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Dr. Se-Bum Paik
Department of Neurobiology, David Geffen School of Medicine
University of California, Los Angeles
2844 Slichter Hall, Los Angeles, CA 90095-1563

April 18, 2012

Neuroscience Graduate Program
Brown University
185 Meeting Street
Providence, RI 02912

Dear Faculty Search Committee:

I am writing to apply for a faculty position in the department of neuroscience at Brown University. I am currently a postdoctoral researcher at the University of California, Los Angeles, in the David Geffen School of Medicine. I completed my Ph.D. in physics at the University of California, Berkeley, in December 2009, directed by Prof. Donald A Glaser. I am confident that my educational background, research experience, and teaching experience provide a strong background for my future research at Brown.

My main research interest is the computational study of the functional architecture of neural circuits in the brain and sensory systems, which is crucial for understanding the fundamental working mechanisms of the brain. This interdisciplinary research requires combined knowledge and skills in biology, physics, mathematics, and computer programming. My graduate work in physics and postdoctoral research in neurobiology make me well prepared to perform this work.

With regard to teaching experience, I worked as a lecturer and laboratory director in the Department of Physics at the Korea Air Force Academy for 3 years. I also worked as a Graduate Student Instructor at UC Berkeley for 4 semesters and won the Best Teaching Assistant award at Seoul National University in 1999. I am convinced that these experiences will help me work well with students and coworkers.

Enclosed are my statement of research and curriculum vitae, including a list of three references: Prof. Donald A. Glaser (Ph.D. thesis advisor), Prof. Dario L. Ringach (Postdoctoral research advisor), and Prof. Michael R. DeWeese (Ph.D. dissertation and qualifying examination committee advisor).

Thank you for your consideration.

Sincerely,
Se-Bum Paik

SE-BUM PAIK

EDUCATION

2009	Ph.D.	Physics, University of California at Berkeley	Berkeley, CA
2000	M.S.	Physics, Seoul National University	Seoul, Korea
1998	B.S.	Nuclear Engineering and Physics, Seoul National University	Seoul, Korea

RESEARCH EXPERIENCE

2009 ~ Present	Postdoctoral Researcher, University of California at Los Angeles	
	Department of Neurobiology, David Geffen School of Medicine	(Advisor: Dario L Ringach)
2006 ~ 2009	Graduate Student Researcher, University of California at Berkeley	
	Department of Physics	(Advisor: Donald A Glaser)
2003 ~ 2005	Research Assistant, Northwestern University	
	Department of Physics	(Advisor: Donald E Ellis)
1998 ~ 1999	Research Assistant, Seoul National University	
	Department of Physics	(Advisor: Sook-Il Kwun)

TEACHING EXPERIENCE

2005 ~ 2009	Graduate Student Instructor	Department of Physics, University of California at Berkeley
2001 ~ 2003	Full-time Lecturer	Department of Physics, Korea Air Force Academy
2000 ~ 2001	Lecturer	Department of Physics, Korea Air Force Academy
1999	Teaching Assistant	Department of Physics, Seoul National University

HONORS

2005 ~ 2006	University Fellowship	Department of Physics, University of California at Berkeley
2003 ~ 2004	Huang Fellowship	Department of Physics, Northwestern University
2003 ~ 2004	University Fellowship	Department of Physics, Northwestern University
1999	TA of the Semester	Department of Physics, Seoul National University

PROFESSIONAL AFFILIATIONS

Society for Neuroscience

Korean Physical Society

RECENT PUBLICATIONS

PEER-REVIEWED JOURNALS

Se-Bum Paik & Dario L Ringach, Link between the orientation and retinotopic maps in primary visual cortex, ***Proceedings of the National Academy of Sciences***, published ahead of print, doi:10.1073/pnas.1118926109 (2012)

Se-Bum Paik & Dario L Ringach, Retinal origin of orientation maps in visual cortex, ***Nature Neuroscience*** 14, 919-925 (2011) (Cover Article, July issue)

Se-Bum Paik & Donald A Glaser, Synaptic plasticity controls sensory responses through frequency-dependent gamma oscillation resonance, ***PLoS Computational Biology*** 6(9) e1000927 (2010) (Corresponding Author)

Se-Bum Paik, Tribhawan Kumar & Donald A Glaser, Spontaneous local gamma oscillation selectively enhances neural network responsiveness, ***PLoS Computational Biology*** 5(3) e1000342 (2009) (Corresponding Author)

CONFERENCES

Se-Bum Paik & Dario L Ringach, A link between the orientation and retinotopic maps in tree shrew V1, *Society for Neuroscience* (2011)

Se-Bum Paik & Dario L Ringach, Moiré interference of retinal ganglion cell mosaics generates periodic orientation maps in visual cortex, *Society for Neuroscience* (2010)

Se-Bum Paik & Dario L Ringach, Orientation maps as moiré interference of retinal ganglion cell mosaics, *COSYNE* (2010)

