THE MINDS OF GODS

NEW HORIZONS IN THE NATURALISTIC STUDY OF RELIGION

EDITED BY
BENJAMIN GRANT PURZYCKI
& THEISS BENDIXEN

SCIENTIFIC STUDIES OF RELIGION
INQUIRY AND EXPLANATION

BLOOMSBURY

The Minds of Gods

Scientific Studies of Religion: Inquiry and Explanation

Series editors:
Luther H. Martin, Donald Wiebe, Radek Kundt and Dimitris Xygalatas

Scientific Studies of Religion: Inquiry and Explanation publishes cutting-edge research in the new and growing field of scientific studies in religion. Its aim is to publish empirical, experimental, historical, and ethnographic research on religious thought, behaviour, and institutional structures. The series works with a broad notion of scientific that includes innovative work on understanding religion(s), both past and present. With an emphasis on the cognitive science of religion, the series includes complementary approaches to the study of religion, such as psychology and computer modelling of religious data. Titles seek to provide explanatory accounts for the religious behaviors under review, both past and present.

The Attraction of Religion
Edited by D. Jason Slone and James A. Van Slyke

The Cognitive Science of Religion
Edited by D. Jason Slone and William W. McCorkle Jr.

Connecting the Isiac Cults
Tomáš Glomb

The Construction of the Supernatural in Euro-American Cultures
Benson Saler

Contemporary Evolutionary Theories of Culture and the Study of Religion
Radek Kundt

Death Anxiety and Religious Belief
Jonathan Jong and Jamin Halberstadt

Gnosticism and the History of Religions
David G. Robertson

The Impact of Ritual on Child Cognition
Veronika Rybanska

Language, Cognition, and Biblical Exegesis
Edited by Ronit Nikolsky, Istvan Czachesz, Frederick S. Tappenden and Tamas Biro

The Learned Practice of Religion in the Modern University
Donald Wiebe

The Mind of Mithraists
Luther H. Martin

Naturalism and Protectionism in the Study of Religion
Juraj Franek

New Patterns for Comparative Religion
William E. Paden

Philosophical Foundations of the Cognitive Science of Religion
Robert N. McCauley with E. Thomas Lawson

Religion, Disease, and Immunology
Thomas B. Ellis

Religion Explained?
Edited by Luther H. Martin and Donald Wiebe

Religion in Science Fiction
Steven Hrotic

Religious Evolution and the Axial Age
Stephen K. Sanderson

The Roman Mithras Cult
Olympia Panagiotidou with Roger Beck

Solving the Evolutionary Puzzle of Human Cooperation
Glenn Barenthin

The Study of Greek and Roman Religions
Nickolas P. Roubekas

Understanding Religion Through Artificial Intelligence
Justin E. Lane

The Minds of Gods

New Horizons in the Naturalistic Study of Religion

Edited by
Benjamin Grant Purzycki and Theiss Bendixen

BLOOMSBURY ACADEMIC
LONDON • NEW YORK • OXFORD • NEW DELHI • SYDNEY

BLOOMSBURY ACADEMIC
Bloomsbury Publishing Plc
50 Bedford Square, London, WC1B 3DP, UK
1385 Broadway, New York, NY 10018, USA
29 Earlsfort Terrace, Dublin 2, Ireland

BLOOMSBURY, BLOOMSBURY ACADEMIC and the Diana logo are
trademarks of Bloomsbury Publishing Plc

First published in Great Britain 2023

A catalogue record for this book is available from the British Library.

Library of Congress Control Number: 2022942225

ISBN: HB: 978-1-3502-6570-7
ePDF: 978-1-3502-6571-4
eBook: 978-1-3502-6572-1

Series: Scientific Studies of Religion: Inquiry and Explanation

Typeset by Newgen KnowledgeWorks Pvt. Ltd., Chennai, India

To find out more about our authors and books visit www.bloomsbury.com
and sign up for our newsletters.

For Ezra and Edward

Contents

Figures

Tables

Contributors

Adam Baimel is currently an early career research fellow at Oxford Brookes University, UK. He studies the cultural evolution of religion and is currently working on a series of projects identifying when (and in what ways) socioecological challenges create changes in religious systems with a particular focus on how (and with what consequences) religious systems are adapting their concerns to the rising threats associated with the climate crisis.

John Balch is a doctoral candidate at Boston University and a Lindamood Research Fellow at the Center for Mind and Culture. His research utilizes tools drawn from computational social science and the cognitive sciences to analyze the evolution of religious ideologies over time, particularly as individuals respond to the challenges posed by climate change.

