January 21, 2011

Dr. Edward Miller
Dean/CEO Johns Hopkins Medical School
100 Medical School Administration

Dear Dr. Miller,

I am writing to nominate Dr. Amy J. Bastian for promotion to Professor of Neuroscience, full time. Amy came to Johns Hopkins in 2001 after spending 3 years as an Assistant Professor at Washington University in St. Louis. She was promoted to Associate Professor here at The Johns Hopkins School of Medicine in 2005. Amy is an internationally recognized researcher with an outstanding teaching and academic service record. Her laboratory is located at The Kennedy Krieger Institute and is an important part of the research program there. A committee of senior Neuroscience Department faculty has unanimously endorsed her nomination for promotion.

Amy received her Ph.D. from Washington University in St. Louis under the mentorship of W. Thomas (Tom) Thach (1991-1995). With Tom, she studied human movement control, using quantitative techniques such as motion capture, dynamics calculations, and recording from muscles. In her dissertation work Amy discovered that people with damage of the cerebellum make uncoordinated or ataxic reaching movements because they do not account for mechanical interactions between different parts of the body. In other words, they do not predict how a movement of one part of the body creates motion in other parts of the body. Amy continued her work with Tom as a post-doctoral fellow (1995-1997) and began to explore how people learn new movements. In her research career at Hopkins, she has become a leading expert on human movement control and learning. Amy's laboratory has produced a series of publications in high impact journals that explain how movements are normally learned and how damage to the brain affects motor learning and motor control. Her research accomplishments are summarized below along with information about her teaching and academic service contributions.

Research

A fundamental question in neuroscience is how animals learn to control the incredibly complex, yet fluid and accurate, motions of the body. Amy's major approach is to compare humans with and without damage to different neural structures as they move (e.g. reach, walk) under varying behavioral conditions. She then uses her findings to infer the normal functions and computations performed by specific parts of the brain. Her work also focuses on understanding neural mechanisms of learning and their importance for rehabilitation of brain injuries. Her laboratory uses a high-speed, 3-D infrared motion-tracking device to record natural movements, biomechanical techniques such as force plates to measure foot contact forces, surface EMG recordings, and custom devices and robotics for controlling movement. She has also developed novel experimental methods and analytical techniques adapted for evaluating human movement control.

Amy has been a leader in studying how people learn walking patterns. Her approach is innovative—she uses a custom-built split-belt treadmill that allows her to independently control each leg's walking speed. She has developed paradigms in which people learn to walk with one leg moving 2-4 times faster than the other, or even in the opposite direction. This has allowed her to answer fundamental questions about human walking control.

For example, she has shown that the circuits used to learn new walking patterns can be independently modified for each leg and for different walking directions: learning a forward walking pattern has no effect on backwards walking, and vice versa. This finding is so robust that humans can store different walking patterns for forward versus backward walking simultaneously, with no interference between the two. She has also shown that adults can easily perform and learn new walking patterns in which the right and left legs move in opposite directions, which made it possible to dissociate learning patterns in the two legs. These findings have revealed a surprising degree of independence between the basic learning mechanisms controlling the right and left legs during walking.

This work also has direct implications for clinical strategies in patients with severe gait impairments. For example, her group has also recently found that the ability to learn new walking patterns develops rather slowly during childhood. While the basic walking pattern is thought to mature by about age 6, she has found that the ability to learn new patterns is not mature until age 14. This mature learning ability may depend on more complete development of specific neural structures such as the lateral cerebellum and corticospinal system. At the clinical level, this finding suggests that different training schedules may be required for children versus adults.

Amy's work on walking also points toward specific rehabilitation strategies depending on the nature of injuries. She has shown that learning new walking patterns is dependent on cerebellar, but not cerebral structures. Thus, cerebellar patients are unable to learn inter-limb coordination during split-belt walking, and they retain nothing after training. In contrast, individuals with hemiparesis from stroke involving the cerebrum (and <u>not</u> involving the cerebellum) learn normally in a single session, and are able to retain a motor memory that improves their limp (i.e. step symmetry). Ongoing work is showing that these rehabilitative changes can be made more permanent with long-term training.

The other major focus of Amy's work has been human cerebellar function. She has been a leader in this area for many years. Early in her career, Amy showed that the cerebellum is important for predicting complex mechanics associated with multi-jointed movements and is also required for motor learning in novel mechanical situations. Absence of this learning ability implies that people with cerebellar damage will be unable to fine tune motor performance, through practice, in response to the demands of everyday life. Her group and collaborators have also shown that cerebellum-dependent learning is driven by "sensory prediction errors," or errors predicting where a limb will move given a specific motor command (i.e. did I land where I thought I should?). This is different than an error in achieving a specific target or goal, and suggests that cerebellum-dependent motor learning can occur without target or goal-related errors.

