Effects of prenatal and adult EMF exposure on brain development

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Prenatal 900 MHz EMF exposure decreased number of brain cells in region critical to thinking

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BRAIN RESEARCH

Research Report

Effects of prenatal exposure to a 900 MHz electromagnetic field on the dentate gyrus of rats: a stereological and histopathological study☆

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ABSTRACT

Electromagnetic fields (EMFs) inhibit the formation and differentiation of neural stem cells during embryonic development. In this study, the effects of prenatal exposure to EMF on the number of granule cells in the dentate gyrus of 4-week-old rats were investigated. This experiment used a control (Cont) group and an EMF exposed (EMF) group (three pregnant rats each group). The EMF group consisted of six offspring ($n=6$) of pregnant rats that were exposed to an EMF of up to 900 megahertz (MHz) for 60 min/day between the first and last days of gestation. The control group consisted of five offspring ($n=5$) of pregnant rats that were not treated at all. The offspring were sacrificed when they were 4 weeks old. The numbers of granule cells in the dentate gyrus were analyzed using the optical fractionator technique. The results showed that prenatal EMF exposure caused a decrease in the number of granule cells in the dentate gyrus of the rats ($P<0.01$). This suggests that prenatal exposure to a 900 MHz EMF affects the development of the dentate gyrus granule cells in the rat hippocampus. Cell loss might be caused by an inhibition of granule cell neurogenesis in the dentate gyrus.

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Prenatal exposure

whether electromagnetic fields (EMFs) inhibit the formation and differentiation of neural stem cells during embryonic development

Material and Methods:

The effects of prenatal exposure to EMF on the number of granule cells in the brain (dentate gyrus) of 4-week-old rats were investigated.

Groups:

- The control (Cont) group (3 pregnant rats)
- EMF exposed EMF group (3 pregnant rats)

Electromagnetic field exposure system

- A special device consisting of a round plastic tube cage (diameter: 5.5 cm, length: 12 cm) and a dipole exposure antenna was used in this study.
- A 900 MHz continuous modulated wave electromagnetic energy generator [the peak specific absorption rate (SAR) was 2 W/kg, average power density 1±0.4 mW/cm2] was used.
- The Peak SAR value was obtained by model calculations. An EMF meter was used for the power density measurements.

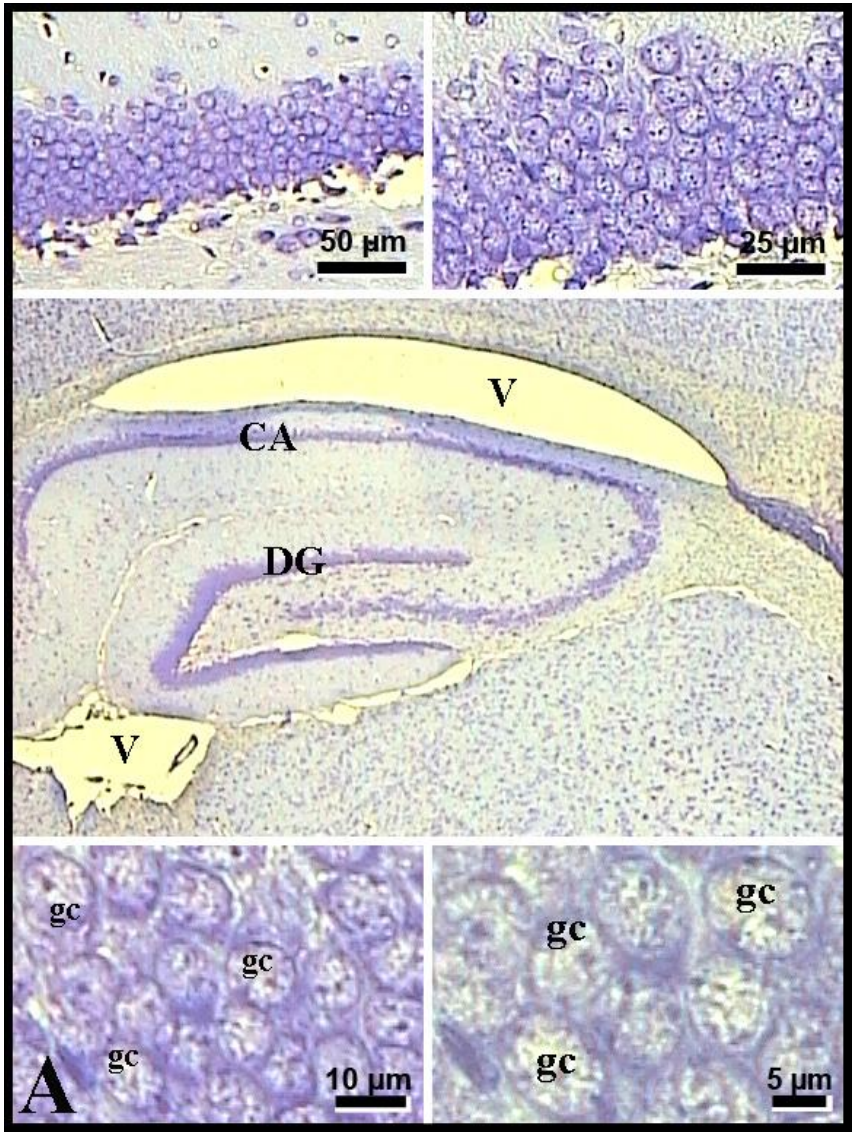
Groups:

