Acute effect of a 60 Hz magnetic field on the vestibular function.

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Introduction

We are surrounded by natural and artificial sources of magnetic fields (MF), from the earth geomagnetic field, to electricity induced MF (60 Hz in North America, 50 Hz in Europe). Since a time-varying MF has the property to induce electric fields and currents in conductors, the question of their potential impact on living systems is crucial from a human health and safety perspective. It is particularly important to establish thresholds for acute neurophysiological effects in humans, and the vestibular system appears to be a good model. Recent studies investigating MF effects on postural stability in humans have suggested the implication of the vestibular system. Moreover, it is well known that experimental modulations of standing balance can be achieved using direct current (DC) stimulation to the vestibular system (galvanic vestibular stimulation, GVS). Two questions rise from these observations: Can a 60 Hz electric current have a similar acute effect as GVS on the vestibular system? Can electric fields and currents induced by 60 Hz MF have a similar acute effect?

Hypothesis

1. A transcranial alternating current stimulation (tACS) of the vestibular system of 1 mA at 60 Hz will modulate the postural stability in a similar fashion than a GVS of 1 mA.

2. A 60 Hz MF at 100 mT applied to the vestibular system will produce the same acute outcome on the standing balance.

Materials and Methods

Six participants have been tested to date. 40 participants will be recruited. GVS and tACS will be delivered using the StarSim system. MF exposure will be delivered via a custom headset exposure system (under development). Electric and magnetic stimulations will be delivered on the mastoid, targeting the vestibular system. Participants will receive series of 5 s exposure (1 mA GVS, 1 mA tACS at 60 Hz, and 100 mT MF at 60 Hz) on left and right side of the head. A force plate will record the center of pressure (COP) displacement. A rotating L.E.D. bar light will be used to assess the subjective visual vertical (SVV).

Results

Pilot data shows an effect of GVS and tACS on COP displacements with a tilt towards the side of anode. The current stationary MF stimulator does not allow free head movement and therefore no clear effect on COP has been noted. No data have been collected yet on the SVV, but results will be presented at the conference.

Discussion and Summary

The results regarding the GVS and tACS on postural stability are similar to the findings of Fitzpatrick and Day (2004) and suggest that a 60 Hz current is capable of modulating standing balance. The absence of effect for the 60 Hz MF stimulation is inconclusive at this stage due to the current development of the MF stimulator. The SVV protocol still has to be finalized.

The results from this study will be discussed in conjunction with works on the magnetophosphene perception. Magnetophosphenes are a flickering visual perception when exposed to a time-varying MF. Magnetophosphenes result from the interaction of the MF-induced electric fields and currents with graded-potential neurons from the retina: the rods. The hair cells in the vestibular system are also graded potential cells, and share similar electrical properties with the rods, which make them potentially responsive to 60 Hz MF exposure. Once the threshold for an acute MF-induced vestibular response will be identified at 60 Hz, the frequency-response characteristics will have to be tested to better approach underlying mechanisms.