This chapter details notable discoveries about neural systems in the 1950s. For instance, research revealed, for the first time, widely distributed systems involved in global functions underlying behavior. The first evidence was also found that the brain is a gland as well as a computer. The reticular activating system in the brainstem was shown to provide for arousal of the cortex as an accompaniment to sensory perception. Rapid eye movements were demonstrated in sleep, leading to an entirely new understanding of sleep as a complex active brain state. Operant conditioning was demonstrated, introducing a new paradigm for studying brain mechanisms in motivation and learning.

This chapter considers how a neural system could properly combine cues even as their reliabilities change dynamically and continuously in time. It describes a framework for characterizing how uncertain information may be represented in population codes, and how the representation may be optimized to facilitate optimal decoding. It then motivates and presents a coding scheme within this framework that applies to time-varying stimulus variables. Next, it describes a hierarchical network setup that utilizes this coding approach, and demonstrates an application to a
dynamic cue-combination task—a novel adaptation of a sensorimotor task. Specifically, it considers how a neural population might recursively integrate dynamic inputs from multiple sensory modalities with learned prior information, to determine appropriate motor commands that control behavior; the results of simulated experiments with this network are presented. Finally, the implications of this scheme and suggest some future directions are discussed.

**Decision Making, Affect, and Learning**
Mauricio R. Delgado, Elizabeth A. Phelps, and Trevor W. Robbins (eds)

Published in print: 2011 Published Online: May 2011
DOI: 10.1093/acprof:oso/9780199600434.001.0001
Item type: book

This latest volume in the Attention and Performance series focuses on two of the fastest moving research areas in cognitive and affective neuroscience — decision making and emotional processing. This book investigates the psychological and neural systems underlying decision making, and the relationship with reward, affect, and learning. In addition, it considers neurodevelopmental and clinical aspects of these issues, for example the role of decision making and reward in drug addiction. It also looks at the applied aspects of this knowledge to other disciplines, including the growing field of Neuroeconomics. After an introductory chapter, the book is arranged according to the following themes: psychological processes underlying decision-making; neural systems of decision-making; neural systems of emotion, reward and learning, and neurodevelopmental and clinical aspects.

**Sex Differences in Motivation**
Jill B. Becker and Jane R. Taylor

in Sex Differences in the Brain: From Genes to Behavior

Published in print: 2007 Published Online: January 2010
DOI: 10.1093/acprof:oso/9780195311587.003.0010
Item type: chapter

This chapter develops the thesis that sexually dimorphic development of the neural systems involved in motivation has evolved due to sex differences in care of young. It proposes that sex differences in the neural systems important for maternal motivation result in sex differences in motivated behaviors in general. In particular, the greater oxytocin projection to the nucleus accumbens (NAcc) in females is hypothesized to play an important role in these sex differences. In
addition, there are effects of gonadal hormones that modulate the reward system. Specifically, estradiol enhances the rewarding value of potential targets, while progesterone counteracts the effect of estradiol.

A neural systems model of decision making in adolescents
Monique Ernst

in Decision Making, Affect, and Learning: Attention and Performance XXIII
Published in print: 2011 Published Online: May 2011
Publisher: Oxford University Press
Item type: chapter

This chapter focuses on a heuristic neural systems model of motivated behaviour. This model provides hypotheses for mechanisms underlying changes in behaviour across development and psychopathology. The fractal triadic model (FTM) posits that goal-directed behaviour results from the interaction among three nodes of behavioural control. These three functional nodes are centred on the amygdala, striatum, and medial prefrontal cortex, which contribute to avoidance, approach, and modulation, respectively. They feed two distinct neural circuits: one that is modulated primarily by appetitive stimuli and serves approach behaviour, and one that is modulated primarily by aversive stimuli and serves avoidance behaviour. The behavioural output results from the integration of the information that is processed by these two neural circuits and is submitted to the control of the supervisory node. Such organization of three functional nodes subserving two neural circuits relies on the well-described structural and functional heterogeneity of these nodes. In addition, asynchrony in the maturational trajectories not only among the nodes, but also among the subunits of these nodes, is the central principle that underlies the typical behavioural changes seen in adolescence. Functional neuroimaging research is beginning to examine ontogenetic changes in neural responses to reward-related processes that can further inform this heuristic model. The chapter addresses the major points mentioned above and ends with selected questions proposed as priority for future research.

Spiking
Pierluigi Frisco

in Computing with Cells: Advances in Membrane Computing
Published in print: 2009 Published Online: September 2009
Publisher: Oxford University Press
Item type: chapter
Spiking neural P systems are the subject of this chapter. They were inspired by a very specific kind of cell: neurons, and their method of operation mimics the functioning of these cells. Despite the fact that this model is relatively recent compared to the other ones considered in this book, the number of results concerning it is considerable.

