REPEATED MAGNETIC FIELD SHIELDING INDUCES ANALGESIA IN MICE.

Dawn Desjardins [(1)], **Alex W. Thomas** [(2)], **Charles Cook** [(2)], **Frank S. Prato** [(2)]

[(1)] University of Western Ontario, Neuroscience Program, London, Ontario, Canada.
Email: ddesjard@lri.sjhc.london.on.ca

[(2)] Lawson Health Research Institute, Imaging, 268 Grosvenor Street N6A 4V2, London, Ontario, Canada
Tel: 519-646-6100 ext. 64140, Fax: 519-646-6135 Email: prato@lri.sjhc.london.on.ca

ABSTRACT

Behavioural effects related to the Earth's geomagnetic field, such as orientation, migration route determination, and direction finding, are perhaps the most consistent reported effects of exposure to magnetic fields. As well, acute exposure to a weak electromagnetic field has been shown to interrupt this behaviour, and attenuate opioid-induced analgesia. Here we show that 10 days of daily repeated 1 hour exposures of mice to the environment produced by a μ-metal box (geomagnetic field attenuated by a factor of ~125) induces significant analgesia (160% of sham exposed) that peaks at day 5 and abates by day 10.

INTRODUCTION

A single exposure of mice to extremely low frequency (ELF) magnetic fields (MF) has been shown to attenuate opioid induced analgesia [1-2] whereas repeated daily exposures have been shown to induce analgesia [3]. Del Seppia [4] found that deprivation of the normally occurring geomagnetic field also affects stress-induced analgesia. Stress-induced analgesia was significantly suppressed (attenuated) in a manner comparable to that observed in mice that were either acutely exposed to an ELF magnetic field or treated with the prototypic opiate antagonist naloxone. We have recently observed that a single exposure of mice to a magnetically shielded environment produced by placement in a μ-metal box can also attenuate opioid induced analgesia [5]. It was the objective of this study to determine if daily repeated exposures of mice to the nearly magnetic field free environment produced by a μ-metal box would induce analgesia.

METHODS

Adult male Swiss CD1 mice [n = 47, Charles River, Canada], 12/12 hr light/dark cycle, single housed with food and water *ad lib*, were placed in an opaque Plexiglas^{TM} lined μ-metal box or an opaque Plexiglas^{TM} box (sham condition) for 1 hour a day (midday) for 10 consecutive days. The μ-metal box attenuates ambient magnetic fields from 0 to 60 Hz by a factor of 125 or more [5]. Nociception was measured as the latency of a foot lifting/lick to an aversive thermal stimulus (50 ± 0.5° C) before (pre) and immediately after (post) placement in the boxes. Two experiments were conducted, one in which thermal latency was tested on each of the ten days (n = 23) and one in which thermal latency testing was only performed on days 1, 5 and 10 but exposure was for 10 consecutive days as in the first experiment (n = 24). Post exposure latency values were normalized (post/pre) to pre exposure values and significance was tested using ANOVA with $p < 0.05$.

RESULTS

An analysis of variance showed a significant between-subjects effect by exposure condition [$F_{(1,21)}=10.81$, $p<0.001$, $Eta^2=0.34$] where those subjects exposed to the μ-metal box showed a significant increase in latency as compared to the control subjects (see Fig. 1). In experiment one a multivariate analysis showed a significant within subjects interaction between days of exposure and exposure condition [$F_{(1,9)}=1.942$, $p<0.05$, $Eta^2=0.64$]. The latency times of the μ-metal exposed group dropped to 80% of pre-values after the first exposure which corroborates previous findings [5] and then increased to 160% as compared to pre-values after exposures of days 3, 4 and 5. By day 10 post values were not different from pre-values. No such results were seen in the control group. Results of experiment 2 confirmed those of

experiment 1 showing again a decrease in post latency values on day 1 (70% of pre-values), increase on day 5 (180% of pre-values) with a return to pre-latency values on day 10.

