Monkey see, monkey do

The Imitative Mind: Development, Evolution and Brain Bases

edited by Andrew N. Meltzoff and Wolfgang Prinz
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Reviewed by Marco Iacoboni

Scientific interest in the study of imitation dates back to Darwin, who wrote detailed descriptions of mimicry in animals. There is now a rapidly growing neuroscience literature on imitation and its related functions, with studies ranging from single-unit recording to brain imaging and computational approaches. For even the most reductive neuroscientist, imitation is of interest because it requires the perception of motion and body parts, the integration of these percepts with motor plans, and finally the control and execution of those motor plans. *The Imitative Mind* is among the first books to address the neural bases of imitation. It is a survey of empirical work on imitation that provides a well-integrated view of imitative behavior and its neural mechanisms by drawing from a wide range of disciplines in the behavioral and brain sciences. Indeed, the study of imitation necessarily requires an interdisciplinary approach that reaches well beyond the boundaries of the neurosciences. Traditionally the target of study in comparative and developmental psychology, imitation is also studied in anthropology and artificial intelligence.

The book is divided into three sections: the first presents work from developmental and comparative psychology, the second from experimental and cognitive psychology and the third from neuroscience. Although this structure would not seem to favor cross-talk between the chapters and topics addressed by different disciplines, the book succeeds in achieving a high level of integration. Part of this success is certainly due to the editors'

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introductory remarks, which concisely and effectively address the renewed interest in imitation and the approaches used to study its functional and neural mechanisms. Most of the book's merit, however, is in the chapters themselves, most of which are skillfully written such that their relevance goes beyond the limits of the discipline at hand and illuminates issues relevant to neighboring disciplines as well.

The two editors are leading figures in the fields of developmental and experimental psychology, and their respective research contributions blend well conceptually. Andrew Meltzoff revolutionized the world of developmental psychology in the 1970s when he showed that very young infants (the youngest was only 42 minutes old) have some rudimentary imitative ability. His findings overturned the then-dominant paradigm of 'learning to imitate' proposed by Piaget, and actually suggested that babies learn by imitation. Wolfgang Prinz has framed his experimental work within a model that assumes shared codes for perception and action, which fits nicely with the developmental evidence provided by Meltzoff's work. The recent discovery of 'mirror neurons' in the macaque—premotor neurons that fire both when monkeys perform an action and when they observe another animal performing that action—by the group led by Giacomo Rizzolatti seems to be the natural neuroscientific counterpart of Meltzoff's developmental psychology work and of Prinz's experimental psychology work. Needless to say, mirror neurons have a central role in this book. Rizzolatti and colleagues clearly describe most of their basic findings in one chapter, and several other contributors refer to mirror neurons in their chapters or invoke mirror neurons to support and explain some of their findings.

Three main concepts emerge from this book that are of particular interest to neuroscientists: the role of sequence learning in imitation, the role of hierarchical structures in imitated actions and the critical role of fronto-temporal interactions for action perception and imitation. Andrew Whiten addresses comparative imitative sequence learning in normal and autistic children and in apes. Interestingly, sequence learning has been frequently studied in cognitive neuroscience in the last ten years, but the neural basis of sequence learning within an imitative task has not yet been addressed. It is to be hoped that this book will stimulate such study. Robert Byrne investigates hierarchy in imitation in great apes, and Gattis, Bekkering and Wolschläger do the same in their exploration of goal-oriented imitation in children. Recent imaging data suggest that a critical neural structure for goal-oriented imitation in humans is the inferior frontal gyrus, and precisely Brodmann area 44, which is considered the human homolog of area F5 of the macaque brain, a premotor area containing mirror neurons. The chapter by Perrett and colleagues describes systematically the visual properties of neurons in the anterior sector of the superior temporal sulcus. These neurons have visual properties that are very similar to those of premotor mirror neurons. It is natural to assume some level of interaction between superior temporal and inferior frontal neurons in action perception and imitation. Recent imaging work has started addressing this issue empirically.

The book is also well defined by what is left out. Recent computational and robotics approaches, strongly tuned toward an understanding of the mechanisms favoring imitation learning, are not discussed. Psychological models that address experience-dependent mechanisms encounter the same fate. In a way, this makes sense. The work of Meltzoff has been interpreted, more by others than by Meltzoff himself, within a strong, albeit unnecessary, nativistic framework. Moreover, the action-perception model of Prinz is not heavily concerned with the question of whether the sharing of perceptual and motor codes is shaped by experience or hard-wired. Although *The Imitative Mind* does not take a strong position on the issue of innate versus experience-dependent imitation, I would not be surprised if the book is perceived more on the 'nature' side of the nature–nurture continuum. Even if so perceived, I am convinced that even those who land more on the 'nurture' side of the continuum will find the book worth reading.