MIND AND BODY:
René Descartes to William James

by Robert H. Wozniak

RENÉ DESCARTES AND THE LEGACY OF MIND/BODY DUALISM

René Descartes

1. René Descartes

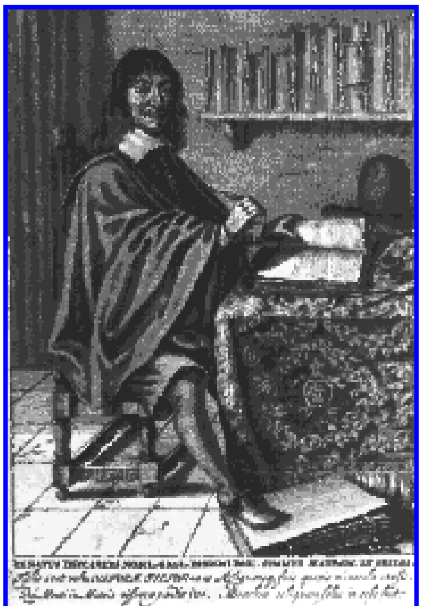

Figure 1
René Descartes (1596-1650)

While the great philosophical distinction between mind and body in western thought can be traced to the Greeks, it is to the seminal work of René Descartes (1596-1650) [see figure 1], French mathematician, philosopher, and physiologist, that we owe the first systematic account of the mind/body relationship. Descartes was born in Touraine, in the small town of La Haye and educated from the age of eight at the Jesuit college of La Flèche. At La Flèche, Descartes formed the habit of spending the morning in bed, engaged in systematic meditation. During his meditations, he was struck by the sharp contrast between the certainty of mathematics and the controversial nature of philosophy, and came to believe that the sciences could be made to yield results as certain as those of mathematics.

From 1612, when he left La Flèche, until 1628, when he settled in Holland, Descartes spent much of his time in travel, contemplation, and correspondence. From 1628 until his ill-fated trip to Sweden in 1649 he remained for the most part in Holland, and it was during this period that he composed a series of works that set the agenda for all later students of mind and body. The first of these works, *De homine* [1] was completed in Holland about 1633, on the eve of the condemnation of Galileo. When Descartes' friend and frequent correspondent, Marin Mersenne, wrote to him of Galileo's fate at the hands of the Inquisition, Descartes immediately suppressed his own treatise. As a result, the world's first extended essay on physiological psychology was published only well after its author's death.

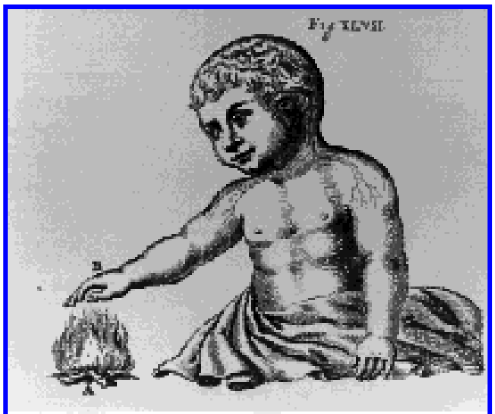

Figure 2
The mechanism for automatic reaction in response to external events, illustrated in Descartes' *De homine* (1662).

In this work, Descartes proposed a mechanism [see figure 2] for automatic reaction in response to external events. According to his proposal, external motions affect the peripheral ends of the *nerve fibrils*, which in turn displace the central ends. As the central ends are displaced, the pattern of *interfibrillar space* is rearranged and the flow of *animal spirits* is thereby directed into the appropriate nerves. It was Descartes' articulation of this mechanism for automatic, differentiated reaction that led to his generally being credited with the founding of reflex theory.

Although extended discussion of the metaphysical split between mind and body did not appear until Descartes' *Meditationes*, his *De homine* outlined these views and provided the first articulation of the mind/body interactionism that was to elicit such pronounced reaction from later thinkers. In Descartes' conception, the rational soul, an entity distinct from the body and making contact with the body at the pineal gland, might or might not become aware of the differential outflow of animal spirits brought about through the rearrangement of the interfibrillar spaces. When such awareness did occur, however, the result was conscious sensation -- body affecting mind. In turn, in voluntary action, the soul might itself initiate a differential outflow of animal spirits. Mind, in other words, could also affect body.

The year 1641 saw the appearance of Descartes' *Meditationes de prima philosophia, in quibus Dei existentia, & animae à corpore distinctio, demonstratur*

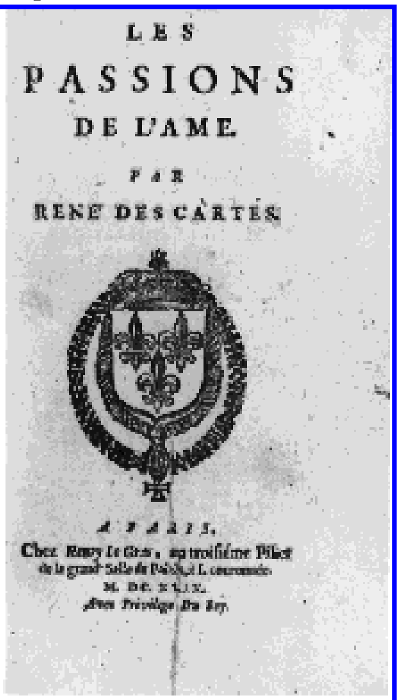

Figure 3
Descartes' Les passions de l'ame (1649) was his most important contribution to psychology proper.

In 1649, on the eve of his departure for Stockholm to take up residence as instructor to Queen Christina of Sweden, Descartes sent the manuscript of the last of his great works, *Les passions de l'ame*[3], to press. *Les passions* [see figure 3] is Descartes' most important contribution to psychology proper. In addition to an analysis of primary emotions, it contains Descartes' most extensive account of causal mind/body interactionism and of the localization of the soul's contact with the body in the pineal gland. As is well known, Descartes chose the pineal gland because it appeared to him to be the only organ in the brain that was not bilaterally duplicated and because he believed, erroneously, that it was uniquely human.

In February of 1650, returning in the bitter cold from a session with Queen Christina, who insisted on receiving her instruction at 5 a.m., Descartes contracted pneumonia. Within a week, the man who had given direction to much of later philosophy was dead. By focusing on the problem of true and certain knowledge, Descartes had made epistemology, the question of the relationship between mind and world, the starting point of philosophy. By localizing the soul's contact with body in the pineal gland, Descartes had raised the question of the relationship of mind to the brain and nervous system. Yet at the same time, by drawing a radical ontological distinction between body as extended and mind as pure thought, Descartes, in search of certitude, had paradoxically created intellectual chaos.

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RENATUS DESCARTES, NOBIL. GALL. PERRONI DOM. SUMMUS MATHEM. ET PHILOS.

Talis erat vultu NATURÆ FILIUS: unus Assignansq; suis quavis miracula caussis,
Qui Menti in Matris viscera pandit iter. Miraclum reliquum solus in orbe fuit.

