1 Common mechanisms in perception and action
Introductory remarks

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The contributions to this volume discuss a classical theme in human-performance research, and they do so under some new perspectives that have emerged in recent years. The classical theme refers to the interplay between perception and action—a theme that is, and has ever been, one of the core issues in the field of attention and performance. For instance, in the classical work inspired by linear stage theory, notions like stimulus–response translation and/or response selection have been introduced to account for putative operations underlying the transition from stimulus- to response-related processing, and a number of factors affecting these operations have been identified. Yet, despite their supposed central function, the study of translation mechanisms has always played a somewhat marginal role. Instead, research has tended to emphasize stimulus- over response-related processing, and there has been rather little interest in response-related processing mechanisms and the way they are linked to those dealing with stimulus information.

In recent years, some new perspectives have emerged, suggesting both structural diversity and functional coherence in the interplay between perception and action. On the one face there is now substantial evidence from a large variety of neuroscience studies supporting diversity in the sense that interaction between perception and action may be going on in parallel in a number of pathways, and a variety of maps or modules for special computational purposes may be involved. On the other face there is also much evidence supporting a substantial degree of functional coherence within these modules—in the sense of questioning the classical separation between sensory, or stimulus-related processing and motor, or response-related processing and calling for more overlap and integration between the two. Surprising interactions between perception and action have been observed in a number of both behavioral and neuroscience studies indicating that input and output may draw on tightly coupled, or perhaps even identical representations. At the same time, new theoretical frameworks and models have been proposed to meet the challenges inherent in these observations and account for these interactions, for example, in terms of shared mechanisms that draw on common representational resources.

The aim of this volume is to gather these various approaches in an attempt to focus on structural and functional aspects of the architecture mediating between stimulus- and response-related processing, with an emphasis on both diversity due to its modular organization and coherence due to common mechanisms within modules.

The chapters in this volume are based on oral contributions to: 'Attention and Performance, XIX: Common Mechanisms in Perception and Action', a symposium held on behalf of the International Association for the Study of Attention and Performance (IASAP) at Kloster Irsee, Bavaria, Germany from July 16 to 22, 2000. At every Attention and Performance symposium it is customary to honor an eminent researcher's distinguished contribution to the field by an invitation to give the Association Lecture. For this symposium, IASAP's Executive Committee invited Sylvan Kornblum to deliver the Association Lecture. In his Lecture, Kornblum presents evidence on interactions between stimulus–response compatibility and sequential order in choice-reaction tasks and discusses their implications for his Dimensional Overlap model.

The Association Lecture is followed by five sections devoted to different domains and forms of interactions between perception and action. The first two sections are concerned with the classical domains of space and time, where issues related to the interplay between perception and action have long been topical. The third section deals with action perception and imitation, which has recently attracted converging attention in developmental and cognitive psychology, neurophysiology as well as clinical neuropsychology. The last two sections then address various forms of interaction between perception and action, partly going from input to output, partly taking the reverse perspective, and partly dealing with their integration. Since each section comes with an introductory overview of its own, we can here be very brief in sketching the varieties of the themes discussed in the sections and the underlying theoretical issues that link them together.

Section I considers *Space perception and spatially oriented action*. Spatially adapted behavior requires reliable, high-precision alignment of perceptual space and action space. Traditional theories in this domain have therefore tended to invoke underlying representational structures that act as a common representational basis for both space perception and spatially oriented action. Over the past two decades this view has become increasingly challenged by clinical and experimental evidence suggesting parallel pathways and multiple maps in the brain as well as related dissociations between perception and action in behavioral performance. The contributions to this section present new evidence on the dialectic relationship between the diversity of pathways and maps and the functional unity of perception and action in space perception and spatially adapted behavior.

Section II considers *Timing in perception and action*. Time is a dimension underlying both actor-independent events in the environment and actions, that is, actor-generated body movements. Like in the spatial domain, adaptive behavior requires high-precision alignment of the timing of actions to the timing of events, suggesting a common representational basis for events and actions and shared mechanisms for their timing. Moreover, since any representational operation and any neural activity carrying such operation is, in itself too, extended in time, the dimension of time has often been considered special in the sense that the representation of time is isomorphically grounded in the time of representation. Accordingly, the contributions to this section address mechanisms of timing and sequencing in perception and action as well as relationships between the representation of time and the timing of representational operations.

Section III considers *Action perception and imitation*. Issues of action perception and imitation have recently become topical in neurophysiology, brain imaging, human development, and human performance. Studies from these fields differ considerably with respect to scope and aims, ranging from single-cell-based mechanisms involved in afferent and efferent processing to high-level mechanisms subserving the construction of mental selves. However, they do converge in suggesting close couplings, and even a considerable degree of equivalence between perceiving and producing actions. Correspondingly, processing theories in this field tend to invoke shared representational

structures for information from different modalities (e.g. vision and proprioception) or for representations of more abstract features shared by perceived and produced actions. The contributions to this section discuss new findings from various approaches to action perception and imitation and assess their implications for understanding the underlying representational structures and processing mechanisms.

Section IV considers *Content-specific interactions between perception and action*. Research on stimulus–response compatibility plays an increasingly important role in providing insights into both the processes and cognitive structures underlying the relationship between perception and action planning; into how stimulus and response codes are formed; how they speak to each other; and how their interactions change in the course of practice. Progress has also been made in tapping into the temporal dynamics of stimulus and response coding, and of the interactions between those codes, especially by applying increasingly sophisticated data-analysis techniques and by including psychophysiological measurements. Interestingly, recent investigations have revealed that stimulus–response relations do not only affect action planning, but perception as well. In fact, planning an action sometimes facilitates, sometimes interferes with, and sometimes even changes the perception of stimulus events, depending on the specific relation between planned action and perceived stimulus. The contributions to this section sketch the emerging picture of perception and action as the outcome of a dynamic interplay between content-specific codes, rather than a unidirectional flow of information from stimulus processing to motor execution.

Section V considers *Coordination and integration in perception and action*. Perceptual and action-related structures and processes are tightly coupled and coordinated, and in several cases they share cognitive resources. However, resource sharing creates all sorts of capacity bottlenecks and binding problems—problems that are revealing with respect to how stimulus and response information is organized, integrated, and coordinated. Aspects of stimulus–response (or response–effect) coordination and integration have gained attention only recently, but both empirical evidence and theoretical insights are growing steadily. Accordingly, the contributions to this section provide a colorful but nicely converging overview of basic principles governing the integration of perception and action, and of actions and action goals, in and across stimulus and response processing, manual action and eye movements, and perception–action sequences.