Se-Bum Paik & Donald A Glaser, Spontaneous gamma oscillations control the responsiveness of a neural network, *The Korean Physical Society Spring Meeting* (2009)

OTHER PUBLICATIONS

PEER-REVIEWED JOURNALS

Hong Z, Luan L, **Paik S**, Deng B, Ellis DE, Ketterson JB, Mello A, Eon JG, Terra J & Rossi AM, Crystalline hydroxyapatite thin films produced at room temperature - An opposing radio frequency magnetron sputtering approach, *Thin Solid Films* 515, 6773-6780 (2007)

Hong Z, Mello A, Luan L, Farina M, Andrade LR, Ferreira CL, **Paik S**, Deng B, Eon JG, Terra J, Rossi AM, Ellis DE, Ketterson JB, Characterization of crystalline hydroxyapatite thin coatings for biomedical applications, *Key Engineering Materials* 330, 525-528 (2007)

Moon SE, **Back SB**, Kwun SI, Lee YS, Noh TW, Song TK & Yoon JG, Orientational dependence of electro-optic properties of $SrBi_2Ta_2O_9$ ferroelectric thin films, *Japanese Journal of Applied Physics* 39, 5916-5917 (2000)

Moon SE, Song TK, **Back SB** & Kwun SI, Controlled growth of a-/b- and c-axis oriented epitaxial $SrBi_2Ta_2O_9$ ferroelectric thin films, *Applied Physics Letters* 75, 2827-2829 (1999)

Moon SE, **Back SB** & Kwun SI, Controlled growth of $SrBi_2Ta_2O_9$ thin films by the rf magnetron sputtering deposition, *Journal of the Korean Physical Society* 35, s1206-s1209 (1999)

REFERENCES

Donald A Glaser
Nobel Laureate in Physics
Professor Emeritus, Department of Physics
University of California Berkeley, Berkeley, CA 94720, USA
+1-510-642-7231
glaserda@gmail.com

Dario L Ringach
Professor, Department of Neurobiology and Psychology
David Geffen School of Medicine
University of California Los Angeles, Los Angeles, CA 90095, USA
+1-310-825-6606
dario@ucla.edu

Michael R DeWeese
Assistant Professor, Department of Physics
University of California Berkeley, Berkeley, CA 94720, USA
+1-510-643-4988
deweese@berkeley.edu

SE-BUM PAIK sbpaik@ucla.edu

RESEARCH STATEMENT

My research interest is in the neural circuits of the functional architecture of the brain. Specifically, I am interested in the various functional maps of the primary visual cortex that are responsible for processing visual information. The main goal of my research is to answer the following questions:

1. *How are cortical functional maps created and modified?*
2. *How do neurons interact in the maps and affect the function of the sensory system?*

My research will help us better understand how the visual system works and provide insights into the developmental and working mechanisms of the sensory cortex.

Background and Current Work

In the primary visual cortex of higher mammals, neurons respond selectively to the various features of visual stimuli, such as the orientation of edges and direction of movement. These neurons are spatially organized by their selectivity, forming various types of functional maps. Explaining the origin and role of these maps is crucial for understanding sensory systems and has been considered one of the most interesting issues in neuroscience. Currently, however, very little is known about the mechanisms by which these maps arise, how they are modified during development, and what function they may play.

My research over the past few years under the direction of my advisor Prof. Dario Ringach at UCLA has focused on developing a new theoretical model of the initial development of an orientation map that is one of the most important functional maps in the cortex. The model successfully explains the initial wiring of an orientation map and accounts for many features of the map [1-5] in a completely different way from classic models that have been generally accepted for decades. This theory does not require the relatively complicated biological mechanisms that were generally assumed in previous developmental models of the brain. It uses simple mathematical and physical phenomena to explain the early development of cortical functional maps. Thus, once this initial work is complemented by subsequent studies, it may significantly change our current view of the development of the functional structure of the brain.

I am confident that this work is a solid foundation for the next step in my career trajectory, specifically understanding the functional maps of the adult animal. My research plan is described below.

Research Agenda - Neural Circuits in Functional Maps

My future research will focus on the dynamics of the functional organization of the neural system. I am interested in how neurons interact with each other within a large neural circuit and how this affects the structure of functional maps and their response to sensory stimuli. Together with the initial developmental model of the maps, this work will provide a more complete understanding of the functional organization of the brain. Two main directions of this work are described below.

1. Neural Plasticity and Adaptation – Developmental Modification of Functional Maps

Significance. Neurons in the brain have plasticity in their structure and connectivity. This feature is particularly important during critical periods of development, in which the functional maps of the brain are refined and modified. My first work will extend my early developmental model described above, which focuses on the mechanisms in young animals, to explain the features of functional maps in adult animals.

Approach. Computational simulation is an effective tool to test theoretical models for this type of task and useful for making predictions and planning the direction of experimental work. During my Ph.D. research, I have been developing a computational simulation system of Hodgkin-Huxley-type model neurons to study various parameters and their effects on neural system activity. My experience in the modeling-and-simulation method will enable me to effectively perform the task, and the findings will provide valuable information about the functional maps of the cortex.

