VOICE QUALITY

The first phonetic description of voice quality production in 40 years, this book provides a new framework for its analysis: The Laryngeal Articulator Model. Informed by instrumental examinations of the laryngeal articulatory mechanism, it revises our understanding of articulatory postures to explain the actions, vibrations and resonances generated in the epilarynx and pharynx. It focuses on the long-term auditory-articulatory component of accent in the languages of the world, explaining how voice quality relates to segmental and syllabic sounds. Phonetic illustrations of phonation types and of laryngeal and oral vocal tract articulatory postures are provided. Extensive video and audio material is available on a companion website. The book presents computational simulations, the laryngeal and voice quality foundations of infant speech acquisition, speech/voice disorders and surgeries that entail compensatory laryngeal articulator adjustment, and an exploration of the role of voice quality in sound change and of the larynx in the evolution of speech.

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Cambridge University Press
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THE LARYNGEAL ARTICULATOR MODEL

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CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India

79 Anson Road, #06–04/06, Singapore 079906

Cambridge University Press is part of the University of Cambridge.

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www.cambridge.org
Information on this title: www.cambridge.org/9781108498425
DOI: 10.1017/9781108696555

First published 2019

Printed in the United Kingdom by TJ International Ltd, Padstow Cornwall

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

Library of Congress Cataloging-in-Publication Data
Names: Esling, John H., 1949– author. | Moisik, Scott R., 1983– author. | Benner, Allison, author. | Crevier-Buchman, Lise, author.
Title: Voice quality : the laryngeal articulator model / John H. Esling, University of Victoria, British Columbia ; Scott R. Moisik, Nanyang Technological University, Singapore ; Allison Benner, University of Victoria, British Columbia ; Lise Crevier-Buchman, National Scientific Research Centre (CNRS).
Description: United Kingdom ; New York : Cambridge University Press, 2019. | Series: Cambridge studies in linguistics ; 162 | Includes bibliographical references and index.
Identifiers: LCCN 2019003350 | ISBN 9781108498425 (hardback) | ISBN 9781108736039 (paperback)
Subjects: LCSH: Voice–Physiological aspects.
Classification: LCC QP306 .E85 2019 | DDC 612.7/8–dc23
LC record available at https://lccn.loc.gov/2019003350

ISBN 978-1-108-49842-5 Hardback

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Preface

This book presents a revised approach to phonetic voice quality description through the introduction of the Laryngeal Articulator Model, a new approach to vocal-tract articulatory function. Our model supersedes the simple glottal phonation paradigm of the lower vocal tract that has guided a century of phonetic and linguistic research. The Laryngeal Articulator Model presents the larynx as a complex articulator that shapes resonances and generates multiple vibration sources. This model has important consequences for the interpretation of basic places of articulation as well as for how voice quality interacts with the other elements of speech.

Our aim is to provide the groundwork for generating new hypotheses for experimental phonetic and linguistic research into speech-sound production in the lower vocal tract. We introduce new structures and movements to clarify and simplify the process we identify as laryngeal constriction. We present many examples of speech production (phonetic, extralinguistic, paralinguistic, and linguistic) to demonstrate how the laryngeal articulator works and case studies that illustrate the application of the model to linguistic analysis. The model is particularly relevant to the analysis of voice quality, as the lower vocal tract is the primary shaper of sound quality that is transferred through the rest of the vocal tract. This work is part of an ongoing attempt to construct an auditory portrait of what the laryngeal articulator produces.