Theiss Bendixen is a psychologist and PhD fellow at Aarhus University. His PhD project involves developing and testing accounts of how and why religious beliefs, appeals, and rituals vary across cultures using cognitive and cultural evolutionary theory and statistical modeling of large cross-cultural datasets. He has written two popular science books and is also involved in research on meta-science, science communication, and the evolution of intelligence in the animal kingdom.

Emily Reed Burdett is Assistant Professor at the University of Nottingham and retains a research associate post at the University of Oxford. She is currently investigating the development of belief across thirty different sites globally (developingbelief.com) as well as the developmental origins of creativity. Her research interests include science and religion, child development, the developmental origins of creativity and learning, morality, and social cognition. Her work has been published most recently in *Journal of Experimental Child Psychology*, *Philosophical Transactions of the Royal Society*, and *Child Development*.

Kurt Gray is Professor of Psychology and Neuroscience at the University of North Carolina at Chapel Hill. He studies people's deepest beliefs and how to best increase moral understanding.

Joshua Conrad Jackson is a postdoctoral research fellow in the Kellogg School of Management at Northwestern University. He studies the coevolution of culture and social cognition, with a focus on religious belief, emotion, and moral cognition. He has also developed and taught methods for studying cultural evolution, such as in vivo spatial tracking, agent-based modeling, quantitative ethnographic analysis, and natural language processing.

Kathryn A. Johnson is Associate Research Professor in Psychology at Arizona State University. Her research focuses on the social perception of nonhuman agents with expertise in representations of God and their influence on values, social attitudes, and prosocial behavior.

Justin E. Lane is the cofounder and CEO at CulturePulse, an AI company focused on the development of advanced forms of AI for social prediction. Justin has pioneered new approaches using AI to study human cultures at large scales. He has helped develop grants with an awarded value of over US$85 million. His work has been covered globally in outlets such as the *New York Times*, *BBC News*, *Vice News*, *The Atlantic*, *New Scientist*, and *The Telegraph* and he has been a featured speaker at research, technology, and policy conferences in North America, Asia, and Europe. He's also the author of the book *Understanding Religion through Artificial Intelligence* (2021).

Aaron D. Lightner is a postdoctoral researcher in the Department of the Study of Religion at Aarhus University. His research has focused on religion, cooperation, and knowledge specialization from cross-cultural and evolutionary perspectives. He is working on a series of articles about how and why religious systems often reflect the social and ecological challenges that people encounter around the world.

Anne Lundahl Mauritsen is a PhD student in the Department of the Study of Religion at Aarhus University. Her primary research areas are nonreligion and cultural religion in Scandinavia. She works in the fields of sociology of religion and the cognitive science of religion, employing qualitative and quantitative methods and interdisciplinary approaches in her work.

Ryan McKay is professor of psychology at Royal Holloway, University of London. He is the primary investigator of the Morality and Beliefs Lab (MaB-Lab) and is also a member of the COVID-19 Psychological Research Consortium (C19PRC). He is interested in the causes and consequences of dysfunctional beliefs.

Patrick McNamara, PhD is Full Professor of Psychology at Northcentral University; Associate Professor of Neurology, Boston University School of Medicine; President Emeritus, Center for Mind and Culture, Boston, MA; and Founding Editor at *Religion, Brain and Behavior.*

Rita Anne McNamara is a senior lecturer in cross-cultural psychology in the Victoria University of Wellington School of Psychology, where she is director of the Mind in Context Lab. She is also a fellow of the Victoria University of Wellington Centre for Cross-Cultural Research.

Valerie van Mulukom is Assistant Professor at the Brain, Belief, and Behaviour Lab at Coventry University, UK. She does research on imagination, memory, and belief and their overlaps from the perspectives of cognitive science and experimental and social psychology. Main recent points of focus have been religious and nonreligious rituals and worldviews, and their psychological functions and effects. As part of this research she has conducted fieldwork on rituals in churches and nonreligious assemblies throughout the UK, and a large cross-cultural survey on nonreligious beliefs and worldviews with one thousand participants from ten countries around the world. She is an editor of the *Journal for the Cognitive Science of Religion*.

Anders Klostergaard Petersen is Associate Professor for the Study of Religion at Aarhus University. He has written extensively on early Christ-religion, Second Temple Judaism, matters relating to philosophy of science in the humanities and social sciences, and biocultural evolution in the general history of religions. Among his most recent books are *The Emergence and Evolution of Religion: By Means of Natural Selection* (2018, with Jonathan H. Turner, Alexandra Maryanski, and Armin W. Geertz) and *Theoretical and Empirical Investigations of Divination and Magic: Manipulating the Divine* (2021, edited with Jesper Frøkjær Sørensen).