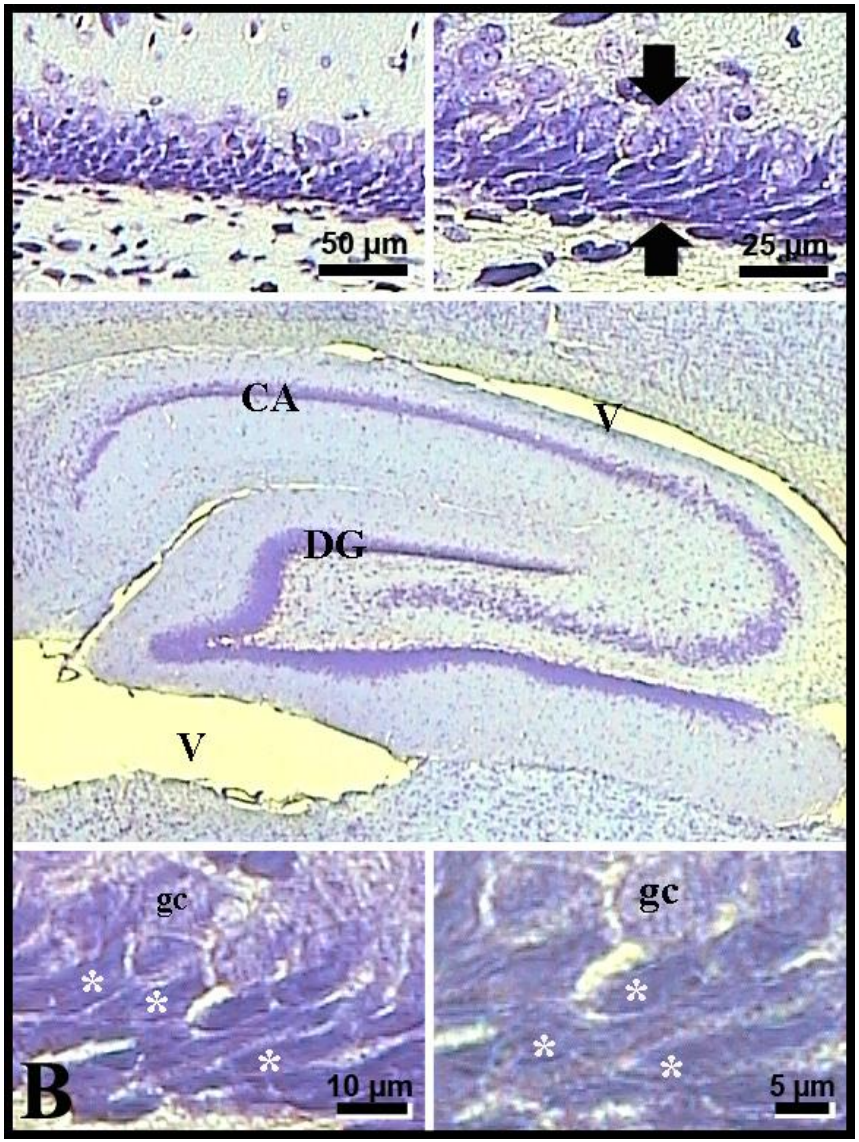
- The control group consisted of 5 offspring of pregnant rats.
- The EMF group consisted of 6 offspring of pregnant rats
- Exposed to an EMF of up to 900 MHz for 60 min/day between G1-G21

