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FOUNDATION



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Guang H. Yue, Ph.D.
Department of Biomedical Engineering/ND 20
9500 Euclid Avenue
Cleveland, Ohio 44195

Office: 216/445-9336
Fax: 216/444-9198
Email: yueg@ccf.org

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Biocomplexity Faculty Search Committee,
c/o Prof. Rob de Ruyter van Steveninck,
Department of Physics,
Indiana University,
Swain Hall West 117,
Bloomington IN, 47405-7105

Re: Dr. Jingzhi Liu

Dear Professor Rob de Ruyter van Steveninck:

This letter is to enthusiastically support the application of Dr. Jingzhi Liu for the faculty position in your department. I have known Dr. Liu for more than seven years and can attest to the fact that he is highly competent, insightful, and has the background and ability necessary to be a leader in the field of magnetic resonance imaging (MRI), functional MRI (fMRI), electroencephalographic (EEG), and biophysical study of human brain/neuromuscular function.

Dr. Liu received his Ph.D. from the Physics Department at Case Western Reserve University (CWRU). His expertise is biomedical physics in general and MRI in particular. His current research focuses on understanding human neuromuscular function using structural and functional MRI, EEG, magnetoencephalographic (MEG), computer simulation, and mathematical and biophysical modeling methods. In a relatively short time, Dr. Liu has established a promising independent research program and has published an array of papers in leading scientific and biomedical journals.

Dr. Liu's major contribution to the scientific literature comes from his pioneer studies of the central nervous system control of muscle fatigue. Muscle fatigue has been studied for over a century. Based on information recorded from fatiguing muscles, many hypotheses

have been made regarding how the brain modulates fatigue and how fatigue influences the activities of the brain. However, Dr. Liu was the first to investigate brain signal changes while human limb muscles undergo severe fatigue. He has reported detailed brain activation patterns during different fatigue tasks. His results have both basic science and clinical significance. For basic science, the information provides new knowledge regarding human motor control principles. Clinically, increased fatigability occurs in almost all patients with muscle weakness, regardless of whether the weakness is due to a central or peripheral neurological disorder. The underlying mechanisms of this prevailing clinical symptom are not well understood but are believed to be involved in impaired central nervous system function. His findings in healthy individuals provide a “gold standard” or control data for comparisons with future patient data. Currently, Dr. Liu is investigating how muscle fatigue affects functional connections among brain regions that are involved in the control process and between the brain and working muscles. In addition, Dr. Liu is working on a project to estimate potential EEG signal source migration (rotation of center of brain activation) during muscle fatigue. Dr. Liu has also developed an excellent model that explains human muscle fatigue, recovery, and the adaptation of brain command. In the first years of his research career, Dr. Liu lacked physiological/biomedical background; however, his knowledge in this field has substantially increased in recent years.

To improve the quality of motor function study using fMRI, Dr. Liu built an MRI accessory hardware system to simultaneously collect fMRI brain images with muscle electrical signals and force applied by hand or fingers. This project was very challenging because he had to overcome a number of technical difficulties, such as adequately shielding the muscle electrical signals from interference with the magnetic field of the scanner. He eventually successfully solved all the problems and built a high-quality system. This system has enabled him to evaluate fatigue-related changes in brain and muscle electrical (electromyogram) and mechanical (force) signals (studies described above), the relationship between signals of the brain and muscle, and fMRI signal reproducibility under precisely measured motor activities, etc. All these studies have been published with Dr. Liu as the leading author and the studies have drawn substantial attention from investigators in the related fields.

Besides his strong interest in understanding physiological process of human neuromuscular system, Dr. Liu also works on quantifying structural adaptations of human brain as a consequence of normal aging and diseases. Under his direction, a highly accurate and reproducible algorithm for measuring the brain and its substructures has been developed. This algorithm was used to calculate brain, its hemisphere and frontal lobe volumes in young and healthy aging subjects. The results provided new evidence on asymmetric and selective local atrophies of brain cortices due to aging and gender effects on these atrophies. Dr. Liu has also directed a program to evaluate age-related brain white matter changes by quantifying the structure’s fractal dimension (FD), a variable widely studied in physics. Preliminary data of this analysis have shown that brain white matter structure complexity, measured by the FD, is significantly reduced in normal aging. These methods, developed by Dr. Liu, are among the very few methods that can be used to quantify the dynamical changes (often very subtle) in brain structures in live

human subjects. It is highly likely that Dr. Liu's methods will soon be widely adopted by others to advance the research in this field and his contribution to these advancements will soon be felt.

Dr. Liu has also demonstrated great enthusiasm and ability to teach and mentor students. He has demonstrated his abilities as a teacher in different ways: first by giving lectures in a graduate course in the Physics Department at CWRU (course director: Dr. Robert W. Brown); second by offering high-quality seminars in our institution and research communities, and at national and international conventions; third as a mentor to six graduate students (five Ph.D. and one M.S. students). His mentorship has been essential for the successful development of the research programs of these students and has produced great results, such as age-related brain structural changes described above. In addition to mentoring graduate students, Dr. Liu has involved in advising a number of undergraduate and high school students in the past years.

In summary, Dr. Liu has been highly trained and well prepared to launch his independent research career and graduate and undergraduate teaching programs. In fact, he has previously directed a number of research programs independently and mentored graduate and undergraduate students. He has been a co-investigator in a number of major NIH and other federal research grants. In recent months, he has submitted two R01 NIH grants. His major strength comes from a combined strong background of physics, biomedical engineering, and biomedical sciences. His unique background will likely strengthen his research programs and competitiveness for funding. It is my professional opinion that Dr. Liu will make significant contributions to the advancement of neuroscience research technologies (MRI, fMRI, EEG, etc) and understanding of human neuromuscular system. Consequently, I have no reservation in giving my highest recommendation to Dr. Liu for the faculty position offered by your institution. If additional information is needed, please feel free to contact me.

Sincerely,

Guang H. Yue, Ph.D.
Staff Scientist
Department of Biomedical Engineering/ND20
Associate Professor
Cleveland Clinic Lerner College of Medicine