

*If touch is not a single perception, but many instead,  
then its purposes are also manifold*

Aristotle (384–322 BC) *De Anima*

## Preface

The quotation by Aristotle aptly describes the complexity of content and structure embodied in the sense of touch. No other sense exhibits properties so variable in scope or remains so puzzling even today – understood only in terms of its principle features. Viewed from phylogenetic and ontogenetic perspectives, the sense of touch plays a central role relative to the other senses. Its fundamental significance to humans derives from its epistemological function, making possible an awareness of surroundings and the consciousness of self. In this way, the sense of touch is *sine qua non* for thought, action, and consciousness.

Since the beginnings of scientific research into touch, the most varied of scientific disciplines have investigated one aspect or the other of this sense. The questions posed and the methods used to conduct such research are just as varied as the disciplines devoted to it. The particular results of these efforts, however, have not yet led to a comprehensive theory of the sense of touch. Too many questions remain unanswered. As of today, the wish expressed by Max Dessoire, to integrate the various areas of research pertaining to the sense of touch into one scientific doctrine – described by him as the doctrine of haptic perception – remains illusive. This state of affairs stands in contrast to the fact that there exists a great, almost unmanageable quantity of findings that are oriented toward elucidating basic principles and related to applications that, it must be admitted, clarify many facets of the sense of touch and are of technical benefit. Manifold are the findings in the realm of tactile perception where the investigated subject doing the perceiving behaves passively with

respect to the stimulus. But just as fundamental is scientific clarification of the haptic perception process that derives from a subject who is actively engaged – either aware or unaware. This state of perception-cognition for tactile perception requires the entire scope of properties inherent to the sense of touch and is an everyday, universal process in our lives. Long before our birth, this active process constructs the initial, flexible neuro-sensorial matrix to which all other senses are obliged to relate, a set of circumstances that persists as a life-long requirement for life. And for this reason, ever more scientists worldwide are researching the biological, psychological, neurochemical, and social mechanisms of human haptic perception and its interactions with the other senses. Additionally, new areas of application are continually developing, e.g. in the field of rehabilitation, virtual interfaces, robotics, and in haptic design, where principles of human haptic perception are converted and then implemented in practice.

In view of this fascinating, dynamic background, this volume, which subdivides into six sections, compiles contributions from 46 international authors on the most varied topics of human haptic perception. In the first section, philosophical and historical aspects of the sense of touch are introduced. Here, authors from four different countries analyze the beginnings of scientific research into the sense of touch, from the start of the 19<sup>th</sup> to the middle of the 20<sup>th</sup> century, a time when psychological, terminological, and methodological foundations were laid for today's research. These contributions are intended to clarify the essential sources of the branches of research that exist today and should be helpful

in placing current research into the required historical context. It will not hereby remain unstated that we are amazed by our own recognition that – during recourse to the progenitors of the science of touch – a number of concepts considered new today are, in fact, more than 100-years old.

The second section of this volume presents fundamental aspects of the anatomical, physiological and neurophysiological conditions in our bodies that provide the basis for the realization of human haptic perceptions. These biological aspects are essential to an understanding of the various psychological and clinicopathological processes of human haptic perception. Beyond that, they represent a link, in terms of function and content, between the human model and areas of virtual-technical application.

As nature would have it, haptic perception fulfills multifaceted psychological functions in all realms and stages of life. Several of these functions, as well as various psychological and psycho-physiological aspects of human haptic perception, are covered in section three of the book. Although such a presentation can never be exhaustive, the contributed topics range from prenatal mechanisms of haptic perception to learning, memory, illusions, synaesthesia – all the way to questions of haptic perception in space travel.

Section four continues with a presentation of various clinico-neuropsychological topics. Even if this subject area is not yet a part of the mainstream of clinicopsychological and neurological diagnostics and intervention, new and exciting perspectives have emerged in recent years that benefit the pathology of haptic and tactile perception both therapeutically and in clinical diagnosis. Of particular significance in this regard is the universal interconnection between haptic perception and body schema representation in relation to different mental disorders.

In parallel with rapid technical developments in recent decades, an innovative and, in part, spectacular field of research and applications has been established, having the goal of implementing the principles of human haptic perception in virtual scenes, different electro-mechanical

interfaces, and in robotic systems. In this way, engineers, psychologists and neuroscientists are making great strides into the field of haptic simulation in the context of various technical systems. As a result, not only are new and beneficial applications being discovered and applied, but, by these means, new perspectives are emerging in the field of research methodology. The fundamental principles of this field of research and the areas of application are described in section five of the book.

Research into our senses has always been associated with the search for practical as well as industrial applications. The search for knowledge has thus never been far removed from the goal of practical utility. In part, such goals are, in fact, the motivation for the research. Even as we see this trend emerge more evidently in other realms of the senses and in our everyday lives, practical/technical applications as far as research pertaining to the sense of touch is concerned often still go unnoticed at large. The spectrum of these developments – so-called haptic design – ranges from new and improved surface properties for devices and products of all types, to changes in complex haptic properties in the operation of machinery or vehicles. Equally broadly diversified are practical applications in the fields of rehabilitation or assistance to help orient the blind and individuals with poor sight. A selection of such types of applications are illustrated in section six by way of examples.

This present volume is tied to the hope that the broadly diversified illustrations of the most varied aspects of human haptic perception will provide a useful tool to those unfamiliar with the field as well as to students and to scientist from various disciplines. Not least, the book should be a stimulus and a support for all those who are currently, or will be in the future, concerned with new perspectives on research and application in human haptic perception. The fact that not all of the planned aspects of human haptic perception could be taken into consideration in this volume is attributable to the natural limitations of such a project. The publisher and the authors sincerely

hope that editions to follow will expand the spectrum of depiction.

The publication of this textbook has only been possible because two powerful and dedicated forces were active in equal measure – for which I would like to express my deepest thanks at this time. First of all, we had the many authors who believed in this project and who, by means of their contributions, created the inherent substance of this book. Equally, I thank Dr. Hans Detlef Klüber, of Birkhäuser Publishers, for his proposal to bring this book into being and for his patient support and optimism in all phases of this project. I would like to give special thanks for the trust placed, and the dedication contributed, by all of those who participated in this book project, as well as for the personal support offered by my colleagues, F. Krause and I. Thomas. I conclude this editorial effort on this volume with the sincere hope that the basic, interdisciplinary research and applications pertaining to the sense of touch will come to assume a central role within the life sciences in the future.

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