ONE

The Nervous Man of Science

> The physiological problem of the formation of our space perception was actually forced upon naturalists by the observation of pathological cases, such as the acquisition of sight in later life through couching, the existence of colour blindness, and a variety of optical delusions which still serve as indispensable test cases for the various theories that have been propounded. Only when something turns out to be palpably wrong do we begin to inquire what constitutes the right side of many things.
>
> —J. T. Merz, *History of European Thought in the Nineteenth Century*

ATOP THE MANLY SHOULDERS of Britain's first industrial age sat some of history's coolest heads of scientific genius: James Watt, Humphry Davy, and William Thomson (Lord Kelvin), just to name a few. While new generations of scientifically and industrially minded men tethered Britain's profits, governance, and other public domains, women disappeared into factories, dark streets, yellow wallpaper, and madhouses.

At least, this is a typical vision of the gendered and scientific quality of Britain's Industrial Revolution. But look a little closer, and several of the narrative's threads show signs of fraying. For example, we have begun to question the extent to which science drove the industrial engine.[1] This book questions a different aspect of the standard story. If masculinity and science epitomized vigor and rationality in industrial Britain, then why and how did so many men of science so frequently endure nervous illness? Among the middling and genteel classes that elite natural philosophers occupied, nervous illness ran rampant, and neither men—nor men of science in particular—were spared from what Elaine Showalter famously called the female malady.[2]

Examples of nervous illness among prominent men and women of science in industrializing Britain are legion. Cambridge dons Richard Watson and Isaac Milner were both hypochondriacs. Watson's teaching duties, he believed, compromised his health, and he stopped giving lectures in 1790.[3] Much to the chagrin of a nineteenth-century hagiographer, James Watt's delicate health seemed to have hindered his abilities in mathematics and the technological arts.[4] German-born astronomer William Herschel's declining health heralded a nervous breakdown and required him to abandon observing for theoretical work in 1802.[5] Chemist Humphry Davy so zealously pursued his famous experiments on the effects of breathing nitrous oxide that he was forced to recuperate in Cornwall, "where new associations of ideas and feelings, common exercise, a pure atmosphere, luxurious diet, and moderate indulgence in wine, in a month restored me to health and vigour."[6] Under less chemically induced circumstances, Mary Somerville also found herself cripplingly fatigued by her translation and explanation of Laplace's *Mécanique Céleste,* and she recuperated in Paris.[7] Charles Babbage became so absorbed in his initial plans for the difference engine that he made himself ill, and his doctor recommended a respite from the project. Babbage's enthusiasm for the project hardly flagged, however, and neither did his periodic nervous complaints.[8] A young James Clerk Maxwell attended school irregularly because of his "delicate health." His attempts to keep up his energy by jogging through the Trinity College corridors in the morning's wee hours annoyed many of his classmates.[9] From his midthirties onward, Herbert Spencer endured a neurotic condition that often prevented him from sleeping, working, or socializing. Ironically, his "nervous system finally gave way" while he was writing the chapter on reason for his *Principles of Psychology,* and prevented him for some time from completing a chapter on the will.[10]

The biographies, correspondence, and even some published scientific papers from the period 1780–1860 are filled with such examples of ill health and physical abnormality among British natural philosophers. These men (and some women) found some solace in writing to each other of their ailments. They also joined their contemporaries in swapping homespun remedies and palliatives, a practice that must have been aided by the chemical experimentation that engaged so many of them.[11] We have mistakenly overlooked the importance of these scientific conversations about nervous disorder, perhaps because they tend to occur in the margins—literally, at the beginning or end of letters, sandwiching the seemingly more important scientific meat—and tend to adopt a mundane tone. We should not be so easily fooled. Men of science

experienced nervous abnormalities as significant events not just in their own lives but also in the very fate of science itself.

Our interest in scientists' nervous conditions thus extends well beyond biographical intrigue. These nervous conditions can also tell us a much more significant tale about how science secured its place in modern, industrial society. In this book, I argue that early industrial British natural philosophers thought of the well-maintained nervous system as a model of the ideal scientific and social organization that they hoped to institute nationally and even internationally.[12] The preventatives and palliatives that kept the nervous system in order could have the same salutary effect on the sciences and the rest of society. When working properly, the nervous system literally embodied good scientific method. Simple sensations entered the body at its extremes; those sensations became gradually refined into facts, generalizations, and laws as information traveled through the nerves, into the brain, and finally entered the mind. Ideally speaking, that division of labor was supposed to obtain on a macroscopic scale as well. For example, the fact collectors who populated the city streets and countryside acted as the nerve endings who passed unfiltered information inward to the more mentally sophisticated philosophers at the metropolitan centers. In the physiological and philosophical works of these elite natural philosophers, both nervous physiology and scientific and other social organizations necessarily involved hierarchical systems of management. The very personal and sometimes agonizing experience of illness ironically imbued natural philosophers with the confidence to medicate not only themselves, but also a variety of social ills, with the healing powers of science.

To understand why this is significant, we must understand that Britain in the late eighteenth and nineteenth centuries was undergoing a serious investigation of its own status as a nation and the sciences' place in it. The proliferation of industrial economies, rapid growth of towns, rising importance of provincial areas, and increasing pressure to recognize nonconformist religions all fertilized the political landscape. Many of the nation's leading thinkers (including its natural philosophers) believed that the road forward should be paved with a more extensive national government. The sciences offered a model of rationality and information exchange that would assist with the systematic relief of poverty, religious factionalism, economic inefficiency, and other problems. In the first industrial age, men and women of science dedicated themselves to improving methods for collecting the idiosyncratic experiences of individuals (including individual observers, but also individual towns, counties, religions) and converting them systematically into universally reliable data and theories.[13]

If this system sounds rather mechanical, this is no accident, since most functions of a nervous system, an industrial economy, or a scientific investigation were considered virtually automatic. But before we simplistically contrast soulless, mechanistic philosophers to their Romantic and vitalistic counterparts on the Continent and in poetic circles, we cannot forget how important the mind, free will, and the Creator were to all but the very most radical philosophers in Britain. If the world obeyed natural law, the vast majority of Britain's natural philosophers believed, it did so because of divine design. Similarly, if the body performed an amazing number of functions automatically, this did not preclude the existence of consciousness; if free trade ensured the best economy, the occasional protectionist legislation might help correct its course; if workers or even machines could keep a factory running nearly automatically, one never left them entirely unsupervised. Each of these caveats signaled a strong desire among British elites to preserve human free will and individual moral character.