Modularity in music relative to speech: framing the debate
Isabelle Peretz
in Language and Music as Cognitive Systems

This chapter presents a response to the commentaries in Chapters 28-31. It addresses the four points raised by Besson and Schön on their comments questioning the usefulness of the modularity frame. Skoe and Kraus provide a useful reminder and compelling case for considering that cortical modules do not function in isolation from subcortical neural systems. They remind us of the importance of top-down processing or corticofugal influences on the early tuning of brainstem responses to auditory input. Goswami draws attention to the role of prosody and rhythm in both music and speech from development and animal cognition. This chapter thanks Goswami for bringing to attention a study in which auditory chimera were created by interchanging sentences for melodies in using the envelope of one sentence or melody and the fine time structure of another.

The Social Brain in Interactive Games
James K. Rilling
in Social Neuroscience: Toward Understanding the Underpinnings of the Social Mind

This chapter discusses the advantages and disadvantages of an approach to social cognitive neuroscience that involves imaging brain function in subjects who are immersed in genuine social interactions. It also discusses what this approach can and cannot reveal about one of the fundamental questions in social neuroscience: whether the human
brain has domain-specific neural systems that are specialized for social cognition.

Brain Bases of Levels of Specificity and Levels of Control, Part 1
Wilma Koutstaal

This chapter focuses predominantly on the relatively more controlled and abstract ends of the levels of control and levels of specificity continua. It considers evidence at several levels, including that of neural systems (e.g., the frontal-parietal network) and also, although less extensively, neurochemical and neurophysiological levels. It begins with an overview of ways in which the frontal cortex is uniquely situated to play an adeptly adaptive and abstract representational role. Subsequent sections focus on evidence from single-cell recordings for the flexible abstract representation of categories and rules, neuroimaging evidence for hierarchical and functional distinctions within the frontal cortex, and neurochemical and neuroanatomical contributors to three forms of cognitive flexibility, including set shifting, reversal learning, and task switching. Neuropsychological and lesion evidence for cognitive flexibility of a more “spontaneous” form, such as typically called on in tasks of fluency and divergent thinking, is then considered. A final section takes up the interrelated topics of goal neglect, fluid intelligence, and working memory, and underscores the need to go “beyond frontal cortex” to consider the dynamic and continually changing interactions of frontal regions with parietal and occipitotemporal cortex.

Social Neuroscience and the Representation of Others
James V. Haxby

The representation of others is a central problem that brings social neuroscience and cognitive neuroscience together. Chapters 1–4 present an overview of the current state of our understanding for the neural
systems that participate in the representation of others and highlight the major themes and issues that characterize this area of investigation. This chapter addresses why this particular problem is of great interest to both social and cognitive neuroscientists.

Sex
William J. Jenkins and Jill B. Becker

in The Behavior of the Laboratory Rat: A Handbook with Tests
Published in print: 2004 Published Online: May 2009
Item type: chapter

This chapter provides an overview of the reproductive systems and the neural systems that mediate sexual behavior, and discusses how to study sexual behavior in male and female rats. It shows that the male and female rat share many commonalities in terms of the anatomical substrates of sexual behavior. Another common feature in the sexual behavior of males and females is the role that the striatum and nucleus accumbens (NAcc) play in mediating sexual behavior and motivation.

Sensorimotor Foundations of Higher Cognition
Patrick Haggard

Published in print: 1993 Published Online: March 2012
Item type: book

This book is dedicated to exploring how much of higher cognitive function can be explained by reduction to simpler sensorimotor processes. It uses a series of specific cognitive domains to examine the sensorimotor bases of human cognition. The first section deals with the common neural processes for primary and ‘cognitive’ processes. It examines the key neural systems and computational architectures at the interface between cognition, sensation, and action. The second section deals with specific themes in abstract cognition: the origins of action, and the conceptual aspects of sensory, particularly somatosensory, processing. It looks at how mental and neural processes of abstraction are vital to the cognitive–sensorimotor interface. It also covers topics such as tool use, bodily awareness, and executive organization of action patterns, and probes the extent to which principles of sensorimotor information processing extend to further hierarchical representations. The next section deals with the representation of the self and others. The questions of self-consciousness and of attribution to other minds have
a fundamental place, and a long history, in psychology. At first sight, few aspects of cognition could seem more abstract, more refined than these. However, recent research suggests that sensorimotor systems are good ‘social levellers’: your sensory and motor apparatus is much like mine. Can people vicariously experience the sensory and motor events of other individuals? Which aspects of social representation are explained by sensorimotor sharing, and which are not? The chapters in this section offer strongly contrasting perspectives. The final section deals with upper limits of cognition.

Two neural systems for visual orienting and the pathophysiology of unilateral spatial neglect
Maurizio Corbetta, Michelle J. Kincade, and Gordon L. Shulman

in The Cognitive and Neural Bases of Spatial Neglect
Published in print: 2002 Published Online: March 2012
DOI: 10.1093/acprof:oso/9780198508335.003.0019
Item type: chapter

This chapter critically assesses current neurobiological models of attention and unilateral spatial neglect, particularly in relation to neuroimaging results acquired over the last decade. It highlights that these models do not account for significant discrepancies between lesion studies and neuroimaging results. It then reports a new experiment that clarifies some of these discrepancies and proposes a revision of current models. It is noted that lesions causing neglect in the frontal lobe do not match with frontal areas of activation during visuospatial attention; rather, they better match the location of regions mediating alerting/vigilance. Moreover, the current evidence supports a role for human anterior cingulate cortex (AC) in response evaluation and monitoring, and not stimulus selection or motivation. It is also shown that temporoparietal junction (TPJ) plays a critical role in alerting. The proposed model clarifies some of the discrepancies between neuropsychological studies of neglect and brain imaging studies of visuospatial attention, and provides novel information on the pathophysiology of neglect.

