

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  
November 25, 2004

Dear Prof. Rob de Ruyter van Steveninck,

I am applying for the tenure track faculty position advertised in Nature jobs.

I am working at the University of Laval in a Professor Associe position (Associate Professor – not tenure track). Here I am examining the mechanisms underlying membrane potential state dependent responses in primary somatosensory “barrel” cortex and thalamus of the rat. These state dependent responses are a reflection of levels of activity in cortical circuits. I recently published my work with Dr. Charlie Wilson on the effect of cortical Up and Down membrane-potential-states on the cortical response to sensory stimuli. In the near future, I expect to carry this work forward into the awake animal. I will try to determine the mechanisms underlying attention, movement and membrane potential state dependent responses in cortex.

In my earlier work in Ford Ebner’s laboratory I examined the details of rat whisker movement and tactile behavior. The goal of this work was to determine how rats use their whiskers and to determine appropriate stimuli for the system. In the process we discovered that rats move single whiskers independently of adjacent whiskers. This discovery points to the rat whisker system as model system for the study of motor control: whisker movement is controlled by a CPG in the brainstem, coordinated whisker movement requires synergistic contraction of ~30 muscles on each side of the face and this synergy can be disrupted by cortical stroke like damage. One of my long-term goals is to follow up on this discovery and to determine the circuit and physiologic mechanisms that control this CPG.

I am interested in teaching neurobiology, comparative neurobiology, physiology and comparative physiology courses. I would like to develop courses on the origins of neurophysiology.

I look forward to hearing from you.

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## References

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### **Research Statement**

The focus of my research is on how the brain guides movement and uses tactile information to perceive the environment. I use a model system, the rodent whisker system for my research. Rats have ~ 30 whiskers on each side of the face that move together most of the time. The purpose of this movement is to sample the environment.

Currently, I am working in the barrel cortex, thalamus and striatum to determine the mechanisms underlying cortical state dependent sensory responses (Sachdev et al. 2004). During slow wave sleep, under some anesthetic conditions and in the awake animal, cortical neurons show two membrane potential states – a hyperpolarized Down state and a depolarized Up state, that reflect the level of activity in cortex. These states occur naturally and are a reflection of cortical and sub-cortical circuit organization and activity. In my work I show that even though cortical neurons are hyperpolarized in the Down state, they respond better to sensory stimuli delivered in the Down state. Thalamic neurons on the other hand fire at each stimulus independent of the cortical state indicating that the cortical Down state response depends primarily on cortical circuit activity. Striatal neurons follow the cortical response pattern, but the differences in cortex and striatum suggest an important role for the medium spiny striatal neuron's intrinsic membrane properties and an important role for intra-laminar thalamic inputs to striatum. I expect to continue this work and to bring the intracellular recording methods into the awake behaving animal.

Traditionally, state dependent responses refer to different states in the awake animal, a movement state or an attention state. The attention state, the position of whiskers and whisking frequency of the rat do determine the cortical response to whisker stimulation. These state dependent responses are caused by the state of circuits in the brainstem, or on interactions between thalamic and cortical neurons, or on interactions between cortical neurons. I will use the awake animal preparation and *in vivo* intracellular recordings to examine the mechanisms underlying this type of state dependence.

An additional focus of my research is how the brain guides movement. Specifically, I am interested in the role of descending and sensory inputs in guiding movement. The movement of the roughly 30 whiskers on each side of the face is usually coordinated – that is whiskers move together most of the time, the intrinsic muscle associated with each whisker contracts at roughly the same time. But adjacent whiskers can move at different times and in different directions (Sachdev et al., 2002), suggesting that the contraction of the roughly 30 muscles on each side of the face is a result of synaptic interactions between neurons. Cortical lesions disrupt the coordinated movement of whiskers, suggesting that one role of descending inputs could be to coordinate the synchronized movement of whiskers. The mechanisms that create this muscle synergy and maintain the bilateral coordination of whisker movement will be examined using intracellular recording methods in the anesthetized animal, and extracellular recording methods in awake behaving animals.

## Curriculum Vitae

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Current Position (from 9/01/04): Prof. Associate University Laval, Quebec City

## Education

**MFA (Writing)** 8/91-8/94  
*Columbia University, New York, NY.*

**Ph.D. (Neuroscience)** 9/86-8/90  
*University of Michigan, Ann Arbor, MI.*  
Committee Chairs: Drs. J.W. Aldridge and S. Gilman  
**Supervisor:** Dr. J.W. Aldridge

**BS (Neuroscience-Biochemistry)** 9/82-5/86  
*University of Michigan, Ann Arbor, MI.*

**High School Diploma**, Scarsdale High, Scarsdale, NY. 8/78-5/82

## Post Doctoral Experience

University of Texas at San Antonio 9/00-9/04  
Sub-threshold membrane potential states and their relationship to the  
cortical and striatal response to whisker stimulation  
**Supervisor:** Prof. C. J. Wilson

Vanderbilt University, Nashville 95-9/00  
Cortical plasticity and whisker use  
Development of awake rat single unit recording and fMRI  
for analysis of awake rat somatosensory and motor cortices  
**Supervisor:** Prof. F. F. Ebner  
NRSA Fellowships (NINDS)

Funding Budget period  
Type: NRSA (2 years) Agency: **NINDS** 9/95-9/97  
Title: Acetylcholine and norepinephrine in whisker pairing plasticity.