These analogous wishes to systematize *and* to preserve some independence from automatism required a healthy appetite for paradox and delicate balance. For example, nervous disorders simultaneously threatened to compromise one's scientific authority and masculine integrity, but also promised to verify that authority if one could exert mental control over the disease. To admit to a nervous weakness in the first place, the natural philosopher had to be able to rely upon free will and rationality to keep that weakness in check. The very narrative of restoration foregrounded a weakness in order to display one's strength in subduing it. Anne Hunsaker Hawkins makes this point in her discussion of "pathographies," autobiographical memoirs written by modern-day physicians who suffer an illness: "Pathographies concern the attempts of individuals to orient themselves in the world of sickness . . . to achieve a new balance between self and reality, to arrive at an objective relationship both to experience and to the experiencing self. The task of the author of a pathography is not only to describe this disordering process, but also to restore to reality its lost coherence and to discover, or create, a meaning that can bind it together again."[14]

The pathography, or what Anita Guerrini has called the "spiritual autobiography," is a time-honored genre modeled on Augustine's *Confessions*. The authors of these narratives seek to demonstrate their development from profligacy, through conversion, to salvation. The early modern physician George Cheyne, for instance, experienced chronic vertigo and hypochondria after the emotional distress of his repeated attempts to achieve acceptance among the Newtonians. His illness inspired his widely popular work, *The English Malady*

(1733). In that bildungsroman, he argued that in order to heal the body, one had also to heal the soul, and he sealed this point by recounting his own resurrection.[15] A recognizable genre of pathography or spiritual autobiography only increased in popularity into the nineteenth century.

Peter Melville Logan refers to these texts as "nervous narratives" because a new attention to the nervous system at the turn of the century had changed the nature of disease, particularly among the middle and upper classes. A nervous narrative, he argues, paradoxically "promotes, in its formal structure, the same disorder it cautions against by transforming the narrator's debility into narrative premise. . . . Thus these narratives have to negotiate two contradictory problems, one in which hysteria implicitly undermines the authority to speak, the other in which it becomes the basic condition of speech."[16]

Drawing together these insights, I argue that during the early industrial period in Britain (about 1780–1860) natural philosophers developed special narrative tools for finding meaning in their illness. Like their kindred authors of nervous narratives, natural philosophers turned the adversity of physical weakness into the virtue of the sciences' mental and organizational strength. In turn, that personal apotheosis might serve as a model for the nation's transcendence over its own weaknesses. The mid-Victorian confidence in the sciences, masculinity, and the nation that we have come to take for granted as bedrocks actually had to be rolled, in Sisyphean fashion, up the hill over and over again in the eighteenth and nineteenth centuries. The sciences secured their place in modern society by constantly asserting the power of management over adversity, not by achieving perfect enlightenment. The marginalia describing natural philosophers' illness and recovery, then, turn out to be the frayed edges of a deeply uncertain fabric of scientific, gender, and nationalist politics. The remainder of this book will tug at some of those loose threads in order to unravel what natural philosophers so desperately strove to weave together.

An Overview of the Argument

This book investigates some of the cultural meanings of the nervous system within eighteenth- and nineteenth-century natural philosophy, and the conditions that shaped that meaning. The first part of the book addresses these questions generally. In the remainder of this chapter, I indicate how natural philosophers understood the physiology and philosophy of the nervous system, and why a healthy body mattered so much to scientific practice.

Chapter 2 investigates how subjective experience of both illness and natural phenomena presented problems not only to the sciences but to other areas of society. Natural philosophers sought methods for standardizing experience, and therefore saw themselves as part of the cure for a disjointed society. This cured, reunited body politic was not supposed to be a radically democratic one. When discussing the nervous system, scientific method, and social and scientific organization, natural philosophers nearly always assumed a hierarchical order—one in which a management system remained firmly in place.

Each case study in the second part of the book addresses a particular kind of nervous disorder that plagued natural philosophers in the early industrial period. In each chapter, I discuss how natural philosophers used a variety of cultural resources in their attempts to normalize and control their nervous conditions. In every case, a key physical and cultural concern was the management of idiosyncratic experience. These three chapters focus especially on the visual part of the nervous system and the perceptive faculties of the mind. Since natural philosophers relied so keenly on vision in their work, it stands to reason that it received a disproportionate amount of their attention.

Natural philosophers' investigations of color blindness (chapter 3) tended to emphasize the need to control provincialism. John Dalton wrote the first extended scientific paper on the nature of color blindness early in his career. Color-blind himself, and a Quaker who had spent virtually his whole life in northern England, Dalton's horizon of experience seemed triply limited to his contemporaries. How much more provincial could one be than a man who had virtually no experience of London or the Continent, little understanding of the normal experience of color, and who lived under carefully circumscribed religious codes of dress and language? And yet, gentlemen of science of the next generation lauded Dalton as a genius whose atomic theory provided the possibility of a universal standard for chemistry. The story of Dalton's transcendence over his provincial limitations symbolized what could happen everywhere in British science. Color blindness became a platform for extolling the virtues and methods of transforming idiosyncratic experience into universal knowledge.

Chapter 4 considers hemiopsy, a migraine-like problem that plagued a number of prominent natural philosophers. In studying their own nervous difficulties, these men of science envisioned their bodies as efficient industrial machines overseen by rational mental governors. The natural philosopher had to manage an abnormal body just as he would any other technological device in his service. The mind acted as a regulatory governor (the device that kept

steam engines from exploding under pressure). The prevalent analogies drawn between engines and bodies indicated many British natural philosophers' hope that the rational mind could manage virtually any mechanical inefficiency. As natural philosophers became increasingly skeptical in the early nineteenth century that the perfectly efficient machine was possible, they proclaimed the continued importance of thinking managers—God, the mind, the factory supervisor, themselves—who intervened to keep the imperfect machines running.

Finally, scientific research on hallucinations and ghosts (chapter 5) allied with a broader reformist attempt to rein in superstitious, gullible, and sectionalist believers under one rationalized, moderate Anglican roof. The rapid growth of non-Anglican religions in the industrial age seemed to indicate a further descent into provincialism that many natural philosophers wished to avoid. The volatile religious and political atmosphere in early-nineteenth-century Britain rekindled a fear among natural philosophers and physicians that the masses clamored for the irrational, both in its materialist-Jacobin and evangelical forms. A renewed wave of literature that appeared during the early industrial period thus encouraged the rationalizing of apparitions. The dominant message that emerged from these works was that using reason to understand visions made better political and intellectual sense than succumbing to the "superstitious" and "enthusiastic" interpretation of visions as communications with the spiritual world—the latter interpretation frequently associated with radical dissenting groups. Rationalist writers did not deny the possibility of miracles, but did sound quite deistic in their claims that only very rarely did a phenomenon defy natural law. Thus emerged yet another strategy for bringing idiosyncratic knowledge under the more rational governance of natural philosophy.

In short, the three chapters in Part II indicate that natural philosophers equated provincialism, economic inefficiency, and a crisis in faith to nervous disorders. Each of these problems suggested that central authority was dissipating. What had become of Truth if the most elite natural philosophers had imperfect vision, if provincial towns had independent scientific communities, if managers did not guide production, if one God no longer reigned over Britain's factionalizing religious culture? If, as Susan Faye Cannon once claimed, a "Truth Complex" dominated early Victorian scientific culture, this resulted only from extraordinary effort in those and previous decades.[17]

The book's conclusion examines a key midcentury victory for the Truth Complex: namely, telegraphy. Almost immediately compared to the nervous system, the telegraphic network that quickly stretched across Britain and the

globe in the 1840s–'60s represented the perceived (if not fully real) healthy exchange and coordination of information that natural philosophers had always hoped to achieve in themselves, their science, and their nation. I conclude with some historiographic reflections on the end of natural philosophy.

