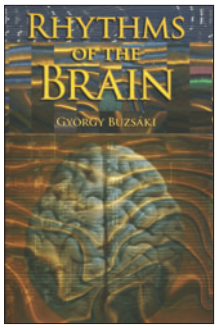
Finding our rhythm



Rhythms of the Brain

By György Buzsáki

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Reviewed by John E Lisman

Although the discovery of brain oscillations goes back to 1924, these rhythms have had difficulty in making their way into the mainstream of neuroscience. I can recall looking, as a graduate student, for a description of brain waves in my textbook and not finding a word on the subject. Even modern textbooks give the subject only minimal treatment.

How important are these oscillations to brain function? There seem to be three camps. Some believe that the oscillations, though present, are really an epiphenomenon. After all, if you kick your trash can, it will oscillate at its resonant frequency, and the brain may be no different. In the middle are scientists who believe that oscillations are important under some circumstances, but are not central to brain function. Finally, there are those who believe that oscillations are as fundamental to the brain as the computer clock is to the digital computer: no oscillations, no function. Indeed, Rodolfo Llinas, who belongs in the last camp, has marshaled evidence that even functions that do not appear to be oscillatory, such as 'smooth' limb movements, show telltale signs of an underlying oscillatory organization. Specifically, if linear limb motion is measured accurately and the second derivative taken, the motion is found not to be smooth, but to show oscillatory acceleration.

Rhythms of the Brain by György Buzsáki of Rutgers University is an excellent overview of this exciting field and one of the first books on this topic that is not written from the perspective of a clinical neurologist. Historically, the field of brain oscillations has been dominated by clinicians who used the electroencephalogram to assess brain function, most notably in relation to epilepsy. In contrast, Buzsáki comes from a tradition that sees brain oscillations as a path to understanding brain function in general. As a result, early chapters in this book are primers on brain function and anatomy, providing an excellent context for the subsequent chapters on oscillations.

The book then goes into a discussion of the remarkable changes in brain rhythms that accompany changes in behavioral state. With standard electroencephalogram methods, one can tell whether a person is awake or asleep and even whether they are dreaming. A great deal has been learned about the interactions between the thalamus and cortex that govern these rhythms, but the complete lack of knowledge about their functional importance may cause an increase in the reader's sleep rhythms.

For those interested in cognitive function, the chapter called "The gamma buzz: gluing by oscillations in the waking brain" will be the most exciting. Buzsáki emphasizes the important contribution of Wolf Singer in developing the idea that gamma oscillations provide a solution to the binding problem. According to this view, cells that fire together during a gamma cycle are interpreted by other brain regions as a unified percept. Thus, it is not so important what a neuron's average firing rate is, but rather what other cells it is synchronized with. If this view is correct, oscillations provide a solution as to how information is represented (coded) in the brain. A corollary is that different 'bound' information is represented in each succeeding gamma cycle. An alternative, but not mutually exclusive idea, is that oscillations represent steps in an iterative process. The idea that gamma oscillations underlie perceptual binding has been an intriguing one, but has received conflicting experimental support. Readers wanting a blow-by-blow description of this controversy will not find it in this book. Rather, what makes this book so valuable is its range; Buzsáki has a worldly intellect, open to information from any discipline that provides insight, while insisting on a rigorous distinction between fact and baloney.

Three chapters deserve special comment. Buzsáki's greatest expertise is in the study of the hippocampus, and his chapter on this structure is a gem. Appropriate space is given to one of Buzsáki's greatest accomplishments, using multi-electrode recording to provide the first clear view of a synchronized cell assembly.

An important chapter for oscillation skeptics is entitled "Coupling of systems by oscillations." Skeptics generally acknowledge the unequivocal evidence for the importance of theta oscillations and theta phase coding in the hippocampus, but are skeptical about whether these ideas also apply to cortex. However, the hippocampus does not exist in isolation; it receives information from cortex and provides output back to cortex. There must thus be 'handshake' rules and common information coding principles. Buzsáki reviews the very exciting new information about the oscillatory influence of the hippocampus on cortex that provides insight into these issues.

The final chapter is called "The tough problem." The task of understanding the brain is indeed tough, and readers hoping to find 'the answer' to why the brain oscillates will be disappointed. As the author points out, it is not yet possible to answer the simple question of whether brain oscillations are necessary for mental function. The oscillations are an emergent property of excitatory and inhibitory interactions, and there is no clean way of interfering with them. Thus, as Buzsáki writes, "there is nothing 'extra' to eliminate without fundamentally interfering with the elementary properties of the parts."

Perhaps the greatest value of *Rhythms of the Brain* is that it provides a starting point for students and scientists who see the importance of this field and want to get a solid overview. As the book makes clear, new ideas and new methods will be particularly important in solving the tough problems in this field. ■

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COMPETING INTERESTS STATEMENT
The author declares no competing financial interests.