- The offspring were sacrificed when they were 4 weeks-old.
- The numbers of granule cells in the dentate gyrus were estimated using the optical fractionator technique

Prenatal 900 MHz EMF exposure decreased number of brain cells critical to thinking

RESULTS: (Histopathological results)





RESULTS: (Stereological results)

Table 1 – Mean values of total granule cell numbers, CV and CE of stereological analysis, mean dissector number, section thickness and number of steps for estimation of total neuron number in the DG of Cont and EMF groups of 4W-old rats

	Cont Group ($n=5$)	EMF Group ($n=6$)
Total granule cell number[a]	1,235,702 ± 21,731	994,188 ± 21,772[b]
CE	0.05	0.04
CV	0.04	0.05
Dissector particle number	428	351
Section thickness (μm)	28.72	28.11
Number of steps for counting	178	175
Number of sampled sections	14.6	15

[a] Values are as mean ± SEM. DG, dentate gyrus; Cont, control group; EMF, electromagnetic field exposed group; MHz, megahertz; CE, coefficient of error; CV, coefficient of variation.
[b] $P<0.01$.

Exposure of 900 MHz EMF induces pyramidal cell loss in the hippocampus of adult female rats

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Postnatal exposure

Research Report

900 MHz electromagnetic field exposure affects qualitative and quantitative features of hippocampal pyramidal cells in the adult female rat

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ABSTRACT

The effects of electromagnetic fields (EMFs) emitted by mobile phones on humans hold special interest due to their use in close proximity to the brain. The current study investigated the number of pyramidal cells in the cornu ammonis (CA) of the 16-week-old female rat hippocampus following postnatal exposure to a 900 megahertz (MHz) EMF. In this study were three groups of 6 rats: control (Cont), sham exposed (Sham), and EMF exposed (EMF). EMF group rats were exposed to 900 MHz EMF (1 h/day for 28 days) in an exposure tube. Sham group was placed in the exposure tube but not exposed to EMF (1 h/day for 28 days). Cont group was not placed into the exposure tube nor were they exposed to EMF during the study period. In EMF group rats, the specific energy absorption rate (SAR) varied between 0.016 (whole body) and 2 W/kg (locally in the head). All of the rats were sacrificed at the end of the experiment and the number of pyramidal cells in the CA was estimated using the optical fractionator technique. Histopathological evaluations were made on sections of the CA region of the hippocampus. Results showed that postnatal EMF exposure caused a significant decrease of the pyramidal cell number in the CA of the EMF group ($P<0.05$). Additionally, cell loss can be seen in the CA region of EMF group even at qualitative observation. These results may encourage researchers to evaluate the chronic effects of 900 MHz EMF on teenagers' brains.

MATERIAL and METHODS:

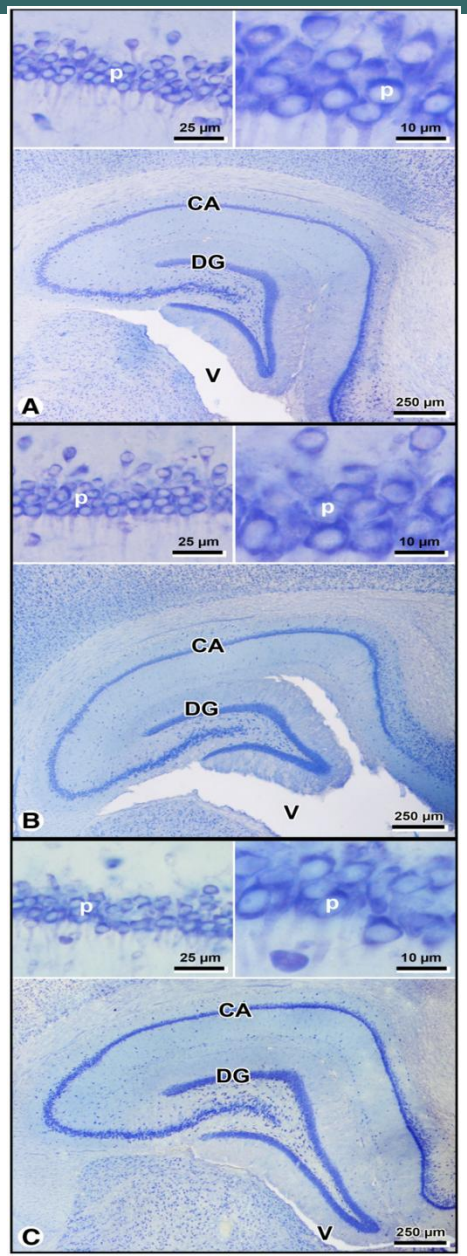
Three groups of adult female rats (12 week-old):