Early Industrial British Natural Philosophy as a Crucible

If nervous illness was not strictly a female malady, neither was it primarily an English one, Enlightenment physician George Cheyne's sardonic claims to the contrary.[18] At the very least, the vigorous investigations of nervous physiology and psychology on the Continent shaped much of the work in Britain. Where it is appropriate—and it often is—I include in this study Continental and American scientists who influenced these discussions in Britain. Many had extensive correspondences with British natural philosophers and published important work on these subjects. Furthermore, many Continental and American colleagues had nervous problems of their own. For example, Herman Boerhaave, in the midst of his highly influential work in physiology at the turn of the eighteenth century, reportedly "suffered for six weeks from excitement of the brain, bordering on madness, and characterized by that want of sleep, irritability, and indifference to ordinary interests, which so often appear as harbingers of insanity."[19] At the Pulkovo observatory in St. Petersburg, F. A. T. Winnecke suffered a nervous breakdown just after becoming the vice director in 1864. He chalked up his collapse to the long hours he had kept since he was a student. He resigned from Pulkovo, and rested in Germany for seven years before becoming director of the Strasbourg Observatory.[20] Swiss naturalist Charles Bonnet's eyesight deteriorated so much over his career that he had to stop using the microscope that had made his fame.[21] Joseph Henry and François Arago had hemiopsy (see chapter 4).[22] Jan Purkyne and Gustav Fechner temporarily lost their sight while experimenting on afterimages.[23] John Sylvain Bailly was severely nearsighted.[24] Hermann von Helmholtz, as a migraine sufferer, had personal reasons for immersing himself in the study of afterimages and the physiology of vision more generally.[25]

This is a book about Britain, however, for one simple reason: from 1780–1860, the country experienced unique economic, political, and cultural changes that crucially shaped the sciences' place in society. These broad-based transformations supplied the context and discourse that natural philosophers used to make sense of nervous disorders. British natural philosophers shared a

"cultural epistemology," or a core set of assumptions and strategies. One of the major projects toward which natural philosophers turned their shared cultural epistemology was the building of a systematic national identity for Britain.[26] Britain's early industrialization, unique history with Protestantism, and dedication to reform all helped to forge a unique environment for the country's natural philosophers. Post-Revolutionary France harbored a more republican vision of the scientific community as laborers.[27] And while a similar literature on nervous temperament developed in the United States in this period, the different political, economic, and religious context gave this literature a different spin. For instance, the prominent New England psychologist Amariah Brigham averred that the level of democratic freedom in the United States was to blame for the nation's high rate of insanity, which was at least double that of any European nation.[28]

The reader might also wonder why I have chosen to focus on natural philosophers, that is, the array of people who dedicated their time to studying the divinely created universe of "natural bodies, . . . their powers, natures, operations and interactions."[29] After all, many physicians, field naturalists, and technicians also labored under nervous disorders. I limited my subject matter in this way partly because other scholars have written, or are writing, about these other groups. Illness among physicians makes for an especially interesting study, and many other scholars have shed light on health and self-study among doctors in early-modern and modern medicine.[30] A segment of the Darwin industry has focused on the nature of his illness, while Anne Secord has turned our attention toward the embodied nature of epistemologies and methods among a broader swath of naturalists.[31] To the extent that they shared intellectual and social relationships with natural philosophers, I have included in this book a number of instrument makers, engineers, naturalists, and physicians.

However, not only British men and women of science, but more precisely British natural philosophers shared their own cultural epistemology, one that would matter greatly to an industrializing society. For all of their differences on matters of theory, method, and so on, one can detect a loose consensus among British natural philosophers in this period. Certain things mattered: precision, mathematics and instruments as guarantors of that precision, experimental techniques, the structure and dynamics of matter, mind-body dualism as a foundational concept underlying inductivism, divine lawfulness in the universe, and so on. Each of these points of loose consensus played prominently in British natural philosophers' attempts to make sense of nervous disorders.

This is not to say that a highly coherent group existed in Britain that recognized itself as "The Natural Philosophers." For one thing, British natural philosophers disagreed with each other on many important issues. For example, David Brewster, John Herschel, and William Whewell, three natural philosophers who figure prominently in this study, held very different views about government involvement and division of labor in the sciences.[32] In addition, the meaning of natural philosophy changed over time. Enlightenment natural philosophers tended to conceive of nature as a mechanical system of balanced forces where errors would eventually disappear in the return of a pendulum swing. The early nineteenth century saw a shift to a more dynamic, steam-engine-like system that could lose energy and whose anomalies had to be managed rather than erased in order to achieve optimum efficiency. Finally, the mid-to-late Victorian period saw another shift, in which men of science became more materialist, secular, and specialized in their approach to nature.[33]

Despite differences of opinion and changes over time, a relatively cohesive natural philosophy persisted in Britain well into the nineteenth century as a loose term describing those concerned with matter, forces, and the properties of motion and change in nature.[34] By looking broadly at what we would now call astronomers, chemists, physicists, physiologists, philosophers of science, and engineers, I hope to overcome some of the discipline-splitting that threatens to artificially divide the field of history. In many instances, we might fruitfully focus on, say, the history of biology or the history of chemistry, but the farther we peer into the sciences' past, the less sense these modern categories make. Science in the professional, highly specialized sense did not emerge until after the mid-nineteenth century. I try to avoid anachronism by focusing on an issue (in this case, how to handle idiosyncrasy in the nervous system, the sciences, and society at large) rather than a discipline (for instance, physiology). I further discuss the significance of my interdisciplinary approach in the concluding chapter.

Why focus on the early industrial age? Clearly this period saw dramatic changes in many areas of natural philosophy, including electricity, magnetism, matter theory, astronomy, and physical optics—not to mention, as I already have, profound changes in the wider society. But what about nervous physiology? Writing in the early nineteenth century, Joseph Priestley established that the physiology of vision had inspired a great deal of research in the previous hundred years, but there are indications that this interest languished in Priestley's own time.[35] The dramatic advances in experimental physiology made on the Continent only made a serious mark in Britain in the last third of

the nineteenth century.[36] Before midcentury, physiological optics—to the extent that it flourished at all—ventured off in numerous, disparate directions. The sciences of nervous physiology before the 1870s in Britain at best enjoyed a "pre-paradigmatic" state.[37]

Early industrial British physiology indeed may not have enjoyed a unifying paradigm in a robust sense. We can again, however, identify a core cultural epistemology that gave coherence to investigations of the nervous system. In particular, as I have already mentioned, this research was shaped by natural philosophers' desire to organize idiosyncratic experiences under rational theories, practices, and philosophies of knowledge. National governance and reform, political economy, and rational religion provided some of the idioms through which natural philosophers understood and managed nervous physiology at both the personal and scientific level.

