INTRODUCTION

Keith Frankish and William M. Ramsey

Overview

Cognitive science is a cross-disciplinary enterprise devoted to exploring and understanding the nature of the mind. In recent years, investigators in psychology, the neurosciences, artificial intelligence, philosophy, and a host of other disciplines have come to appreciate how much they can learn from one another about the various dimensions of cognition. The result has been the emergence of one of the most exciting and fruitful areas of interdisciplinary research in the history of science.

This volume of original essays is designed to describe the state of the art in cognitive science and to survey the major theoretical, philosophical, and foundational issues across the field. With a focus on theory rather than technical and applied issues, the volume is designed to appeal to both cognitive scientists and philosophers of cognitive science. Each chapter is a specially commissioned article from a leading writer in the area – either a philosopher of cognitive science or a scientist with strong theoretical interests. These writers cover the foundations of cognitive science, the principal areas of study, major research methodologies, and the philosophical implications of current research. The chapters are largely thematic rather than historical, and although the essays are primarily survey pieces, readers will find important critical insights, assessments, and analyses included in each essay. Readers are not expected to have extensive background in the primary subject areas.

This volume is distinctive in several ways. First, its coverage is both broad and authoritative. Its fifteen chapters provide a concise, up-to-date survey of a field that is developing and expanding rapidly, written by leading philosophers of cognitive science and front-line researchers with important and broad-ranging perspectives. Second, it is designed to be widely accessible. The contributors present scientific work in a form that is comprehensible to a humanities audience and focus on theoretical issues and applications rather than the details of experimental work. Third, the contributions are written at an intermediate level, suitable for both advanced students and scholars new to the area, and the book includes supporting materials, such as a glossary and chapter-specific 'Further Reading' sections, that make it an ideal teaching text. A companion handbook to artificial intelligence has also been

compiled, which has similar scope and aims and is designed to complement this one.

The philosophy and science of cognition

A number of the chapters in this volume are written by people who are usually characterized, not as cognitive scientists *per se*, but as *philosophers of* cognitive science. Moreover, the volume's co-editors both have their primary homes in philosophy departments. Thus, one might wonder why a volume about the *science* of the mind is so heavily infused with input from philosophers.

In truth, the distinction between cognitive science and the philosophy of cognitive science is not nearly as sharp as one might suppose. First, there really is no clear demarcation between empirical investigation on the one hand and philosophical reflection on that investigation on the other. Cognitive scientists must reflect on the broader implications of their findings, speculate about more abstract matters such as hidden assumptions and overarching themes, appeal to thought-experiments in arguing for their positions, and invoke traditional philosophical concepts such as knowledge, representation, and consciousness. In other words, there is a lot of philosophical reasoning involved in being a cutting-edge scientist. At the same time, philosophers of cognitive science must be well versed in the empirical theories and methods of investigation, so that their own contributions are relevant and beneficial. In fact, there is often little difference between doing, say, theoretical psychology and the philosophy of psychology.

Secondly, the philosophy of cognitive science involves two features that provide scholars in the discipline with a unique perspective on cognitive science itself. One is a broad-based understanding of the more general metaphysical, epistemological, and even ethical issues that arise in cognitive science. These include questions about the nature of mind–brain identity, reductionism, cognitive explanation and modeling, appropriate taxonomies for mental states, types of mental content, and so on. The other feature is an appreciation of the specific foundational issues associated with particular areas of cognitive research. For centuries, philosophers have been thinking and writing about a wide array of mental phenomena that different empirical researchers are now exploring. Aspects of the mind such as consciousness, mental representation, perceptual experience, and human action are traditional areas of philosophical analysis *and* the target of increased scientific scrutiny. The philosophy of mind has been dramatically transformed by scientific findings and theories, and, at the same time, philosophers have a unique vantage from which they can elucidate empirical work.

Thus, not only is there no sharp distinction to be made between science and philosophy (in this area at least), but researchers with a background in philosophy are particularly well placed to provide an overview of the science and to draw out the foundational issues.

The future of cognitive science

Because the essays in this volume present state of the art research and theorizing, they also provide a glimpse of where things are heading in the discipline of cognitive science. It is, of course, always difficult to predict the future of any field, but we can see certain trends that we expect to continue. For example, in their chapter on core themes, Abrahamsen and Bechtel discuss the expansion of cognitive science both downward and outward. The expansion is downward in the sense that more and more work in psychology is informed by discoveries and findings in the neurosciences. As many of the chapters here reveal, current work on consciousness, perception, learning, and a host of other aspects of cognition is increasingly being influenced by our growing knowledge of the brain. We fully expect this trend to continue and, indeed, to strengthen as neuroscientific knowledge develops. Expansion in cognitive science is outward in at least two senses. First, as Clark's chapter on embedded and extended cognition reveals, there is a growing movement to treat things beyond the cranium as vitally important to, and perhaps even constituent of, cognitive processes and states. This movement will no doubt continue as more investigators come to view cognitive agents as inextricably embedded in a web of complex interactions with a broader external environment. Second, over time cognitive science itself has increasingly interfaced with other disciplines and subdisciplines, expanding both the range of research it draws upon and the extent of its own influence. The chapters here strongly suggest that this theoretical expansion will continue, and, with it, the vital importance of cognitive science as the field that is at the heart of our understanding of ourselves.