Dr. Bastian's research has been steadily supported by grants from the National Institutes of Health since 1997. She is currently the Principal Investigator on two grants (R01 HD048741, RO1 HD0402089), which are scheduled to be funded until 2015 and 2016, respectively. She is a co-investigator on other two other grants supported by the National Institutes of Health.

Dr. Bastian collaborates on several other projects studying sensory and motor function. In collaboration with Reza Shadmehr (BME), she has been exploring ways to improve motor learning in cerebellar patients. She is actively studying coordination and motor learning in children with autism spectrum disorder (Stewart Mostofsky MD, Ped. Neuro); visual perception in children with autism (Ed Connor PhD, Neuroscience); use of robotics to understand motor coordination deficits (Allison Okamura PhD, Mech. Eng.); somatosensory function in humans (Steve Hsiao, Neuroscience) and use of non-invasive brain stimulation to improve motor learning (Pablo Celnik MD, PM&R).

Teaching

Amy is an accomplished teacher and mentor for graduate students. During her time at the Johns Hopkins University School of Medicine, she has been the Course Master for Current Issues in Systems and Cognitive Science for many years, and is now the Course Director for the second semester of the core neuroscience course, Neuroscience and Cognition II. She has also lectured in multiple Neuroscience courses including: CNS Physiology, Neuroscience A (medical students) and Neuroscience and Cognition II (neuroscience graduate students). She has received outstanding teaching evaluations, and was among the top-rated lecturers for the Medical School Neuroscience course.

Amy has previously mentored 7 pre-doctoral students and 7 post-doctoral students. She is currently advising 5 pre-doctoral students, 3 post-doctoral students, and 4 junior faculty with K awards. She has helped 7 of the 12 pre-doctoral students that she advised (or is advising) receive fellowships from the NIH or other research foundations. Her former students and post-docs have also been very successful: 9 have obtained tenure track faculty positions at major research institutions (e.g. Washington University, Boston University, University of Iowa) and 1 is a post-doctoral fellow (Georgia Tech, Atlanta). Several of her former students have received NIH K awards and NIH R01 grants. Based on the success of her students, it is clear that Dr. Bastian has provided excellent and effective training in her laboratory.

Academic Service

Amy has provided many years of service on Hopkins committees, including the Neurology Department Promotions Committee, Search Committee for the Director of Biomedical Engineering, Medical School Faculty Council, and the Kennedy Krieger Neurobehavioral Research Unit review committee. She has also been on a Faculty Search Committee for the Neuroscience Department and the Biomedical Engineering PhD Admissions Committee. She has served on international committees including the Society for Neuroscience Program Committee and the Society for Neural Control of Movement Executive Board. Amy is an Associate Editor for the Journal of Neurophysiology (2008-2011) and is on the editorial board for the journal Neurorehabilitation and Neural Repair. She reviews for top tier journals such as Nature Neuroscience, Journal of Neuroscience, and Brain. She has participated in several NIH study sections and is currently a member of the Musculoskeletal Rehabilitation Study Section (2010-2014). She has also reviewed grants for NSF, the Dana Foundation, the Foundation for Physical Therapy, the Canadian Institutes of Health Research, and the Medical Research Council in the UK.

National and International Stature

Amy is one of the foremost investigators in human movement control and dysfunction in the world. Her research has resulted in 34 peer-reviewed articles since she became an associate professor in 2005, including publications in the Journal of Neuroscience, Journal of Neurophysiology, Nature Neuroscience and Brain, all leading journals in the field of Neuroscience. This represents outstanding productivity given the time-intensive nature of systems neuroscience. Amy's work on walking control has been written about by the Associated Press and distributed widely to news sites such as CNN and the New York Times. She has also been interviewed on National Public Radio about her work on motor function in autism.

Amy's expertise in her field has been internationally recognized by her peers, as evidenced by the fact that she was awarded an international prize, the "Susanne Klein-Volgelbach Award for Research in Human Movement" for her work on walking control and learning. She has chaired many slide sessions at meetings such as the NIH task force meeting on Childhood Motor Disorders, American Physical Therapy Association Meeting, and the Society for Neurosciences annual meeting. She has given more than 50 invited lectures at universities around the world, including multiple named lectureships—for example she was the inaugural lecturer for the "Rubin Annual Lectureship" at Northwestern University and gave the "Gustave Gingras Lectureship" at the University of Montreal.

In summary, Amy is widely recognized as a leader in the field of motor control and has demonstrated new principles of human walking control, motor learning, and cerebellar function. She is an outstanding teacher and mentor. Amy is a vital member of our faculty, and I believe her accomplishments merit promotion to the rank of Full Professor.

Thank you for your thoughtful consideration.

Sincerely,

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