Just as we would be mistaken, though, to homogenize British natural philosophers' views, we also cannot ignore the profound changes that occurred within this community over time. The early industrial period grappled with the legacy of Enlightenment and the insights of Romanticism, and forged mid-Victorian confidence. I will trace these historical changes in more detail in later chapters, but we can summarize the trajectory this way: first, the Enlightenment bequeathed to the late eighteenth century both the promise of systematic, unified knowledge grounded in the System of Nature and the thorny problem of how to incorporate local peculiarities into one grand narrative. Early-nineteenth-century philosophies immersed themselves in this tension between local and universal and attempted to resolve it.[38] I argue that we can see this tension in natural philosophers' attempts to deal with their own nervously disordered bodies. Empiricism had become foundational to British Enlightenment thought, but empiricism required a fully functioning nervous system, a luxury many men of science did not enjoy.

Early industrial British natural philosophers envisioned a way out of this problem by making a virtue out of necessity: nervous disorder would provide the opportunity to develop stronger discipline and will. Knowledge would come not through spontaneous revelation or enlightenment, but through carefully structured labor. The challenge posed by the idiosyncratic and the local was met by natural philosophers with the solution of management. Rather than eradicating imperfection, natural philosophy instead sought to extract as much work from imperfect systems as possible. Conceding bodily and mechanical imperfections and yet achieving work regardless made victory all the sweeter. In fact, the more that natural philosophers studied how to achieve the

most efficiency from bodies and machines over the first half of the nineteenth century, the more confident they became that the idiosyncratic and the local really posed no serious problem to the structuring power of the sciences. Mid-Victorian scientific confidence in management remained firmly grounded in the earlier dilemma—even in this heyday of optimism about objectivity, the idiosyncrasies of the self never disappeared from the picture—but relegated the unruly psyche to the background and to the interior.

Who exactly were these early industrial British natural philosophers who populate this study, then? I have identified a loosely knit and multigenerational set of practitioners who shared a need to organize idiosyncratic experiences into systematic knowledge *and* an interest in the nervous system, often because their own was out of whack. The actual social ties that bound these men, and a few women, together were complex. Most of my subjects knew each other through universities (especially Cambridge and Edinburgh), through scientific societies (especially the Royal Society, British Association for the Advancement of Science, and provincial groups), and in some cases through government bodies (such as the Greenwich Observatory and the Board of Longitude). Most of my protagonists identified with a moderate whig politics for most of their careers. Most came from financially comfortable families, some of them titled. All believed in the Divine, and if they were not Anglican, they at least played their nonconformism in a minor key (with the notable exceptions of Joseph Priestley and David Brewster).[39] When their differences threatened to rend their social fabric, they fell back on a common commitment to instituting the sciences as society's most reliable adhesive. In the nervous system and its disorders they found a useful arena for debating how precisely the sciences would help structure and cohere that society.

The Philosophy and Physiology of the Nervous System

Natural philosophy in the eighteenth and nineteenth centuries owed a great deal to contemporary theories and experiments on the body and mind. In particular, scientific epistemology and method frequently looked to nervous physiology to learn what was possible for human investigators.[40] In the industrial age, anatomists, physiologists, and philosophers devoted substantial attention to understanding the nervous system and how it might structure thought.

The ideas of the philosophers and physicians of the Scottish Common Sense school set the agenda for subsequent British mental and moral philoso-

phy. The Common Sense philosophers, for instance, made an important distinction between sensation and perception. Sensation was the virtually unmediated mapping of the outside world onto the retina, while perception was the mind's active judgment of what the sensation was and what it meant.[41] This distinction helped differentiate the material and passive aspects of nervous physiology from the immaterial and dynamic nature of mental activity. A healthful life and science therefore required not only a well-kept body, but also the cultivation of mental and moral faculties such as reason, judgment, heightened attention, sympathy, and sensibility.

In his 1749 *Observations on Man,* English physician David Hartley had made the explicit, associationist connections between nervous physiology and the mental-moral philosophy that would so dominate British thought. He argued that ideas arose and became connected through vibrations in the nerves and brain.[42] Following on Hartley's example, two of the most important early figures in the Scottish Enlightenment, William Cullen and Robert Whytt, had given their colleague's mental philosophy a more empirical basis in nervous physiology. Their approach emphasized the active nature of the mind—and therefore, the active nature of perception and other mental processes. Furthermore, they elevated the nervous system to the place of chief importance in physiology. Cullen informed his students at the University of Edinburgh that the nervous system, "as the organ of sense and motion, is connected with so many functions of the animal oeconomy, that the study of it must be of the utmost importance, and a fundamental part of the study of the whole oeconomy."[43] Popular texts through the first half of the nineteenth century reinforced the idea that the nerves acted not only as a route for sensations from the outside world, but also as the conduit for the mind's direction of the body. For physician John Elliot, for example, the human body was "a machine composed of bones and muscles, with their proper appendages, for the purpose of motion at the instance of its intelligent principle; from this principle nerves, or instruments of sensation, are likewise detached to the various parts of the body, for such information as may be necessary for determining it to those motions of the body which may be most conducive to the happiness of the former, and preservation of both."[44] Members of a later generation such as Charles Bell continued to challenge the passive model of the nerves maintained by Albrecht von Haller and other materialists. Bell insisted that the mind was not merely acted upon, but active during sensation and other nervous activities.[45]

This idea made sense in light of the connections formed in the early nineteenth century between nervous impulses and other imponderable (invisible)

forces. If nervous impulses acted like electricity, for example, it stood to reason that the nerves existed in a continually active state. Luigi Galvani's connection between electrical and nervous impulses and Johannes Müller's law of specific energies both emphasized the the body's similarity to a machine powered by imponderable forces. Just as varying stimuli (e.g., electricity, mechanical pressure) could garner the same response when applied to a nerve, so also machine technology was demonstrating the correlation of different kinds of forces.[46] By the mid-nineteenth century, London physician Henry Holland considered it a commonplace to liken nervous power to light, electricity, magnetism, heat, and chemical force. Important implications of this analogy for Holland were the continuity of material and mental phenomena, and the possibility that the rational will might still control the "more automatic machinery which surrounds it."[47] By the time Holland was flourishing, this image of the body as a machine governed by a mind had become quite popular. Not only epistemological idealists such as William Whewell, but also many of his empiricist critics argued that the mind actively shaped knowledge of the world.[48]

Interest in the connections between mental philosophy and nervous physiology was widespread within the natural philosophical and medical communities. A quick skim of any scientific periodical from this period demonstrates a keen fascination with bodily abnormalities and their effects. Goethe's *Zur Farbenlehre* (1810) and Brewster's *Letters on Natural Magic* (1832) are only the two best-known treatments of these phenomena. Speculations and experiments on all manner of illusions and aches, phantasmagoria and pangs, appeared in the specialized and popular scientific literature. The *Philosophical Magazine* published an especially large number of notices about various nervous effects—understandably, given that that prolific student of optics David Brewster edited the journal from 1832 to 1868.[49] But more formal society transactions also appeased their readers' interest in experiences of nervous malfunction and its effects on the understanding.[50] In their correspondence and private notes as well, natural philosophers noted their experiences with nervous disorder.[51]

