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DEPARTMENT OF PSYCHOLOGY
3210 TOLMAN HALL # 1650

BERKELEY, CALIFORNIA 94720-1650
TEL: (510) 642-5292

David Sheinberg, Ph.D.
Computational Neuroscience Search Committee Chair
Department of Neuroscience, Brown University

April 1, 2012

Dear Dr. Sheinberg and Members of the Faculty Search Committee:

I am writing to offer my **strongest possible recommendation** for Dr. Shinji Nishimoto, who has applied for a position in your department. Dr. Nishimoto has been a post-doctoral researcher in my laboratory for the past five years. His groundbreaking work has included neurophysiology, functional MRI (fMRI) and computational modeling. **Let me state at the outset that Dr. Nishimoto is the best post-doc that I've ever had. He has produced some incredibly beautiful work, accomplishing feats that many others in the field thought impossible.** He is a remarkable and gifted cognitive, systems and computational neuroscience. Based on his strong record, technical skills, obvious creativity and outstanding promise, I give him my strongest possible endorsement.

Dr. Nishimoto did his undergraduate and graduate work in Biophysical Engineering at the University of Osaka. His Ph.D. Was supervised by Professor Izumi Ohzawa, a leading researcher on neurophysiological and computational studies of the early visual system. He was Prof. Ohzawa's very first graduate student, and he was largely responsible for building and equipping Prof. Ohzawa's laboratory. Dr. Nishimoto's graduate work focused on neurophysiological studies of visual area V2. Although almost all the information used for higher vision passes through V2, when he began his work remarkably little was known about the way that V2 encodes spatial information. To address this issue he developed a novel computational tool for characterizing single neurons, local spectral reverse correlation (LSRC). This new tool enabled him to describe how V2 encodes spatial information with unprecedented detail, revealing several important new aspects of V2 function. His beautiful Thesis work was published in the Journal of Neuroscience and it had a big influence on all subsequent studies of V2 (including those from my lab).

After receiving his Ph.D. at Osaka, and with an outstanding recommendation from Prof. Ohzawa, Dr. Nishimoto moved to my laboratory at Berkeley. My lab was a natural choice given Dr. Nishimoto's interests in quantitative analysis and modeling of vision. His first research project in my laboratory focused on area MT, an important stage of motion processing. Area MT has been an important target of neurophysiological research for some time. However, at that time all previous work on MT had been conducted using simple stimuli such as gratings, plaids and dots. Researchers assumed that their results would generalize to more complicated natural stimuli, but no one had actually investigated this issue because it was generally believed impossible to characterize area MT neurons quantitatively using natural moving stimuli.

Dr. Nishimoto tackled this issue head on in an ambitious neurophysiology study that aimed to quantitatively model area MT neurons under naturalistic viewing conditions. His project required development of several new computational algorithms for analyzing and modeling responses of MT neurons under these conditions. **To my great delight, the MT project was remarkably successful, producing the first computational model of motion processing in area MT that accurately predicts neuronal responses during natural vision.** Although this model shares attributes with some of the simpler models proposed in earlier studies, it also includes several innovative and critical features that describe important neural mechanisms that were unknown previously. It would not be an overstatement to say that Dr. Nishimoto 's work is the culmination of several decades of effort to develop a computational model for area MT. His model also provides a springboard for new experimental and computational research. This fantastic work was published in the Journal of Neuroscience last Fall.

More recently, much of Dr. Nishimoto 's effort has been directed toward functional MRI, a line of inquiry that grew directly out of his earlier work on area MT. A bit of background is warranted here. Over the last eight years or so my laboratory has adapted the computational modeling approach that we developed for single neurons so that it can be used to model single voxels recorded by fMRI. Our initial voxel-wise modeling work focused on responses elicited by static natural scenes, but we had never tried to model fMRI responses to natural movies. In fact, because hemodynamic responses are extremely slow and fMRI measurements are typically made only once every 1-2 seconds, everyone in the field of fMRI had generally assumed that it would be impossible to recover dynamic information from fMRI data at a time scale finer than 1-2 seconds.

Dr. Nishimoto sought to apply the MT model that he had constructed for neurons to volumetric units (voxels) recorded by fMRI. To solve this problem he had to developed several new computational and statistical methods. The result was an ingenious model that consists of two components: a bank of spatio-temporal motion-energy filters that reflect tuning of the latent and unmeasured neural population, and a set of hemodynamic coupling filters that reflect the link between each motion-energy filter and observed blood-oxygen level-dependent (BOLD) responses. **This modeling framework is remarkably powerful, and it has produced the first successful spatio-temporal receptive field models of single voxels.**