The account of the structure of voice quality settings presented here follows the phonetic theories of Abercrombie (1967) and Laver (1980). The major and novel difference is in how the vocal tract is described. Rather than defining the larynx as only the glottis, generating phonation types but not articulations, with an open pharynx above it in which the tongue is the main articulator, the Laryngeal Articulator Model (LAM) introduces the ‘two-part vocal tract’, comprising a laryngeal and an oral articulator (Esling 2005). The glottis is still the opening from the lungs, bronchi and trachea into the vocal tract, but instead of it being the only site at which periodic energy is generated as a function of vibrating tissues, the laryngeal articulator contains multiple sites of potential vibration. The role of the tongue is also redefined. Instead of the tongue being the principal articulator in the laryngeal vocal tract, the epilaryngeal tube, incorporating the ventricular folds and aryepiglottic folds, is identified as the 'first articulator' above the glottis, which exerts changes, together with lingual retraction and larynx raising, on the shape of the rest of the pharynx and of the oral vocal tract. Above the velopharyngeal port, the nasal tract acts primarily as a resonating cavity rather than as an articulator. The oral articulator, from the uvula to the lips, generates the complex articulations and resonances that characterize most sounds in the world's languages. The important distinction in the LAM lies in the interaction between the laryngeal and oral regions, affecting the balance of overlapping secondary articulation and sequential coarticulation. In order to define linguistic, paralinguistic, and extralinguistic phonetic sound qualities, this auditory balance must be dissected and attributed to the relevant regions of the vocal tract.

In the simplest deconstruction of the Laryngeal Articulator Model, the vocal tract is divided into two parts – the laryngeal vocal tract and the oral vocal tract. At the next level of complexity, the vocal tract can be divided economically into five major articulators: larynx, velopharyngeal port, tongue, jaw, and lips. The model is relevant at any level of phonetic description, but our primary aim is to demonstrate how the laryngeal region of the vocal tract shapes the longest-term construct of speech – voice quality. In describing a speaker's voice quality, the five articulators can serve as a checklist to identify the key settings or postures that best characterize each region. The laryngeal articulator is considerably larger in the LAM than in previous models of vocal-tract function. This is telling for phonetic theory. The larynx in the LAM incorporates the pharynx, that is, those multiple cavities between the glottis and the uvula, and, in a departure from previous models, the larynx is an articulator. The laryngeal articulator is critical for speech acquisition by infants, as well as having implications for the origin of speech and for the rehabilitation of speech in the event of speech disorders and surgical repair. The number and types of sounds that can be produced by the articulating structures in the larynx are far greater than in traditional interpretations, and they are more closely co-related to the articulations produced in the oral part of the vocal tract than previously thought. The articulatory decision at the velopharyngeal port is basically whether a sound is nasal (with an open port) or oral (with a closed port), with gradations that are important when distinguishing the segmental, dynamic, and long-term strands of accent. The tongue is arguably the primary articulator of the majority of sound contrasts across the languages of the world, making up the large repertory of lingual sounds evident in the various tableaux of speech sounds, including the official chart of the International Phonetic Association (IPA 2005) and the charts in the *iPA Phonetics* app, derived from Esling (2010). Significantly linked with lingual articulation is the action of the jaw, which determines the openness of vowels (and of voice quality) in the front part of the vocal tract. The final determinant of voice quality is labial configuration, significantly coordinated with lingual articulation. This reanalysis of the vocal tract prompts a fundamental research question: how does the laryngeal articulator interact with the articulators in the oral vocal tract (and vice versa)? The material presented in this book – voice quality categories, simulation of articulatory interactions, illustrations of auditory qualities, phonological mapping of articulator relationships, characterization of infant speech, description of clinical interventions, and discussions of where laryngeal articulation and voice quality fit within larger phonetic debates – provides an articulatory and auditory framework for addressing that research question. (An inventory of voice quality descriptors, to which this volume makes reference, can be found in the *iPA Phonetics* app on the Apple Store (Coey et al. 2014, Esling et al. 2015).) Audio files of settings on the Voice Qualities page can be compared with videos of articulatory postures at each place along the Consonant Chart.

Notation for the transcription of voice quality has expanded somewhat since Laver (1980: 162–165), mainly in the clinical context. Ball et al. (2000) increased symbol designations to accommodate the description of disordered speech. Ball et al. (2018) expanded and reorganized the inventory and re-evaluated phonation-type symbols to be more compatible with laryngeal articulator behaviour as described in the LAM. Some of these categories are incorporated in the expanded Consonant Chart in the app.