Benjamin Grant Purzycki is Associate Professor at Aarhus University's Department of the Study of Religion. Trained as an anthropologist, he engages in the cognitive, evolutionary, and ethnographic sciences of sociality and cultural variation. He works mostly on topics of religion, morality, and their coevolution. He has conducted fieldwork in the Tyva Republic and managed large cross-cultural projects. Purzycki's recent book is *Religion Evolving: Cultural, Cognitive, and Ecological Dynamics* (2022, coauthored with Richard Sosis).

Matt J. Rossano is an evolutionary psychologist at Southeastern Louisiana University who specializes in the evolution of ritual and religion. He has authored, coauthored, or edited over fifty scholarly papers, books, book chapters, commentaries, and reviews. His work has appeared in both highly respected academic journals as well as more popular outlets. His books include: *Supernatural Selection: How Religion Evolved* (2010); *Mortal Rituals: What the Story of the Andes' Survivors Tells Us about Human Evolution* (2013); *Ritual in Human Evolution and Religion* (2020); and *Handbook of Cognitive Archaeology: Psychology in Pre-History* (2020, coeditor).

Uffe Schjoedt is Associate Professor at the School of Culture and Society, Aarhus University. His research focuses on the relationship between social cognition, neuroscience, collective rituals, and religious experience.

Jesper Frøkjær Sørensen is Associate Professor in the Department of the Study of Religion at Aarhus University. He has published books including *A Cognitive Theory of Magic* (2007) and *Theoretical and Empirical Investigations of Divination and Magic: Manipulating the Divine* (2021) and numerous articles and book chapters on magic, ritual, research history, and theoretical issues pertaining to the application of cognitive theories and methods in the study of religion.

John Teehan is Professor of Religion at Hofstra University, where he also teaches in the Department of Philosophy, and the Cognitive Science Program. His research focuses on an evolved cognitive scientific study of morality and religion, and its philosophical implications. He is the author of *In the Name of God: The Evolutionary Origins of Religious Ethics and Violence* (2010), as well as numerous articles on these topics.

Wesley J. Wildman is Professor in Boston University's School of Theology and in the Faculty of Computing and Data Sciences, and Executive Director of the Center for Mind and Culture. Author of two dozen books and numerous articles, he is a philosopher and ethicist specializing in understanding complex human social systems, including those involving religion, and he uses high-tech computational and data science methods to study the seemingly intractable problems that arise within those systems. For more details, visit www.wesleywildman.com and www.mindandculture.org.

Acknowledgments

It has been a genuine delight to work with the contributors of this volume. Just as with their other work, they have taught us a great deal in their contributions to this book. We appreciate their steadfast enthusiasm and effort and hope they are pleased with this collection.

We also thank Luther Martin, Lily McMahon, Don Wiebe, our reviewers, and the fine folks at Bloomsbury for their support, guidance, and patience.

We also extend our appreciation to Lotte Varnich and the faculty at the Department of the Study of Religion at Aarhus University for providing a warm and welcoming place to work. Many thanks also go to our students in the Minds of Gods classes who inspired us to organize this book.

The Aarhus University Research Foundation generously supported us throughout the preparation of this volume and its related works. Purzycki also acknowledges support from the Max Planck Institute for Evolutionary Anthropology and the Culture of Schooling grant funded by the Issachar Fund (#TIF0206).

Introduction: Studying the Minds of Gods: State of the Art

Benjamin Grant Purzycki and Theiss Bendixen

Our species' ability to infer the mental activities of other entities is probably not unique. However, the apparently compulsive human propensity to infer the existence of powerful, spiritual minds ranks among the more curious novelties of our lineage. As a consequence of this ability, we are also the only known species that appeals to divine minds and engages in various behaviors believed to alter their dispositions, curry their favor, soothe their anxieties, and use them against our enemies. All societies postulate the existence of spirits and engage in corollary behaviors devoted to them. Presumably, all human societies of the past maintained similar traditions. Despite the fact that what gods know, desire, and care about have comprised a lasting human obsession in all societies throughout history, only until recently have thinkers and scientists begun to approach understanding this obsession seriously and rigorously from a naturalistic perspective. The present volume is a wide-ranging sample of works showing just how seriously the topic can be taken from this vantage point and why it matters in our modern world.