In the last quarter of the nineteenth century, Hubert Airy (son of Greenwich Observatory director George Airy) looked back over this vast literature and proclaimed natural philosophers especially qualified for the study of nervous disorder. Because of their particular education and experience, he argued, natural philosophers had unique claims to authority on the subject that surpassed even the claims of physicians:

> The votaries of Natural Philosophy are especially qualified by their habits of accurate observation to contemplate attentively any strange apparition, without or within, and, I had almost said, are especially exposed to the risk of impairment (temporary or permanent) of the eyesight, by the severity of the eye-work and brain-work they undergo, and therefore possess especial advantages for the study of visual derangements; whereas the physician, unless personally subject to the malady, must depend, for his acquaintance with its phenomena, on the imperfect or exaggerated accounts of patients untrained to observe closely or record faithfully.[52]

According to Airy, anyone who presumed that the physiology of the nervous system was the exclusive territory of physicians, thought wrong. Nervous physiology—and particularly vision—played too important a part in the methodology of natural philosophy. The natural philosopher not only valued the nervous system as a tool; he also often worked it to the point of impairment. Finally, he brought the necessary training to investigate accurately any physiological problems he might himself have. His familiarity with epistemology, the science of imponderable forces, precision instrumentation, and optics made him a unique authority on nervous issues. Ironically, a natural philosopher's bodily vulnerability afforded him the heroic opportunity to achieve mastery. Masculine scientific "habits" constituted the endless work of keeping the house in order.

Vision in Natural Philosophy

For natural philosophers especially, one of the creakiest, but most vital parts of the house was the visual system.[53] Accordingly, natural philosophers had a particular interest in those parts of the nervous system and mind involved with vision. It is therefore worthwhile to consider the particular epistemological problems and solutions raised by that sense and its disorders. Like other kinds of perception, vision seemed to engender an unavoidably subjective experience, though the fact that the vast majority of people gave very similar descriptions of everyday phenomena generally masked this subjectivity. Problems arose when one tried to explain the experiences of people who saw phenomena that others could not see (e.g., the spots one sees after looking directly at the sun, or worse, hallucinations), or who gave significantly different descriptions of

what should have been the same phenomenon (e.g., observers' differences about what time Venus begins and ends its transit across the sun).

Despite a trend toward the use of self-registering instruments, the practice of natural philosophy still depended greatly on human perception. And for all its faults, vision held a privileged place among the senses. Sight seemed to provide the natural philosopher with the most, and the most accurate, information. Chemist and physician Samuel Brown vividly captured the importance of vision to the natural sciences:

> It may be said that it is always the first effort of the exact sciences to transform the dimmer perceptions of the more deceivable organs into those of sight, the most discursive and accurate of the senses. The mineralogist does not satisfy himself with the intimations of what has been called the muscular sense [touch], or that sense of resistance which is related to the perception of weight, concerning the specific gravity of the stone. He weighs it first in the air, then in the water; notes the difference between the two weights; and thence computes its specific heaviness. The chemist does not trust his fingers, or even his lip, for the temperature of his agents and reagents; but invents the thermometer, and reads of his measurements with the eye. It is the same in the sciences of magnetism proper, electricity, and galvanism. Even in the investigation of sound (which is measurable with such exquisite nicety by the ear, as to render the art of music not only possible, but the very anti-type of mathematical proportion,) the natural philosopher converts its vibration into visible things before he will philosophize upon them.[54]

Just after extolling the virtues of vision, Brown warned that it should still be checked by more trustworthy instruments such as micrometers and photoscopes. In fact, a careful examination of the quotation above indicates that Brown privileged sight more because it was the main point of contact between instruments and the mind, and less because of any inherent superiority to that sense. Indeed, natural philosophers did not feel universally comfortable with their dependence on their visual capacity. French *physicien* Eugène Péclet instructed readers of his textbook that "the imperfection of our organs and of our instruments does not allow us to make absolutely exact observations; they will never rigorously satisfy the laws that govern them; one must require only that the differences be smaller than the probable errors in the instruments. Further, the series of observations must be very extensive; for one would rather risk obtaining, not a general law, but a law that would apply only within the period observed."[55]

The careful observer attended not only to the facts gathered by sensation, but also to deduction, which could be a powerful corrective for perceptual error.[56] Once a general law was established it could be used to isolate and eliminate such errors. But notice the persistent uncertainty in these passages. Eyesight did not promise perfect knowledge, only *better* knowledge than the other senses offered. Likewise, empirical methods could lead to powerful, general scientific laws, but not absolute certainty. Mastery required constant labor and discipline. In short, natural philosophy, one of the cornerstones of modern science, rooted its power in its greatest source of vulnerability. It promised progress through visionary work, not a static truth.

Warnings about visual imperfection became more urgent as the accuracy of instruments and theories improved. Perceptual errors appeared more and more gross by comparison to the fine registers of precision instruments. Even healthy human perception could not always be trusted to produce accurate accounts of natural phenomena. Any lens had its imperfections, and as a special case of the lens, the eye came with its share of problems. For example, the constant, involuntary adjustment of the pupil made judging the relative brightness of stars extremely difficult.[57] In some cases, natural philosophers replaced the eye with an instrument such as the camera. In others, they compared the sightings of several different observers, as with the transits of Venus. In those instances where visual evidence was unavoidable but problematic, natural philosophers sought to discipline vision through various protocols.

Refining these protocols depended partly on improving knowledge about the philosophy and physiology of perception, and partly on the sheer quality of the scientific investigator's higher mental faculties. In other words, mechanization alone could not correct for the flaws in the body's perceptual apparatus. The natural philosopher had also to cultivate conscious mental muscles such as the will and attention. These would help him accurately to interpret raw data from his senses and instruments. Both in the body and in the system of scientific methodology, nervous physiology and empiricism thus had far more complexity than simple mechanical processes.

Attention, the Will, and Power

British mental and moral philosophy in this period tended to highlight the mind's various faculties, or the types of operations that the mind could perform. Intense debates ensued as to whether these operations were metaphysical

entities or simply heuristic conveniences. Phrenologists and many other anatomists assigned these faculties to specific areas of the brain, but even those who viewed such reification as speculative agreed that the mind and brain had a number of distinct ways of processing information.[58] In the empiricist-associationist view that dominated British thought, some faculties enabled action (e.g., the will, appetites, and the moral faculty), while others enabled understanding (e.g., memory and judgment). Of the faculties of understanding, some gave trustworthy accounts of the external world (e.g., perception, abstraction, and reason), while others transformed that world into something generally unusable to natural philosophy (the imagination).

