Preface

New Directions in Touch

Susan J. Lederman and Roberta L. Klatzky
Guest Co-Editors

The purpose of this special issue on New Directions in Touch is to focus the spotlight on a number of critical topics concerning the sense of touch, with invited reviews written by some of the top researchers in the field today. Some of these are traditional topics that have seen impressive advances in recent years, while others are quite new. Our intent in highlighting this work is to reflect the increasing excitement in recent years surrounding the exponential increase in highly innovative and diverse research devoted to the sense of touch.

There are a total of nine articles in this special issue of the *Canadian Journal of Experimental Psychology*. Collectively, they cover a wide assortment of topics related to human tactile and haptic sensing and its application, including sensation, perception, cognition and their underlying neural mechanisms, and how basic research on touch has been applied to the design of haptic interfaces for teleoperation and virtual environments. Many different methodologies have been employed in this research, including psychophysics, a variety of perceptual and cognitive behavioural paradigms, single-unit recording, fMRI, and examination of neurologically impaired populations and neuropsychology case studies. The papers also report on methods used by mechanical engineers and computer scientists to design haptic interfaces (hardware and software systems) for use in a wide range of teleoperation and virtual-environment application domains.

McGlone, Vallbo, Olausson, Loken, and Wessberg discuss a new submodality of the cutaneous system, in addition to those long established and consisting of touch, temperature, itch, and pain. They propose that this recently discovered tactile submodality is found only in hairy skin, and that it serves the function of affiliative or emotional (pleasant) touch. In their article, McGlone et al. review the peripheral and central neural mechanisms of pleasant touch and compare them to those related to discriminative touch.

Hollins and Bensmaıa carefully describe how the somatosensory system extracts, encodes, and processes surface roughness and smoothness, two of the most comprehensively studied components of surface texture to date. They propose an elegant model of the roughness perception of fine and coarse surfaces, involving two coding mechanisms and subserved by two populations of tactile afferents and their central connections. The model is strongly supported by a series of very clever psychophysical experiments.

Spence and Gallace consider evidence that reveals that it is possible to direct one’s attention to the tactile modality or to the region of space where tactile stimuli are delivered via voluntary (endogenous/top-down) or reactive (exogenous/bottom-up) orienting. These authors present the most recent research on the interaction between these two modes of attention, as well as on tactile numerosity judgments and change detection, highlighting substantial cognitive (attentional) restrictions that may limit people’s ability to process more complex tactile displays.

Kappers tackles the challenging topic of how people encode space through haptic exploration. A highly comprehensive series of psychophysical experiments reveal impressively large systematic errors in all experimental conditions. These data lead to a model of haptic space perception in which an egocentric reference frame biases judgments of allocentric space. The roles of hand-centred and body-centred egocentric frames of reference are both considered.

James, Kim, and Fisher address the neural organization of haptic object processing, focusing primarily on the object properties of shape and material. They propose two separate hierarchically organized neural pathways, one for processing material properties, such as texture, via cortical regions in SI and SII, and another for processing object shape. Paralleling the neural organization of the visual system, the haptic system is further broken down into dorsal and ventral streams for purposes of action and perception, respectively.

Lederman, Kilgour, Kitada, Klatzky, and Hamilton summarize a new body of research on face processing, which indicates that both facial identity and universal facial expressions of emotion can be haptically processed at levels well above chance. Their research adopts a set of converging methodologies, including behavioural paradigms with both neurologically intact
and prosopagnosic populations, and neuroscientific imaging techniques (fMRI). These recent results further highlight the fact that the haptic system can serve as an efficient tactile communication system.

Ernst, Lange, and Newell take on the topic of cross-modal object recognition and offer new empirical data on the multisensory recognition of objects using both vision and haptics. Their results lead to the proposal that participants naturally adopt an exploration strategy during visual and haptic object learning that involves restricting object orientation to a single perspective. While such a heuristic produces good intramodal performance, it interferes with achieving optimal intermodal performance.

Sathian and Lacey provide a highly informative overview of a program of somatosensory research that continues to pose a fascinating question for behavioural and neural scientists alike, regarding the role of traditional “visual” cortical regions in human tactile processing. The collection of behavioural and neuroscience studies involving comparisons of blindfolded sighted, congenitally blind, and late-blind groups offers important insights into the underlying processes, including top-down visual mediation and bottom-up multisensory processing by so-called visual areas of the cortex.

Tan offers a good example of the ways in which careful psychophysical experimentation can contribute to the work of engineers and computer scientists who design haptic and multisensory interfaces for use in teleoperation and virtual-environment applications. The results of this fundamental work on human factors inform designers of the relevance of critical sensory, information-processing, and motoric characteristics of the operators.

Although space restrictions in this issue have prevented us from including additional important topics by other notable researchers, we hope that the following pages will encourage the reader to explore this highly challenging and stimulating area of research more widely. In recent years, there has been a spectacular rise in special issues published on various aspects of touch, increasing from only one to two per year from 1997 to 2002 to an average of about eight per year from 2003 to the present. Many of these issues focus on display technologies, control and rendering algorithms, as well as on perception, multimodal interaction, neuroscience and medical applications. In providing a number of reviews of fundamental scientific research on the sense of touch, the current issue is intended to play a unique and timely role.

Back copies of the special issue on New Directions in Touch may be purchased at reasonable rates. The Canadian Psychological Association (CPA) will accept payment by cheque or money order made out to the Canadian Psychological Association, or by VISA or MasterCard. For further information, please contact Dan Berman at the CPA office 613-237-2144, ext. 325 or by e-mail at: publications@cpa.ca.