These notes describe material that can be accessed online. A set of media files accompanies this book to illustrate canonical voice quality categories from Chapters 1 and 2, case studies and simulations from Chapter 3, linguistic, paralinguistic, and extralinguistic illustrations from Chapter 4, qualities of infant speech in the progression of ontogenetic phonetic development from Chapter 6, illustrations of voice qualities in disordered speech and post-surgery from Chapter 7, and quality-related phenomena from Chapter 8. The video, audio, and text companion files accompanying each chapter are available on a Google Drive site with a link from CUP. Examples of canonical voice quality categories are also available within the *iPA Phonetics* app.

Acknowledgements

We are grateful to a number of people, as research collaborators, linguistic consultants, and supporters, whose assistance and input helped to make this work possible. We would like to thank Jerold A. Edmondson, Jimmy G. Harris, and Zeki Majeed Hassan for their fieldwork expertise, their collaboration in carrying out experimental phonetic procedures, their astute ability to identify contrasts in articulation and quality across a range of disparate languages, and their contribution of data to the illustration of articulatory production and quality distinctions in this volume and online. We are grateful to Li Shaoni (李绍尼), to Ziwo Lama (拉玛兹偓), and to Cécile Padayodi for participating in phonetic experimentation and contributing their linguistic expertise and data samples. We are also grateful to Chakir Zeroual for his participation on our research projects and for facilitating the collection and analysis of infant vocalizations from Morocco. We thank Michael Mawdsley and Michael Ross for attending laryngoscopic examinations. We owe a debt of gratitude to Thomas M. Hess, Geoffrey N. O'Grady, and Barry F. Carlson for their expertise in understanding the sound systems of Indigenous languages and for the inspiration and encouragement they provided over the years towards the analysis and description of phonetic patterns in many languages of the world. We are especially appreciative of the contribution of Katherine E. (Katie) Fraser and George Louie in providing linguistic data and interpretation, and we acknowledge the participation of Arne Foldvik in early laryngoscopic research, together with James K. F. (Tony) Anthony at the University of Edinburgh, and for providing data. We appreciate and acknowledge the contributions of Mihoko Teshigawara, Izabelle Grenon, and Lisa Bettany to our research projects and in the evaluation of voice quality and infant speech, and the contribution of Christopher Coey for providing technical support in data collection, programming, and post processing.

We have enjoyed the support of the Laboratoire de Phonétique et Phonologie, UMR7018, at the Université Sorbonne Nouvelle Paris 3, and the active sponsorship by Jacqueline Vaissière of the Canadian research team in Paris in

2006 and of the LABEX lecture series in 2014. We thank the ORL teams at the Hôpital Laennec and the Hôpital européen Georges-Pompidou – Daniel Brasnu, Ollivier Laccourreye, Stéphane Hans, and Madeleine Menard – for their research collaboration in laryngeal surgery and anatomical/pathophysiological classification. We are grateful to Philippe Halimi for supporting our experimental phonetic MRI investigations at the Hôpital européen Georges-Pompidou and to Angélique Amelot for data processing, and we acknowledge the material shared by Didier Demolin on comparative laryngeal anatomy. Bernard Harmegnies has supported our approach to investigating voice quality at the Université de Mons since 1989. We are indebted to Leonardo Fuks and Milton Melciades Barbosa Costa at the Universidade Federal do Rio de Janeiro for facilitating an innovative experimental investigation of laryngeal postures, and to Ian Stavness, Sidney Fels, John Lloyd, Peter Anderson, Antonio Sanchez, and Bryan Gick, among many others at UBC for the use of ArtiSynth, their work on the ArtiSynth platform, and enabling the development of a model to illustrate the action of the laryngeal mechanism.

For contributing linguistic data from a variety of languages, we would like to thank Gedung Jungney, Gugsa Tekle, Châu Văn Nguyễn, Akiyo Pahalaan, Signe Eggers-Weber, Thomas Jensen, Ivan Omari, Rhoda Spinks, Alex Sherwood, Margaret Sherwood, Pauline Flett, Mohamed Hassan Mohamoud, and John Nyok. For her management of our field site in Yunnan, China, and for facilitating the collection of infant vocalizations, we would like to thank Duan Jianying (段剑英).