In an account of nervous disorders and scientific epistemology, the faculty of perception of course played a very important part. But I also want to emphasize the vast importance of the will and attention in empiricist accounts of the mind and body. These "active" faculties trumped any radical moves that British philosophy might have made toward total mechanization or skepticism.[59] For example, David Hume famously attacked the robust notion of causation that buttressed much moral and natural philosophy. Seeking to moderate this skepticism, empiricist philosophers in the next few generations appealed to a commonsense experience. When human beings will an arm to move, said Thomas Brown in an oft-repeated argument, they can see it move, and simultaneously feel the exertion of the muscles lifting the arm. This visceral sense of a cause powering an effect allowed one to believe that at least human action had a clear cause. One willed and felt the force of that will simultaneously, ergo causation.[60]

The will's power mattered in early industrial British society partly because it had become so important in differentiating masculinity and femininity. During the eighteenth century, women had become increasingly associated with sensibility, or nervous rawness of feeling. Men were also supposed to cultivate sensibility, but most believed that men could control its wilder impulses through the exercise of higher mental faculties. In the industrial age, though, balancing an active life and work ethic against the virtues of contemplation and sensibility proved no simple matter. Even the most seemingly confident believer in the power of heroes, Thomas Carlyle, in reality had tremendous difficulty carving out a suitably active, masculine life for himself as a writer.[61]

In early-nineteenth-century natural philosophy as in letters, the assertion of masculine will became a crucial ideal, an ideal honored more in the breach than in the observance. The will would, natural philosophers hoped, transform the feminine, hypersensible experience of nature's beauty into a vigorous, exhilirating

wrestling match. The much-respected mid-Victorian natural philosopher James Clerk Maxwell vividly painted this image for his colleagues at the British Association for the Advancement of Science:

> There are [those] who feel more enjoyment in following geometrical forms, which they draw upon paper, or build up in the empty space before them.
>
> Others, again, are not content unless they can project their whole physical energies into the scene which they conjure up. They learn at what rate the planets rush through space, and they experience a delightful feeling of exhilaration. They calculate the forces with which heavenly bodies pull at one another, and they feel their own muscles straining with the effort.
>
> To such men momentum, mass, and energy are not mere abstract expressions of the result of scientific inquiry. They are words of power, which stir the souls like the memories of childhood.[62]

Maxwell sought to retire the image of the natural philosopher as passive camera obscura who projected his geometries into empty space. Into the gap vacated by this weakened, feminized projector, Maxwell thrust the dynamic, physical man of science who rushed into nature and muscled it around instead of simply mirroring it.[63] Over the course of the industrial era, natural philosophers increasingly depicted the Enlightment mirror of nature as inadequately static. The new, heroic vision of natural philosophy required men of action, who professed to *manipulate* nature in a dynamic tug-of-war between sensing and willing, between body and mind.

Maxwell's heroic vision of an active, analytical dynamics would have pleased many of his predecessors, especially William Hamilton, whose lectures on mental philosophy at the University of Edinburgh first presented Maxwell with "the doctrine of a muscular sense [which] gave promise of a rational analysis of the active powers."[64] The will allowed the natural philosopher to do more than simply *observe* and *measure* nature. One threw in one's very body, and *manipulated* and *experienced* nature. As I will argue, particularly in chapters 2 and 4, this highly masculine approach also allowed natural philosophers to manage their own bodily abnormalities, to convert weakness to strength rather than sink into victimhood.

The will proved so important to the practice of science and everyday life, in fact, that doubts about its existence caused several famous nervous breakdowns—including that of the young John Stuart Mill, who suffered his much-discussed crisis in the winter of 1826–27 after immersing himself in the study of

Benthamite utilitarianism. Among his critiques of his father's philosophy was that it was radically deterministic. "I felt as if I was scientifically proved to be the helpless slave of antecedent circumstances; and as if my character and that of all others had been formed for us by agencies beyond our control, and was wholly out of our power." He eventually saw his way through the problem by deciding that free will was compatible with a nonfatalistic view of how circumstances shape moral decisions.[65] Apparently, looking the experience of "slavery" straight in the face could bring one to the brink of disaster but then to an even stronger state of grace.

Related to the all-important will, the faculty of attention also played prominently in moral and natural philosophy. Without attention, the mind remained unable to prioritize or recall ideas. As physiologist William Carpenter put it, "it is solely by the Volitional *direction of the attention* that the will exerts its dominion; so that the acquirement of this power, which is within the reach of every one, should be the primary object of all mental discipline." Those who did not exercise their will by disciplining their attention were little better than automata (or women).[66] Because attention connected the will to the intellectual faculties, it kept the intellect from being strictly mechanical. Sensation, for instance, might consist merely of an automatic impression of light upon the retina, but the mind's attention to certain aspects of that impression made sensation subject to the will. The more powerful one's will, the more developed one's intellectual faculties. The will improved mainly through its exercise in active faculties such as the appetites, desires, and morality. Therefore, power, morality, and the intellect all connected through the nexus of attention.

Natural philosophers repeatedly credited attention as one of their sharpest disciplinary tools. Among the many innovations that George Airy introduced to the Royal Greenwich Observatory, for instance, was an alarm clock set to sound whenever certain stars crossed the meridian. This alerted the observer on duty to check his instruments.[67] Charles Babbage, reflecting on his success in life, also extolled the importance of well-directed attention. One of his "most important guiding principles," he said, was that "every moment of my waking hours has always been occupied by some train of enquiry." Sometimes this meant working in the wee hours of the morning, one of the only times he found respite from "the nuisances of the London streets," most particularly their organ grinders.[68] Echoing Hubert Airy's point (cited earlier) that natural philosophers had the best firsthand knowledge about flawed vision, Hermann von Helmholtz also sounded this common theme when he argued that focused attention was rare but definitive of the best natural science:

> Who can easily discover that there is an absolutely blind point, the so-called *punctum caecum,* within the retina of every healthy eye? How many people know that the only objects they see single are those at which they are looking, and that all other objects, behind or before these, appear double? I could adduce a long list of similar examples, which have not been brought to light till the actions of the senses were scientifically investigated, and which remain obstinately concealed, till attention has been drawn to them by appropriate means—often an extremely difficult task to accomplish.[69]

If brought under rigorous investigation, even the natural philosopher's own physical abnormalities might become legitimate subjects of scientific knowledge. Active mental faculties could turn even perceptual errors into object lessons on how to improve scientific practice. Given the realities that instruments never achieved perfect accuracy, eyesight could play tricks, and bodies fell ill, natural philosophers relied on their minds as a beacon through the fog.

The Body in Scientific Practice

The fact that the body intruded so unpredictably and demandingly into the practice of science is one of the primary concerns of this book. Since investigation of the body's cultural importance has arrived rather late to science studies, I want to address briefly how historians have talked about the body in recent years, and discuss more thoroughly the body's place in the sciences.[70]

The historical literature on the body as a cultural force began to appear in the 1970s–'80s, following particularly on the work of Michel Foucault and Norbert Elias, who sketched the body as a locus of power relations within the construction of modernity,[71] and feminists such as Evelyn Fox Keller, Genevieve Lloyd, and Susan Bordo, who documented the historical division of labor between embodied women and intellectual men.[72] Both sets of literature emphasized that the body, long taken for granted as a hard-wired instrument, had absorbed as many cultural values as the more familiarly flexible icons of gender, race, and class.

