The Quarterly Review of Biology
Volume 91, Number 3, September 2016

Particularly interesting here is the evolution of image-forming eyes and, eventually, complex sensory-processing hierarchies and mental imagery in Cambrian-era, fish-like animals. The parallel evolution of auditory and tactile processing hierarchies made possible neurally encoded, integrated multisensory images and, in turn, SC. More specifically, in the case of vertebrates, the authors propose that SC evolved in a series of evolutionary stages: first in fish in the Cambrian era (approximately 520 mya), then in birds (approximately 165 mya), and then in the first mammals (approximately 22 mya). Accordingly, the neural and functional architecture of fish-like animal brains in the Cambrian era, capable of first-order mental images, initially ushered in the "dawn of SC." Where in animal brains did all this occur? The authors propose that the tectum in fish and amphibia is associated with constructing a multisensory map of the world as well as accessing and attending to the more salient features of that map to guide behavior. In the case of mammals and birds, this process is associated with functional (although not architectural) similarities in their respective pallia-centered SC.

The explanatory and descriptive models argued for in this book are consistent with the three postulates of their neurobiological naturalism. First, SC can be explained by empirically known neurobiological principles, requiring no references to mysterious, metaphysical properties. On a neural naturalism, SC is "an *emergent* characteristic of a *living, neural*, and *complexly hierarchical* brain" (p. 195). Second, SC is "ancient and widespread in the animal kingdom, and diverse neural architectures can create it" (p. 198). In response to the epiphenomenalist claim that SC is a mere byproduct of neural processing, the third postulate argues that consciousness has in fact played a key role in the evolutionary selection and survival of animals from the Precambrian era to the present.

There are two subtexts in this book: one is the language of the neurosciences, the other of a mentalistic psychology. The concepts of the former include multisensory convergence mapping, recursive neural networks, and nested neural hierarchies. The language of the latter includes subjectivity, consciousness, mental imagery, and sensory qualia. The former subtext is defined by neural architecture and function. The latter subtext denotes those mentalistic states that evolved as vertebrate brains became increasingly complex and differentiated with well-developed neural hierarchies. For example, Chapters 4–6 discuss in detail this increasing neural complexity, such as Nilsson's four-stage evolution of light-detection eye spots to the image-forming eyes of vertebrates. For the authors, this increase in complex processing of visual representations resulted in "the brain's first conscious mental images" (p. 83).

Interestingly, first we have the evolving neural architecture in Nilsson's four states then, magically, this architecture generates consciousness and mental images. Why is it necessary for the authors to introduce this second, prescientific linguistic text, particularly one whose concepts are so semantically open-ended and "loosely textured" (to use Wittgenstein's expression)? Employing Occam's Razor, why not simply retire mentalistic concepts from scientific discourses and model the evolution of animal sensory and cognitive processing in terms of neural architecture and neural computations. It is time for the cognitive neurosciences to leave the mentalist vocabulary subtext to introspective psychology and meditation forums. Although this subtext continues to appear in the cognitive science literature, it is no less mysterious in its empirical references. If so, this would appear to violate the authors' first postulate above in their neurobiological naturalism to avoid all references to "mysterious, metaphysical properties."

A viable semantic option to the authors' mentalistic, folk-psychological script is that of cognitive states and cognitive processing, concepts equally applicable to animal, human, and machine second-order information processing. Just as importantly, such concepts are entirely neutral regarding the linguistic dualism of two distinct subscripts associated with Cartesian metaphysics.

This book is recommended for library purchases in the life and evolutionary sciences, animal minds, cognitive neurosciences, and the philosophy of mind. I would also like to note that the many detailed neuroanatomical and evolution-related drawings are alone worth the price of this volume. They are some of the clearest and thought-out technical drawings I have ever seen and will engage the eye at length.

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Comparative Cognition.

By Mary C. Olmstead and Valerie A. Kuhlmeier. Cambridge and New York: Cambridge University Press. $135.00 (hardcover); $64.99 (paper). xi + 471 p.; ill.; index. ISBN: 978-1-107-01116-8 (hc); 978-1-107-64831-9 (pb). 2015.

