

Master of Rhythms: Mircea Steriade

Mircea Steriade, M.D., D.Sc., one of the giants of sleep research, died Friday April 14, 2006, of cancer, at the age of 81. He was Professor of Anatomy and Physiology and Head of the Laboratory of Neurophysiology at the University of Laval in Quebec, Canada. He was, with Michel Jouvet, the first recipient in 1989 of the US Sleep Research Society's most prestigious honor—the Distinguished Scientist Award—and was formally named one of the Founders of the Field in 2003. He was awarded the Peter C. Farrell Harvard Prize in Sleep Medicine in 2006. Among his many other honors were the Scientific Prize of Quebec, Prix Marie-Victorin (Montreal, 1991), and his election as a Fellow of the Royal Society of Canada (Academy of Sciences) (1994). He was Editor-in-Chief of *Thalamus & Related Systems*, and served on many editorial boards. He authored 345 scientific articles and book chapters, and was the author, coauthor or editor of 12 books.



Mircea Steriade was born in Rumania and received his M.D. in 1952, and D.Sc. in 1955, from Bucharest. He was a postdoctoral fellow in Brussels with Bremer in 1958, and on return to Bucharest rose to be head of the Laboratory of Neurophysiology. He joined the faculty of Université Laval in Quebec in 1968, and was named Professor and Chief of the Laboratory of Neurophysiology in 1969. Those who were fortunate to know him personally were aware of his passion for “watching spikes”, as he put it, observing the electronic record of the interplay of neurons as they went about their rhythmic dance of activity, with tempo and timing shaped by changes in state. He also showed a ferocious, ecumenical scholarship and an equally ferocious delight in scientific challenge and debate. I like to think his fascination with neuronal interplay and their melodic counterpoint in the composition of sleep was morphed and molded from his deep enthrallment with music and his training as a classical pianist.

The genesis of the spindle rhythm is a pre-eminent and beautiful illustration of his contributions, as explained in his recent book.¹ Shown in Figure 1, which was adapted from this book¹ and his review in *Trends in Neuroscience*,² is a trio of cells, recorded intracellularly in the intact animal. Stimulation of the cortical cells starts the spindle sequence, this triggers a solo performance by the GABAergic thalamic reticular neurons, which depolarize and hyperpolarize in spindle rhythmicity. Soon the reticular rhythmic activity recruits the thalamocortical neurons to a duet, to oscillate at the reticular neuronal spindle frequency, with the thalamocortical action potentials powered by low threshold calcium spikes. In turn, the thalamocortical neuronal activity impinges on the dendrites of cortical neurons at the spindle frequency, generating the EEG of spindle activity. The main factor in the termination of the spindles is the depolarizing action of cortical input on reticular and thalamocortical neurons.

Among his many achievements was the discovery of the slow neocortical oscillation (~0.5-1 Hz), which has the effect of grouping

other sleep rhythms, including spindles, delta activity, and fast oscillations including gamma activity.³ The slow oscillation consists of prolonged neocortical depolarizations, associated with brisk firing (~8-40 Hz), and prolonged

hyperpolarizations during which neurons are silent. The synchronous firing of neocortical neurons during the depolarizing phase triggers spindles. The K-complex, a reliable sign of stage 2 human sleep, but present in all stages of NREM, consists of the combination of a surface-positive EEG transient corresponding to excitation of deep neocortical neurons, a surface negative component, and a short spindle sequence.

Mircea Steriade illuminated all areas in which he worked, and his early papers on discharge activity of neurons in brainstem cholinergic nuclei and their effect on thalamus remain classics in the field.^{4,5}

This is but a brief sample of his work, which doesn't even touch on his research related to seizures,² but which may stimulate the reader's appreciation of the depth and breadth of his work^{6,7} and a desire to learn more.

In closing one can not help but emphasize his indomitable will and toughness of character, as he continued to work and publish⁷ even as he struggled with his illness. He is survived by his wife, Jacqueline, and his daughters, Donca and Claude, to whom he showed an open and affectionate love, tenderness and softness, an aspect of him also experienced by his close colleagues. He will be missed as a scientist and as a person.

Brief Bibliography related to sleep and, for further reading, emphasizing recent reviews.

1. Steriade M and McCarley RW, Brain control of wakefulness and sleep. New York: Kluwer Academic/Plenum, New York, 2005.
2. Steriade M. Sleep, epilepsy and thalamic reticular inhibitory neurons. *Trends Neurosci.* 2005 Jun;28:317-24.
3. Steriade M. Grouping of brain rhythms in corticothalamic systems. *Neuroscience.* 2006;137:1087-106.
4. Steriade M, Dossi RC, Pare D, Oakson G. Fast oscillations (20-40 Hz) in thalamocortical systems and their potentiation by mesopontine cholinergic nuclei in the cat. *Proc Natl Acad Sci U S A.* 1991 May 15;88:4396-400.
5. Steriade M, Datta S, Pare D, Oakson G, Curro Dossi RC. Neuronal activities in brain-stem cholinergic nuclei related to tonic activation processes in thalamocortical systems. *J Neurosci.* 1990 Aug;10:2541-59.
6. Steriade M. Local gating of information processing through the thalamus. *Neuron.* 2004 Feb 19;41:493-4.
7. Crochet S, Fuentealba P, Cisse Y, Timofeev I, Steriade M. Synaptic plasticity in local cortical networks in vivo and its modulation by the level of neuronal activity. *Cereb Cortex.* 2006 May;16:618-31.