Here, we take up many compelling questions: *Why are humans so interested in divine minds? How do beliefs in gods emerge, evolve, and affect human lives and relationships? Why do gods have the dispositions they do? What do gods know and what do they care about? What happens to us and our relationships when gods are involved? How are beliefs in gods produced? How do they develop throughout the life course? Are there cross-cultural similarities in how individuals appeal to their gods? What do the gods of nonliterate or traditional societies care about? What accounts for religious diversity across cultures? Do local beliefs about minds affect religious worldviews? Do leaders appeal to gods merely as rhetorical flourish? Are norms more likely to be followed when couched in such appeals? Does following such norms hold societies together? And what happens when gods are supplanted by governments?*

This volume is a general-but-targeted survey of the topic, one we designed to be educational and inspiring for experts and curious bystanders alike. Each chapter offers brief intellectual histories of their respective topics, summarizes current cutting-edge approaches to various questions, and, through argument and implication, points to areas in need of attention. We encouraged the contributors to write inviting and accessible pieces that did not shy away from requiring some technical engagement to get more out of them.

Drawing from neuroscience, evolutionary, cultural, and applied anthropology, social psychology, religious studies, history, philosophy, the computer, cognitive, neurological, and political sciences, the contributors to this volume probe the mysteries of the minds of gods from a multitude of naturalistic perspectives. They highlight the manifold ways in which we can address the aforementioned questions. Also as evinced herein, our contribution to this ongoing conversation is one that transcends the so-called "two cultures" problem (Snow 2012); without sacrificing their colorful accents, dialectical idiosyncrasies, and eccentric fascinations, social scientists and humanists can learn to speak a common language.

We organized the chapters into three general sections. The first section (Chapters 1–7) focuses on the mechanics and processes that underlie the perception of gods and the formation of religious beliefs. It includes discussions of what it is about *our* minds that make the minds of gods possible and why specific aspects of gods' minds are predictable. The second section (Chapters 8–13) focuses more on the social side of beliefs and religious expression. Homing in on problems of cooperation and social scale, it brings theological problems, religious history, and cross-cultural psychology together with evolutionary theory, behavioral ecology, and ethnography. The third section (Chapters 14–16) situates the study of gods' minds in contemporary issues including artificial intelligence, climate change, and secularism.

While the chapters refer to each other explicitly, there are many connections we leave for thoughtful readers to make. Indeed, we think this is a rare edited volume in that it can be interactively read cover to cover. In Chapter 1, Purzycki and Schjoedt discuss important models of human cognition and point to how they relate to each other, their limitations, and their relevance to the social scientific study of religion. They lay some of the groundwork that informs some of the subsequent chapters that might assume or adopt particular models of human cognition. For example, just as Chapter 1 details cognitive theory's growing appreciation for flexibility and culture, Chapter 2 provides an overview of the developmental processes that contribute to conceptions of and beliefs in what gods know. There, Burdett highlights the growth of the field, and details an abundance of studies aimed to unravel the way the child's mind generates and culturally inculcates aspects of their religious traditions. These chapters address agency detection and theory of mind in a variety of ways.

These two systems, however, are not the only mental systems potentially undergirding beliefs in gods. By assessing our tendency to anthropomorphize, our egocentrism, and motivations, in Chapter 3, Jackson and Gray examine how individuals attend to the minds of gods by projecting aspects of their own minds onto the gods'. Similarly, Chapter 4 homes in on gods' personalities and dispositions. There, Johnson surveys a range of traditions and posits that gods' temperaments are dynamically linked to individuals' social lives in important ways. While these two chapters highlight how individual psychological profiles can seep into representations of gods, Chapter 5 probes questions about the generation of gods' minds by examining the content and functions of dreams. In it, Balch and McNamara show both how cross-culturally, dreams can be both the source of religious inspiration and beliefs, as well as place social cognition as central in the production of dreams. In Chapter 6, Sørensen and Purzycki shift the scope from the minds of gods to spiritual forces more generally, such as *mana* and *wakan*. Drawing upon the ethnographic record and anthropological thought, they frame the link between *mentalized* and *non-mentalized* spiritual agency as fundamentally exploiting more fundamental causal cognition and one that naturally demands human intervention.

One important way in which people believe they enact change in the world is through rituals devoted to gods. Building a bridge between the first and second sections of the book, Chapter 7 closely examines the evolutionarily deep relationships between gods, ritual, and human cooperation. Drawing from the archeological record, Rossano pinpoints beliefs in gods as central to maintaining the ritual order that, in turn, has served societies since before the dawn of modern humans. In Chapter 8, Teehan moves us into the realm of theology to address the age-old problem of theodicy. Rather than approach the Problem of Evil theologically, however, Teehan reframes the question to address the deeper assumption that gods have some moral role in the first place by applying contemporary insights from the cognitive and evolutionary sciences of religion. Chapter 9 is an historical examination of beliefs in omniscience. Critically assessing various popular ideas about pivotal changes in the history of religions, Petersen posits that a central shift in religious thought was not only that gods' knowledge covered more political territory, but that it also reached deeper into human thoughts. These shifts, he contends, correspond to human group living. While Teehan and Petersen draw upon theology, history, and biblical studies, Chapter 10 widens the scope and considers various culturally expressed models of mind. Contrasting standard approaches that focus on Western conceptions of mental activity, McNamara discusses models of mind from India, Oceania, and Amazonia, arguing that religious beliefs are reflections of these more general models.