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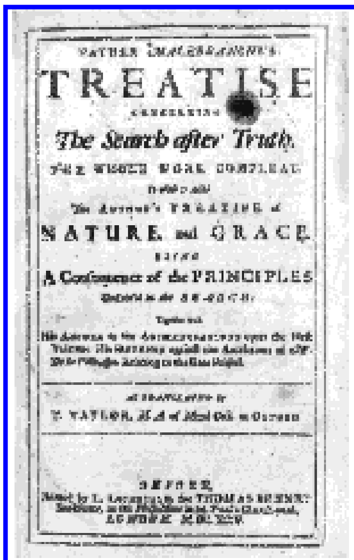
2. The 17th Century: Reaction to the Dualism of Mind and Body

The history of philosophizing about the relation of body and mind since Descartes is the history of attempts to escape the Cartesian impasse. Early maneuvers of this sort, such as those of Malebranche, Spinoza, Leibniz, and the French materialists La Mettrie and Cabanis, were formulated in the context of metaphysics, in direct response to Cartesian dualism. Later views which arose in the 19th century needed to reconcile evidence from studies on the localization of cerebral function and on functional nervous disorders with prevailing theory in biology and psychology. These discussions reflected the newly accepted view that the brain serves as the organ of mind. Although these theories of mind/brain relations -- epiphenomenalism, interactionism, dual-aspect monism, and mind-stuff theory -- were formulated in the context of science, they too were oriented toward circumventing the Cartesian impasse.


TREATISE

The Search after Truth.

NATURE and GRACE

A Consequence of the PRINCIPLES

Figure 4
Malebranche's *Treatise Concerning The Search after Truth* contained the classic statement of the occasionalist view that mind and body are both causally ineffective.

If the natural world is radically divided into the mental and the physical such that the physical is extended in space and the mental is not, and if the nature of causality is such that causes and effects must have a necessary connection and be of a similar type, then mind/body interactionism of the Cartesian sort is obviously untenable. Perhaps the first important attempt to deal with this contradiction in Descartes is that known as *occasionalism*. Although preceded and influenced by *Le discernement du corps et de l'ame* (1666) of Géraud de Cordemoy (d. 1684), the work of Nicolas Malebranche (1638-1715) was probably the most influential purveyor of occasionalism.

Born in Paris and educated at the Collège de La Marche and the Sorbonne, Malebranche began to read Descartes in 1664. A decade later, he published *De la recherche de la vérité*[4,see figure 4] in which he argued that both of Descartes' substances, mind and body, are causally ineffective. God is the one and only true cause. Not only is there no influence of mind on body or of body on mind, there is no causality operative at all except insofar as God, the one true cause, intervenes to produce the regularities that occur in experience. Thus, for example, when a person wills to move a finger, that serves as the occasion for God to move the finger; when an object suddenly appears in a person's field of view, that serves as the occasion for God to produce a visual perception in the person's mind.


Figure 5
Benedictus de Spinoza
[Baruch Spinoza] (1632-1677)

An alternative and much more enduring attempt to respond to the Cartesian impasse was that of Benedictus de Spinoza (1632-1677) [see figure 5]. Born in Amsterdam, Spinoza spent his life as a lens grinder. A Jew who had been expelled from the synagogue for unorthodoxy, he maintained few ties to either Dutch or Jewish contemporaries and published little during his lifetime. The metaphysical masterpiece,*De ethica*, appeared in his *Opera posthuma*[5], first published in 1677.

In order to retain the notion of God as the one true cause without sacrificing the idea of causality as operative in both the mental and the physical spheres, Spinoza abandoned Descartes' two-substance view in favor of what has come to be called double-aspect theory. Double-aspect theories are based on the notion that the mental and the physical are simply different aspects of one and the same substance. For Spinoza, that single substance was God. While agreeing with Descartes that the world of consciousness and that of extension are qualitatively separate, Spinoza rejected the Cartesian view that consciousness and extension are attributes of two finite substances in favor of the notion that they are attributes of only one infinite substance. That substance, God, is the universal essence or nature of everything that exists.

The direct implication of Spinoza's view is that while mental occurrences can determine only other mental occurrences and physical motions can determine only other physical motions, mind and body nonetheless exist in pre-established coordination, since the same divine essence forms the connections within both classes and cannot be self-contradictory. In the later half of the 19th century, as we shall see, dual-aspect theories underwent a revival.

Still another alternative to Cartesian interactionism is that of *psychophysical parallelism*. This view retains both the dualism of mind and body and the notion of a regular correlation between mental and physical events, but avoids any assumption of causal mind/body connection, direct or indirect. Psychophysical parallelism eschews interactionism on the grounds that events so totally dissimilar as those of mind and body could not possibly affect one another. It also rejects occasionalism and dual-aspect theory on the grounds that no third entity, whatever that might be, could be responsible for such vastly different effects. Parallelists simply accept the fact that every mental event is correlated with a physical event in such a way that when one occurs, so too does the other.

Parallelism in this form is usually traced to Gottfried Wilhelm Leibniz (1646-1716). Historian, mathematician, philosopher, scientist, and diplomat, Leibniz was born and received most of his education in Leipzig. In 1676, after a period at Mainz and four years at Paris, he went to Hanover, where he spent the remainder of his life. An inveterate correspondent, contributor to scholarly journals, and creator of manuscripts, much of Leibniz' most important work was embodied in letters, published in article form, or left unpublished at his death.

In the *Système nouveau de la nature* (1695) and the *Eclaircissement du nouveau sisteme* (1696), Leibniz presented the famous articulation of psychophysical parallelism in which he adapted an occasionalist metaphor to support the view that soul and body exist in a pre-established harmony. Comparing soul and body to two clocks that agree perfectly, Leibniz argued that there are only three possible sources for this agreement. It may occur through mutual influence (interactionism), through the efforts of a skilled workman who regulates the clocks and keeps them in accord (occasionalism), or by virtue of the fact that they have been so constructed from the outset that their future harmony is assured (parallelism). Leibniz rejects interactionism because it is impossible to conceive of material particles passing from one substance to the other and occasionalism as invoking the intervention of a *Deus ex machina* in a natural series of events. All that remains is parallelism -- the notion that mind and body exist in a harmony that has been pre-established by God from the moment of creation.

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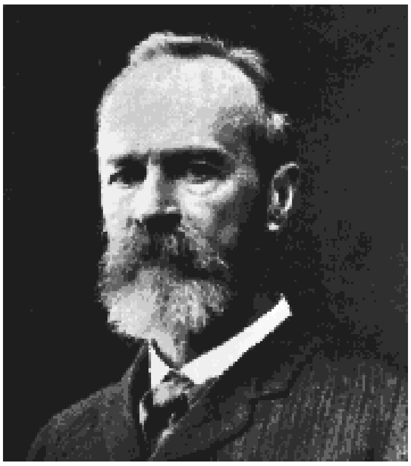

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3. The 18th Century: Mind, Matter, and Monism

Figure 6
Julien Offray de La Mettrie
(1709-1751)

All of the above views, even that of Spinoza, make some distinction between mind and body. Once such a distinction is drawn, at whatever level, the problem of re-relating mind to body immediately arises. In order to avoid the mind/body problem entirely, one must deny any distinction between mind and body. Over the course of intellectual history, denials of this sort have taken different forms. *Immaterialism*, best represented by George Berkeley (1685-1753) in his *A Treatise concerning the Principles of Human Knowledge* (1710), denies even the possibility of mindless material substance. For something to exist for Berkeley, it must either be perceived or be the active mind doing the perceiving. From this perspective, there is no mind/body distinction because what we think of as body is merely the perception of mind. While Berkeley had few contemporary adherents, immaterialism was to resurface in the later 19th century in the guise of mind- stuff theory.

