

## Official Position of the Division of Clinical Neuropsychology (APA Division 40) on the Role of Neuropsychologists in Clinical Use of fMRI: Approved by the Division 40 Executive Committee July 28, 2004

The development of functional magnetic resonance imaging (fMRI) began in 1991 and has evolved rapidly since that time. Images produced with fMRI reflect local changes in brain activity evoked by performing sensory, motor, or cognitive tasks. As a result, this widely used technique offers information regarding the functional organization of brain systems. fMRI is considered a safe technique and requires no invasive procedures, allowing for repeat scanning to evaluate change in patients over the course of illness or after acute treatment. With relatively small voxel sizes on the order of a few millimeters, fMRI provides good spatial resolution and allows for strong functional – anatomical identification when the results of functional scans are coregistered with high resolution anatomical scans. Temporal resolution is typically a few seconds, another advantage over other functional neuroimaging techniques. Data resulting from this technique has been found to be robust and reproducible, and fMRI has become a major tool of cognitive neuroscience researchers. From a more practical standpoint, there is also wide availability of MR scanners capable of acquiring fMRI data. While these advantages likely contributed to the exponential growth in the use of this neuroimaging technique, individuals less familiar with fMRI should be aware that this procedure is technically challenging and analysis and interpretation of fMRI data is complicated. As a result, fMRI results are at risk of overinterpretation or misuse by those without adequate training. This is a key issue as fMRI becomes a more widely used clinical tool, for example as a less invasive Wada test, and to assess the functional impact of

structural abnormalities from stroke, trauma and other lesions.

Early studies using fMRI focused primarily on research questions; however, as the technology developed, numerous clinical applications have been proposed and are actively pursued. Researchers and clinicians are using fMRI in fields such as neurosurgery, neurology, psychiatry, and rehabilitation. For example, studies have considered fMRI as a tool to assess integrity of intrahemispheric functions, identify boundaries of functional tissue, identify seizure foci, and lateralization of memory and language functions in preparation for neurosurgical or radiosurgical intervention for intractable epilepsy, tumors, arteriovenous malformation, and other pathology. fMRI has also seen limited application in investigations of brain trauma and stroke. This tool has been used to understand and identify early changes in brain function associated with Alzheimer's disease, and it has been proposed as a technique for evaluating recovery of brain systems after stroke and predicting stroke recovery. fMRI has also been considered as a tool for diagnosis and evaluation of treatment response in chronic pain, as well as understanding and diagnosing conditions such as schizophrenia, obsessive compulsive disorder, addictions, and depression.

A tool such as fMRI requires expertise and knowledge in an array of areas, including neuroanatomy, the organization of functional brain systems, brain-behavior relationships, statistical approaches for detecting and localizing brain activation, a basic understanding of MR physics and of image acquisition and reconstruction artifacts that can confound

data interpretation, and in the use and development of psychological tools to optimally probe brain regions and systems of interest. Use of fMRI generally requires regular collaboration of physicists and engineers to develop approaches for acquiring functional images and analyzing data. Now, functional imaging data acquisition software for MRI systems is part of standard pulse sequence packages for most new MR systems from major manufacturers, and software for analyzing fMRI data sets are available on the web as freeware.

Thus, at this point, fMRI is primarily an applied tool, that can be employed by basic and clinical neuropsychologists, as well as other professionals, to test hypotheses about normal brain function and about clinical disorders. The actual clinical usefulness of fMRI depends on the extent to which the activation protocol or task design meets the demands for the purpose of the study. Activation protocols must be reliable, sensitive to the function under investigation, and specific to the proposed clinical use. Validation is essential. Here, neuropsychologists are uniquely prepared to insure that the most appropriate task paradigm is used for specific clinical questions about a patient. Interpretation of fMRI results is also complex, as numerous variables must be considered such as behavioral performance, effort and attention, mood state, strategy to perform task, extent of brain pathology, medication effects, and education level. While fMRI has not been formally approved for clinical use, the research testing and validating this technique for clinical use has grown rapidly and the transition to routine clinical use of fMRI has begun.

Given the complexity of this technique, execution of fMRI requires a multidisciplinary, collaborative approach with individuals knowledgeable in areas such as neurophysiology, magnetic resonance imaging, statistics, and neuropathology. fMRI disciplines include neuroscience, physics, computer science, statistics and mathematics, physiology, biochemistry, radiology, neurology, neuropsychology, neurosurgery, pharmacology,

psychiatry, and rehabilitation. To an extent, this multidisciplinary approach is similar to the Wada procedure, a clinical procedure used for determining neural representation of language and memory functions in surgical candidates for intractable epilepsy. Individuals involved in the Wada procedure typically include a radiologist, neurologist, neuropsychologist, and EEG technician.

Given that the actual integrity of an fMRI study ultimately depends on the adequacy with which the activation protocol measures what is relevant to the purpose of the study, it is critical that use of fMRI also involve experts in the area of cognitive assessment, task design, and understanding of behavioral brain function. A clinical neuropsychologist is trained in the science of brain-behavior relationships and specializes in the use of assessment principles based on the scientific study of human behavior. Moreover, neuropsychologists are specifically trained to understand the complex, distributed neural systems engaged during specific mental operations. This provides a critical perspective regarding the ways in which disturbances in these neural systems may lead to increases, decreases, or region changes in brain activation elicited by specific tasks. A neuropsychologist considers the entire lifespan and is knowledgeable regarding normal and abnormal functioning of the central nervous system. Training and experience of clinical neuropsychologists involves development of cognitive tasks, validation of measures, assessment, and interpretation of cognitive data gathered in assessment, and making recommendations for accommodations and potential for rehabilitation. By virtue of their training in psychometric theory and statistics, neuropsychologists are able to understand and design and optimal paradigms for eliciting clinically useful information from fMRI exams, and to avoid the misinterpretation of invalid results that may impact enormously important clinical decisions. With this training, neuropsychologists are well qualified to be active in research and clinical activities involving fMRI.

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As fMRI technology continues to grow, application of this functional brain imaging technique to clinical populations will likely become common practice. Clinicians and researchers using this technique are obligated to apply the technique responsibly. All individuals are expected to obtain adequate training in the use of fMRI, as many components to fMRI use are beyond traditional practice of each field. However, it is the aspirational goal of this paper to emphasize the unique role neuropsychologists have in the use of fMRI in the development of task protocols and interpretation of findings, and hence the role they should play in conducting and interpreting fMRI studies for clinical purpose.

By virtue of their training in multiple relevant disciplines, as noted above, neuropsychologists are clearly qualified and may be regarded as essential contributors to

multidisciplinary teams conducting clinical fMRI. Indeed, considering all professions involved in applying fMRI as a clinical or clinical research tool, neuropsychologists who have obtained specialized training in fMRI are among the best prepared to perform these clinical functions. To assure that the development of clinical fMRI provides maximum benefit and minimal risk to patients, we believe it is now timely and important to codify guidelines for formal training in this area, to define the specific areas of expertise needed to perform this function, and to seek billing authority for performing these procedures.

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