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The Cognitive Structure of Scientific Revolutions

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The Cognitive Structure of Scientific Revolutions

Thomas Kuhn's *Structure of Scientific Revolutions* became the most widely read book about science in the twentieth century. His terms "paradigm" and "scientific revolution" entered everyday speech, but they remain controversial. In the second half of the twentieth century, the new field of cognitive science combined empirical psychology, computer science, and neuroscience. In this book, recent theories of concepts developed by cognitive scientists are used to evaluate and extend Kuhn's most influential ideas. Based on case studies of the Copernican revolution, the discovery of nuclear fission, and an elaboration of Kuhn's famous "ducks and geese" example of concept learning, the volume offers new accounts of the nature of normal and revolutionary science, the function of anomalies, and the nature of incommensurability. This new approach to the intellectual content of science and its historical development incorporates insights from both traditional philosophy of science and constructivist sociology of science. The main technique presented, the dynamic frame model of human concepts, may be applied to any field where the nature of concepts is important.

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The Cognitive Structure of Scientific Revolutions

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For

C.S.

C.M.W.

and

L.L.

Perhaps the best way to express our position is by proposing a ten year moratorium on cognitive explanations of science. . . . We hereby promise that if anything remains to be explained at the end of this period, we too will turn to the mind!

Bruno Latour and Steve Woolgar, 1986

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Acknowledgments

Over the last ten years, the three authors of this book have collaborated on a series of studies applying ideas from cognitive psychology to issues in the philosophy of science, and particularly to the work of Thomas Kuhn. In our previous papers we have included a statement that each work was a collaboration to which all three authors contributed equally. The same is true of the current book, which consolidates and extends our ten years of joint work. None of us could have written this book without the help of the others; our discussions have now continued for so long that it is not appropriate to connect particular points in the overall argument with individual contributors.

Our earlier papers on the themes treated in this book include, in chronological order: Andersen, H., Barker, P., and Chen, X. (1996), "Kuhn's mature philosophy of science and cognitive science," *Philosophical Psychology*, 9: 347–363, used by permission of the Taylor & Francis Group (http://www.tandf.co.uk); Andersen, H. (1996), "Categorization, anomalies, and the discovery of nuclear fission," *Studies in History and Philosophy of Modern Physics* 27: 463–492, © 1996, material used here by permission of Elsevier; Chen, X., Andersen, H., and Barker, P. (1998), "Kuhn's theory of scientific revolutions and cognitive psychology," *Philosophical Psychology* 11: 5–28, used by permission of the Taylor & Francis Group (http://www.tandf.co.uk); Andersen, H. (2000), "Kuhn's account of family resemblance: A solution to the problem of wide-open texture," *Erkenntnis* 53: 313–337, © 2000, with kind permission of Springer Science and Business Media;

Andersen, H. (2000), "Learning by ostension: Thomas Kuhn on science education," *Science & Education* 9: 91–106, © 2000, with kind permission of Springer Science and Business Media; Chen, X., and Barker, P. (2000), "Continuity through revolutions: A frame-based account of conceptual change," *Philosophy of Science (Proceedings)* 67: 208–223, © 2000 by the Philosophy of Science Association, all rights reserved; Andersen, H. (2001), "Reference and resemblance," *Philosophy of Science (Proceedings)* 68: S50–S61, © 2001 by the Philosophy of Science Association, all rights reserved; Barker, P. (2001), "Kuhn, incommensurability and cognitive science," *Perspectives on Science* 9: 433–462, © the Massachusetts Institute of Technology; Barker, P. (2001), "Incommensurability and conceptual change during the Copernican Revolution," in P. Hoyningen-Huene & H. Sankey (eds.), *Incommensurability and Related Matters*, Boston Studies in the Philosophy of Science (Boston: Kluwer), 241–273, material used with kind permission of Springer Science and Business Media; Chen, X. (2002), "The 'platforms' for comparing incommensurable taxonomies: A cognitive-historical analysis," *Journal of General Philosophy of Science* 33: 1–22, © 2002, used with kind permission of Springer Science and Business Media; Barker, P., Chen, X., and Andersen, H. (2003), "Kuhn on concepts and categorization," in T. Nickles (ed.), *Thomas Kuhn* (Cambridge: Cambridge University Press), 212–245, material reprinted with permission.

While portions of the present work recapitulate or rework material presented in some of these papers, this book presents a new setting for all our earlier work. In addition to new historical material, we here present completely new accounts of the nature of anomaly, the nature of normal and revolutionary science, and the nature of incommensurability, which supersede the accounts given in our previous papers. This book is the only complete statement of our current views.

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The Cognitive Structure of Scientific Revolutions

1

Revolutions in Science and Science Studies

1.1 THE PLACE OF KUHN'S WORK IN STUDIES OF SCIENCE

Thomas Kuhn's *Structure of Scientific Revolutions* became one of the most influential books of the twentieth century, although its author suffered the fate of many prophets: he was ignored by the people he most hoped to influence. His technical terms became so widely known that a popular cartoonist could depict a newly hatched chick greeting the world with the cry "Oh! Wow! Paradigm shift!" (Taves 1998) and a best-selling guide to success in life and business would tell its readers, "[W]e need to understand our own 'paradigms' and how to make a 'paradigm shift'" (Covey 1990: 26). But there is no Kuhnian school of history, and many philosophers of science remain skeptical about his ideas. At the close of the twentieth century philosophers generally rejected paradigm shifts and normal science as useful categories for understanding scientific change and were still arguing about another key idea, incommensurability (Curd and Cover 1998; Hoyningen-Huene and Sankey 2001). Meanwhile Kuhn's emphasis on the historical variability of scientific standards and the role of research communities in scientific change was embraced by a new generation of sociologists of scientific knowledge. The new sociologists of science adopted Kuhn as a founding father, if not an intellectual guide: Kuhn's emphasis on the cognitive content of science was marginalized. Our aim in this book is to rectify this situation, by legitimizing the study of the cognitive content of science, in a new way, and providing the tools needed to write a