Materialism, which dates to antiquity, holds that matter is fundamental. Whatever else may exist, if it exists, it depends on matter. In its most extreme version, materialism completely denies the existence of mental events, a view which would appear to have its roots in Descartes' conception of animals as purely physical automata. In a less extreme form, materialism makes mental events causally dependent on bodily events, but does not deny their existence. This was the view offered a century after Descartes by Julien Offray de la Mettrie (1709-1751) [see figure 6].

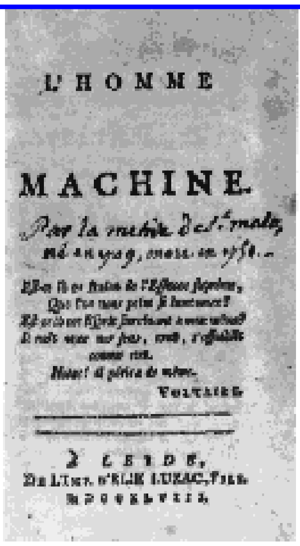

Figure 7
L'homme machine appeared in three French editions of 1748: the "W" edition of 108 pages, which is exceptionally rare (perhaps burned); the standard "X" edition of 109 pages, with errors of the "W" edition corrected; and a "Y" edition, possibly pirated, of 148 pages.

La Mettrie was born in Brittany, in the town of Saint-Malo. After studying medicine at Paris and Rheims, he worked under Hermann Boerhaave at Leiden. In 1745, he published his first work, *Histoire naturelle de l'ame*. Public outcry over his materialism, exacerbated by outrage over his publication of an incautious medical satire, led to La Mettrie's self-exile to Holland. There, in 1748, he published *L'homme machine*[6], an extension of Descartes' automata concept from animals to man. With *L'homme machine*, La Mettrie succeeded in testing the patience of even the liberal Dutch clergy. The book was publicly burned [see figure 7] and La Mettrie was forced to seek protection from Frederick the Great at Berlin. There, until his death in 1751, he continued to publish on a variety of topics, usually in a manner calculated to infuriate his enemies.

In many ways, *L'homme machine* was a ground-breaking work. While arguing the case for a uniform material dependence of states of the soul upon states of the body, it maintained a distinctly antimetaphysical tone. As Vartanian (1967) pointed out, La Mettrie's "naturalistic view of man ... is offered mainly as a general heuristic hypothesis necessary in the positive study of behavior, without the need being felt ... to make mental processes reductively identical with their physiological causes" (p. 380). In addition, *L'homme machine* introduced the critical notion that conscious and voluntary processes are only distinguished from involuntary and instinctual activities by the relative complexity of their mechanical substrate. In articulating this point, La Mettrie went far beyond the static mechanism of Descartes to conceive of the living machine as a purposive, autonomous, and dynamic system.

Figure 8
Pierre Jean Georges Cabanis
(1757-1808)

Although vilified in his own time, La Mettrie's often unacknowledged influence continued to be felt for many years within French intellectual circles. Pierre Jean Georges Cabanis (1757-1808) [see figure 8] was among those indebted to La Mettrie's ideas. Indeed, Cabanis, the most ardent materialist of the French enlightenment, was simply taking La Mettrie's naturalism to its logical extreme in his *Rapports du physique et du moral de l'homme* (1802) [7], when he argued that "to have an accurate idea of the operations from which thought results, it is necessary to consider the brain as a special organ designed especially to produce it, as the stomach and the intestines are designed to operate the digestion, (and) the liver to filter bile..." (English translation, p. 116)

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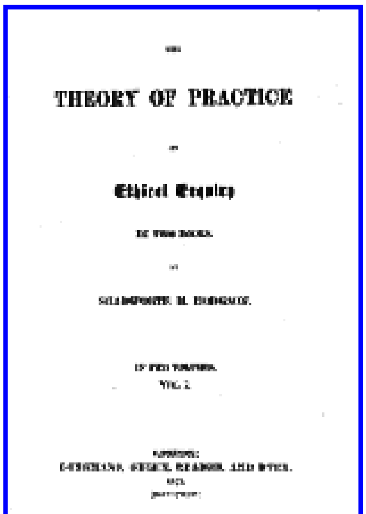
4. The 19th Century: Mind and Brain

As the 19th century progressed, the problem of the relationship of mind to brain became ever more pressing. Indeed, so deep was the concern with mind/brain relations that it is difficult to find a systematic text written after 1860 that does not contain a discussion of this issue. To a large extent, this directly reflected two major developments that converged to impress philosophers and psychologists with the centrality of the mind/brain problem. The first of these involved progress in understanding the localization of cerebral function, based on the idea that the brain serves as the organ of mind. The second involved a growing familiarity with the thesis that mental events -- beliefs, mental suggestions, mesmeric trance states, psychic traumas and the like -- sometimes bring about radical alterations in the state of the body. This change occurred as progress was made in understanding the nature of functional nervous disorders. Before proceeding further, we will briefly describe some of the major mind/brain perspectives articulated in response to these trends.

Although the theories of mind/brain relationship prevalent in the 19th century -- epiphenomenalism, interactionism, dual-aspect monism, and mind- stuff -- were formulated in the context of science, they, like their predecessors, were attempts to deal with the metaphysical complexities of the Cartesian impasse. It is not surprising, therefore, that these views evolved for the most part as variations on themes already addressed.


THEORY OF PRACTICE

Ethical Enquiry

SHADWORTH H. HODGSON.

VOL. I.

LONGMANS, GREEN, READER, AND DYER.

Figure 9
In *The Theory of Practice* (1870), Hodgson offered the first modern articulation of the view that mind is an epiphenomenon.

In 1870, Shadworth Holloway Hodgson (1832-1912), an English philosopher, published a two-volume work entitled *The Theory of Practice* [8]. In it he provided the first modern articulation of a view that he termed *epiphenomenalism*. Descartes, of course, had conceived the idea that animals were purely physical automata devoid of mental states, a notion that carries with it the implication that a completely self-sufficient neural mechanism can produce complicated and apparently intelligent acts. In La Mettrie and, later, in Cabanis, this view was extended to humans, but moderated so that only the causal efficacy and not the actual existence of mental states was denied. In this regard, the French materialists anticipated Hodgson.

In *The Theory of Practice* [see figure 9], Hodgson argued that, regardless of their intensity, feelings have no causal efficacy whatsoever. Comparing mental states to the colors laid on the surface of a stone mosaic and neural events to the supporting stones, Hodgson asserted that just as the stones are held in place by one another and not by the colors they support, events in the nervous system form an autonomous chain independent of accompanying mental states. Mental states are present only as "epiphenomena," incapable of reflecting back to affect the nervous system.

This view was subsequently taken up, popularized, and placed within an evolutionary framework by Thomas Henry Huxley (1825-1895). In 1874, in an address in Belfast to the British Association for the Advancement of Science, Huxley presented one of the most widely cited and influential papers of the period, "On the hypothesis that animals are automata, and its history." In it Huxley suggested that states of consciousness are merely the effect of molecular changes in brain substance that has attained a prerequisite degree of organization. Animals, therefore, are "conscious automata."

