This chapter summarizes a decade or more of research on the functions of the frontal lobes through the study of patients with pathology restricted to that region. It begins with one assumption: there is no unitary frontal lobe process, no central executive. Evidence is presented to demonstrate that different cognitive processes can be related to distinct regions of the frontal lobes. A very brief review of the relation of less cognitive human abilities, such as humor appreciation and theory of mind, provides some support that even higher human abilities depend on the interaction of more distinct localizable functions. The chapter then moves from the location of distinct processes to the interaction of these in networks and cognitive systems. Finally, it presents the implications of the review.

Frontal Lobe Plasticity and Behavior

Bryan Kolb and Robbin Gibb

This chapter focuses on how the structure of the frontal lobe changes over time, how this relates to behavior, and how the rest of the brain changes when the frontal lobe is injured. It shows that the prefrontal cortex is plastic, but its plasticity is different from that of other forebrain areas. The organization of the prefrontal cortex is affected by injury, and
especially perinatal injury, in other parts of the brain. Other parts of the brain change when the prefrontal cortex is damaged. Various factors modulate the injury-related changes observed after frontal lobe injury. These include experience, psychomotor stimulants, gonadal hormones, neurotrophic factors, and neuromodulators.

The Human Frontal Lobes: Transcending the Default Mode through Contingent Encoding
M.-Marsel Mesulam

in Principles of Frontal Lobe Function

This chapter sets the stage for the rest of the book, presenting anatomical and clinical distinctions that serve as organizational and memory “hooks” for reading many of the other chapters. It discusses how massive damage to the frontal lobes can cause dramatic changes in personality and comportment while keeping sensation, movement, consciousness, and most cognitive faculties. It addresses questions such as: Is there a unitary “frontal lobe syndrome” encompassing all signs and symptoms? Are there regional segregations of function within the frontal lobes? Is it possible to identify a potentially unifying principle of organization which cuts across the heterogeneous specializations attributed to the frontal lobes?

Principles of Frontal Lobe Function
Donald T. Stuss and Robert T. Knight (eds)

This book provides a review of historical and current research on the function of the frontal lobes and frontal systems of the brain. The content spans frontal lobe functions from birth to old age, from biochemistry and anatomy to rehabilitation, and from normal to disrupted function. The book covers a variety of disciplines including neurology, neuroscience, psychiatry, psychology, and health care.
Executive Functions after Frontal Lobe Injury: A Developmental Perspective
Vicki Anderson, Harvey S. Levin, and Rani Jacobs

in Principles of Frontal Lobe Function

Published in print: 2002 Published Online: May 2009
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Item type: chapter

This chapter contrasts normal cerebral and cognitive development with that of children who have sustained frontal pathology. It focuses specifically on the domain of executive function, with the assumption that frontal regions are essential to the development and implementation of efficient executive skills. It discusses two studies from that illustrate the impact of frontal lobe pathology during childhood and the problems of assessing these skills accurately with current methodologies. The first study describes an ongoing program of research that examines the range of executive deficits exhibited by children who have sustained traumatic brain injury involving the frontal regions. The second study investigates the impact of focal frontal lesions during childhood, with an emphasis on approaches to the measurement of executive function.

Regulating Action
Don M. Tucker and Phan Luu

in Cognition and Neural Development

Published in print: 2012 Published Online: January 2013
Publisher: Oxford University Press
DOI: 10.1093/acprof:oso/9780199838523.003.0003
Item type: chapter

This chapter considers the neurophysiological mechanisms of learning in relation to specific requirements of motivated (viscerally charged) sensory and motor (somatic) operations. It shows that complex abilities in self-regulation, often described as executive functions, can be understood to emerge through the human elaboration of more elementary capacities for motivational control of action. The capacity for working memory is integral to complex plans, and to complex choices in self-control. The frontal lobe's contribution to working memory is closely linked to action regulation, and to the motive base of action in the limbic networks. The dorsal and ventral divisions of the frontal lobe operate in tandem with their dorsal and ventral counterparts in the posterior brain. Linked in a kind of opponent reciprocity, the frontal-temporoparietal networks of each division provide coherent organization to action regulation.
This chapter gives a demonstration of how different incidences of scanning modify the anatomical appreciation of structural brain lesions. Examples include lesions in left parietal, left calcarine, right temporal, and left frontal regions.

An evaluation of the frontal lobe theory of cognitive aging
Louise H. Phillips and Julie D. Henry

In the 1990s, it was argued that age-related changes in the frontal lobes predict cognitive changes in older adults. However, evidence for this hypothesis from behavioural and neuroimaging studies were equivocal at best. This chapter reviews the following four issues. First, there is little strong evidence to support the conclusion that executive control is differentially affected by age in comparison with other cognitive functions. Second, there are differences in the pattern of deficits seen following focal frontal lobe damage and those accompanying the ageing process. Third, the effects of age on social and emotional functioning have been largely ignored, despite considerable evidence linking such functions to the frontal lobes of the brain. Fourth, functional neuroimaging data do not support a straightforward version of the frontal-lobe theory of ageing.