What is it like to be a bat? Thomas Nagel once posed this question as a thought experiment and in doing so neatly illustrated the fact that we will never be able to experience the world from another animal's perspective. Despite the daunting task, however, *Comparative Cognition* attempts to do just that. The authors bring decades of research and teaching experience in compiling this valuable volume. The book contains 13 chapters and covers the breadth of comparative cognition in an introductory format that is likely to suit third-year undergraduate university students. Each chapter has a chapter plan, summary points, and ends with a series of discussion topics and further reading. Key terms are highlighted in bold, and defined in a glossary at the end of the volume to help with tricky terminology that is typical of a multidisciplinary field. Learning and teaching is further enhanced with an online tool set including PowerPoint slides.

The first half of the book covers topics from behavioral psychology with an emphasis on evolutionary function and underlying neural mechanisms. Topics range from learning and memory to orientation and navigation. The second half covers higher cognitive processes such as tool use, communication, and social learning. Not everyone will agree with the compartmentalization of different cognitive processes, but the authors go to great lengths to reiterate that these functions rarely operate in isolation when animals are performing cognitive processes with obvious fitness consequences such as foraging or navigating. The authors also make every effort to reiterate that, from an evolutionary perspective, there is no higher or lower species in comparative cognition. Each species is unique with its brains and behavior exquisitely shaped by natural selection to suit the niche it occupies.

Each chapter is richly illustrated with examples drawn from both human and animal studies and the weighting of these examples is very much is a reflection of the current state of knowledge in the topic. In addition, each chapter profiles key researchers in the field adding a personal touch and perhaps providing inspiration to aspiring students. Text boxes throughout provide complementary information to the text in the main body and vary in their content ranging from recent discoveries to real-life applications. Pictures, figures, and diagrams are plentiful and help illustrate points being made in the text.

Overall, the volume is very easy to read and pleasant to look at. It is perhaps the first textbook that assimilates knowledge from the rapidly developing, cross-disciplinary field of comparative cognition. As such it will be a valuable addition to bookshelf of both undergraduates and lecturers.

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THE MYTH OF MIRROR NEURONS: THE REAL NEUROSCIENCE OF COMMUNICATION AND COGNITION.

By Gregory Hickok. New York: W. W. Norton & Company. $26.95. ix + 292 p.; ill.; index. ISBN: 978-0-393-08961-5. 2014.

Sometimes in science a discovery comes along that seems almost too good to be true. Mirror neurons—premotor neurons that activate both when a monkey makes a movement itself, and when it observes someone else make the same movement—are one such idea. Discovered in macaques in 1992 by Giacomo Rizzolatti and his colleagues, such neurons were initially claimed to play a central role in action understanding (how a monkey knows what the movement of another monkey means or intends). From there, especially after similar "mirroring" activations were observed in the human brain, a veritable mirror neuron industry developed that used this cell type as the basis for theories of imitation, speech, language, theory of mind, empathy, and autism.

When an idea seems too good to be true, this book argues, it probably is not true. In a clear and engaging style, neurolinguist Gregory Hickok provides a concise historical introduction to the mirror neuron craze, giving a very accessible introduction to the key concepts and methods of cognitive neuroscience and neurolinguistics along the way. Crucially, the volume is not just a negative exposé, but gradually builds up an alternative conception of the role of mirror neurons in cognition that balances their contribution with those of many other parts of the brain (including visual, somatosensory, and prefrontal cortices). Thus, the book uses its critique of mirror neuron theory as a platform to build a more holistic model of brain function.

In Hickok's conception, the entire brain is essentially a predictive system, attempting to make sense of sensory input and organize motor output via local predictions, at each level of cortex. Although the motor predictions made by mirror neurons and related premotor circuitry are an important part of this system, they are just one part and not the sole basis for predictive coding. The resulting predictive system is more complex than one based solely on mirror neurons, but the author argues compellingly that only this can do justice to the real complexity of cognition and the brain. This predictive system perspective on the brain is becoming increasingly accepted among computationally oriented neuroscientists.

If the volume has a fault it is that it is sometimes more critical of research supporting mirror neuron claims than of work contesting them. For example, damage to the mirror neuron system has been argued to be an important problem in autism. Hickok advocates an alternative theory developed by Henry Markram and colleagues suggesting that oversensitivity to social stimuli (rather than reduction) is the real problem. Although intriguing, this model is based solely on a rat model of autism, and at present is far from a well-developed theory. Thus, in fairness, anyone reading this book should also peruse several of the key mirror neuron publications