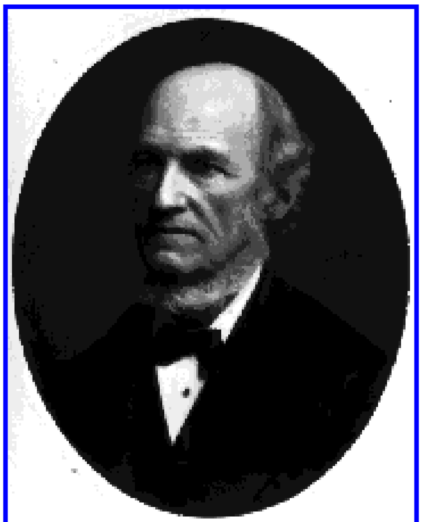


Figure 10
William Benjamin Carpenter (1813-1885)

In the same year, another work appeared, *Principles of Mental Physiology* [9] by William Benjamin Carpenter (1813-1885) [see figure 10], which took a position on the mind/brain relation diametrically opposed to the epiphenomenalism of Hodgson and Huxley. Carpenter was a British physician who had received his medical education at Bristol, University College London, and Edinburgh. In 1845 he assumed the Fullerian Professorship of Physiology at the Royal Institution and from 1856 to 1879 served as Registrar at the University of London. *Principles of Mental Physiology* contained as thoroughgoing an interactionism as the 19th century produced:

"Nothing," Carpenter wrote, "can be more certain, than that the primary form of mental activity, -- Sensational consciousness, -- is excited through physiological instrumentality. A certain Physical impression is made, for example, by the formation of a luminous image upon the Retina of the Eye ... Light excites Nerve-force, and the transmission of this Nerve-force excites the activity of that part of the Brain which is the instrument of our Visual Consciousness. Now in what way the physical change thus excited in the Sensorium is translated (so to speak) into that psychical change which we call seeing the object whose image was formed upon our Retina, we know nothing whatever; but we are equally ignorant of the way in which Light produces Chemical change ... And all we can say is, that there is just as close a succession of sequences -- as intimate a causal relation between antecedent and consequent -- in the one case, as there is in the other."

Conversely, "the like Correlation may be shown to exist between Mental states and the form of Nerve-force which calls forth Motion through the Muscular apparatus ... each kind of Mental activity, -- Sensational, Instinctive, Emotional, Ideational, and Volitional, -- may express itself in Bodily movement ... Just as a perfectly constructed Galvanic battery is *inactive* while the circuit is "interrupted," but becomes *active* the instant that the circuit is "closed," so does a Sensation, an Instinctive tendency, an Emotion, an Idea, or a Volition, which attains an intensity adequate to "close" the circuit, liberate the Nerve-force with which a certain part of the Brain ... is always charged" (pp. 12-14).

Unfortunately, in the 241 years separating Descartes' *De homine* from Carpenter's *Principles of Mental Physiology*, little progress had been made in removing the primary objection to interactionism. In the oft quoted words of John Tyndall (1871), "the passage from the physics of the brain to the corresponding facts of consciousness is unthinkable. Granted that a definite thought, and a definite molecular action in the brain occur simultaneously; we do not possess the intellectual organ, nor apparently any rudiment of the organ, which would enable us to pass, by a process of reasoning, from the one to the other" (pp. 119-120). Since this is an objection that can be just as effectively urged against epiphenomenalism, which rids itself of only half the problem of interactionism, other 19th century thinkers turned, as had their predecessors, to monism as the view of last resort. Two of the most influential monisms of the period, both aspect theories, were *dual-aspect monism* and *mind-stuff theory*.

Dual-aspect monism was the brain child of George Henry Lewes (1817- 1878). Born in London, Lewes was one of the most versatile and brilliant minds of the century. A writer, actor, biologist, philosopher, and psychologist, his interests ranged across a staggering array of topics. He was the author of a still widely read *Biographical History of Philosophy* (1845/1846). His *Physiology of Common Life* (1859/1860) converted the young Pavlov to the study of physiology, and his five-volume *Problems of Life and Mind* (1874/1879) constituted a major contribution to the psychology of the period.

In *The Physical Basis of Mind* [10], which forms the third volume of *Problems of Life and Mind,* Lewes articulated the classic modern formulation of double aspect theory, *dual-aspect monism*. In presenting his position, Lewes went well beyond the theories of his predecessors, supplementing the double aspect notion with a view that has come to be called *neutral monism*. Neutral monism involves the claim that there is only one kind of "stuff" and that mind and body differ only in the arrangement of that stuff or in the perspective from which it is apprehended.

Borrowing a metaphor from Fechner, Lewes characterized the relation of mind to body as a curve that maintains its identity as a single line even though characterized at every point by both concavity and convexity. Mental and physical processes, in other words, are simply different aspects of one and the same series of psychophysical events. When seen from the subjective point of view (e.g., when someone is thinking), the psychophysical series is mental; when seen from the objective point of view (e.g., when someone observes what is going on in the thinking person's brain), it is physical.

In the argument for the dual-aspect view, however, Lewes's innovation was by no means restricted to his neutral monism. Mental and physical descriptions, he went on to assert, employ terms which are not intertranslatable. The visual experience of a large elephant can not be adequately described through statements that characterize either the laws of light or the mechanisms of the nervous system. Mental terms, in other words, cannot in principle be replaced by physical terms. In making this claim, Lewes transferred the domain of discourse from metaphysics to language and provided what is still the best argument against extreme reductionism and the replacement of psychology by physiology.

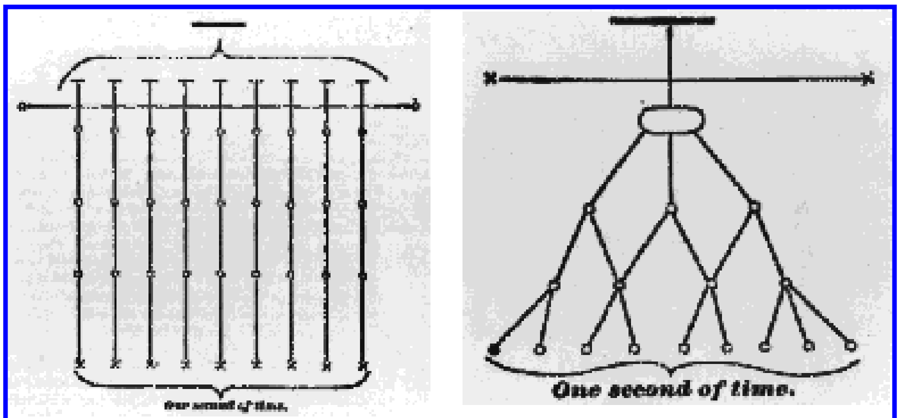


Figure 11
"Mind-Stuff" compounding, as illustrated by William James in his *Principles of Psychology* (1890).