- Control (Cont) group (n=6)
- Sham exposed (Sham) group (n=6)
- EMF exposed (EMF) group (n=6)

- EMF group rats were exposed to 900 MHz EMF (1 h/day for 28 days) in an exposure tube.
- Sham group was placed in the exposure tube but not exposed to EMF (1 h/day for 28 days).
- Cont group was not placed into the exposure tube nor were they exposed to EMF during the study period.
- In EMF group rats, the specific energy absorption rate (SAR) varied between 0.016 (whole body) and 2 W/kg (locally in the head).
- All of the rats were sacrificed at the end of the experiment (16th week).

The number of pyramidal cells in the CA of hippocampus was estimated using the optical fractionator technique.

Exposure of 900 MHz EMF induces pyramidal cell loss in the hippocampus of adult female rats

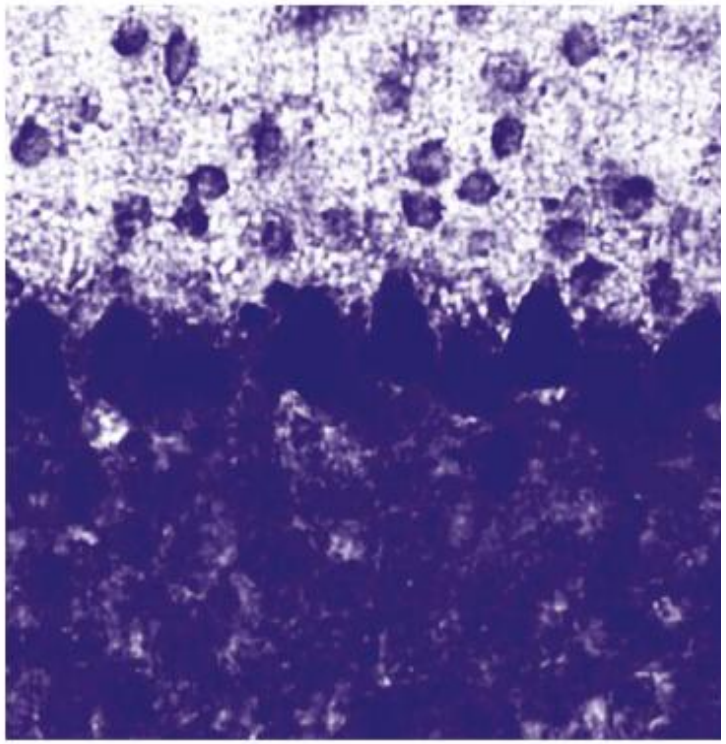


Hippocampus is critical to thinking & memory

Exposure of 900 MHz EMF induces Purkinje cell loss in the cerebellum of adult female rats

Postnatal exposure

Brain Research



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Research Report

Purkinje cell number decreases in the adult female rat cerebellum following exposure to 900 MHz electromagnetic field