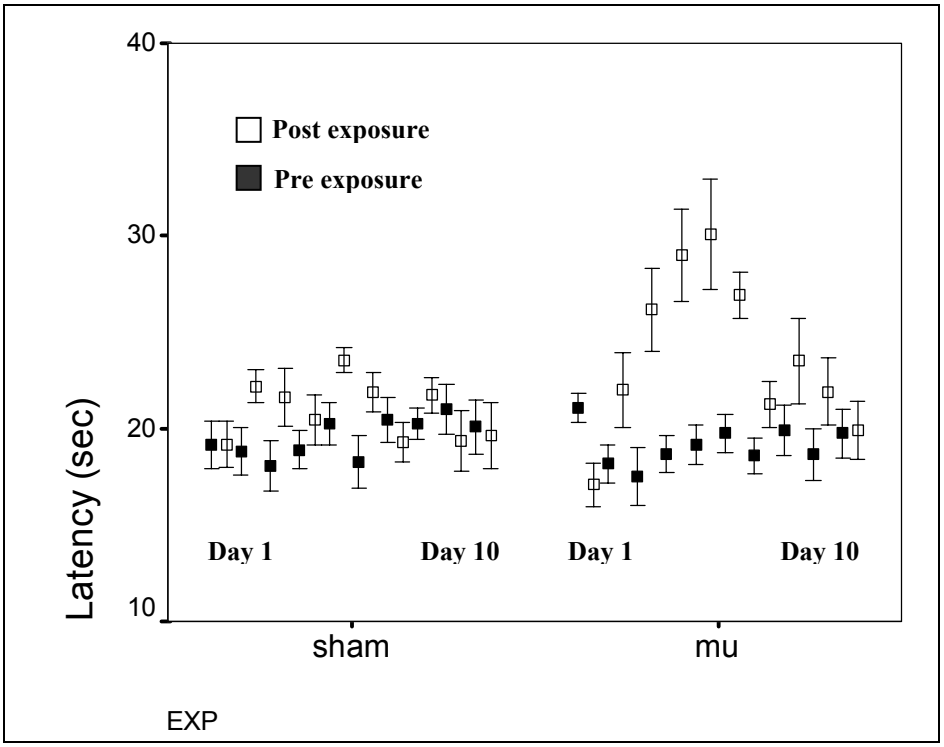

Fig. 1. Pre- and post exposure for sham (opaque Plexiglas™ box) and mu (opaque Plexiglas™ lined μ-metal box) treatments for days 1 thru 10 (n = 23). Error bars represent the S.E.M.

DISCUSSION

These experiments further suggest that shielding from ambient magnetic fields affects opioid related behaviours in a manner similar but not identical to affects from exposure to increased ELF magnetic fields (MF). The initial reduction on day 1 was consistent with previous data [5] as was the induction of analgesia on day 5 [3]. Further experiments are needed to compare and contrast the effects of ELFMF exposure and ELFMF shielding on opioid function.

ACKNOWLEDGEMENTS

This research was funded, in part, by: the Canadian Institutes of Health Research, FrAlex Therapeutics Inc., the Ontario Innovation Trust, and the Canada Foundation for Innovation.

REFERENCES

[1] M Kavaliers, K-P Ossenkopp, FS Prato, JJL Carson. "Opioid systems and the biological effects of magnetic fields," in *On the Nature of Electromagnetic Field Interactions with Biological Systems*. Frey AH (Ed.) R. G. Landes Co., Austin, pp 181-194, 1994.
[2] M Kavaliers,K-P Ossenkopp. Stress-induced opioid analgesia and activity in mice: inhibitory influences of exposure to magnetic fields. Psychopharmacology (Berl). 1986;89(4):440-3.
[3] M Kavaliers, K-P Ossenkopp. "Tolerance to morphine-induced analgesia in mice: magnetic fields function as environmental specific cues and reduce tolerance development." *Life Sciences*, vol. 37, pp 1125-1135, 1985.

[4] C Del Seppia, P Luschi, S Ghione, E Crosio, E Choleris, F Papi. "Exposure to a hypogeomagnetic field or to oscillating magnetic fields similarly reduce stress-induced analgesia in C57 male mice," *Life Sci*, vol. 66(14), pp.1299-306, Feb 2000.
[5] E Choleris, C DelSeppia, AW Thomas, P Luschi, S Ghione, GR Moran, FS Prato. "Shielding, but not zeroing of the ambient magnetic field reduces stress-induced analgesia in mice," *Proc R Soc Lond B Biol Sci*, vol. 269(1487), pp.193-201, Jan 2002.