Springer Handbook of Auditory Research

Volume 64

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ASA Press

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Auditory Development and Plasticity

In Honor of Edwin W Rubel

ASA Press

Springer

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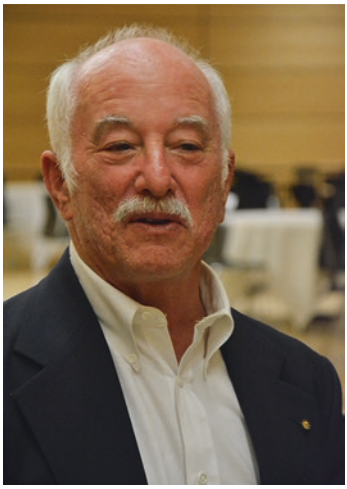

This volume is dedicated to Edwin W Rubel, an extraordinary scholar, mentor, colleague, and friend.[1]

[1] Photo courtesy of Rudolf Rubsamen.

Acoustical Society of America

The purpose of the Acoustical Society of America (www.acousticalsociety.org) is to generate, disseminate, and promote the knowledge of acoustics. The Acoustical Society of America (ASA) is recognized as the world's premier international scientific society in acoustics, and counts among its more than 7,000 members, professionals in the fields of bioacoustics, engineering, architecture, speech, music, oceanography, signal processing, sound and vibration, and noise control.

Since its first meeting in 1929, the ASA has enjoyed a healthy growth in membership and in stature. The present membership of approximately 7,000 includes leaders in acoustics in the United States of America and around the world. The ASA has attracted members from various fields related to sound including engineering, physics, oceanography, life sciences, noise and noise control, architectural acoustics; psychological and physiological acoustics; applied acoustics; music and musical instruments; speech communication; ultrasonics, radiation, and scattering; mechanical vibrations and shock; underwater sound; aeroacoustics; macrosonics; acoustical signal processing; bioacoustics; and many more topics.

To assure adequate attention to these separate fields and to new ones that may develop, the Society establishes technical committees and technical groups charged with keeping abreast of developments and needs of the membership in their specialized fields. This diversity and the opportunity it provides for interchange of knowledge and points of view has become one of the strengths of the Society.

The ASA's publishing program has historically included the *The Journal of the Acoustical Society of America, JASA-Express Letters, Proceedings of Meetings on Acoustics*, the magazine *Acoustics Today*, and various books authored by its members across the many topical areas of acoustics. In addition, ASA members are involved in the development of acoustical standards concerned with terminology, measurement procedures, and criteria for determining the effects of noise and vibration.

Series Preface

The following preface is the one that we published in Volume 1 of the Springer Handbook of Auditory Research back in 1992. As anyone reading the original preface, or the many users of the series, will note, we have far exceeded our original expectation of eight volumes. Indeed, with books published to date and those in the pipeline, we are now set for over 70 volumes in SHAR, and we are still open to new and exciting ideas for additional books.

We are very proud that there seems to be a consensus, at least among our friends and colleagues, that SHAR has become an important and influential part of the auditory literature. While we have worked hard to develop and maintain the quality and value of SHAR, the real value of the books is very much because of the numerous authors who have given their time to write outstanding chapters and to our many coeditors who have provided the intellectual leadership to the individual volumes. We have worked with a remarkable and wonderful group of people, many of whom have become great personal friends of both of us. We also continue to work with a spectacular group of editors at Springer. Indeed, several of our past editors have moved on in the publishing world to become senior executives. To our delight, this includes the current president of Springer US, Dr. William Curtis.

But the truth is that the series would and could not be possible without the support of our families, and we want to take this opportunity to dedicate all of the SHAR books, past and future, to them. Our wives, Catherine Fay and Helen Popper, and our children, Michelle Popper Levit, Melissa Popper Levinsohn, Christian Fay, and Amanda Fay Sierra, have been immensely patient as we developed and worked on this series. We thank them and state, without doubt, that this series could not have happened without them. We also dedicate the future of SHAR to our next generation of (potential) auditory researchers—our grandchildren—Ethan and Sophie Levinsohn; Emma Levit; and Nathaniel, Evan, and Stella Fay.