Superior Longitudinal Fasciculus and Arcuate Fasciculus
Jeremy D. Schmahmann and Deepak N. Pandya

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Superior Longitudinal Fasciculus and Arcuate Fasciculus
Jeremy D. Schmahmann and Deepak N. Pandya

in Fiber Pathways of the Brain

Published in print: 2006 Published Online: May 2009
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DOI: 10.1093/ acprof:oso/9780195104233.003.0013
Item type: chapter
The superior longitudinal fasciculus (SLF) and the arcuate fasciculus (AF) have long been considered synonymous in the human, and these names have been used interchangeably. According to observations in the monkey, however, they are separate entities. The SLF comprises three subcomponents (SLF I, II, and III) linking the parietal lobe association cortices with the frontal lobe. The AF, by contrast, appears to be separate and distinct from the SLF. This chapter presents a historical account of SLF and AF. It reviews the origins of the earlier notions and how the understanding of these fiber bundles became embedded in neurological anatomy and perpetuated in current terminology.

Introduction
Donald T. Stuss and Robert T. Knight

in Principles of Frontal Lobe Function

Published in print: 2002 Published Online: May 2009
Item type: chapter

This introductory chapter presents an overview of the different contributions in this book. By highlighting some of the similarities and differences among approaches, it seeks to entice the astute reader to consider the diversity of approaches there are to the same question about the role of the frontal lobes in organized behavior, to advance the field ahead.

Unifying Clinical, Experimental, and Neuroimaging Studies of the Human Frontal Lobes
Brian Levine and Fergus I. M. Craik

in Mind and the Frontal Lobes: Cognition, Behavior, and Brain Imaging

Published in print: 2011 Published Online: January 2012
Item type: chapter

The frontal lobes are central to human cognition and consciousness. This chapter reviews the history of research on frontal lobe function in three eras, from the mid-19th to the mid-20th century, characterized by clinical case studies and qualitative observations of animals with experimental frontal lesions, from the mid-20th century to the late 20th century, containing more organized experimental group studies of animals and humans with frontal lobe lesions, and the current era, characterized by a proliferation of detailed anatomical research using multimodal imaging
and sophisticated cognitive science paradigms. Stuss and Benson’s The Frontal Lobes, published in 1986, provided a springboard into the current era by cogently synthesizing anatomical and experimental human and animal research to date. The remainder of this chapter summarizes the contributions to this volume, a Festschrift for Don Stuss.

Principles of the Rehabilitation of Frontal Lobe Function
Paul W. Burgess and Ian H. Robertson

in Principles of Frontal Lobe Function
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Publisher: Oxford University Press
DOI: 10.1093/acprof:oso/9780195134971.003.0033
Item type: chapter

This chapter outlines the practical rehabilitation implications of current theories and models of frontal lobe function, with the aim of providing some provisional principles for the rehabilitation of the dysexecutive patient. It argues that there must be a theory of the cause of an impairment before a treatment can be designed. However, currently there is a gap between pure experimental work from which such theories might evolve and potential treatment applications. There is actually more potential cross-talk between these concerns than might at first appear. Six provisional principles for treatment are presented.

Memory Retrieval and Executive Control Processes
Arthur P. Shimamura

in Principles of Frontal Lobe Function
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Item type: chapter

This chapter shows that episodic retrieval and source recollection are associated with frontal lobe function. The role of the prefrontal cortex in such retrieval tasks appears to be related to on-line control of memory activations. That is, extraneous information at the time of recollection can significantly interfere with episodic retrieval and source recollection. Such interference effects appear more significant for source recollection than for the recollection of item information. Boosting or supporting executive control can improve source memory performance in patients with frontal lobe lesions.
The frontal and temporal lobes, along with the basal ganglia, are the most intensively studied regions of the brain in relation to schizophrenia. This chapter describes the behavioral and biological characteristics of the temporal lobes, with a focus on the left temporal area. It shows that some psychological functions associated with the left temporal lobe, notably memory but also language comprehension and selective attention, are probably deficient in about three-quarters of schizophrenia patients. Although there is no replicated evidence of complete separation of patient and healthy samples, the findings of disturbed semantic processing in many patients are substantial in magnitude. On the other hand, there is no evidence that defective temporal lobe cognition is a necessary part of schizophrenia. There are substantial numbers of patients with the illness who perform normally on these tests.