One part of this literature has presented us with a mundane and yet simultaneously profound fact: illness, and the management of illness, were regular features of life before our own time.[73] Bruce Haley vividly illustrated this point in his study of the Victorian culture of health. He argued that the Victorians imbued the healthy body with enormous cultural meaning. To them, health

was "a state of constitutional growth and development in which the bodily systems and mental faculties interoperate harmoniously under the direct motive power of vital energy or the indirect motive power of the moral will, or both. Its signs are, subjectively recognized, a sense of wholeness and unencumbered capability, and, externally recognized, the production of useful, creative labor. All of this is said more simply in *mens sana in corpore sano*."[74] In other words, the strenuous, unceasing moral and physical task of maintaining personal health also helped one achieve one's social duties: economic productivity, political progress, and piety.

This intimate relationship between health, intellect, productivity, and morality has clear implications for the history of science. Probably because of its deep roots in intellectual history, however, historians of science have been slow to consider the body as much more than a biomedical specimen. In the last two decades, a number of studies have begun to address the issue. The earliest literature considered medicine as a tool that inscribed social, cultural, economic, and religious values onto the body.[75] Another set of studies has examined how bodies have been compared to machines.[76] More recent inquiries have explored how scientific investigators' bodies have shaped scientific practice.[77]

A study of nervous disorders among natural philosophers must involve all of these approaches. In fact, it seems that science studies sits on the verge of a new synthesis in its analysis of the body. Roy Porter expressed the need for this synthesis more than a decade ago: "We need a thick-textured study of the body, unprejudiced by timeless philosophical dualisms or Lovejoyan unit-ideas . . . research which contextualizes the human frame within specific sociocultural frames of reference, sensitive to experience, representations, and meaning."[78] The body has never been just a machine, just an organism, just an instrument, just a device for gender, class, or racial politics. It has been all of these things at once and has undergone constant shifts in meaning. Recognizing this gives us one escape route from the fruitless dichotomy between positivism and constructivism. We do not need to think of the embodiment of science as meaning the reduction of the natural world to just words or just things.[79]

Within the maelstrom of meanings imprinted on the industrial-era body, men and women of science faced a special problem. They had invested in the body as a powerful source of scientific and medical knowledge (both in its capacity as a subject and as a scientific instrument). Yet, all classes of society, including natural philosophers, were subject to physiological idiosyncrasies. If we wish to understand how scientific knowledge has been produced, then, we must pay closer attention to the poor health and body consciousness of its practitioners.

So much of scientific methodology emphasized the desirability of a fully functioning and virtually invisible body. But illness was so common that rendering the body invisible—or at least translucent—involved a great deal of work. The discipline of the natural philosopher's body was a never-ending project. In fact, industrial-era natural philosophers based their claims to accuracy, precision, objectivity, and other scientific virtues on the proper *management* of the body, not the perfection of the body in the first or last place. These men and women aspired to something like the public image of Cambridge Lucasian Professor Stephen Hawking, who is immobilized by Lou Gehrig's disease. As Hélène Mialet has aptly written: "We glorify him because he has transcended the conditions imposed on him by his own body, while the prevailing ideology promotes a scientist without a body or self-awareness."[80]

Even without the complications of near total paralysis, the pursuit of natural knowledge could be punishing work. Numerous medical treatises in the early modern period had emphasized the care required for the upkeep of a scholar's body. Francis Bacon, for instance, outlined two paths to longevity. The first was a "country life" where one's actions were "free and voluntary." Superior even to this lifestyle was that of monks and philosophers who lived under "regulation and commands within themselves; for then the victory and performing of the command giveth a good disposition to the spirits."[81] By contrast, a century later, Cheyne famously dubbed nervous frailty an "English malady" that preyed on contemplatives. He advised such people frequently to shave their heads and faces, wash and scrape their feet, and pare their toenails.[82] Both the lusty poet and the patient philosopher were prone to physical degeneration, acute in the former case, chronic in the latter:

> Your Men of *Imagination* [poets] are generally given to *sensual* Pleasure, because the Objects of *Sense* yield *them* a more delicate *Touch,* and a livelier *Sensation,* than they do *others*. But if they happen to live so long (which is hardly possible), in the *Decline* of Life they pay dearly for the greater bodily Pleasures they enjoyed in youthful Days of their *Vanity*. Those of *rigid, stiff* and *unyielding* Fibres, have *less vivid* Sensations, because it requires a greater Degree of *Force* to overcome a greater *Resistance*. Those excel most in the *Labours* of the *Understanding* [philosophers], or the *Intellectual* Faculties, retain their *Impressions* longest, and pursue them farthest; and are most susceptible of the slow and lasting *Passions,* which secretly consume them as *chronical* Diseases do. And *lastly,* those whose *Organs* of *Sensation* are (if I may speak so) *un-elastick,* or intirely *callous, resty* for want of Exercise, or any way *obstructed,* or naturally *ill-formed,* as they have scarce

> any *Passions* at all, or any lively *Sensations,* and are incapable of lasting *Impressions;* so they enjoy the *firmest* Health, and are subject to the fewest *Diseases:* such are *Ideots, Peasants,* and *Mechanicks,* and all those we call *Indolent People*.[83]

Ironically, Cheyne concluded, the "indolent" enjoyed the best physical health. They did not wear down their nervous fibers quickly like the "men of imagination" or slowly like the philosophers.

No one was more convinced of Cheyne's wisdom than one of his patients, David Hume. From the spring of 1730 onward, Hume's work caused him severe emotional despair. Despite Cheyne's pessimism about the health of scholars, Hume set about healing himself by improving his temper, will, reason, and understanding. This might have worked quite well, had he lived an active physical life. Such a life, Cheyne would have advised, would etch his virtuous reflections deeply into his soul. But in his sedentary solitude, those reflections would "serve to little other purpose than to waste the spirits, the force of the mind meeting with no resistance, but wasting itself in the air, like our arm when it misses its aim."[84]

These concerns about the nervous susceptibility of contemplative men intensified in the nineteenth century. Where once nervous illness was associated almost exclusively with the aristocracy, it became a middle-class epidemic in the industrial age. As early as 1768, the physician William Smith proclaimed that "there are very few disorders, which may not in a large sense be called nervous," and by another, later estimate, nervous disorders accounted for two-thirds of all disease in the early nineteenth century.[85] Whether or not this statistic was exaggerated, scholars and professionals could not help but wonder when, not whether, they too would confront nervous illness. James MacKenzie, a founding physician at the Worcester Infirmary, warned his fellow scholars to "endeavour to repair by their temperance, regularity, and care, what is perpetually impaired by their weakness, situation and study."[86] Likewise, John Herschel admonished his friend, the astronomer and stockbroker Francis Baily, to follow his physician's advice while recovering from a concussion. He should stick to light reading, for one could imagine "how hard a task thinking must impose on the nerves and fibres in their delicate offices they have to perform as ministers of the soul."[87]

A key antidote here was *management,* what would become the "therapeutic watchword" of the last decades of the nineteenth century.[88] The well-balanced man of science neither entirely transcended his body nor entirely subordinated himself to it. The work to improve one's health mattered more—and

appeared far more realistic—than the actual *achievement* of perfect health. Industrial-age Britons aspired to progress more than perfection.