Preface 1992

The Springer Handbook of Auditory Research presents a series of comprehensive and synthetic reviews of the fundamental topics in modern auditory research. The volumes are aimed at all individuals with interests in hearing research including advanced graduate students, postdoctoral researchers, and clinical investigators. The volumes are intended to introduce new investigators to important aspects of hearing science and to help established investigators to better understand the fundamental theories and data in fields of hearing that they may not normally follow closely.

Each volume presents a particular topic comprehensively, and each serves as a synthetic overview and guide to the literature. As such, the chapters present neither exhaustive data reviews nor original research that has not yet appeared in peer-reviewed journals. The volumes focus on topics that have developed a solid data and conceptual foundation rather than on those for which a literature is only beginning to develop. New research areas will be covered on a timely basis in the series as they begin to mature.

Each volume in the series consists of a few substantial chapters on a particular topic. In some cases, the topics will be ones of traditional interest for which there is a substantial body of data and theory, such as auditory neuroanatomy (Vol. 1) and neurophysiology (Vol. 2). Other volumes in the series deal with topics that have begun to mature more recently, such as development, plasticity, and computational models of neural processing. In many cases, the series editors are joined by a coeditor having special expertise in the topic of the volume.

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Volume Preface

Auditory function depends on highly ordered structures and extremely precise connectivity. Understanding the ontogeny of these pathways represents a unique interdisciplinary challenge in auditory research. This volume presents some of the most recent advances in the field. The volume is also presented as a celebration of the career of Dr. Edwin W Rubel, a scholar, mentor, and friend who has contributed a vast range of new discoveries in this area. Indeed, Ed's broad contributions to auditory system development have substantially impacted the field and spawned new generations of investigators pursuing new questions in these areas. This volume spans a wide range of topics within auditory development, from cellular specification of the auditory periphery to physiological development of the central auditory system and maturation of auditory perception. These chapters, from colleagues whose work has been touched by Ed's contributions, pay homage to the breadth of this area and the advances that have been made possible.

In Chap. 2, Matthew Kelley and Jennifer Stone review sensory hair cell development and examine the innate plasticity (or lack thereof) that characterizes hair cell regeneration in vertebrates. Next, in Chap. 3, Hillary McGraw, Catherine Drerup, Teresa Nicolson, and Alex Nechiporuk review the development of the lateral line, a sensory system present in aquatic vertebrates in which lateral line organs (neuromasts) contain clusters of hair cells and supporting cells, analogous to the inner ear.

Auditory brainstem development is then considered in Chap. 4, in which Jason Sanchez and Yong Lu review the role of the excitatory neurotransmitter glutamate in the auditory brainstem, drawing on the vast literature from both birds and mammals. Next, in Chap. 5, Michael Burger describes the role of inhibition in the auditory brainstem, relying primarily on the elegant avian model pioneered by Ed Rubel. Then, in Chap. 6, Leonard Kaczmarek examines functional maturation and plasticity of the auditory brainstem through the lens of potassium current changes.

The last two chapters focus on perceptual development of auditory processing and vocal communication in species that learn their vocalization. In Chap. 7, Lynne Werner reviews the maturation of the human outer and middle ear and development of perceptual features of sound, relying largely on behavioral studies in human infants and children. Then, in Chap. 8, Sarah Woolley addresses vocal learning in

songbirds, including the critical role of auditory experience, highlighting some important parallels with language learning in humans.

As most other SHAR volumes, this volume closely complements earlier ones in the series. Most notably, this volume represents the advances in the field of auditory development since *Development of the Auditory System* (Vol. 9, 1998, edited by Rubel, Popper, and Fay) and *Plasticity of the Auditory System* (Vol. 23, 2004, edited by Parks, Rubel, Fay, and Popper). Other related volumes include *Development of the Inner Ear* (Vol. 26, 2005, edited by Kelley, Wu, Popper, and Fay), *Hair Cell Regeneration, Repair, and Protection* (Vol. 33, 2008, edited by Salvi, Popper, and Fay), and *Human Auditory Development* (Vol. 42, 2012, edited by Werner, Fay, and Popper).

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