
CONTENTS

INTRODUCTION	ix
1 FROM IMHOTEP TO HUBEL AND WIESEL: THE STORY OF VISUAL CORTEX	1
ANCIENT EGYPTIAN SURGERY AND MEDICINE	1
GREEK PHILOSOPHER-SCIENTISTS AND THE BEGINNING OF BRAIN SCIENCE	8
THE MEDIEVAL CELL DOCTRINE OF BRAIN FUNCTION	31
THE REBIRTH OF BRAIN SCIENCE	37
THE BEGINNING OF THE MODERN ERA OF CORTICAL LOCALIZATION	53
THE DISCOVERY OF A VISUAL CENTER IN THE CEREBRAL CORTEX	65

CONTENTS

2	LEONARDO DA VINCI ON THE BRAIN AND EYE	93
3	EMANUEL SWEDENBORG: A NEUROSCIENTIST BEFORE HIS TIME	119
4	THE HIPPOCAMPUS MINOR AND MAN'S PLACE IN NATURE: A CASE STUDY IN THE SOCIAL CONSTRUCTION OF NEUROANATOMY	137
5	BEYOND STRIATE CORTEX: HOW LARGE PORTIONS OF THE TEMPORAL AND PARIETAL CORTEX BECAME VISUAL AREAS	181
	REFERENCES	211
	INDEX	249

INTRODUCTION

I am an experimental neuroscientist specializing in brain mechanisms in vision, and a teacher of neuroscience. This introduction explains what led me temporarily to put aside my experiments and neglect my students to write the five tales on the history of neuroscience.

The first essay began in 1960. I had just completed the experimental work for my Ph.D. thesis, “Some Alterations in Behavior after Frontal Lesions in Monkeys,” at Cambridge University and sat down to write the requisite review of the literature. Six months later I had reached Galen and the second century. At that point, my advisor, Larry Weiskrantz, suggested that, actually, it might be better if I got on with the write-up of my experiments, even though, as I explained to him, Galen had carried out experiments on frontal lobe damage in piglets. So I never included this historical survey in my thesis, and ultimately its review of previous work began with studies in the 1930s.

I did show my “up to Galen” manuscript to Joseph Needham. He wrote me an encouraging note, resplendent with Chinese characters, comparing Greek *pneuma* with Chinese *chi*. After graduate school I went to the Massachusetts Institute of Technology as a postdoctoral fellow to work with Hans-Lukas Teuber, the charismatic founder of the Department of Psychology, now the Department of Brain and Cognitive Sciences (Gross, 1994a). I showed him my

history manuscript and proposed to continue working on it on the side. Teuber was deeply knowledgeable about the history of biology, almost as deeply as he pretended to be; however, he assured me that I had no time “on the side” and should save history for my retirement days.

Despite this advice, when I began to teach what became my perennial undergraduate course on physiological psychology (later renamed cognitive neuroscience), first at Harvard and then at Princeton, I increasingly inserted historical interludes on Vesalius, Willis, and Gall, and other “high points in man’s understanding of his brain.” When some of the premedical students in the course started getting restless at the length of these interludes, I began occasionally teaching a separate course entitled “Ideas on Brain Function from Antiquity to the Twentieth Century.”

After the (perceived) success, described below, of my paper on the hippocampus minor, I reached into my “up to Galen” draft and my history of neuroscience lecture notes and began revising and updating them for publication. So when I was asked a few years ago to write an article on visual cortex for the multivolume handbook *Cerebral Cortex* I seized the opportunity to achieve my thwarted ambition to write a historical introduction starting at the beginning. I began with the first written mention of the brain from the pyramid age, went on to investigations and theories of brain function among Greek physician-philosopher-scientists, and continued through the coma of European science between Galen and the Renaissance. At that point in the article, for obvious practical reasons (my word limit and, certainly, my time were not infinite), I began to narrow my subject, first to the cerebral cortex and then, by the end of the article, to striate cortex. Chapter 1, “From Imhotep to Hubel and Wiesel: The Story of Visual Cortex” is a combination of that article (Gross, 1997c) and one I wrote entitled “Aristotle and the Brain” for the *Neuroscientist* (Gross, 1995).

