Speed of Movement Through a High Magnetic Field Affects Locomotor Circling But Not Conditioned Taste Aversion in Rats

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Introduction

For the last several years we have been characterizing the behavioral and neural effects of high magnetic field exposure (> 4T) in rodents [1]. We have found several significant effects, e.g. acquisition of conditioned taste aversion, induction of locomotor circling, and activation of brainstem vestibular relays. Ablation of the inner ear abolishes all observable effects of the magnetic field [2]. These effects are consistent with the magnetic field acting on the vestibular apparatus of the inner ear, which in humans would cause dizziness and motion sickness.

A common assumption among users and operators of high-strength magnets is that vertigo occurs during rapid head movements, and can be minimized by moving slowly [3]. There is no experimental evidence, however, that confirms these assumptions. Therefore, in order to test the role of speed of motion on the behavioral effects of high magnetic field exposure, we moved rats through a 14 T superconducting NMR magnet at varying speeds.

Experimental

Adult female rats received 10-min access to novel saccharin and then restrained in 5-cm diameter Plexiglas tubes and placed in the center of the 600WB 14T NMR magnet. Rats were moved from the floor (at 0.1 T) to the center of the magnet (at 14.1 T) at 3 different speeds: 0.01 m/s, 0.1 m/s, and 1 m/s. Rats were exposed to the 14T static field for 30 min, and then removed at the same speed. Control rats were restrained and sham-exposed in an opaque PVC. All rats were videotaped in an open field test chamber for 2-min after exposure, in order to score circling behavior. Taste aversion was evaluated by 2-bottle preference tests.

Results and Discussion

Control rats that were not exposed to the magnetic field did not show any locomotor circling, and did not acquire a conditioned taste aversion (i.e. consumed large amounts of saccharin). Magnet-exposed rats walked in counterclockwise circles. The number of circles, however, was inversely proportional to speed of entry and exit (0.6 ± 0.4 circles/2 min after 0.01 m/s vs. 5.5 ± 1.1 circles/2 min after 1.0 m/s). All magnet-exposed rats showed a robust taste aversion, as shown by low intakes of saccharin. The magnitude and persistence of the magnet-induced taste aversion was independent of entry and exit speed and was not different among groups.

Conclusions

This study provides the first evidence in animals that rate of entry and exit can affect vestibular symptoms induced by high magnetic fields. In agreement with human reports, faster movement through the gradient of a static magnetic field induced greater circling in rats. However, after 30-min exposure to 14T in the center of the magnet, all rats acquired taste aversions regardless of their speed of entry and exit. Thus, the immediate circling response to magnetic field exposure can be distinguished from the long-term expression of vestibular perturbation.

Acknowledgements

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References

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