Brain mechanisms of vision, memory, and consciousness
EDMUND T. ROLLS

in Cognition, Computation, and Consciousness
Published in print: 1997 Published Online: March 2012
DOI: 10.1093/acprof:oso/9780198524144.003.0006
Item type: chapter
This chapter begins by examining how brain mechanisms are involved in visual-object recognition. The author focuses on neural systems involved in processing information about faces because with the large number of neurons devoted to this class of stimuli, this system has proved amenable to experimental analysis. Evidence on how a part of the brain involved in memory, the hippocampus, operates is considered next. It is said to be involved in a particular type of memory: the memory for recent episodes. The latter part of the chapter explores one view of consciousness as influenced by contemporary cognitive neuroscience.

Afterword
Aniruddh D. Patel

in Music, Language, and the Brain

As this book examines the relations between language and music through a wide variety of viewpoints, we have come to realize that both music and language should be perceived as a complex collection of subprocesses, that may be shared by both domains, and that can be exclusive to one or different with that of the other. Through exploring the similarities and differences of music and language in several different aspects, it is shown that music and language are indeed closely related if perceived as neural and cognitive systems, and that examining the mechanisms the mind utilizes when making sense of sound is greatly aided by comparing the several dimensions of music and language.

Habituation in infancy...from interacting neural systems to active exploration
Denis Mareschal, Mark H. Johnson, Sylvain Sirois, Michael W. Spratling, Michael S. C. Thomas, and Gert Westermann

in Neuroconstructivism - I: How the brain constructs cognition

This chapter describes the process of habituation. It starts by cautiously reviewing the feature behaviors of habituation responses. It then asks what kind of functional neural interaction might give rise to these observed traits. Competition and cooperation at the functional neural
level act in this process. Furthermore, the chapter discusses the computational model that shows how the competitive mechanisms can actually give rise to ‘novelty preference’. The aim is to come up with an explicit account that is restrained by what is known about key neural systems functional in infancy. Moreover, the chapter suggests a list of five essential markers of habituation. The data reveal that habituation is an excellent example of the neuroconstructivist principles in action. The content of representations that underlie overt behaviors decides how the infant will go on to explore proactively novel parts of the environment.

How can temporal expectations bias perception and action?
Anna C. Nobre
in Attention and Time
Published in print: 2010 Published Online: March 2012
DOI: 10.1093/acprof:oso/9780199563456.003.0027
This chapter examines how temporal expectation can bias action and perception. It explains that the brain continuously generates predictions about expected relevant events to guide perception and action. The chapter describes how these predictions incorporate the temporal dimension to anticipate the timing of events. It also describes studies concerning the neural systems and mechanisms by temporal expectations bias perception and action and discusses the notion that temporal expectations are mediated via networks closely associated with spatial and motor control.

Dyslexia, Learning, and Neural Systems
Roderick I. Nicolson and Angela J. Fawcett
in Dyslexia, Learning, and the Brain
Published in print: 2008 Published Online: August 2013
DOI: 10.7551/
mitpress/9780262140997.003.0008
This chapter investigates the neural systems level—a level intermediate between brain and cognition. It also discusses the specific procedural learning difficulties (SPLD) framework, which interprets dyslexia as a specific deficit in the procedural learning system as opposed to the declarative memory system.
Neural systems underlying episodic memory: insights from animal research

John P. Aggleton and John M. Pearce

in Episodic Memory: New Directions in Research

Published in print: 2002 Published Online: March 2012
Item type: chapter

This chapter examines two strategies used in animal research and considers how the resultant information has helped to identify functional systems for the processing of episodic-like memory. In the first approach, a particular component of episodic memory that can be examined in animals is identified and the neural systems underlying that facet of episodic memory identified. Relevant to this approach is the acknowledgement that ‘the presence or absence of episodic memory is no more an all-or-none matter between species than it is within them’. Accordingly, it should be possible to break down episodic memory into a number of simpler components and examine them separately.

Introduction

Erik De Schutter

in Computational Modeling Methods for Neuroscientists

Published in print: 2009 Published Online: August 2013
Item type: chapter

This book concentrates on data-driven modeling, i.e., the use of fairly standardized modeling methods to replicate the behavior of neural systems at different levels of detail. The chapters are structured in intuitive order and try to cover all aspects of neural modeling, from molecules to networks. Each addresses the equations needed to simulate these models, sources of data for the model parameters, approaches to validate the models, and a short review of relevant models. This chapter provides an overview of those that follow.