Mind-stuff theory, which is logically akin to Lewes's dual-aspect monism, involves a number of related ideas. The first of these is that higher properties of mind, such as judgment, reasoning, volition, or the continuous flow of consciousness, are compounded from mental elements (pieces of mind-stuff) that do not in themselves manifest these higher properties. The second is that even the most basic material elements possess a small piece of mind-stuff such that when these elements are combined, mind-stuff is similarly combined. Thus, for example, when molecules come together at a level of complexity sufficient to form a brain and nervous system, correlative mind-stuff forms consciousness. And finally, in contrast to the dual-aspect monism of Lewes, which construes both mind and matter as aspects of a neutral substance, mind-stuff theory takes a position of psychical monism, arguing that mind is the only actual substance and that the material world is nothing more than an aspect under which mind is apprehended.

The idea that consciousness is compounded of mental elements which do not themselves possess consciousness was widespread during the 19th century. Thus, for example, in a passage roundly criticized by William James [see figure 11], Herbert Spencer (1870) went so far as to suggest that "there may be a single primordial element of consciousness, and the countless kinds of consciousness may be produced by the compounding of this element with itself and the recompounding of its compounds with one another in higher and higher degrees: so producing increased multiplicity, variety, and complexity" (I, p. 150). Although this idea is usually attributed to Leibniz and his doctrine of unconscious *petites perceptions* (see his *Nouveau essais sur l'entendement humain*, written in 1695 but first published in the 1765 *Oeuvres philosophiques latines & françoises*), Diamond (1974) has identified a clear anticipation of this concept in the work of Leibniz's friend, Ignace Gaston Pardies (1672).

The coining of the term "mind-stuff" and the application of this view to the metaphysics of mind and body is generally credited to William Kingdon Clifford (1845-1879), who brought the components of "mind-stuff" theory together in his paper, "On the nature of things in themselves," published in 1878 in the journal *Mind*. The clearest and most succinct exposition of the mind-stuff position, however, was provided by Morton Prince (1854-1929) [see figure 12] in *The*

Nature of Mind and Human Automatism (1885)

Figure 12
Morton Prince (1854-1929)

Prince was born in Boston and educated at Boston Latin, Harvard College, and Harvard Medical School. Inspired by the work of Charcot and Janet on hysteria, Liébeault and Bernheim on suggestion, Gurney on the hypnotic induction of dissociation, and James on automatic writing, Prince entered early upon the study of conscious and unconscious mental phenomena which was to become his life's work. Indeed, while he was still a medical student, he won the Boylston Prize for his graduation thesis, a treatise that eventually formed the core of *The Nature of Mind and Human Automatism*.

In *The Nature of Mind and Human Automatism*, Prince concerned himself with justifying the intuitive belief that our thoughts have something to do with the production of our actions. "No amount of reasoning," he wrote, "can argue me out of the belief that I drink this water because I am thirsty" (p. 101). After rejecting parallelism as being at variance with this intuition, Prince presented the classic formulation of the mind-stuff metaphysic: "instead of there being one substance with *two properties* or 'aspects,' -- mind and motion, -- *there is one substance, mind;* and the other *apparent* property, motion, is only the way in which this real substance, mind, is apprehended by a *second organism*: only the sensations of, or effect upon, the second organism, when acted upon (ideally) by the real substance, mind" (pp. 28-29). For Prince, in other words, the psychical monism of mind-stuff constituted a modern form of immaterialism.

Like Prince, William James could never shake his conviction in the efficacy of mind; but like Hodgson, who had exerted a considerable early influence on the development of James's thought, neither could he shake his belief in the reality and efficacy of the brain. In 1890, when *The Principles of Psychology* was finally published, James devoted two chapters to the analysis and critique of contemporary mind/brain views, one to the automaton theory and another to the mind-stuff theory. Both chapters present extensive discussions of reasons for and against the views under analysis. The reader proceeding through the systematic dismantling of each of these views expects James, at any moment, to produce his own brilliant synthesis. Instead, however, even the redoubtable James, like many of those who had preceded him, found himself confounded by the Cartesian impasse:

"What shall we do? Many would find relief at this point in celebrating the mystery of the Unknowable and the 'awe' which we should feel at having such a principle to take final charge of our perplexities. Others would rejoice that the finite and separatist view of things with which we started had at last developed its contradictions, and was about to lead us dialectically upwards to some 'higher synthesis' in which inconsistencies cease from troubling and logic is at rest. It may be a constitutional infirmity, but I can take no comfort in such devices for making a luxury of intellectual defeat. They are but spiritual chloroform. Better live on the ragged edge, better gnaw the file forever!" (I, pp. 178-179).

James's "solution" is to opt for a provisional and pragmatic empirical parallelism of the sort to which many psychologists still subscribe. The "simplest psycho-physic formula," he writes, "and the last word of a psychology which contents itself with verifiable laws, and seeks only to be clear, and to avoid unsafe hypotheses" would appear to be a "blank unmediated correspondence, term for term, of the succession of states of consciousness with the succession of total brain processes ..." (I, p. 182). Beyond that, James suggests, we are unable to go at present without leaving the precincts of empirical science.

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MIND AND BODY: René Descartes to William James

by Robert H. Wozniak

5. Mind, Brain, and Adaptation: the Localization of Cerebral Function

As the 19th century progressed, the problem of the relationship of mind to brain became especially acute as physiologists and psychologists began to focus on the nature and localization of cerebral function. In a diffuse and general way, the idea of functional localization had been available since antiquity. A notion of "soul" globally related to the brain, for example, can be found in the work of Pythagoras, Hippocrates, Plato, Erisistratus, and Galen, among others. The pneumatic physiologists of the middle ages thought that mental capacities were located in the fluid of the ventricles. As belief in animal spirits died, however, so too did the ventricular hypothesis; and by 1784, when Jiri Prochaska published his *De functionibus systematis nervosi*, interest had shifted to the brain stem and cerebrum.

Despite these early views, the doctrine of functional localization proper -- the notion that specific mental processes are correlated with discrete regions of the brain -- and the attempt to establish localization by means of empirical observation were essentially 19th century achievements. The first critical steps toward those ends can be traced to the work of Franz Josef Gall (1758- 1828).

Figure 13
Franz Josef Gall (1758-1828)

Gall [see figure 13] was born in Baden and studied medicine at Strasbourg and Vienna, where he received his degree in 1785. Impressed as a child by apparent correlations between unusual talents in his friends and striking variations in facial or cranial appearance, Gall set out to evolve a new cranioscopic method of localizing mental faculties. His first public lectures on cranioscopy date from around 1796. Unfortunately, his lectures almost immediately aroused opposition on the grounds of his presumed materialism, and in 1805, he was forced to leave Vienna. After two years of travel, he arrived in Paris accompanied by his colleague, Johann Gaspar Spurzheim (1776-1832). In 1810, Gall and Spurzheim published the first volume of the *Anatomie et physiologie du système nerveux en général* [12], Gall's most important contribution to neuroanatomy and the first major statement of his cranioscopy.

The essence of Gall's method of localization lay in correlating variations in character with variations in external craniological signs. The validity of this approach depended on three critical assumptions: that the size and shape of the cranium reflected the size and shape of the underlying portions of the cerebrum, that mental abilities were innate and fixed, and that the relative level of development of an innate ability was a reflection of the inherited size of its cerebral organ. On these assumptions, an observed correlation between a particularly well-developed ability and a particularly prominent area of the cranium could be interpreted as evidence of the functional localization of that ability in the correlative portion of the cerebrum.