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ABSTRACT

The biological effects of electromagnetic field (EMF) exposure from mobile phones have growing concern among scientists since there are some reports showing increased risk for human health, especially in the use of mobile phones for a long duration. In the presented study, the effects on the number of Purkinje cells in the cerebellum of 16-week (16 weeks) old female rats were investigated following exposure to 900 MHz EMF. Three groups of rats, a control group (CG), sham exposed group (SG) and an electromagnetic field exposed group (EMFG) were used in this study. While EMFG group rats were exposed to 900 MHz EMF (1 h/day for 28 days) in an exposure tube, SG was placed in the exposure tube but not exposed to EMF (1 h/day for 28 days). The specific energy absorption rate (SAR) varied between 0.016 (whole body) and 2 W/kg (locally in the head). The CG was not placed into the exposure tube nor was it exposed to EMF during the study period. At the end of the experiment, all of the female rats were sacrificed and the number of Purkinje cells was estimated using a stereological counting technique. Histopathological evaluations were also done on sections of the cerebellum. Results showed that the total number of Purkinje cells in the cerebellum of the EMFG was significantly lower than those of CG ($p<0.004$) and SG ($p<0.002$). In addition, there was no significant difference at the 0.05 level between the rats' body and brain weights in the EMFG and CG or SG. Therefore, it is suggested that long duration exposure to 900 MHz EMF leads to decreases of Purkinje cell numbers in the female rat cerebellum.

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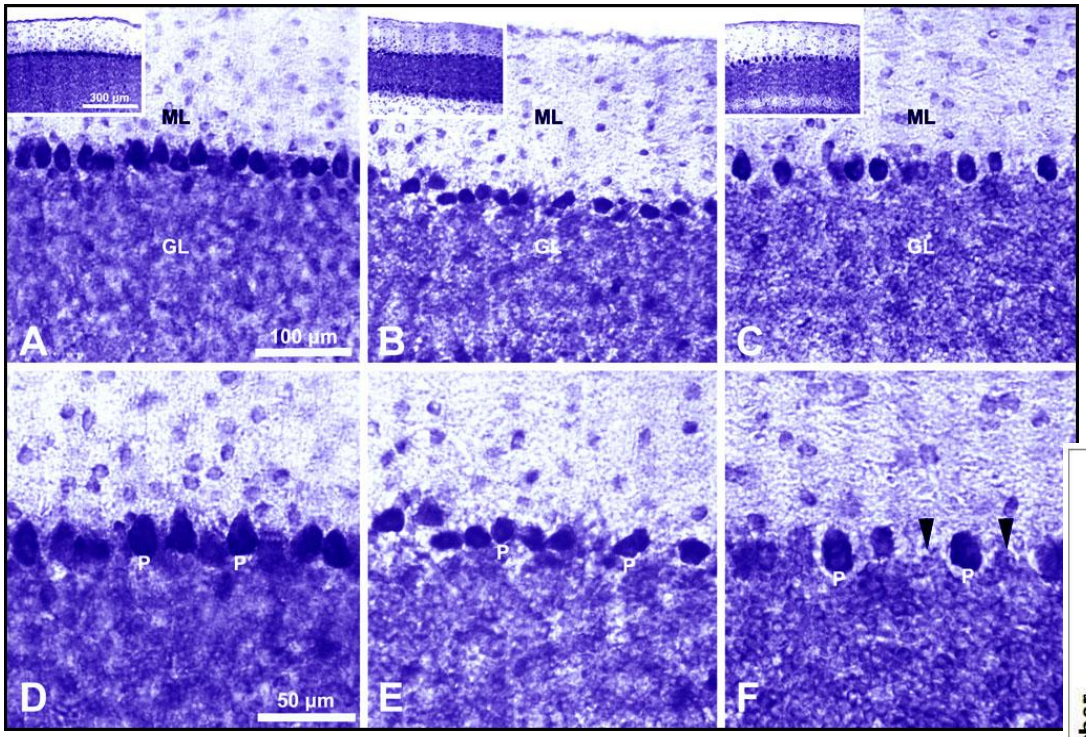
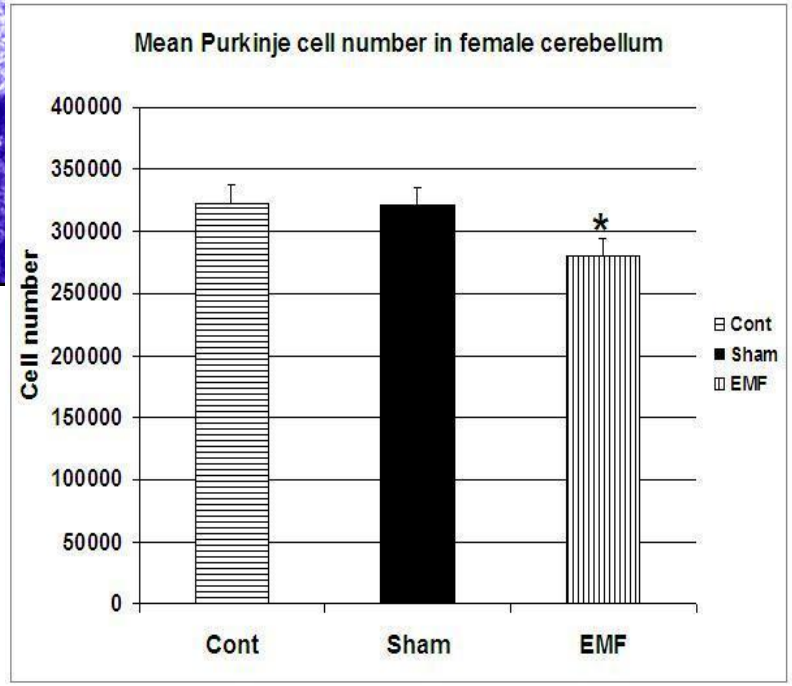
Exposure of 900 MHz EMF induces Purkinje cell loss in the cerebellum of adult female rats