Summary of the volume

The volume is composed of fifteen chapters divided into three main sections: *Foundations*, *Aspects of cognition*, and *Research programs*. We selected these sections because, taken together, they provide an excellent overview of the theoretical landscape of cognitive science. Each section and each chapter stands alone and can be read individually, though the sections and chapters are designed to complement each other, and the collection as a whole provides a systematic and comprehensive survey of the field.

Part I: Foundations

This section is devoted to the foundational issues of cognitive science. The first chapter, which is by Adele Abrahamsen and William Bechtel, provides a brief history of the cognitive revolution and the emergence of cognitive science. It also introduces some of the foundational issues, such as the philosophical

roots of cognitivism, the computer model of the mind, and the merits of cross-disciplinary research. The second chapter, by Barbara Von Eckardt, introduces the representational theory of the mind and explains the role that representationalism has played in the development of cognitive science. It explains some of the arguments for and against representationalism and looks at philosophical work on the problem of naturalizing intentionality. The third and final chapter of this section is by Paul Thagard. It deals with cognitive architectures – general models of processing and representation, which serve as paradigms in cognitive science. Thagard surveys the two most influential architectures – rule-based and connectionist – and considers the prospects for developing a general cognitive theory that combines aspects of both.

Part II: Aspects of cognition

This section is devoted to recent research on various aspects of cognition. The authors present a survey of recent findings and theories and discuss the more significant philosophical implications of this research. Readers can use this section of the volume to gain both a good grasp of specific areas of cognitive research and an understanding of the philosophical issues surrounding them.

The chapters, written by leading specialists in each field, cover a variety of topics. Casey O'Callaghan looks at perception, explaining traditional philosophical problems which form the backdrop to contemporary scientific research and introducing empirically motivated theoretical issues, such as the relationship between perception, cognition, and action. Elisabeth Pacherie discusses action, showing how a more comprehensive, integrative picture of action is gradually emerging which draws on both conceptual frameworks developed by philosophers and empirical investigations into motor cognition. Charan Ranganath, Laura A. Libby, and Ling Wong survey modern memory research and introduce key issues in the field, stressing the theoretical advances that are resulting from collaboration between psychologists and neuroscientists. Mike Oaksford, Nick Chater, and Neil Stewart introduce some recent developments in the large and complex field of human reasoning and decision making, explaining both the main normative theories and important experimental paradigms, findings, and interpretations. In the next chapter, Gregory L. Murphy and Aaron B. Hoffman look at work on concepts and category learning. They identify and survey two main strands of contemporary research, one concerned with formal models of category learning, and the other focusing on the content of concepts and the interaction between learning and prior knowledge. Progress in the field, Murphy and Hoffman suggest, requires further integration of these two strands. The study of language has always had a central role in cognitive science, and linguists have developed detailed models of the mental structures involved in language processing. In

his chapter, Ray Jackendoff surveys this work and seeks to integrate linguistic theory with wider issues in cognitive science. Next, Jesse Prinz reviews recent research on the emotions, focusing on their causes, constituents, and effects, and introducing a major dispute over the role of cognition in emotion. Finally in this section, William G. Lycan looks at the aspect of the mind often regarded as the most resistant to scientific understanding: consciousness. Lycan disentangles different facets of consciousness and distinguishes empirical issues, on which cognitive scientists are making progress, from purely philosophical issues, which, he suggests, are likely to remain contentious.

Part III: Research programs

This section introduces readers to some broader research programs and their particular methodological and theoretical commitments. In the first chapter Dominic Standage and Thomas Trappenberg provide an overview of developments in the growing field known as computational neuroscience, which aims to provide explanations of cognitive phenomena that are rooted in models of brain structure and functioning. In the next chapter, H. Clark Barrett explores the developing and controversial discipline of evolutionary psychology and discusses why evolution is relevant to understanding the mind. The penultimate chapter, by Andy Clark, focuses on the boundaries of cognition. Clark explores the claim that cognitive systems and processes can be understood only by including the surrounding environment in which the system is embedded, along with the provocative suggestion that cognitive systems themselves actually extend out into the world. The volume concludes with a chapter on animal cognition, in which Sara J. Shettleworth presents some of the more significant findings in the field of cognitive ethology and discusses the different ways in which the study of animal brains and behavior has helped shape our understanding of cognition.

This choice of chapter topics is, we feel, sound and as comprehensive as possible given the size of the volume. Of course, there are other topics we would have liked to have included, in particular some alternative and emerging research programs. However, given the limitations of space, we decided to focus on mainstream cognitive science and established programs (though non-mainstream work is touched on in many places). We do not suggest that no work of value is being done outside this mainstream, nor do we deny that cognitive science may take a very different turn in the future. But the topics covered here are undeniably central to the discipline, and it is not our job as editors of a handbook to impose a vision of how the field will develop. Moreover, as mentioned earlier, this volume is one of a pair, and some alternative approaches to cognition are discussed in detail in the companion

volume, *The Cambridge Handbook of Artificial Intelligence* (also edited by us). This contains chapters on, among many other things, challenges to traditional AI conceptions of cognition, dynamical systems and embedded cognition, robotics, and artificial life.

We have enjoyed putting this volume together, and we hope it will introduce many readers to the rich and exciting work being done in contemporary cognitive science. Some readers, we hope, will be spurred to join the enterprise, and others to apply insights and ideas from cognitive science in their own fields. All, we hope, will benefit from an increased understanding of the complex cognitive machinery that makes us what we are.