



ELSEVIER

Contents lists available at ScienceDirect

# Consciousness and Cognition

journal homepage: [www.elsevier.com/locate/concog](http://www.elsevier.com/locate/concog)

## Review

# The cognitive significance of resonating neurons in the cerebral cortex

David LaBerge<sup>a,\*</sup>, Ray Kasevich<sup>b</sup><sup>a</sup> Department of Cognitive Sciences, University of California, Irvine, USA<sup>b</sup> Stanley Laboratory of Electrical Physics, Great Barrington, MA, USA

## ARTICLE INFO

### Article history:

Received 5 April 2013

Available online 6 November 2013

### Keywords:

Resonating neuron

Apical dendrite

Corticothalamic circuit

Conscious impressions

Aspects of attention

Feelings

Insular cortex

## 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.

© 2013 Elsevier Inc. All rights reserved.

## Contents

1. Introduction . . . . .	1524
2. Anatomy of the apical dendrite of the pyramidal neuron . . . . .	1526
3. Short summary of the Dendritic Resonance Model (Kasevich & LaBerge, 2010) . . . . .	1527
4. Pyramidal neurons within the minicolumn structure . . . . .	1530
5. Column clusters of minicolumns in the cortical fabric . . . . .	1530
6. Pyramidal neurons of Layers 5 and 6 connect with the thalamus in recurrent circuits (loops) to produce resonant activity . . . . .	1530
7. Electric resonating of the apical dendrite of the pyramidal neuron . . . . .	1530
7.1. Electric surges in the apical dendrite . . . . .	1531
7.2. Sharpening of the current input profile of frequencies . . . . .	1531
7.3. Local control of peak resonance frequency by membrane channels . . . . .	1531
7.4. Resonance curves produced from the simulation of the resonance model . . . . .	1532
7.5. Column level control of the peak resonance frequency by layer 6 pyramidal neurons . . . . .	1532
8. The center-surround structure of the minicolumn: a loop in the center and a network in the surround . . . . .	1533
9. Connecting two corticothalamic loops across the cortex . . . . .	1534
10. The case of apical dendrites with compartments exhibiting different resonances . . . . .	1537
11. Cognitive implications of the center loop and surrounding network of the cortical minicolumn . . . . .	1539
11.1. “Aboutness” . . . . .	1539

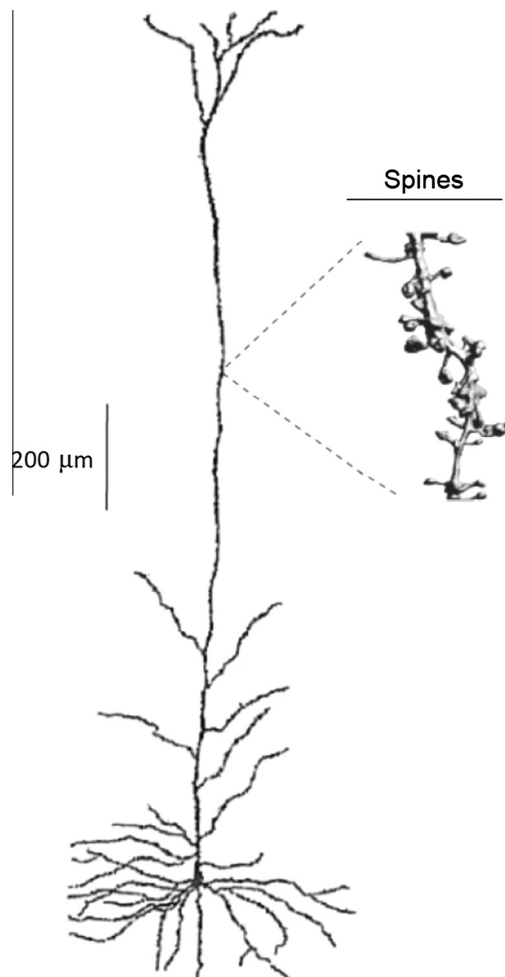
\* Corresponding author.

E-mail addresses: [dlaberge@earthlink.net](mailto:dlaberge@earthlink.net) (D. LaBerge), [rkasevich@jrtechnologiesllc.com](mailto:rkasevich@jrtechnologiesllc.com) (R. Kasevich).

12.	Mechanisms of attention . . . . .	1541
12.1.	Selective attention . . . . .	1542
12.1.1.	A role of inhibition in selective attention . . . . .	1545
12.2.	Preparatory attention . . . . .	1546
12.3.	Sustained attention . . . . .	1546
13.	Describing feelings as resonant activity in the insular cortex . . . . .	1546
13.1.	Anatomy and connections of the insular cortex . . . . .	1547
13.2.	Attention to specific insular functions . . . . .	1548
	Acknowledgments . . . . .	1548
	References . . . . .	1549

## 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.

Download English Version:

<https://daneshyari.com/en/article/10458533>

Download Persian Version:

<https://daneshyari.com/article/10458533>

[Daneshyari.com](https://daneshyari.com)