Building on some of the themes in previous chapters, Chapter 11 questions the view that only a narrow subset of religious traditions posit that gods care about morality. Drawing on the ethnographic records and anthropological intellectual history, Purzycki and McKay introduce us to the question of the ubiquity of gods' and spirits' moralistic punishment and cast doubt on the founding assumptions of this area. In addition to morality and ritual, Chapter 12 focuses on the narrow range of behaviors that gods care about. Examining various cross-cultural religious behaviors such as Balinese ritual, Australian field burning, and Siberian ritual, Lightner and Purzycki show how game theoretical models can be useful for coming to terms with a cross-culturally diverse range of behaviors associated with the gods. Chapter 13 takes and runs with this baton and evaluates various cultural evolutionary approaches to religious diversity. There, Bendixen and Purzycki contend that the behaviors that gods care about are reflections of pressing threats to cooperation and coordination, so-called "god problems." They derive a set of hypotheses from this account, and wager that much of the appeals to gods' minds we find in the ethnographic world can be accounted for by these threats to sociality.

The final section brings three pieces together that point to future horizons not only in the scientific study of religion but also in the state of the world we all share. Chapter 14 focuses on one pressing threat that affects us all, namely, the collapse of the natural environment. In it, Baimel examines the role beliefs in gods have played on the modification of the natural world and what its current and future roles might be in softening the blows of climate change. In Chapter 15, Wildman and Lane discuss the promise, power, and application of simulating theoretical models to understand the social dynamics of religious thought and practice and profile emerging software that simulates human interactions with gods through an artificial intelligence intermediary. They provide a rich history of simulating religious systems and point to ways in keeping our models sophisticated, our thinking clear, and our technology useful. We close the volume with Chapter 16, where Mauritsen and van Mulukom point to some ways toward an *absence* of religiosity. Along the way, they survey current approaches to when the minds of gods lose traction and are no longer the targets of individuals' and communities' devotions.

As all the chapters of this book attest, the minds of gods are a window into the human mind—its social and epistemic needs, its cognitive quirks, cultural malleability, and evolutionary contingencies. More importantly, however, the minds of gods also tell us quite a bit about relationships within and beyond human communities. We hope you find these essays as inspiring as we do.

1

Toward a Cognitive Science of the Gods: A Brief Introduction

Benjamin Grant Purzycki and Uffe Schjoedt

Introduction

How can we account for humans' ubiquitous and exceptional propensity to believe in gods? Many in the cognitive sciences of religion posit that there is dedicated machinery or a suite of task-specific mechanisms that make the representation of gods' minds both possible and probable. Yet, there are growing movements in the field that challenge these views. Here, we detail the models of cognition that guide these disparate views and discuss current limitations and blind spots. We first provide an overview of various models of human cognition from cognitive modularity to predictive processing (PP). We then discuss how these models have shaped—and continue to shape—the cognitive sciences of religion and point to some avenues for future thought and research.

Models of Cognitive Architecture and Processing

Modularity and Symbolic Input Systems

One view that has had a lasting influence in the cognitive sciences of religion is that the human mind is *modular* in structure. While what exactly this means varies considerably across sources (e.g., Anderson 2007; Barrett and Kurzban 2006; Callebaut and Rasskin-Gutman 2005; Chomsky 1980, 2000: 117–19; Fodor 1983, 2000, 2005; Karmiloff-Smith 1992; Pinker 2005a, 2005b; Segal 1996; Sperber 1996, 2002), one of the most influential views of cognitive modularity is presented by Jerry Fodor (1983) in his now-classic text *The Modularity of Mind*.

Introducing a notably conservative view, Fodor emphasizes four features of modular systems: *encapsulation*, *inaccessibility*, *domain specificity*, and *innateness* (Fodor 1998: 127–8). *Encapsulation* refers to information that is locked-in and released upon exposure to the right inputs. To be processed, these inputs are converted into some form of symbolic "mentalese" and transformed into intelligible outputs (Fodor 1975). This information is *inaccessible* both to reflective human manipulation as well as other cognitive systems. They may interact and interfere with each other, but only by interfacing at other phases of processing. Modular input systems are *domain-specific* inasmuch as they attend to a relatively narrow range of information and are *innate* to the extent that they are a typical and untutored feature of human development (see Margolis and Laurence 2013; cf. Samuels 2004).