For those melancholics (such as scholars) who did not physically labor for a living, exercise stood in as a substitute. It set the animal spirits in motion and reinvigorated the body and the sensorium. Conventional wisdom held that physical weakness and nervous complications went hand-in-hand. Samuel Taylor Coleridge, for example, once speculated in casual conversation that color blindness might "proceed from general weakness, which will render the differences [in colors] imperceptible, just as the dusk or twilight makes all colours one."[89] Physician James Jurin noticed that when people aged or neglected to exercise their vision, their eye muscles lost elasticity just as any other unused muscle would. Aging and looking extensively at distant objects led to farsightedness. Reading, microscopy, and other activities which involved looking at near objects produced nearsightedness.[90]

Besides exercise, impeccable moral caliber could also shield the scholar from nervous disorders. As in Charles Bell's division of the nerves into irritable and motor types, the mind also had its receptive and active faculties. From the late eighteenth century, the rationalist approach held that those whose active powers of reason, judgment, and attention held the imagination in check, enjoyed greater intellects and nervous immunity than those who succumbed to exceeding sensitivity, or "sensibility." While training a new generation of philosophers at the University of Edinburgh, Dugald Stewart approvingly quoted his mentor, Thomas Reid, on the subject: "A person of acute sensibility is so much affected with his own strong sensations, produced by the contemplation of any object, or work, calculated to excite them, that he cannot exert any discerning power, which a man of less lively sensations employs in contemplating works of taste."[91]

Those rare individuals who combined reason, regular exercise, good diet, and moral discipline had gathered all the available inoculations against nervous disorder. Jean-Baptiste Biot's 1829 portrait of Newton as subject to psychological instability therefore seemed unfathomable to many British scholars. Far from meaning any disrespect to Newton, Biot figured that a life of continuous and lofty meditations would naturally fatigue any mind. But in a spirited defense of his countryman's sanity, David Brewster argued that the "unbroken equanimity of Newton's mind, the purity of his moral character, his temperate and abstemious life, his ardent and unaffected piety, and the weakness of his imaginative powers, all indicated a mind which was not likely to be overset by any affliction to which it could be exposed." Others, such as William Whewell

and Baden Powell, accepted that genius sometimes engendered madness, and simply hoped such affiliations were rare.[92] Either way, the importance of Newton's self-control to natural philosophy's nationalism was clear.

Regardless of their assessments of Newton's character in particular, most British natural philosophers in the industrial era acknowledged that the scholar had to work not to buckle under the weight of his own thoughts. If few wished to question a national hero's sanity, the physical dangers of the scientific life were readily admitted. In fact, thwarting those dangers made the natural philosopher's life all the more heroic. Charles Wheatstone neatly encapsulated this tension between, on the one hand, the desire for the expansion of knowledge, and, on the other hand, the danger to the natural philosopher's health should this desire be overindulged. After examining Czech physiologist Jan Purkyne's ingenious but physically damaging experiments, Wheatstone found it undeniable that "their frequent repetition may be attended with dangerous effects on the eyes. On the other side, it is indispensable that the experiments should be frequently repeated and varied; for at the commencement of the inquiry the observer must be quite unaccustomed to this new field of experiment." Perhaps, Wheatstone demurred, with a hint of post hoc justification, Purkyne's eye problems had really been congenital rather than induced by experimentation.[93] Here, and in other commentaries on the risks of scientific investigation, we can detect an overarching value: the more fundamental the research, the greater the justification for self-sacrifice.

Few natural philosophers yet had the luxury of devoting their full day to the sciences. For many, then, scientific investigation was a relaxing leisure activity that could temper the strain of one's other duties, so long as one did not overindulge. For instance, William Henry lauded his fellow chemist Joseph Priestley for recommending "experimental philosophy as an agreeable relief from employments that excite the feelings or over-strain the attention," and proposed it "to the young, the high-born, and the affluent, as a source of pleasure unalloyed with the anxieties and agitations of public life."[94] The trick was to walk the narrow line of health between work and rest. French *physicien* François Arago characterized John Sylvain Bailly's instruction under Nicolas-Louis de Lacaille as particularly grueling. The modern astronomer, Lacaille told his student, agreed to devote his whole attention to his work, disregarding foul weather or fatigue:

> To complete the observation, he must read off the microscopical divisions of the graduated circle, and for what opticians call *indolent vision* (the only sort the an-

> cients ever required) must substitute *strained vision,* which in a few years brings on blindness.
>
> When he has scarcely escaped from this physical and moral torture, and the astronomer wishes to know what degree of utility is deducible from his labours, he is obliged to plunge into numerical calculations of a repelling length and intricacy.

The English translators of Arago's éloges took umbrage with his complaints about the work required in astronomy, and expressed admiration for Lacaille's "very great practical perseverance."[95] This disagreement, however, should not be read as indicating a national difference of opinion over the strenuousness of astronomy. Arago's emphasis on the physical trials of his éloge subjects was not unusual to biographical writing either in France or Britain. The significance of the English rebuttal rather speaks to the confusion among natural philosophers about what levels of diligence would best promote *both* the growth of knowledge *and* personal and national health. This point was vividly and tragically illustrated by the suicide of William Henry, the same Manchester chemist whom we heard earlier thanking Priestley for offering experimental philosophy as a relief from public life. In the 1830s Henry became more involved with organizing meetings of the British Association for the Advancement of Science, a highly public and national exercise of experimental philosophy. Several historians have argued that the extreme stress Henry endured in Bristol was the proximate cause for his suicide.[96]

While the extremity of Henry's suffering was the exception rather than the rule, we have seen how common ill health and particularly nervous disorders were among British natural philosophers. Because the nervous system also occupied the center of the inductive process in the sciences, the natural philosopher strove after nervous health not only for physical comfort, but also for the sake of epistemological authority. The active and unceasing cultivation of a rational mind and a healthy body thus constituted a normal part of the scientific process. Natural philosophers considered their arduous but successful management of the body as one indication of their ability to manage other areas of British life. As Hubert Airy would argue by 1870, the very physical frailties that threatened to bring natural philosophy's authority to its knees, actually gave the man of science the opportunity to exercise his peculiarly cultivated, disciplined habits of mind. Or so they hoped. As we will continue to see in subsequent chapters, industrial-age natural philosophers' proclamations of self-mastery and authority to govern other national affairs had to be established, not assumed.