RESULTS:

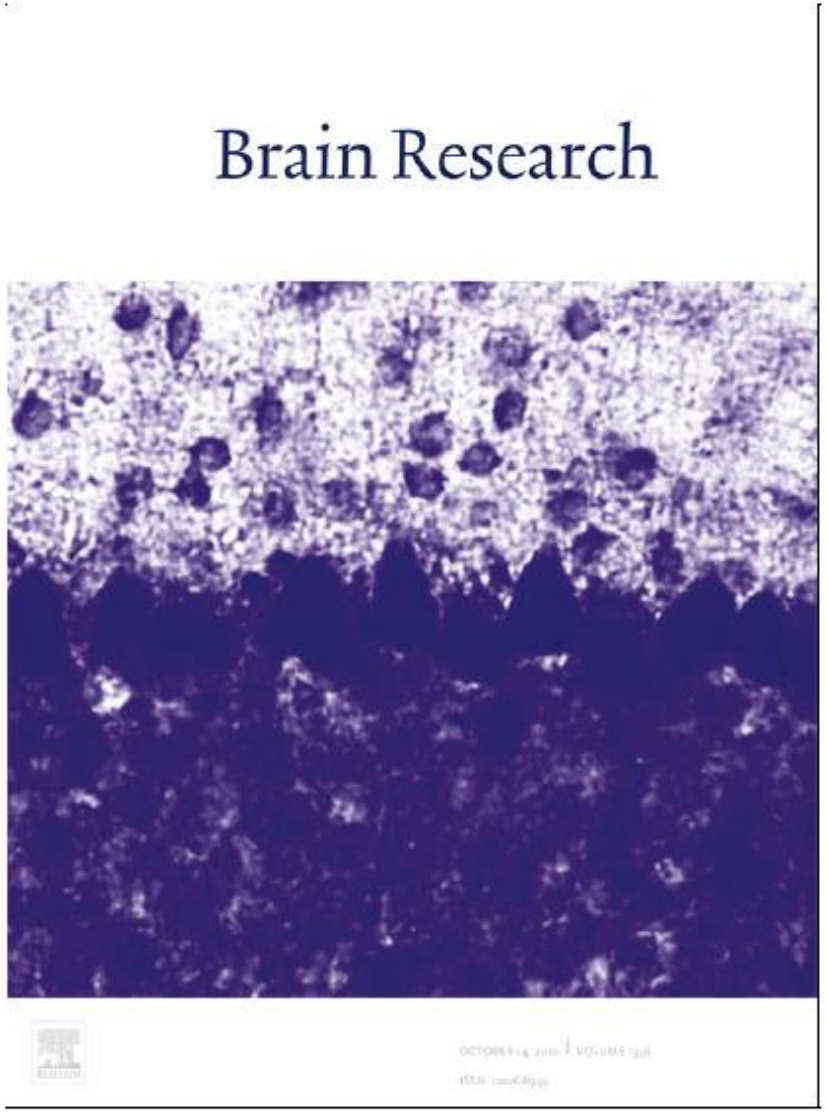




Conclusion:

One month exposure to MHz EMF decreases Purkinje cell numbers in the female rat brain (cerebellum).

Exposure of 900 MHz EMF induces Purkinje cell loss in the cerebellum of adult female rats



Thank you very much