The second essay was inspired by a visit to an exhibit of Leonardo’s anatomical drawings at the Metropolitan Museum of Art in New York. The rooms were dimly lit and the hushed crowd slowly and reverentially shifted from drawing to drawing of bones, muscles, and viscera, all borrowed from the

Queen's collection at Windsor Castle. No pamphlets were available nor were there explanations on the walls, not even labels or dates of the drawings. What were we looking at? The drawings of the superficial musculature seemed accurate enough and certainly beautiful. But the viscera often seemed rather strange, the organs not looking quite right or in the correct places. Of course, I had previously seen his two drawings of brain ventricles, one a purely medieval three circles in the head and the other a realistic, but not quite human ventricular system. I became intrigued as to what Leonardo was illustrating in these famous drawings: the body observed? the body remembered? the body read about? the body rumored? the human body, or animals in human form? Was he illustrating medieval theory, as in the drawing of circular ventricles? Or was he drawing from his own dissection, as in the later ventricular drawing? Hence, eventually, the article on Leonardo's anatomy. Although it is restricted to a detailed discussion of only a few of Leonardo's neuroanatomical drawings, I think my comments are applicable to his other biological work. Chapter 2, "Leonardo da Vinci on the Eye and Brain," was first published in the *Neuroscientist* (Gross, 1997b).

The third essay derived from the question of whether there can be a theoretical biology or a theoretical biologist. Certainly I see no sign yet of anyone who made significant and lasting theoretical contributions while remaining only a theorist. All the great theoretical work was done by individuals buried up to their necks if not their eyebrows with empirical data all their busy lives, such as Darwin, Mendel, Bernard, Sherrington, and even Freud. In contrast, those individuals who were only theorists and did little empirical slogging, such as Lotka, Reshevsky, and D'arcy Thompson, have disappeared except as antiquarian curios.

Was Emmanuel Swedenborg, the eighteenth-century Swedish mystic, an exception? Solely on the basis of reading the literature of the day, he proposed theories of the functions of the cerebral cortex, of the organization of motor cortex, and of the functions of the pituitary gland that were at least 200 years ahead of everyone else. On the other hand, perhaps he was no exception since, although he often got it right, he never had any impact on biology. Indeed,

his work was published and republished in many volumes, but his ideas on the brain continued to go unnoticed until after those that were actually correct were rediscovered independently. Chapter 3, “Emanuel Swedenborg: A Neuroscientist Before His Time,” first published in the *Neuroscientist*, tells his story (Gross, 1997a).

The fourth essay originated when my wife, Greta Berman, bought me a copy of Desmond and Moore’s biography of Darwin soon after it appeared. She had been attracted by a very enthusiastic blurb on the back cover written by a friend of ours. At first I was skeptical, as the book had been rather negatively reviewed in the *New York Times Book Review* by my old history of science teacher, I. B. Cohen. But as soon as I began to read, I realized what an absolutely splendid book it was, a truly exciting page turner placing Darwin in his social, economic, and scientific world.

Right in the middle of the book I encountered several references to a lobe of the brain called the hippocampus minor. I do sometimes come across names of unfamiliar brain structures, but never a whole lobe, particularly one that was supposed to be unique to humans. As I looked into more accounts of Victorian biology and the battles over evolution, I realized that although the hippocampus minor was repeatedly mentioned by historians of evolution, it was clear that none of them had any idea of what or where it was. Apparently they had never read or even looked at the pictures in the many articles about the hippocampus minor in midnineteenth-century scientific and popular journals. Furthermore, I could find no mention of such a structure in any of my neuroanatomy textbooks (until later when I looked at outdated ones). When I called several of my friends around the country who were among the leading students of the anatomy and physiology of the hippocampus, they too had never heard of the hippocampus minor. Clearly, there was or should have been a ready audience for a paper on this mysterious structure. Hence I researched and wrote “The Hippocampus Minor and Man’s Place in Nature: A Case Study in the Social Construction of Neuroanatomy,” a version of which constitutes chapter 4. It tells what the hippocampus minor is, why it was so important in