2. Nonlinear Behaviors in Large Neural Networks – Oscillations and Synchrony

Significance. Understanding the population properties of a neural network is a difficult task because of the large number of constituent neurons and extremely complicated interactions in interneuron connectivity. However, some important and interesting properties can only be studied in a large-scale neuronal population. For example, spontaneous neural oscillations of various frequencies are observed in many regions of the brain and thought to be important for sensory and cognitive function. Experimentally, exploring this neural activity in detail is difficult because of the difficulty controlling and measuring many relevant variables simultaneously. In this case, theoretical modeling and computational simulation may provide insights into the task. The findings will help us better understand how neural population behaviors can affect the function of sensory systems.

Approach. I have been developing computational tools to study the population dynamics of a large neural network. As a preliminary study, I showed that a neural network can dynamically modify its response properties from the selective amplification of input signal by spontaneous oscillation activity [6, 7]. Because the mechanism I found is applicable to various neural network systems, this could be a proper method to further study the working mechanism of neural circuits in various functional maps in the brain.

General Research Plan

My research will be performed mostly using theoretical and computational methods. The computational simulations will be performed using Matlab, GENESIS, and other programming languages, such as C and C#. Most of the simulations can be run with normal personal computers and require no special facilities. For larger scale tasks, I plan to use commercial GPU clusters and supercomputing facilities.

I also intend to work closely with other experimenters and researchers in related fields. Because my modeling technique is applicable to various types of tasks, I believe my work will be interesting to both theoreticians and experimental researchers who study neural systems and may contribute to understanding and explaining neural behavior in the brain.

References

1. SB Paik & DL Ringach, Link between orientation and retinotopic maps, *Proceedings of the National Academy of Sciences*, Published ahead of print, doi:10.1073/pnas.1118926109 (2012)
2. SB Paik & DL Ringach, Retinal origin of orientation maps in visual cortex, *Nature Neuroscience* 14, 919-925 (2011)
3. SB Paik & DL Ringach, A link between the orientation and retinotopic maps in tree shrew V1, *Society for Neuroscience* (2011)
4. SB Paik & DL Ringach, Orientation maps as moiré interference of retinal ganglion cell mosaics, *COSYNE* (2010)
5. SB Paik & DL Ringach, Moiré interference of retinal ganglion cell mosaics generates periodic orientation maps in visual cortex, *Society for Neuroscience* (2010)
6. SB Paik & DA Glaser, Synaptic plasticity controls sensory responses through frequency-dependent gamma oscillation resonance, *PLoS Computational Biology* 6(9) e1000927 (2010)
7. SB Paik, T Kumar & DA Glaser, Spontaneous local gamma oscillation selectively enhances neural network responsiveness, *PLoS Computational Biology* 5(3) e1000342 (2009)

SE-BUM PAIK sbpaik@ucla.edu

TEACHING STATEMENT

Over the past decade, teaching has been an important part of my academic career. Lecturing has expanded and solidified my knowledge and teaching and counseling skills. Building rapport with my students through curricular and extracurricular activities has given me a deep sense of satisfaction. I am convinced that these experiences will help me contribute to both research and education at Brown.

Teaching Experience

Seoul National University (1999). My first teaching experience at the college level was during my graduate studies for a master's degree. I was a teaching assistant for an undergraduate course, *College Physics and Laboratory*, at Seoul National University (Seoul, Korea) and won the Best Teaching Assistant award for that semester in the physics department.

Korea Air Force Academy (2000-2003). I worked as a full-time lecturer in the Department of Physics at the Korea Air Force Academy (Choongbuk, Korea). My primary responsibility consisted of teaching undergraduate physics for both physics majors and non-scientific majors. I introduced several new experimental items that enhanced the curriculum in the general physics laboratory classes. I also built new computer systems for computational physics education and research using various programs. Additionally, as a laboratory director, I built a Simulation System of Laboratory Physics that runs on the Web. Following are the courses I taught for six semesters: *Thermal and Statistical Physics*, *Modern Physics*, *General Physics and Laboratory*, *Introductory Physics*, *Introduction to Natural Science*, and *Basic Computer Programming*.

University of California, Berkeley (2005-2009). At UC Berkeley, I was a Graduate Student Instructor for the *Basic Semiconductor Circuit Laboratory* course (3 semesters) and *Introductory Physics* course (1 semester).

Courses to Teach

I can teach a broad range of courses in the areas of neuroscience, vision science and physics. I am particularly interested in opening a graduate/undergraduate course on the methods of computational and theoretical biophysics. This course can provide effective training to acquire simulation and programming skills that are specialized for research in theoretical neuroscience and related fields.

I am confident my extensive teaching experience has prepared me to effectively teach existing courses and also develop new courses to improve the curriculum, contributing to the department. I look forward to teaching and mentoring at Brown.