Dr. Nishimoto showed that this model recovered most all of the basic information that had been revealed in previous fMRI studies of early visual cortex – retinotopy, spatial frequency and orientation tuning, motion sensitivity and the cortical magnification factor – merely from BOLD responses evoked by natural movies. He also showed, for the first time, that temporal frequency tuning varies with eccentricity across human visual cortex. Finally, Dr. Nishimoto introduced several important theoretical and statistical improvements to a Bayesian decoding framework that had been developed earlier in my laboratory. **His work substantially increased the sensitivity and performance of the decoder, producing the first reconstructions of natural movies entirely from brain activity measurements made using fMRI.**

This work was published in Current Biology this fall, and it ignited a firestorm. The video that accompanied the article was posted on YouTube, and it received over one million hits in just the first four days after publication. The work was featured in over 500 papers worldwide, and it lead to numerous requests for radio and television interviews. Dr. Nishimoto 's decoding process was selected as one of Time magazines 50 Best Inventions of the Year. In sum, this project was a remarkable scientific and technical achievement, one that also resonated deeply with the public. And this is only the beginning. Studies of dynamic brain activity have for the most part been inaccessible to fMRI until now; Dr. Nishimoto 's approach offers a clear and provable way to address these issues. Because his approach has so many potential applications I think that it will be adopted widely in future fMRI studies.

I should note here that although Dr. Nishimoto is also an exceptional collaborator. He has developed several ongoing collaborations with other members of my laboratory, and with several other laboratories across the world. Within my lab he is collaborating with a graduate student, Mike Oliver, to construct a quantitative model of single neurons in area V4 that can accurately predict responses to natural scenes. To do this he is participating in neurophysiological recordings from single neurons in areas V1, V2 and V4 during stimulation with natural movies. By recording from multiple days or weeks from the same neurons, they hope to obtain a data set that is rich enough to enable V4 neurons to be modeled accurately. In a separate collaboration with another graduate student, Alex Huth, Dr. Nishimoto is using fMRI to investigate the representation of semantic information across the cortical surface. And he is collaborating with another post-doc, Tolga Cukur, to model attentional modulation of structural and semantic tuning.

Dr. Nishimoto has also maintained collaborations with his old colleagues at Osaka on several projects that extend his original spectral analysis approach and which apply it to neural development. He has a further collaboration in Japan that aims to use calcium imaging to understand responses to natural movies. Finally, he has begun a collaboration with a European group that aims to combine fMRI and MEG to better understand human vision. I expect that these various collaborations will lead to a minimum of 6-8 co-authored papers for Dr. Nishimoto over the next few years, some out of my laboratory and some with his colleagues from Osaka. This is an unusual level of collaborative activity for a post-doc, even one as gifted as Dr. Nishimoto. But Dr. Nishimoto is very smart and remarkably efficient, so he is able to keep all these balls in the air and to make valuable contributions to multiple projects in disparate areas. I haven't ever seen these collaborations slow down his work in my lab.

During his time in my laboratory, Dr. Nishimoto has distinguished himself as a highly gifted experimentalist and theoretician. He is a quick learner and an extremely intelligent, practical scientist who can solve any problem that comes his way. (His lab nickname is "McGuyver", because of his uncanny ability to come up with a creative and brilliant solution to any problem, even those that have stumped many others.) In addition to his substantial intellectual gifts, Dr. Nishimoto is also a friendly, helpful person, and an excellent collaborator. Finally, he is a deep thinker who appreciates the bigger picture, but one who can balance this with the practical realities of completing a piece of work. It is unusual to find such a strong combination of experimental practicality and big-picture thinking in someone at such an early stage of their career.

In summary, Dr. Nishimoto is the prototype for a new breed of cognitive and systems neuroscientists who combine strong experimental skills with a deep background in quantitative methods. His strong experimental skills will enable him to perform cutting-edge research using the most modern experimental techniques. His strong analytical skills ensure that he will be a leader in the new quantitative and computational approaches that are becoming increasingly important in cognitive and systems neuroscience. His keen intelligence and good personality ensure that he will be able to build a successful laboratory that will make fundamental and important contributions to our understanding of the brain.

Dr. Nishimoto enjoys all aspects of the scientific enterprise, and I think that he would thrive in many different environments. He could easily run an fMRI laboratory, or a neurophysiology laboratory, or one that encompassed both of these important techniques. In fact, I believe Dr. Nishimoto could master any new technology that came his way, from more molecular techniques (e.g., calcium imaging) to cognitive techniques (MEG). Given his extensive experimental background, strong quantitative and statistical skills and demonstrated success in collaborations, Dr. Nishimoto would also be a spectacular hire colleague for a purely computational position.

In sum, I believe that Dr. Nishimoto will be a star of cognitive and systems neuroscience. **I give him my absolute highest recommendation.** If you have any further questions about him, please do not hesitate to contact me. I will be happy to provide any necessary information.

Sincerely,

Jack L. Gallant
Professor, Psychology and Neuroscience
Programs in Bioengineering, Biophysics and Vision Science