Fodor (1983) uses the Müller–Lyer illusion to illustrate (Figure 1.1a). When we view the two lines, line AB appears shorter than CD. This visual input is automatically interpreted in this manner; we have an innate predisposition to interpret this specific kind of input in this fashion. Even if we measure and reflectively know that these lines are the same length, we cannot perceive them any other way without intervention (see below). In other words, the encapsulated information that informs our awareness that CD is longer than AB is inaccessible to conscious thought.

While this example intuitively illustrates the features of modularity, it is intuitive only to the extent that we are fooled. Yet, many traditional populations in Africa are not (Segall, Campbell, and Herskovits 1963, 1966), and this may be linked to features of their environment. Specifically, in "carpentered worlds," similar lines indicate spatial depth or proximity (Stewart 1974). This regularity therefore alters our perceptual inferences about simple 2D images; we *anticipate* line AB is shorter in Figure 1.1a because we regularly witness line CD of Figure 1.1b as farther away. Once we appreciate Figure 1.1b, we can actually see some depth in Figure 1.1; AB looks *closer*. This suggests that input regularities in one's environment can subtly influence how perceptual systems diachronically change over an individual's life course. As such, while perceiving

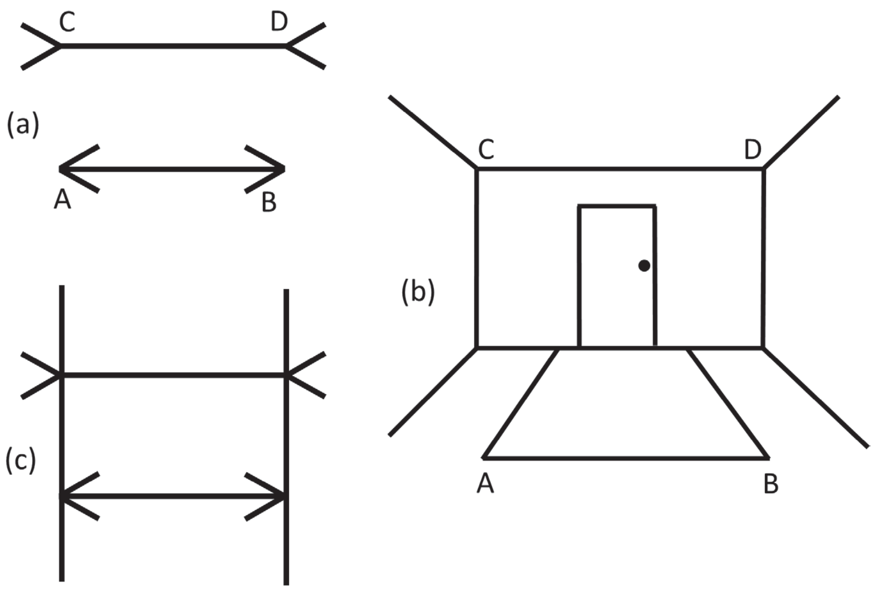

Figure 1.1 Müller–Lyer illusion (a), in a carpentered world (b), and intervened upon (c). Created by Benjamin Grant Purzycki.

this illusion (or not) is domain-specific, innate (i.e., untutored, not socially learned or individually learned through trial and error), and inaccessible, it is not necessarily as rigidly encapsulated as Fodorian modules (see McCauley and Henrich 2006). Instead, there are ontogenetic processes that attend to environmental regularities and thus incorporate information from the environment into their functioning.

In the subsequent decades—particularly in the then-emerging field of the cognitive science of religion (see below)—Fodor's notion of modularity became more popularized and underwent some considerable conceptual drift. While Fodor explicitly restricted modular cognition to only a few systems such as emotions and perception, others repurposed the idea to address a wide range of systems (see Barkow, Cosmides, and Tooby 1992; Hirschfeld and Gelman 1994; Premack and Premack 2003: 17–37 for cross-domain surveys), something Fodor (1987) characterized as "modularity gone mad" (27; cf. Pietraszewski and Wertz 2021; Samuels, Stich, and Tremulet 1999). Some even characterized concepts and their development as modular. For example, Sperber (1996) suggests that we have "an initial template module for living-kind concepts that gets initialized many times, producing each time a new micro-module corresponding to one living-kind concept (the DOG module, the CAT module, the GOLDFISH module, etc.)" (131). In other words, we have a built-in system that, when exposed to incoming stimuli, creates new, more specific iterative members of the same general category. In other words, rather than socially learned, conceptual development largely springs from directed inner processes that attend to relatively uninformative inputs (see the "poverty of the stimulus" argument; Berwick et al. 2011; Laurence and Margolis 2001). While this process might be innate, a process that "produces new micro-modules" or new concepts as described here is still a domain-general process, the production of living-kind subconcepts is likely to be the same process as the generation of nonliving-kind subconcepts. Furthermore, if we assume it is the same process, the fact that we can readily produce new concepts suggests far more accessibility than Fodor's modules. As we discuss below, this divergence is precisely where other approaches to cognition already had much to say.

