New Horizons in Human Brain Imaging: A Focus on the Pacific Rim

Executive Summary

This executive summary concerns our efforts to convene a 3-day international meeting of researchers from North America and Pacific Rim regions entitled "New Horizons in Human Brain Imaging: A Focus on the Pacific Rim" to examine and critique the future of brain imaging using MRI and related modalities of examining *in vivo* human brain structure and function. The meeting, being planned for April 13th-15th 2009, will be comprised of key themes important to the next era of neuroimaging science and address the research and clinical motivations for the next 15 years of research using rapidly evolving neuroimaging technologies. For instance, an important element will concern the better understanding of individual differences in functional activity across subjects. In particular, the meeting will focus specifically on attainable means by which investigators from Pacific Rim nations may maximize collaborative effort in addressing the scientific and clinical challenges facing this dynamic and multi-disciplinary field. In what follows, we provide background and justification for this meeting.

In the early 1990's, several highly influential developments occurred that revolutionized the study of the human brain: 1) the accelerated use of PET to map human brain activity in vivo, 2) the proliferation of magnetic resonance imaging scanners in medical centers and academic departments in the North America and Europe made it possible to obtain exquisitely high resolution images of the brain, 3) the discovery of the blood oxygenation level dependent (BOLD) magnetic susceptibility effect of hemoglobin (Ogawa, Tank et al. 1992) enabled the moment to moment measurement of brain blood flow related signal using MR, and 4) the manipulation of BOLD signal over time using sensory, cognitive, and behavioral stimulation enabling the localization of fundamental brain functions (Bandettini, Wong et al. 1992). In the 15+ years that has elapsed since the first studies appeared in the literature, the number of neuroimaging studies of brain anatomy and cognitive function, in healthy subjects and patients, has increased dramatically. Considerable advancement has been made over that period, ranging from those involving improvements in technology (Bellgowan, Bandettini et al. 2006), development of sophisticated computational methodologies (Yamashita, Sadato et al. 2005), and better understanding into and interpretation of blood flow-related MR signals (Buxton 2001). Newer methodologies have also emerged in recent years, such as diffusion tensor imaging (DTI), that permit the assessment and mapping of white fiber tractography (Golay, Jiang et al. 2002; Bammer, Acar et al. 2003). In addition, the range and depth of the scientific questions that functional and structural MRI is addressing continues to grow. Indeed, nearly 2500 peer-reviewed articles appear in the literature each year that used MR brain imaging to examine the human brain in health and disease.

While initially a discipline largely driven by scientists based in North America and Europe, such as the International Consortium for Brain Mapping (ICBM; see Mazziotta, Toga et al. 2001), the field of brain imaging has experienced increasingly important participation from researchers in Asia and in Australia. And yet, apart from *ad hoc* interactions, ongoing international collaborations and consortia between researchers from these countries concerning human neuroimaging have been relatively infrequent.

The field of neuroimaging is now at a juncture where clear vision is required to chart the course for the next 15 years of imaging research that focuses a directed research effort in the cognitive sciences, maximizes clinical efficacy, inspires new innovation, and leverages emerging methods and

technology to fully utilize collected data. New thinking has emerged that suggests that individual variability of functional activity evoked during cognitive tasks is not an effect that should be "averaged out" but can be examined more closely in relation to differences in cognitive strategy and task performance (Miller, Van Horn et al. 2002). Additionally, recent developments in neuroimaging for tracing white matter fiber pathways make it possible to identify individual-specific patterns of structural connectivity that underlie and support efficient distributed cognitive activity. Functional genomics is increasingly becoming an important way to understand how patterns of brain activity or spectroscopic signals contribute to a person's cognitive abilities (Glahn, Paus et al. 2007). To analyze these increasingly large datasets, new computational approaches, such as grid computing (Van Horn, Dobson et al. 2006), are being examined. Now is the time to examine these issues as a whole and learn how to take advantage of emerging new biotechnologies for understanding what may be a be characteristic of true brain function as opposed to the simple computing of average activity in health and disease. With the emergence of Pacific Rim nations being so prominent in the field, now is the time to examine how to maximize scientific interactions, share data, and resources.

This international meeting on the future human brain imaging will feature emergent fMRI technologies, recent advances in MRI scanner capabilities, research and clinical applications, and novel data processing methods. High resolution imaging, cognitive, behavioral, pharmacological, and genomic neuroimaging will be topics of discussion in addition to their integration with related neurophysiological measurement methods. Speakers will be asked to describe their current research but to contemplate where their research using these technologies will be in 5, 10, and 15 years from the present. Additionally, we will scrutinize some of the most cutting edge clinical and basic neuroscience applications of newly available imaging methodologies and what these mean for future studies of brain structure and function.

This international meeting will be a watershed moment in the development of neuroimaging science: fostering greater cooperation between Pacific Rim scientists and enabling the field to meet the challenges expected in coming decades. We expect this event to have an advanced educational aspect involving the latest advice on how to best integrate recent methodologies into a useful and collaborative research program. Outcomes from the meeting will include a featured article in a leading peer-reviewed journal. Discussions will examine productive and useful collaborations between meeting participants that will speak directly to governmental research agendas, provide insights into scientific directions for future industry technological R&D, and to how international researchers can interact more closely in the study of health and disease of the human brain using advanced neuroimaging techniques. In particular, we expect those in the medical imaging, high performance computing, and related industries to take particular interest in this meeting and the new markets it provide for their products. The meeting has received support from the National Institutes of Health (NIH), the Institute for Collaborative Biotechnology (ICB), the International Neuroinformatics Coordinating Facility (INCF), Sun Microsystems, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the UC Pacific Rim Institute, as well as the International Brain Research Organization (IBRO). Finally, this meeting has been endorsed by the International Society for Magnetic Resonance in Medicine (ISMRM).

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The Informatics Coordinating Facility (INCF), Stockholm, Sweden
Sun Microsystems

This event has also been formally endorsed by the International Society for Magnetic Resonance in Medicine (ISMRM).

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