MULTI-MODALITIES INVESTIGATION OF 60 HZ MAGNETIC FIELD EFFECTS ON THE HUMAN CENTRAL NERVOUS SYSTEM

It has recently been shown that Extremely Low Frequency (ELF, below 300 Hz) magnetic fields (MF) may be able to modulate human movements, brain electrical activity and high-level brain processing. Different strategies have been used to tackle this question using various physiological, neurophysiological and behavioral indicators. Researchers investigating electroencephalography (EEG) have reported that ELF MF can increase resting occipital alpha rhythm (8-12 Hz). Interestingly, other studies have demonstrated that human motor behavior can be modulated by ELF exposure and can, for instance, reduce anteroposterior standing balance or decrease physiological tremor intensity. However, results remain controversial and underlying mechanisms are not well understood. In a recent pilot work, we proposed to approach the question of ELF MF effects on human brain activity using functional Magnetic Resonance Imaging (IM RI). Interestingly, we have found that a 1800 microtesla MF at 60 Hz MF exposure could increase brain activation level with the performance of a simple fingers movement (rhythmic tapping between index and thumb). We followed up on these results with a project investigating the effects of a 60 Hz, 3000 ~T MF on human cognitive performance and brain activation as measured by fMRI. In a first experiment, we used a battery of validated and reproducible psychometric tests to evaluate the potential impact of the MF exposure on human cognitive performance. Overall, the exposure did not seem to affect the cognitive performance in the psychometric testing (though a potential interference with short-term learning is reported). In a second experiment, we investigated the effects of MF exposure on functional brain activation during selected cognitive and motor tasks using fMRI, and were able to detect modulations of brain activation following one hour of MF exposure. First, it appeared that during a classic mental rotation task (the subject mentally rotates geometrical shapes), specific brain regions involved in visual attention were selectively deactivated after exposure without changes in performance. This could be indicative of facilitation in the visual attention processes subsequent to the exposure. Second, brain activation induced by the above-described finger-tapping task was increased only in regions involved in sensorimotor perception, which may be indicative of facilitated sensitive feedback after MF exposure. We are now planning on investigating further the mechanisms supporting these functional effects: we are developing a project aiming to investigate the "synaptic transmission" hypothesis by focusing on the potential neuromodulatory effect of a 60 Hz magnetic stimulus at levels known to induce magnetophosphenes in healthy subjects. Indeed, magnetophosphenes are often reported as well established, consistent effects of ELF MF exposure on humans; and are described as flickering visual sensation. It is usually accepted that they originate from neural interactions with induced electric currents in the retina (described as "synaptic interactions"). The objectives of this project will be first to establish a threshold that consistently gives rise to a response (magnetophosphenes detection), and second to identify neurophysiological modulations associated with this effect (using fMRI, electroencephalography, event related potentials and electromyography).