial perception, working memory, and visual-motor coordination which are investigated in this work. The purpose of this work is to examine if a 60 Hz, 3000 µT MF induces any cognitive changes. Following up on our preliminary results presented last year [4] and based on the literature, we hypothesize exposure to the 60 Hz, 3000 µT MF will decrease the accuracy in test performance but will not affect the time participants take to carry out the task.

MATERIALS AND METHODS

To date 74 participants (between the ages of 18 and 49) have completed a computer driven (LabView 8.5, NI Inc., USA) double-blind protocol with real and sham exposure conditions. Participants came into the lab for two sessions given on two separate days: a baseline session (Se1) followed by an experimental session (Se2). During Se1 (no MF exposure) participants complete the Beck Anxiety Inventory, Beck Depression Inventory-II, and the Wechsler Adult Intelligence Scale-III. The purpose of Se1 is to determine baseline levels of the participants' anxiety, depression, and intelligence. Prior to starting Se2, participants were pseudo-randomly assigned to one of three groups, which determined the distribution of exposure conditions (figure 1). During a "real" exposure condition the whole-body Helmholtz-like coil system produces a 60 Hz, 3000 µT MF (oriented ear-to-ear) with the homogeneous region centered at the level of the participant's head.

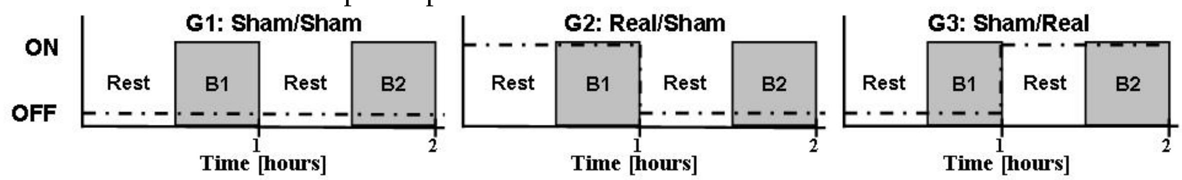

Figure 1: Each of the 3 groups (G1, G2, and G3) completes the same psychometric tests during experimental block 1 (B1) and block 2 (B2) with the same time frame. Only the distribution of the 1 hour exposure condition varies across the groups: G1: sham / sham, G2: real / sham, G3: sham / real).

In Se2, the participant completed two blocks of testing (figure 1) each consisted of performing the following tests in sequence: Digit Symbol Encoding, Block Design, Arithmetic, Digit Span, Trail Making A&B, Stroop, Mental Rotation, and Fitts' Task. These tests were selected because they are validated with test re-test capability and have been used previously by studies in ELF MF research [see for example 1, 2, and 3]. For the purpose of this abstract, only results from the Digit Span Forward (DSF) will be presented in detail. In this test the experimenter reads a sequence of numbers and the participant must repeat them back in the same order. After every second sequence the length increases by one. The parameter measured in this test is the number of successfully repeated sequences which is given as a score out of 16. The statistical analysis consists of a 3 x 2 (groups x MF condition) within-subjects ANOVA with a between subject factor.

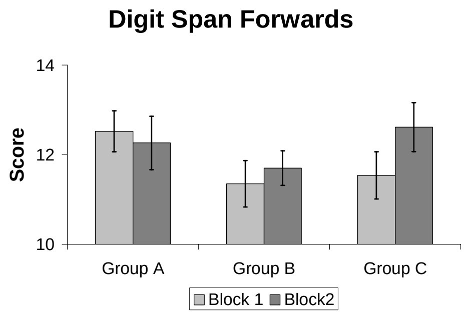

Figure 2 – The scores in each block of the Digit Span Forward task for the 3 groups. The error bars represent the standard error of the mean.

RESULTS

Final data will be presented (currently n=74; expected n=99). Since this is a work in progress, the double blind procedure cannot be broken yet and results from Groups A, B and C cannot be attributed to MF exposure conditions. In the DSF there is no significant group effect ($F = 0.96$, $p = 0.39$, partial $eta^2 = 0.03$). However there are trends present in the difference between blocks ($F = 2.88$, $p = 0.09$, partial $eta^2 = 0.04$) and in the interaction ($F = 2.76$, $p = 0.07$, partial $eta^2 = 0.08$). In terms of B1 vs. B2 it is interesting to note that the block effect is not in the same direction for all groups. This is the interaction which is currently at the level of a trend. Group A shows a decrease in score between blocks while Group B shows an increase and Group C an even more pronounced increase in score.

DISCUSSION/CONCLUSIONS

The increase between blocks in Groups B and C seems to be a practice effect which was expected [5]. In most of the other performance measures the block effect is significant which further illustrates this practice effect. However, though not significant, Group A exhibits a tendency towards degradation in performance opposite of the behaviour in Groups B and C. This suggests that the treatment applied to Group A interferes with the practice effect. This will be discussed at the conference when the double blind procedure will have been broken. Overall, this appears to be the highest level of 60 Hz MF exposure reported to date in published human neurocognitive studies and will give valuable information in the search for exposure levels capable of modulating cognitive performances.

ACKNOWLEDGMENTS

The authors thank Mr. Lynn Keenliside and Mr. John Patrick for building the exposure system and Ms. Nicole Juen for assistance with data acquisition. Research funded by Hydro-Québec, EDF-RTE (France), and Canadian Institutes of Health Research.

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