Modular accounts tend to assume that cognition consists of a set of predisposed procedures either in the shape of inductive and deductive inferences made explicit by propositional representations or in the shape of rule-based systems. Two further points are worth noting here. First, the proposed cognitive procedures are assumed to function relatively independently of the physical properties of the brain; their workings are *analogous* to features of the brain, but they are not themselves constrained by any physical substrate. Second, the proposed systems operate much like computer code using abstract representational units in sentence-like structures, regardless of what information is being processed or how the specific system is organized. Indeed, modules are often thought of "as a set of information processing machines" (Chomsky 1980: 60; Cosmides and Tooby 1997). Modules are assumed to convert analogical signals from sensory input systems into symbolic forms, which are then subject to logical or rule-based procedures. These procedures are made explicit in propositional representations where the symbols are placed in grammatical structures. According to Eysenck and Keane (2000), the propositional representations are characterized by being discrete (made of arbitrary unit, e.g., letters), explicit (symbols are represented explicitly in propositions), subject to strong combination rules (the function of particular symbols depends on the grammatical position in the proposition), and amodal (they consist of arbitrary symbols independent of the brain's visual, auditory, olfactory modalities, etc.): "Thus, they constitute a universal, amodal, mentalese [i.e.,] propositions are a fundamental language or code that is used to represent all mental information" (246–7). In this view, activities in the sensory modalities prior to the transduction into symbols are simply excluded from the cognitive process. The sensory motor systems are reduced to mere input/output channels for an amodal information processor.

The modularity of mind was an immensely successful idea in the first decades of the cognitive science of religion (White 2021). Yet, the abstractness of these proposed modules is increasingly challenged by new theories in which cognition is constrained by the physical brain, including neural processes, networks, and anatomy.

Connectionism and Simulation Theory

Instead of having discrete and arbitrary symbols as the fundamental unit of representation, proponents of connectionism and simulation theory use neurons (e.g., Barsalou 1999; Damasio 1994; cf. Balch and McNamara, present volume). Unlike most modularity accounts, connectionist models of the mind tend to emphasize flexibility, domain-generality, and the generation of rules and procedures as emerging from the dynamic interaction of inputs.

In connectionism, neural networks are modeled on the physical properties of neuron (e.g., axons, dendrites, action potential, etc.), using concepts like input/output units, activation values, "weighted connections," and rules for learning (Bechtel and Abrahamsen 2002: 20) including Hebbian learning (1949), in which units in the neural networks "wire together, if they fire together." Rather than focusing on devoted machinery to evaluate a given situation and provide the appropriate output, then, connectionist models take in multiple inputs and weigh their relevance to produce an output. According to Bechtel and Abrahamsen (2002), connectionist systems learn "not by adding or modifying propositions, but rather by changing the connection weights between the simple units" (38). So, rather than a module computing a particular input and transforming it into perceptual information with a relatively stable system, connectionist networks flexibly incorporate new incoming information for further use.[1]

While connectionism uses the properties of the neuron to model cognition, models still tend to be abstracted from the anatomical brain. To address this limitation, simulation theories situate the activities proposed by connectionist models in the physical brain and body. Simulation theory proposes that cognition takes place directly in the brain's sensory motor modalities by simulating concepts and propositions in perceptual systems. Vision, for example, discriminates topographically between particular colors, shapes, and contrasts, and stores each component of the optic field separately in specific neuronal populations. Barsalou calls these components perceptual symbols, and proposes that these represent the base unit of the representational system, serving as parts of the simulation of objects, concepts, and categories. Perceptual symbols are organized hierarchically linking colors, shapes, and contrasts into more complex structures (Barsalou 1999: 586). A symbol consists of any given neural activity during a particular perception (582–3) so that specific colors and contrasts each make up one symbol (e.g., *red* or *vertical contrast*), while objects and concepts consist of several components (e.g., *a red triangle*). Thus, rather than being mere input channels for an amodal information processing unit, *the physical systems in the brain are assumed to simulate concepts based on prior experience and associative learning.* Simulation theories therefore explore the neural connections being simulated, instead of looking for specific syntactic and grammatical rules. Furthermore, emotional content is integrated in simulations of concepts as reenactments of homeostatic states relevant to a given situation. Damasio (1994) proposes that such somatic markers are crucial for the way the organism responds to its surroundings. In this way, the homeostatic systems of the body hold a kind of automatic intentionality that functions to optimize the organism's interaction with the environment. Thus, the executive system that remains a puzzle for neo-Cartesian models of the mind may be described in terms of simulation theory, as the homeostatic intentionality of the body.