Type: NRSA (1 year) Agency: **NINDS** 9/97-9/98  
Title: Effect of gap cross training on whisker pairing plasticity.

Pending Funding: 3 grants with Canadian Institutes of Health that cannot be carried over to USA.  
400,000 Canadian Dollars.

## Bibliography

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2. Sachdev, R.N.S., S.Gilman, J.W. Aldridge (1991) Bursting properties of units in cat globus pallidus and entopeduncular nucleus: The effect of excitotoxic striatal lesions, *Brain Res.*, 549, 194-204.
3. Sachdev, R.N.S., S.M. Lu, R.G.Wiley, F. F. Ebner (1998) Role of the basal forebrain cholinergic projection in somatosensory cortical plasticity. *J. Neurophysiol.*, 79, 3216-28.
4. Sachdev, R.N.S., M. Egli, M. Stonecypher, R. G. Wiley, F. F. Ebner (2000) Enhancement of cortical plasticity by behavioral training in acetylcholine-depleted adult rats. *J. Neurophysiol.*, 84, 1971-81
5. Sachdev, R.N.S., H. Sellien, F.F.Ebner (2000) Direct inhibition evoked by whisker stimulation in somatic sensory (SI) barrel field cortex of the awake rat. *J. Neurophysiol.*, 84, 1497-504.
6. Sachdev R.N.S., H. Sellien, F.F Ebner (2001) Temporal organization of multi-whisker contact in rats. *Somatosens Mot Res.*, 18, 91-100.
7. Harvey M.A., R.N.S. Sachdev, H.P. Zeigler (2001) Cortical barrel field ablation and unconditioned whisking kinematics. *Somatosens Mot Res.*, 18, 223-7.
8. Sachdev R.N.S., T. Sato, F.F. Ebner (2002) Divergent movement of adjacent whiskers. *J. Neurophysiol.*, 87, 1440-1448.
9. Sachdev, R.N.S., K.C. Catania (2002) Receptive fields and response properties of neurons in the star-nosed mole's somatosensory fovea. *J. Neurophysiol.*, (Cover) 87, 2602-2611.
10. Kleinfeld D., R.N.S. Sachdev, L.M. Merchant, M.R. Jarvis, F.F. Ebner (2002) Adaptive filtering of vibrissa input in motor cortex of rat. *Neuron* 34, 1024-1034.
11. Sachdev, R.N.S., K.C. Catania (2002) Effects of stimulus duration on neuronal response properties in the somatosensory cortex of the Star Nosed Mole. *Somatosens Mot Res.*, 19, 272-8.
12. Sachdev, R.N.S., G.C. Champney, H. Lee, R.R. Price, D.R. Pickens, V.L. Morgan, P. Melzer, F.F. Ebner (2003) Repeated functional magnetic resonance imaging of somatic sensory cortex in the unanesthetized rat. *Neuroimage* 19, 742-750.
13. Sachdev, R.N.S., R. Berg, G. Champney, D.Kleinfeld and F.F.Ebner (2003) Unilateral vibrissa contact: changes in amplitude but not timing of rhythmic whisking. *Somatosens Mot Res.*, 20:163-9.
14. Wilson, C.J., R. N. S. Sachdev (2004) Intracellular and juxtacellular filling of neurons for studies of axonal projections of individual neurons. Current protocols. *Current protocols Neuroscience Suppl.* 26 1.12.1-1.12-10.
15. Sachdev R.N.S., F.F. Ebner, C.J.Wilson (2004) Response Variability in Somatosensory Cortex: the role of Sub-threshold Up and Down States. *J. Neurophys.* 92, 3511-3521.

### Book Chapter

Sachdev, R.N.S., E. Jenkinson, H.P. Zeigler and F.F. Ebner (2001) Sensorimotor plasticity in the rodent vibrissa system, in *Mutable Brain*. Ed. Jon Kaas, pp 123-164.

### Other Publications

Ebner, F.F., V. Rema, R.N.S.Sachdev, F.J. Symons (1998) Activity dependent plasticity in adult somatic sensory cortex. *Seminars in Neuroscience*, 94, 47-58.

### **Presentations**

Barrels Satellite Symposium in San Diego (1998): Effect of stimulus frequency on the response properties of neurons in the awake rat barrel cortex.

Seminars: Gif sur Yvette (Paris, France, 2001)  
University of Connecticut (2001)  
University of Pittsburgh (2001)  
Oxford University (Oxford, UK, 2002)  
Emory University (2002)  
Winter Brain Conference (2003)  
MIT (Brain and Cognitive Sciences, Boston 2003)  
Mass General Hospital (Boston, 2003).  
Max-Planck-Institute for Medicine (Heidelberg, Germany, 2003)  
Albert-Ludwigs-University (Freiburg, Germany 2003)  
Laval University (Quebec City, Canada, 2003)  
University of Texas at San Antonio Health Science Center (2003)  
EPFL (Lausanne, Switzerland 2003)  
University of Provence (Marseille, France, 2003)