

Cambridge University Press  
978-0-521-68216-9 - The Neurology of Olfaction  
Christopher H. Hawkes and Richard L. Doty  
Frontmatter  
[More information](#)

---

## The Neurology of Olfaction

---

Cambridge University Press  
978-0-521-68216-9 - The Neurology of Olfaction  
Christopher H. Hawkes and Richard L. Doty  
Frontmatter  
[More information](#)

---

# The Neurology of Olfaction

---

Christopher H. Hawkes  
Richard L. Doty



Cambridge University Press  
 978-0-521-68216-9 - The Neurology of Olfaction  
 Christopher H. Hawkes and Richard L. Doty  
 Frontmatter  
[More information](#)

CAMBRIDGE UNIVERSITY PRESS

Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Delhi

Cambridge University Press  
 The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

[www.cambridge.org](http://www.cambridge.org)  
 Information on this title: [www.cambridge.org/9780521682169](http://www.cambridge.org/9780521682169)

© C. H. Hawkes and R. L. Doty 2009

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2009

Printed in the United Kingdom at the University Press, Cambridge

*A catalogue record for this publication is available from the British Library*

*Library of Congress Cataloguing in Publication data*

Hawkes, Christopher H.

The neurology of olfaction / Christopher H. Hawkes, Richard L. Doty.  
 p. ; cm.

Includes bibliographical references and index.

ISBN 978-0-521-68216-9 (pbk.)

1. Smell disorders. 2. Smell. 3. Nose—Innervation. I. Doty, Richard L. II. Title.

[DNLM: 1. Olfaction Disorders. 2. Neurodegenerative Diseases—complications.

3. Olfactory Pathways—anatomy & histology. 4. Olfactory Pathways—physiology.

5. Olfactory Pathways—physiopathology. 6. Smell—physiology. WV 301 H392n 2009]

RF341.H387 2009

616.8' 56—dc22 2008045143

ISBN 978-0-521-68216-9 paperback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

Every effort has been made in preparing this publication to provide accurate and up-to-date information which is in accord with accepted standards and practice at the time of publication. Although case histories are drawn from actual cases, every effort has been made to disguise the identities of the individuals involved. Nevertheless, the authors, editors and publishers can make no warranties that the information contained herein is totally free from error, not least because clinical standards are constantly changing through research and regulation. The authors, editors and publishers therefore disclaim all liability for direct or consequential damages resulting from the use of material contained in this publication. Readers are strongly advised to pay careful attention to information provided by the manufacturer of any drugs or equipment that they plan to use.

## Contents

<i>Foreword by Thomas R. Swift MD FAAN</i>	<i>page vii</i>
<i>Preface</i>	<i>ix</i>
<i>Acknowledgments</i>	<i>xi</i>
1 Anatomy and physiology	1
2 Clinical evaluation	59
3 General disorders of olfaction	111
4 Neurodegenerative diseases that affect olfaction	153
5 Investigation, treatment, and general management of olfactory disease	215
<i>Index</i>	<i>233</i>

The plates are to be found between pages 82 and 83

## Foreword

As a 20-year-old I stepped outdoors and in an instant was taken back in time to my grandmother's garden, the aroma of baking bread from her kitchen reawakening in me visual memories, feelings, and experiences of clarity and intense familiarity. I looked about me and saw a bakery nearby.

At the age of 45 my mother lost her sense of smell, and at the age of 65 she developed Parkinson's disease.

When I was a medical student as part of a course in public health our class visited a building on Manhattan's lower east side where coffee was roasted commercially. On entering the building the fragrance of roasting coffee was deliriously wonderful. A workman by the door said: "After 20 minutes you won't be able to stand the smell." He was right.

When playing soccer in school I suffered a hard knock on the head colliding with an opposing player and in that instant smelled an odor as peculiar as it was intense.

The olfactory system is, paradoxically, primitive yet complex and sophisticated, not following many of the rules pertaining to other sensory systems, intimately and immediately connected to deep and important brain structures. It declines with age, and its loss may foretell serious and progressive degenerative disease of the brain. Despite the obvious importance of this vital sensory system, olfaction has largely been neglected by neurologists.

Where have the neurologists been all this time and why have they neglected this important modality? The nose is the "eye" for most nonprimates and just because other sensory modalities have proven critical in human evolution does not make the sense of smell unimportant to human beings. Indeed, this sense plays a critical role in safety and nutrition, and recent studies suggest its understanding may help to unravel the mysteries of certain neurologic diseases.

