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On vibration properties of human vocal folds

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On Vibration Properties of Human Vocal Folds

Voice Registers, Bifurcations, Resonance Characteristics
Development and Application of Videokymography

Jan G. Švec





Rijksuniversiteit Groningen

On Vibration Properties of Human Vocal Folds:

Voice Registers, Bifurcations, Resonance Characteristics,
Development and Application of Videokymography

Proefschrift

ter verkrijging van het doctoraat in de
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Jan Švec

geboren op 22 november 1966
te Olomouc, Tsjechoslowakije

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Paranimfen: dr. ir. G.J. Verkerke
M. de Waard

Dedicated to my grandfather, František Gaspar,
in memory of whom I use the initial “G” in my name,
and to my grandmother, Anna Gasparová.

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On Vibration Properties of Human Vocal Folds: Voice Registers, Bifurcations, Resonance Characteristics, Development and Application of Videokymography

[Over trillingseigenschappen van menselijke stemplooien: stemregisters, bifurcaties, resonantiekenmerken, ontwikkeling en toepassing van videokymografie]

Thesis University of Groningen, the Netherlands – With a summary in Dutch

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FOREWORD

The research summarized in this book was initiated in 1990 when the author studied at the *Department of Optics* (head Prof. J. Peřina) and later on at the *Department of Experimental Physics* (head Prof. J. Pospíšil) of the *Palacký University in Olomouc, the Czech Republic*. At that time the author devoted his free time to playing music as a singer, guitar- and harmonica-player in an acoustic-jazz group *Piano*. The interest in music and voice led the author to initial experiments on singing voice which were done under the supervision of Dr. J. Peřák in the *Laboratory for Logopedic Diagnostics* at the *School for Children with Impaired Speech* in Olomouc-Kopeček and later also in the *Electroacoustic Laboratory of the Neurologic Clinic (Medical Faculty, Faculty Hospital)* and *Institute of Biophysics (Medical Faculty)* of the *Palacký University*.

The main phase of the research, however, started during the research stay of the author at the *Groningen Voice Research Lab* of the *University of Groningen, the Netherlands* in 1993. Here the author had the opportunity to analyze and discuss the problem of singing voice in detail with specialists in this field (Prof. H. K. Schutte and D. G. Miller). Groningen Voice Research Lab enabled the author, for the first time, to use sophisticated experimental methods for examination of human voice and provided him with access to relevant literature on voice production, books and journals, which were not available in Czech libraries.

The research originally devoted to voice registers and, especially, to the transition phenomena between chest and falsetto registers stimulated a search for a more powerful method for observation of the behavior of the vocal folds during these changes. This resulted in the development of a new laryngoscopic method, videokymography, during the second research stay of the author in Groningen in 1994 (in cooperation with H. K. Schutte and Lambert Instruments company).

In 1995 the author moved to the *Center for Communication Disorders, Medical Healthcom, Ltd. in Prague, the Czech Republic* (directed by Dr. F. Šram). This Center provided the author with a well-equipped voice laboratory and made it possible for the first time to employ videokymography in clinical examination of patients with voice disorders. The worldwide positive response from the voice scientist, laryngologists and phoniaticians on the new possibilities offered by this method as well as the introduction of the method to the commercial market (by Kay Elemetrics Corp) has lead to the situation when videokymography became a separate topic of the research carried by the author.

The decade of 1990s brought into voice research the theory of nonlinear dynamics. This theory has provided new tools for interpreting phenomena related to, e.g., irregular, subharmonic or suddenly changing vocal-folds oscillations. Knowledge of bifurcation phenomena introduced by this theory enabled the author to progress also in the search for a scientific interpretation of the phenomena related to transitions between chest and falsetto voice registers.

The close cooperation of the author with the University of Groningen during the years 1993–2000 has been possible via support from various foundations and research grants (listed in Acknowledgments) and enabled to finish the dissertation in the present form.