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Review

The cognitive significance of resonating neurons in the cerebral cortex

David LaBerge [a,*], Ray Kasevich [b]

[a] Department of Cognitive Sciences, University of California, Irvine, USA
[b] Stanley Laboratory of Electrical Physics, Great Barrington, MA, USA

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ABSTRACT

Most neural fibers of the cerebral cortex engage in electric signaling, but one particular fiber, the apical dendrite of the pyramidal neuron, specializes in electric resonating. This dendrite extends upward from somas of pyramidal neurons, the most numerous neurons of the cortex. The apical dendrite is embedded in a recurrent corticothalamic circuit that induces surges of electric current to move repeatedly down the dendrite. Narrow bandwidths of surge frequency (resonating) enable cortical circuits to use specific carrier frequencies, which isolate the processing of those circuits from other circuits. Resonating greatly enhances the intensity and duration of electrical activity of a neuron over a narrow frequency range, which underlies attention in its various modes. Within the minicolumn, separation of the central resonating circuit from the surrounding signal processing network separates "having" subjective impressions from "thinking about" them. Resonating neurons in the insular cortex apparently underlie cognitive impressions of feelings.

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* Corresponding author.
E-mail addresses: dlaberge@earthlink.net (D. LaBerge), rkasevich@jrtechnologiesllc.com (R. Kasevich).

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1. Introduction

From the early beginnings of central nervous system research with spinal cord experiments (Bell, 1811; Magendie, 1822), our understanding of brain activity has rested strongly on the assumption that the basic function of neural fibers is to communicate all-or-none pulse signals from one location to another. For example, this kind of communication occurs in the reflex circuit that connects a receptor in the knee tendon to a muscle cell in the thigh of the leg. In complex neural activities of

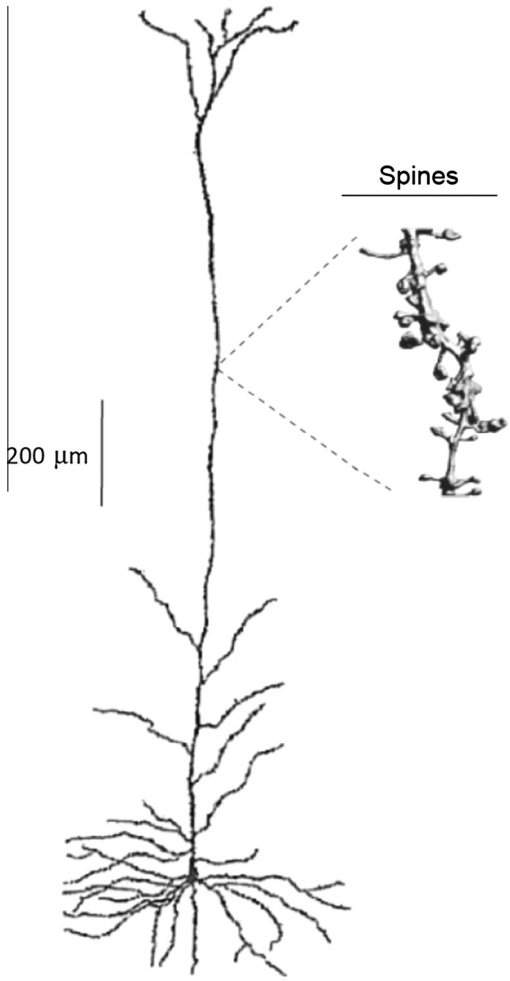

Fig. 1. A camera lucida drawing of a human pyramidal neuron whose soma lies in Layer 5 of the visual primary cortex. From DeFilipe and Jones (1988) and LaBerge (2005). The insert of spines is from Nagerl et al., 2008.