The Frontal Lobes and Self-Awareness

DONALD T. STUSS, R. SHAYNA ROSENBAUM, SARAH MALCOLM, WILLIAM CHRISTIANA, and JULIAN PAUL KEENAN

This chapter summarizes a hierarchical framework proposed by Stuss, Picton, and Alexander (2001) that suggests different levels of awareness of self to account for variations in attributions of awareness to different brain regions. It also challenges current thinking on the relationship between theory of mind, autobiographical memory, and the frontal lobes. A reformulation of the hierarchical framework of self-awareness is presented.
One of the great successes of functional neuroimaging as a method has been to generate theories concerning the cognitive functions supported by rostral PFC (approximating Brodmann Area 10). But these ideas have developed largely without regard to the existing data available from human lesion studies, which should have provided valuable constraints on theorising. These data are outlined here, augmented by a meta-analysis of the work of Donald T. Stuss and colleagues. Rostral PFC lesions do not typically cause widespread cognitive deficits. But they often do cause marked deficits in a range of cognitive abilities which have hitherto received little attention from cognitive scientists. These include (but are not restricted to) prospective memory, multitasking, “metacognitive” control, and social behaviour. It is argued that functional neuroimaging practitioners of functional neuroimaging might wish to consider these data when interpreting, post-hoc, findings of haemodynamic change in rostral PFC.

In the past 25 years, the frontal lobes have dominated human neuroscience research. Functional neuroimaging studies have revealed their importance to brain networks involved in nearly every aspect of mental and cognitive functioning. Studies of patients with focal brain lesions have expanded on early case study evidence of behavioral, emotional, and cognitive changes associated with frontal lobe brain damage. The role of frontal lobe function and dysfunction in human development (in both children and older adults), psychiatric disorders, the dementias, and other brain diseases has also received rapidly increasing attention. In this Festschrift for Donald T. Stuss, one of the world’s leading frontal lobe researchers, 14 researchers review and synthesize the current state of knowledge on frontal lobe function, including structural and functional brain imaging, brain network analysis,
aging and dementia, traumatic brain injury, rehabilitation, attention, memory, and consciousness. The book therefore provides a state-of-the-art account of research in this exciting area, and also highlights a number of new findings by some of the world’s top researchers.

Disorders of Language After Frontal Lobe Injury: Evidence for the Neural Mechanisms of Disorders of Language
Michael P. Alexander
in Principles of Frontal Lobe Function
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Publisher: Oxford University Press DOI: 10.1093/acprof:oso/9780195134971.003.0010

Damage to the frontal lobes, particularly on the left, will impair language capacity. This chapter reviews language impairment at four discrete, although overlapping, levels of clinical phenomena: (1) transcortical motor aphasia (TCMA), the classical aphasic syndrome of left posterior frontal injury; (2) dynamic aphasia, which is the core impairment of (TCMA) and a disturbance of complex, open—ended sentence assembly; (3) discourse impairments, which are disturbances in the assembly of complex narratives; and (4) disrupted action planning, the fundamental impairment of complex, goal-directed, intentional behavior. Dynamic aphasia and discourse impairment should be seen as action planning deficits specific to language use.

Aging, Memory, and Frontal Lobe Functioning
Fergus I.M. Craik and Cheryl L. Grady
in Principles of Frontal Lobe Function
Published in print: 2002 Published Online: May 2009
Publisher: Oxford University Press DOI: 10.1093/acprof:oso/9780195134971.003.0031

A recent review of the evidence for the frontal lobe aging hypothesis concluded that too little attention has been paid to evidence for changes seen elsewhere in the brain and advocates a network approach to this issue, rather than a localization one. This chapter shows that the neuroimaging evidence indicates a critical role not only for the frontal lobes in cognitive aging but also for other areas as well. Age-related declines in memory do occur, but declines are much greater in the performance of some tasks (e.g., recall and working memory tasks) than that of others (e.g., recognition memory and implicit memory

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tasks). Age-related declines in brain volume are also differential, with the greatest amounts of atrophy being seen in the prefrontal cortex and neostriatum. It is now clear that age-related changes in prefrontal cortical structure and function are related to the changes observed in memory performance, although the research is still in its early days.

Effects of Aging on Memory and Attention
Fergus I. M. Craik

in Mind and the Frontal Lobes: Cognition, Behavior, and Brain Imaging

In this chapter I explore the similarities and differences between the effects of normal aging and the effects of frontal lobe damage on aspects of memory and attention. It is well established that normal aging is associated with some degree of frontal lobe atrophy, and is also established that older adults perform relatively poorly on certain tasks of ‘frontal lobe function.’ Indeed, West (1996) has proposed a ‘prefrontal theory of cognitive aging’ to underline the similarities. In my own work I have demonstrated that age-related losses tend to be greatest in memory tasks (such as free recall) that put largest demands on ‘self-initiated activities’ – generally taken to be attributable to frontal lobe function – and this point is illustrated in the chapter. The beneficial effects of context reinstatement are also illustrated. But the point is also made that other brain areas (such as medial-temporal regions) are also affected by aging; for example, older adults’ problems with associative memory may be attributable to the declining efficiency of this region.