We owe much of our conceptual outlook and auditory formulations to the mentorship of Ian Catford, David Abercrombie, Bill Labov, Bill Wang, and Michael Dobrovolsky. For contributing their time and encouragement in productive discussion over the years, we would like to thank John Laver, John Local, Paul Johnston, Francis Nolan, Asher Laufer, Tom Baer, Sandra Whiteside, Dennis Preston, Nina Grønnum, Gert Foget Hansen, Craig Dickson, Henry Warkentyne, and, in particular, Ewa Czaykowska-Higgins for her collaboration in formulating the Phonological Potentials Model.

We would like to acknowledge the Social Sciences and Humanities Research Council of Canada for the funding that made our instrumental research, data analysis, travel and conference participation, and the preparation of reports, of articles, and of this book possible. A series of SSHRC Research Grants – 410-93-0539, 410-2000-901, 410-2003-1624, 410-2007-2375, 410-2011-0229 – supported our research on voice quality and phonatory effects, laryngoscopic and other instrumental experimentation, and our study of the acquisition of the phonetic capacity by infants. Several General Grants from

SSHRC to the University of Victoria also supplemented this research. We also acknowledge Faculty Research Grants from the University of Victoria that supported our phonetic research initiatives.

We owe the greatest debt to the indulgence of our families: to Kazimiera for her belief, patience and support, and to Natalia for inspiring many aspects of this work; to Carly and Azula for their love and support; to Anna and Loucas for their ongoing support and contributions to the study; and to Louis, Lionel, Elena, and Pamela, for their unfailing support – heartfelt gratitude.

Abbreviations

AD	anterior digastric muscles
AE	aryepiglottic (muscles or folds)
AFPL	anterior frontal partial laryngectomy
+ATR	plus advanced tongue root
–ATR	minus advanced tongue root (i.e. retracted tongue root)
CHEP	cricohyoidoepiglottopexy
CHP	cricohyoidopexy
CN	cranial nerve
CT	cricothyroid muscles
EGG	electroglottography (electroglottogram)
EL	electrolarynx (voice)
EMA	electromagnetic articulography
EMG	electromyography
EV	esophageal voice
f0	fundamental frequency
F1	first formant
F2	second formant
FG	Feature Geometry
FLPL	frontolateral partial laryngectomy
GGA	anterior genioglossus muscles
GGM	medial genioglossus muscles
GGP	posterior genioglossus muscles
GH	geniohyoid muscles
HBB	human beatboxing
HG	hyoglossus muscles
(o)IA	(oblique) interarytenoid muscles
(t)IA	(transverse) interarytenoid muscles
ISP	inter-speech posture
LAM	Laryngeal Articulator Model
LCA	lateral cricoarytenoid muscles

LI	longitudinalis inferior muscles
LS	longitudinalis superior muscles
LTAS	long-term average spectrum
LVT	lower vocal tract
MRI	magnetic resonance imaging
NMM	neuromuscular module
OO	orbicularis oris muscles
OOIm	orbicularis oris inferior marginalis
OOIp	orbicularis oris inferior peripheralis
PCA	posterior cricoarytenoid muscles
PD	Parkinson’s disease
PPM	Phonological Potentials Model
RLN	recurrent laryngeal nerve
rtMRI	real-time magnetic resonance imaging
SCHLP	supracricoid hemilaryngopharyngectomy
SCPL	(horizontal) supracricoid partial laryngectomy
SG	styloglossus muscles
SGPL	supraglottic partial laryngectomy
SLLUS	Simultaneous Laryngoscopy and Laryngeal Ultrasound
SLN	superior laryngeal nerve
TA	thyroarytenoid muscles
TE	thyroepiglottic muscles
TEV	tracheoesophageal voice
TH	thyrohyoid muscles
TL	total laryngectomy
TMJ	temporomandibular joint
UES	upper esophageal sphincter
UFT	Unified Feature Theory
UVT	upper vocal tract
VFP	vocal fold paralysis
VPA	Vocal Profile Analysis
VVFC	Vocal-ventricular fold coupling