Ethics in fMRI Studies*
A Review of the EMBASE and MEDLINE Literature
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Abstract
Functional magnetic resonance imaging (fMRI) has surfaced as a powerful method to study brain function in humans. While the involvement of neuroradiologists in fMRI studies in the clinical setting is obvious, in neuroscience research most of the investigators are not specialists trained in reading brain images. Advances in neuroimaging are increasingly intersecting with issues of ethical, legal, and social interest. Debate on fMRI is starting, mainly under the impetus of a new interdisciplinary field, neuroethics. The objective of this review is to bring forth reflection and discussion about ethical issues regarding fMRI, with emphasis to the perspective of the neuroradiologist. EMBASE® and MEDLINE® were searched for articles pertaining to ethics in fMRI, between 1991 and 2007. A total of 42 articles were retrieved, 95% published in the last 6 years. Only 10% were published in radiology journals. The major potential ethical issues identified in the reviewed articles concerned recruitment of vulnerable groups; informed consent; incidental findings; limitations of the technique, interpretation and validity of results; risks and safety; confidentiality and privacy; fMRI applications outside the laboratory (presurgical planning; diagnostic and predictive potential; forensic, security, military and commercial use); and public communication of research results. Not all the identified issues in this review were directly relevant to neuroradiologists in particular, but for sure some did. Neuroradiologists must find the time and energy to have an important role in identifying and solving ethical (and related) issues in fMRI, working in collaboration with ethicists, social scientists, clinicians, neuroscience researchers, patients, healthy volunteers, journalists, marketers, lawyers, and policy makers.

Key Words: Ethics · Magnetic resonance imaging · Morals · Neurosciences · Radiology

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Ethik in fMRT-Studien. Ein Überblick über die EMBASE- und MEDLINE-Literatur
Zusammenfassung
Introduction

Functional imaging comprehends methods utilized to provide measures of brain activity. Functional magnetic resonance imaging (fMRI) is a magnetic resonance imaging (MRI) technique that detects small fluctuations in the magnetic signal resulting from changes in blood oxygen level associated with brain activation. The most frequently used method is known as “blood oxygen level-dependent” (BOLD) contrast, which exploits tiny magnetization differences between oxygenated and deoxygenated blood. In this way, fMRI measures the consequences of neural activation, rather than the neural activation itself. There is good evidence though that increases in the BOLD signal are a reliable indication of increased neuronal activity [1].

fMRI has surfaced as a powerful and popular method to study brain function in vivo in humans. Because of the advantages (especially of spatial resolution), relative safety (therefore allowing a great degree of repeatability), and widespread availability of MRI scanners compared to other imaging modalities, fMRI has had a dramatic impact both in the clinical setting, but in particular in the field of neuroscience. It has been useful to map sensory, motor and language functions, for example, but also to study complex human behaviors, such as love [2], deception [3], empathy [2], religion [4], fairness [5] and even consumer preferences [6]. Between 1991, when the results of the technique were first reported, and 2004, tens of thousands of studies were cited in PubMed® [7].

Although experiments conducted purely for research for neuroscience on the one hand, and for clinical neuroimaging purposes on the other, may employ similar strategies for measuring brain activations, the goals of the experiments often differ. The most obvious difference is that neuroscience is rarely concerned with an individual subject’s activation and is more focused on making inferences to the population. However, in clinical neuroimaging, the individual patient is generally the entire focus. For example, one of the most successful clinical applications of fMRI is the presurgical characterization of eloquent cortex to guide tumor removal [8, 9].

While the involvement of neuroradiologists in fMRI studies in the clinical setting is obvious, in neuroimaging and neuroscience research most of the investigators are not specialists trained in reading brain images, but include graduate and undergraduate students and postdoctoral personnel of various backgrounds [10, 11]. Illes et al. found, in their study cohort of 81 laboratories all over the world, that in only 22% neuroradiologist involvement was a requirement, and that in laboratories where neuroradiologist involvement was not required, scans were nonetheless always read in only 13% of the time. Neuroradiologists were compensated for their services (either financially or in authorship) in a few 36% of the responding laboratories. In 41% of the laboratories, students may have had primary responsibility for scanning. Hands-on and/or safety training was the only requirement for scanning in 44% [10].

Advances in neuroimaging and neuroscience are increasingly intersecting with issues of ethical, legal, and social interest. Debate on fMRI is starting, mainly under the impetus of a new interdisciplinary field, neuroethics, that specifically focuses on the practical and theoretical issues of neuroscience with moral and social consequences in health care, in the laboratory, and in the public domain [7, 12–14]. The objective of this review is to bring forth reflection and discussion about ethical issues regarding fMRI, with emphasis to the perspective of the neuroradiologist.

Material and Methods

EMBASE® and MEDLINE® were searched respectively using Ovid® and Entrez PubMed® search engines, for all articles published between 1991 and 2007 (week 48 – November 30), in English language, in humans. The key words used for the EMBASE® search included the subject heading term “ethics” and also: “fmri”; “functional magnetic resonance imaging”; “functional mri”; “functional mris”; “magnetic resonance imaging, func-