While Gall's correlational approach was eventually abandoned in favor of experiment, his conception of fixed, innate faculties replaced by a dynamic, evolutionary view of mental development, and his pivotal assumption concerning the relationship of brain to cranial conformation rejected, it would be a serious error to underestimate his importance in the history of functional localization. Gall's assumptions may have been flawed and his followers may have taken his ideas to dogmatic extremes; but there was nothing wrong with his scientific logic or with the rigorous empiricism of his attempt to correlate observable talents with what he believed to be observable indices of the brain.

Indeed, it was Gall who lay the foundations for the biologically based, functional psychology that was soon to follow. In postulating a set of innate, mental traits inherited through the form of the cerebral organ, he moved away from the extreme *tabula rasa* view of sensationalists such as Condillac [see 30]. For the normative and exclusively intellectual faculties of the sensationalists, Gall attempted to substitute faculties defined in terms of everyday activities of daily life that were adaptive in the surrounding environment and that varied among individuals and between species. For speculation concerning both the classification of functions and appropriate anatomical units, he substituted objective observation.

Even Gall's most persistent opponent, Marie-Jean-Pierre Flourens (1794- 1867), was willing to admit that it was Gall who, by virtue of marshalling detailed evidence of correlation between variation in function and presumed variation in the brain, first fully established the view that brain serves as the organ of mind. In almost all other respects, however, Flourens was highly critical of Gall. Something of a child prodigy, Flourens enrolled at the famed Faculté de Médecine at Montpellier when he was only 15 years old and received his medical degree before he had turned 20. Shortly thereafter, while Gall was at the height of his career in Paris, Flourens himself moved to the capital. On the basis of his 1824 *Recherches expérimentales sur les propriétés et les fonctions du système nerveux* [13], he was elected to membership and eventually to the office of Perpetual Secretary of the Académie des Sciences, rising to become one of France's most influential scientific figures.

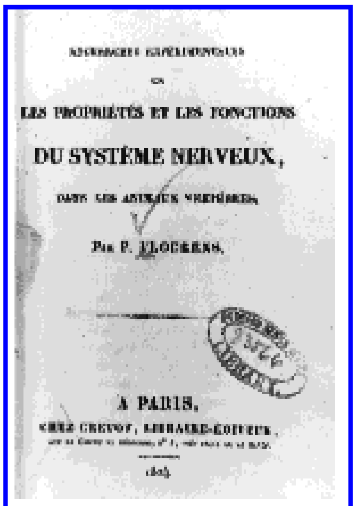

Figure 14
In the *Recherches expérimentales* (1824), Flourens reported the first experimental localization of function in the brain.

In *Recherches expérimentales* [see figure 14], Flourens provided the first experimental demonstration of localization of function in the brain. While previous researchers had lesioned the brain through a trephined aperture that made it impossible to localize damage or to track hemorrhage with any accuracy, Flourens completely uncovered and isolated that portion of the brain to be removed. Taking care to minimize operative trauma and post- operative complications, he employed ablation to localize a motor center in the medulla oblongata and stability and motor coordination in the cerebellum. Although his treatment of sensation was still rather confused in 1824, by the time the second edition of the *Recherches expérimentales* (1842) appeared, Flourens had articulated a clear distinction between sensation and perception (treating perception as the appreciation of the meaning of a sensation) and localized sensory function in several related sub-cortical structures.

With respect to the cerebrum, however, the results were quite different. A successive slicing through the hemispheres produced diffuse damage to all of the higher mental functions -- to perception, intellect, and will -- with the amount of damage varying only with the extent and not the location of the lesion. If adequate tissue remained, function might be restored; but total ablation led to a permanent loss of function. From these results, Flourens concluded that while sensory-motor functions are differentiated and localized sub-cortically, higher mental functions such as perception, volition, and intellect are spread throughout the cerebrum, operating together as a single factor with the entire cerebrum functioning in a unitary fashion as their "exclusive seat."

Unfortunately, however, as Gall (1822/1825) himself observed, Flourens's procedure "mutilates all the organs at once, weakens them all, extirpates them all at the same time" (ENG: VI, pp. 165-166). Ablation by successive slices was not a method well suited to the discovery of cortical localization. Joined to a strongly held philosophical belief in a unitary soul and an indivisible mind and an uncritical willingness to generalize results from lower organisms to humans, Flourens's results led him to attack Gall's efforts at localization and to formulate a theory of cerebral homogeneity that, in effect, anticipated Lashley's (1929) much later concept of mass-action and cortical equipotentiality. Having extended the sensory-motor distinction up the neuraxis from the spinal roots of Bell and Magendie [see 33], Flourens stopped short of the cerebral hemispheres. From his perspective, the cerebrum was the organ of a unitary mind, and, by implication, it could not therefore be functionally differentiated.

Before the cortex could come to be construed in sensory-motor terms, the intellectual ground had to be prepared and the technical means developed. The intellectual requirements for this achievement involved the abandonment of a fixed faculty approach to mind in favor of a balanced sensory-motor, evolutionary associationism and an appreciation of the functional implications of brain disease. The technical requirement was the development of a technique for electrical exploration of the surface of the cortex. The intellectual advances came through the respective psychologies of Alexander Bain and Herbert Spencer and the neuropathological discoveries of Pierre Paul Broca. The technical advance, involving development and use of electrical stimulation, was first employed by Gustav Fritsch and Eduard Hitzig.


Figure 15
Alexander Bain (1818-1903)

Alexander Bain (1818-1903) [see figure 15] was born, educated, and died in Aberdeen, Scotland. After receiving the M.A. degree from Marischal College in 1840, he joined the faculty in mental and moral philosophy. In 1860 he was elected to the chair of logic at the newly created University of Aberdeen where he remained until his retirement. During these years, Bain wrote a rarely read but interesting critique of phrenology, *On the Study of Character, Including an Estimate of Phrenology* (1861), and a valuable survey of mind/body views, *Mind and Body. The Theories of Their Relation* (1873). It is, however, to his general psychology that we must look for his most important contribution to the intellectual climate from which the first specific demonstrations of the cortical localization of sensory-motor function arose. This contribution consisted of the sensory-motor associationism which he worked out in *The Senses and the Intellect* and *The Emotions and the Will* [14], first published in 1855 and 1859 respectively and revised in four editions through 1894/1899.

Bain's work marked a turning point in the history of associationist psychology. Before Bain, the associationists' empiricist commitment to experience as the primary or only source of knowledge [see 27-30] led to the neglect of movement and action in favor of the analysis of sensation. Even when motion was explicitly included in associationist accounts, as for example in the case of Thomas Brown [see 34], it was the sensory side of movement, the "muscle sense," rather than adaptive action that claimed attention. Bain, drawing heavily on Müller [see 38], brought the new physiology of movement into conjunction with an associationist account of mind. As Young (1970) has summarized Bain's view:

"'Action is a more intimate and inseparable property of our constitution than any of our sensations, and in fact enters as a component part into every one of the senses, giving them the character of compounds ...' (Bain, 1868, p. 59) ... Spontaneous movements are a feature of nervous activity prior to and independent of sensations. The acquired linkages of spontaneous movements with the pleasure and pains consequent upon them, educate the organism so that its formerly random movements ... (are) adapted to ends or purposes. Bain defines volition as this compound of spontaneous movements and feelings. The coordination of motor impulses into definite purposive movements results from the association of ideas with them" (p. 115).