Simulation theory effectively explains how humans simulate the world in order to understand and navigate it, and it has also been used in the cognitive science of religion to understand the embodied nature of religious cognition and behavior (e.g., Barbey et al. 2005; Schjødt 2007). However, it views inferences about the world as automatic multimodal pattern completions that are fundamentally passive. This makes it difficult to account for the brain's ability to actively evaluate and test its own models of the world against incoming sensory input. The predictive processing (PP) framework, which appears to be becoming the standard model of cognition in neuroscience, does exactly that.

Predictive Processing

Many cognitive neuroscientists no longer view the brain's perceptual system as a passive receiver of sensory input. Instead, they view the human brain as a scientist that perceives the world by generating predictive models based on prior experience and then actively tests these models against incoming evidence. The brain attends to the most reliable information for testing its prior expectations, and mismatches elicit prediction error signals that force the system to update its predictive models. This general framework is often called PP. Elements of PP can be found quite early (Helmholtz 1867; cf. Westheimer 2008; Kant [1787] 1929: 92; cf. Swanson 2016), but recently it has been reconceptualized and formalized by theoretical neuroscientists (Friston and Kiebel 2009).

According to PP, the brain is a Bayesian inference generator (Clark 2016; Hohwy 2013; Wiese and Metzinger 2017). What this means is that the mind interacts with incoming information and produces perceptions (or *posterior* perceptions) that are partly informed by prior information we have (hypotheses, predictions, or *priors*). Rather than processing symbolic input using modules or necessarily activating networks of units, PP posits that the brain constantly generates and tests *prior* predictions about the world and informs *posterior* outcomes through the interaction of *priors* and data. The primary reason why this processing is named after English mathematician Thomas Bayes (1764) is that this updating process approximates his famous theorem. We express this theorem in a few common ways:

$$P(A|B) = \frac{P(A)P(B|A)}{P(B)} \tag{1.1}$$

$$P(\text{predator}|\text{rustling bushes}) = \frac{P(\text{predator})P(\text{rustling bushes}|\text{predator})}{P(\text{predator})} \tag{1.2}$$

$$\text{posterior} = \frac{\text{prior*likelihood}}{\text{marginal likelihood}} \tag{1.3}$$

$$P(\text{hypothesis}|\text{data}) = \frac{P(\text{hypothesis})P(\text{data}|\text{hypothesis})}{P(\text{data})} \tag{1.4}$$

$$P(h\,|\,d) \propto P(h)P(d\,|\,h) \tag{1.5}$$

The first equation reads that the probability of A given B equals the probability of A times the probability of B given A divided by the probability of B. The second equation is the same but with an example. To illustrate, say you see some bushes rustling, B, and you want to know the probability that there is a predator afoot, A, given the rustling, thus $P(A|B)$. If you know that the probability of there being a predator is quite low in general, say, $P(A) = 10\%$, but a very strong likelihood that when predators are present, they rustle bushes (e.g., $P(B|A) = 90\%$), and since bushes rarely rustle in general, say, $P(B) = 10\%$, then you should consider leaving the premises because $P(A|B) = 90$ percent (0.1*0.9/0.1).[2] What's important here is that the prevalence of a predator in this example can be thought of as *prior* information about the state of the world and the bush rustling can be thought of as incoming data.

The third equation employs Bayesian terminology: the *posterior*—what we should think or perceive *now* is the result of our *prior* information times the *likelihood* of an observation given our prior knowledge divided by the likelihood of the *observation* in the first place. In the first predator example, then, our *prior* is the regularity of predators in your vicinity. The *likelihood* refers to the *likelihood of rustling bushes, given that there is a predator*. The *marginal likelihood* is simply the regularity of rustling bushes. As indicated in the fourth equation, we can further reframe this equation in a predictive coding framework. Specifically, we can treat our *posterior* as the perceived probability of a hypothesis given some data. Our minds calculate this with a prior probability value to our inferences about the world, its product with the likelihood of seeing such data, given that our hypothesis is true, marginalized over the likelihood of seeing the actual data. In other words, the *posterior* represents our updated knowledge; to the extent that it has changed from our *prior* hypothesis, we have learned something. The more informative and precise our *priors*, the less we have to lean on our perceptions. The reverse is also true, the less informative and precise incoming stimuli are, the more we rely on our *priors* to guide our thinking.