



Ruprecht-Karls-Universität Heidelberg
Medizinische Fakultät Mannheim
Dissertations-Kurzfassung

**Effects of high static magnetic fields in magnetic resonance
imaging on cognition and sensory perceptions**

Autor: Angela Heinrich
Institut / Klinik: Zentralinstitut für Seelische Gesundheit Mannheim (ZI)
Doktormutter: Prof. Dr. H. Flor

Magnetic resonance imaging (MRI) is an examination method without ionizing radiation to map structures or functions of tissues and organs using their different magnetic properties. A better signal-to-noise ratio led to growing magnetic field strengths in today's MR scanners resulting in a better resolution of images and shorter examination times. The question has come up if static magnetic fields – one component of the magnetic system in MRI – have an impact on cognitive functions, sensory perception or vital sign measurement. Since the static magnetic field is existent all the time, health personnel is exposed to it every time they walk into the scanner room during interventional MR, for example. Thus, an analysis of the effects of static magnetic fields is primarily important for the safety and working ability of health personnel and accordingly for the safety of patients.

The first study of this dissertation project – a meta-analysis – calculated effect sizes of results of studies dealing with effects of static magnetic fields and combined them in three categories: 1. neuropsychology, 2. vital signs and 3. sensory perception. The first category dealing with all cognitive tests showed very inconsistent results: some studies revealed impairment in cognitive tests due to an exposure to a static magnetic field while others found improvement. In the second category (vital signs) no significant clinical results could be found and only the third category (sensory perception) showed homogeneity: all studies found an increase of dizziness or vertigo in relation to a static magnetic field. On the basis of these results a new study design considering all weak points of former studies was proposed in this meta-analysis.

This design was applied in the experimental, second study of this dissertation project. Participants were 41 healthy persons (20 female) who participated in four examinations in MR scanners with different field strengths: 1.5, 3 and 7 Tesla and a mock scanner with a normal terrestrial magnetic field as a control. Participants were unaware of the actual field strength. Further, a movement condition was implemented in every field strength in which participants performed the tests while the examination table was moved back and forth. As motion in a static magnetic field causes electric fields and currents in living tissues (e.g. brain of moving health personnel) it is important to determine if movement has an influence. The results of the cognitive tests were not significantly different between 1.5, 3 and 7 Tesla and even the 0 Tesla control condition, thus the study showed that field strengths up to 7 Tesla have no significant influence on cognitive functions, not even in the movement condition. Only some sensory perceptions were significantly related to the strength of the magnetic field: dizziness, phosphenes, nystagm and head ringing were significantly increasing with increasing field strength, but none of the effects was strong enough to have an impact on the performance of the cognitive tests and in the majority of cases the effects disappeared after a short habituation time.

In conclusion, it can be said that an MR examination has no significant effect on cognitive function in the static magnetic field and with a short habituation time sensory effects like dizziness can be minimized. Thus, MRI can be regarded as a safe examination method also for health personnel and this has to be considered in safety guidelines, as the alternatives to MRI would bear more risks with their ionizing radiation.

In the future, effects of gradient magnetic fields and radiofrequency waves – the two other components of the magnetic system in MRI – have to be analyzed and possible long-term effects have to be considered as they have not been analyzed up to now.