Within association psychology, these were revolutionary ideas. Together with the evolutionary conceptions of Spencer, they paved the way for the later functionalist psychology of adaptive behavior; and, as we shall see, they provided the intellectual context for a sensory-motor account of the physiological basis of higher mental functions. Ironically, however, this was a step that Bain himself was completely unable to take. Impressed, as those before him had been, with the lack of irritability exhibited by the cortex when pricked or cut, Bain drew the traditionally sharp distinction "between the hemispheres and the whole of the ganglia and centres lying beneath them" (pp. 53-54). Whatever the function of the cerebrum, it was clear to Bain that it could not be sensory-motor.

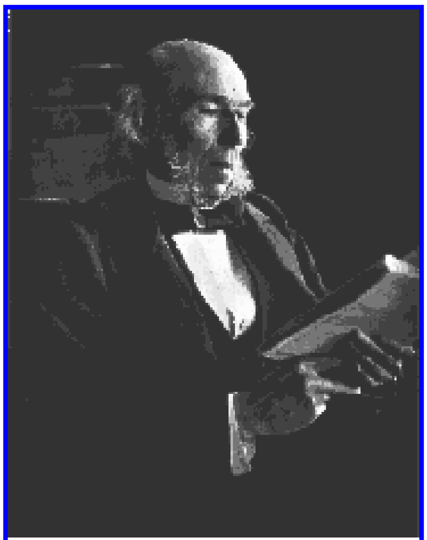
Figure 16
Herbert Spencer (1820-1903)

In 1855, the same year in which Bain published *The Senses and the Intellect*, another even more revolutionary work appeared in England. *The Principles of Psychology* [15] by Herbert Spencer (1820-1903) offered students of the brain an evolutionary associationism and a related concept of cerebral localization that gave impetus and direction to the work of John Hughlings Jackson and through Jackson to that of David Ferrier.

Spencer [see figure 16] was born in Derby, England and was largely self- taught. At the age of 17, he took up railway engineering but left that occupation in 1848 to work first as an editor and then as a free-lance writer and reviewer. In *An Autobiography* (1904), Spencer tells us that, at age 11 or 12, he attended lectures by Spurzheim that for many years made him a believer in phrenology. Indeed, as late as 1846, before his growing scepticism regarding phrenology led him to abandon the project, Spencer had designed a cephalograph [see figure 17] for the purpose of achieving more reliable cranial measurement.

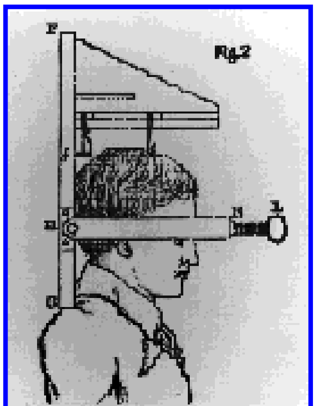
Figure 17
A cephalograph designed by Herbert Spencer to achieve more reliable phrenologicalmeasurement of the cranium, from his Autobiography (1904).

In 1850, as a result of a burgeoning friendship with George Henry Lewes, Spencer began to read Lewes's *A Biographical History of Philosophy* (1845/1846). Within a short time, he found himself so absorbed in the topic that he decided to make a contribution of his own to philosophy in the form of an introduction to psychology. In 1855, Spencer's *Principles of Psychology* appeared. It is a complex and difficult book, hardly an introduction to the topic; and, like Bain's *The Senses and the Intellect*, it too marked a turning point in the history of psychology. While Bain had married movement to the sensations of associationism and arrived at the first fully balanced sensory- motor associational view, Spencer went even further and grounded psychology in evolutionary biology.

In particular, Spencer stressed three basic evolutionary principles that transformed his view of mind and brain into one to which the cortical localization of function was a simple logical corollary. In so doing, he lay the groundwork for Hughlings Jackson's evolutionary conception of the nervous system and extension of the sensory-motor organizational hypothesis to the cerebrum. Spencer's key principles were adaptation, continuity, and development.

Like Gall, Spencer viewed psychology as a biological science of adaptation. "All those activities, bodily and mental, which constitute our ordinary idea of life ... (as well as) those processes of growth by which the organism is brought into general fitness for those activities" (p. 375) consist simply of "the continuous adjustment of internal relations to external relations" (p. 374). Neither the associations among internal ideas, for example, nor the relations among external events, but the increasing adjustment of inner to outer relations must lie at the heart of psychology. Indeed, for Spencer, mental phenomena are defined as adaptations, "incidents of the correspondence between the organism and its environment" (p. 584).

Like adaptation, continuity and development were also focal ideas for Spencer. Development consists of a change from homogeneity to heterogeneity, from relative unity and indivisibility to differentiation and complexity. According to the principle of continuity, life and its circumstances exist at all levels of complexity and correspondence. The level of life varies continuously with the degree of correspondence; no radical demarcations separate one level from the next. Thus, mental and physical life are simply species of life in general, and that which we call mind evolves continuously from physical life -- reflexes from irritations, instincts from compounded reflexes, and conscious life and higher mental processes from instincts -- co-existing at varied levels of complexity.

The implications of these evolutionary conceptions for the hypothesis of cortical localization of function are clear. The brain is the most highly developed physical system we know and the cortex is the most developed level of the brain. As such, it must be heterogeneous, differentiated, and complex. Furthermore, if the cortex is a continuous development from sub- cortical structures, the sensory-motor principles that govern sub-cortical localization must hold in the cortex as well. Finally, if higher mental processes are the end product of a continuous process of development from the simplest irritation through reflexes and instincts, there is no justification for drawing a sharp distinction between mind and body. The mind/body dichotomy that for two centuries had supported the notion that the cerebrum, functioning as the seat of higher mental processes, must function according to principles radically different from those descriptive of sub-cerebral nervous function, had to be abandoned.

While these ideas were to be worked out more fully by Hughlings Jackson, it is quite clear that even in 1855 Spencer was well aware of the implications of his concepts of continuity and development for cerebral localization. In the *Principles*, he wrote that "no physiologist who calmly considers the question in connection with the general truths of his science, can long resist the conviction that different parts of the cerebrum subserve different kinds of mental action. Localization of function is the law of all organization whatever ... every bundle of nerve-fibres and every ganglion, has a special duty ... Can it be, then, that in the great hemispheric ganglion alone, this specialization of duty does not hold?" (pp. 607-608).

With the ground prepared by the sensory-motor associationism of Bain and the evolutionary psychophysiology of Spencer, all that was needed in order to overcome the last obstacle to extension of the sensory-motor view to the cortex was the impetus provided by striking research findings and new experimental techniques. In the period between 1861 and 1876, Broca, and Fritsch and Hitzig, provided the first critical findings and techniques; Jackson, heavily influenced by Spencer and Bain, provided the extension of the sensory-motor paradigm to the cortex; and Ferrier, influenced by Bain and Jackson, provided the experimental capstone to the classical doctrine of cortical localization.