The *Neurology of Olfaction* connects olfactory science to human neurology for the first time. Jointly authored by Professor Christopher Hawkes, a leading clinical neurologist with a special interest in olfaction, and Professor Richard L. Doty, a world-renowned specialist in smell and taste, this monograph provides an engaging overview of the sense of smell and its importance in human neurological disease. The book is replete with compelling experimental

Cambridge University Press  
978-0-521-68216-9 - The Neurology of Olfaction  
Christopher H. Hawkes and Richard L. Doty  
Frontmatter  
[More information](#)

---

**viii** Foreword

findings and fascinating clinical case studies, and each time I picked it up I found myself spending much more time with it than I had planned. It will serve as a valuable reference source for neurologists and others truly interested in the newly developing world of the chemical senses. Every neurologist should have this book in their library.

**Thomas R. Swift, MD FAAN**  
Professor Emeritus and Former Chair  
Department of Neurology  
Medical College of Georgia  
President  
American Academy of Neurology, 2005–2007  
Past President  
American Association of Electromyography and Electrodiagnosis  
Past President  
Society of Clinical Neurologists



## Preface

Olfaction evolved at least 550 million years ago and, in conjunction with the ability to move, eat, and reproduce, detecting chemicals by specialized receptors was about all that invertebrates could do. Today the sense of smell is commonly viewed as a somewhat more primitive modality than its sister sense of taste, in that it does not rely upon the thalamus for cortical transmission. Vision and hearing are even more recent phylogenetically, employing the thalamus in their projections to cortical regions. They have received major attention because of their perceived biological importance in humans. However, the significance of the olfactory system for everyday life is rarely appreciated until dysfunction occurs, and this primary sensory modality is far from immune to disease – in fact it is *more* vulnerable than any other sensory system. This is largely because of its virtually unprotected contact with the external environment in the nose and its close neural connections with temporal lobe and limbic brain regions associated with memory and emotion. As we describe, this anatomy provides access for neurotropic agents and facilitates their spread to regions associated with developmental and degenerative diseases. Clearly, the studious avoidance and trivialization of smell testing by clinicians is unwarranted, but until recently the excuse was always that the sense of smell is not important, and that it provides information of minimal diagnostic value. All this is in the process of change as we try to show here. For example, many studies demonstrate the consistency and probable premotor development of decreased smell function in degenerative disorders, notably Parkinson's and Alzheimer's diseases. This is clearly important: if a simple smell test can assist with a diagnosis, it might replace more complex procedures and, more importantly, it may help to identify those family members at risk of future illness.

This book provides a resumé of the anatomy and physiology of the olfactory pathways and how the sense of smell may be measured. We elaborate those diseases where smell loss is a notable feature that may assist the clinician in making a diagnosis. Approaches are detailed for diagnosing, investigating, and treating a number of olfactory disorders and for counseling patients how to cope best with impairment of olfactory function. Finally, we

Cambridge University Press  
978-0-521-68216-9 - The Neurology of Olfaction  
Christopher H. Hawkes and Richard L. Doty  
Frontmatter  
[More information](#)

---

x Preface

describe strategies that help to minimize food poisoning and avoid dangerous situations, such as leaking natural gas.

We hope this book will stimulate others to take up a clinical and research interest in olfaction and give this ancient modality the full attention it richly deserves.

CHH

RLD





## Acknowledgments

The authors wish to express their thanks to the following colleagues who provided invaluable assistance in writing this book. Their names are presented alphabetically and not in order of their contribution.

Professor Kailash Bhatia, Institute of Neurology, London, UK  
Dr. David Bowsher, Pain Research Institute, University Hospital Aintree, Liverpool, UK  
Professor Heiko Braak, JW Goethe University, Frankfurt, Germany  
Dr. Sanjiv Chawda, Queen's Hospital, Romford, UK  
Dr. Jacquie Deeb, Queen's Hospital, Romford, UK  
Dr. Kelly del Tredici, JW Goethe University, Frankfurt, Germany  
Professor Jay Gottfried, Northwestern University Feinberg School of Medicine, Chicago, USA  
Dr. Ranjan Gunasekara, Queen's Hospital, Romford, UK  
Professor Thomas Hummel, University of Dresden, Germany  
Professor Tim Jacob, University of Cardiff, UK  
Professor Paul Moberg, University of Pennsylvania School of Medicine, Philadelphia, USA  
Dr. Nizar Muhammed, Queen's Hospital, Romford, UK  
Professor Krishna Persaud, UMIST, Manchester, UK  
Dr. Paola Piccini, MRC Clinical Sciences Centre, Imperial College, London, UK  
Dr. Muss Shah, Queen's Hospital, Romford, UK  
Dr. Greg Smutzer, Department of Biology, Temple University, Philadelphia, USA  
Dr. Sarah Tabrizi, Institute of Neurology, London, UK