Figure 18
Pierre Paul Broca (1824-1880)

Paul Broca (1824-1880) [see figure 18] was born in the township of Sainte-Foy-La-Grande in the Dordogne region of France and studied medicine at the Hôtel Dieu in Paris. A lifelong interest in physical anthropology led to his becoming one of the original members of the Société d'Anthropologie and a founder of the *Revue d'anthropologie* and the Department of Anthropology at the University of Paris. On the 4th of April, 1861, at a meeting of the Société d'Anthropologie, Broca sat in the audience as Ernest Aubertin presented a paper citing several striking case studies to argue the craniological case for cerebral localization of articulate language.

Aubertin was the student and son-in-law of Jean Baptiste Bouillaud, a powerful and distinguished figure in Parisian scientific circles, himself a student of Gall and founding member of the Société Phrénologique. As early as 1825, Bouillaud had published a paper that employed clinical evidence to support Gall's view that the faculty of articulate language resides in the anterior lobes of the brain. For almost 40 years, in the face of considerable opposition, Bouillaud had succeeded in keeping the cerebral localization hypothesis alive. Thus, Aubertin was merely carrying on in his father-in-law's tradition when he promised to give up his belief in cerebral localization if even a single case of speech loss could be produced without a frontal lesion.

Intrigued, Broca decided to take up Aubertin's challenge. Within a week, a M. Leborgne ("Tan"), a speechless, hemiplegic patient died from gangrene on Broca's surgical ward. In the "Remarques sur le siége de la faculté du langage articulé, suivies d'une observation d'aphemie (perte de la parole)," published in 1861 in the *Bulletins de la société anatomique de Paris*[16], Broca presented a detailed account of his post-mortem examination of Tan's brain. What he had found, of course, was a superficial lesion in the left frontal lobe, a finding confirmed a few weeks later by another case in which post-mortem examination revealed a similar lesion.

While neither the conception of a faculty of articulate language nor even the notion of its localization in the anterior portion of the brain were especially novel in 1861, what Broca provided was a research finding that galvanized scientific opinion on the localization hypothesis. The detail of Broca's account, the fact that he had gone specifically in search of evidence for the patients' speech loss rather than employing cases post hoc as support for localization, his use of the pathological rather than the craniological method, his focus on the convolutional topography of the cerebral hemispheres, and, perhaps most importantly, the fact that the time was ripe for such a demonstration, all contributed to the instantaneous sensation created by Broca's findings. Now all that was needed was a technique for the experimental exploration of the surface of the hemispheres, and this technique was contributed jointly by Gustav Theodor Fritsch (1838-1927) and Eduard Hitzig (1838-1907).

In 1870, in the *Archiv für Anatomie, Physiologie, und wissenschaftliche Medicin*, Fritsch and Hitzig published a classic paper that not only provided the first experimental evidence of cortical localization of function but, at a single stroke, swept away the age old objection to localization based on the idea that the hemispheres fail to exhibit irritability. Employing galvanic stimulation of the cerebrum in the dog, Fritsch and Hitzig provided conclusive evidence that circumscribed areas of the cortex are involved in movements of the contralateral limbs and that ablation of these same areas leads to weakness in these limbs. Their findings established electrophysiology as a preferred method for the experimental exploration of cortical localization of function and demonstrated the participation of the hemispheres in motor function.


Figure 19
John Hughlings Jackson (1835-1911)

At approximately the same time in England, John Hughlings Jackson (1835-1911) was converging from a different direction on a sensory-motor view of hemispheric function. Hughlings Jackson [see figure 19] was born in Providence Green, Green Hammerton, Yorkshire, England. He began the study of medicine as an apprentice in York and completed his education at the Medical School of St. Bartholomew's Hospital in London and the University of St. Andrews. Among several hospital appointments, perhaps his most important was as physician to the National Hospital for the Paralysed and Epileptic, Queen Square. His contributions to neurology and psychology are scattered throughout papers appearing in a variety of journals between 1861 and 1909. Many of the more important papers have been gathered together in the two volume *Selected Writings of John Hughlings Jackson*, edited by James Taylor (1931/1932).

While Jackson's specific contributions to our understanding of the etiology, course, and treatment of neurological disorders ranging from aphasia and chorea to epilepsy and vertigo were of exceptional importance, it is his evolutionary conception of the localization of sensory-motor function in the cerebrum that was most influential for psychology. This conception was, of course, developed under the inspiration of Spencer. As Young (1970) describes it, "Spencer's principles of continuity and evolution provided Jackson with a single, consistent set of variables for specifying the physiological and psychological elements of which experience, thought, and behaviour are composed: sensations (or impressions) and motions. All complex mental phenomena are made up of these simple elements -- from the simplest reflex to the most sublime thoughts and emotions. All functions and faculties can be explained in these terms" (p. 199).

Jackson's paper, "On the anatomical & physiological localisation of movements in the brain," serialized in the *Lancet* in 1873, is representative of a series of papers during this period that reflect the sensory-motor conception. In an interesting and revealing preface to an 1875 pamphlet, *Clinical and Physiological Researches on the Nervous System* [17], which reprints the 1873 paper, Jackson describes the background for the hypothesis as it developed in his own work, almost as though he is endeavoring to establish his priority. Fond as always of quoting himself, Jackson reprints a footnote from an 1870 paper, "The study of convulsions," that summarizes his views:

"It is asserted by some that the cerebrum is the organ of mind, and that it is not a motor organ. Some think the cerebrum is to be likened to an instrumentalist, and the motor centres to the instrument -- one part is for ideas, and the other for movements. It may, then, be asked, How can discharge of part of a *mental* organ produce *motor* symptoms only? ... *But of what 'substance' can the organ of mind be composed, unless of processes representing movements and impressions ...?* Are we to believe that the hemisphere is built on a plan *fundamentally* different from that of the motor tract? ... Surely the conclusion is irresistible, that 'mental' symptoms ... must all be due to lack, or to disorderly development, of sensori-*motor* processes" (p. xi-xii).

Figure 20
David Ferrier (1843-1928)

Thus, by the early 1870s, Jackson had fully articulated a general conception of the functional organization of the nervous system. In the words of Young (1970), this "constituted the last stage in the integration of the association psychology with sensory-motor physiology ... (and) involved an explicit rejection of ... work which had hindered a unified view: the faculty formulation of Broca, and the unwillingness of Flourens, Magendie, Müller, and others to treat the organ of mind -- the highest centres -- on consistently physiological terms" (p. 206). In Jackson's work, the theoretical analysis of cerebral localization reached the full extent of its 19th century development. In the systematic, experimental investigations of his friend and colleague, David Ferrier (1843-1928), this analysis was strikingly confirmed.

Ferrier [see figure 20] was born and educated in Aberdeen, Scotland where he studied under Alexander Bain. At Bain's urging, he journeyed to Heidelberg in 1864 to study psychology. During that period, Heidelberg was home to both Helmholtz and Wundt. Indeed Wundt had only recently (1862) completed the *Beiträge zur Theorie der Sinneswahrnehmung* [see 40] that contains the first programmatic statement of his physiological psychology and Ferrier must certainly have encountered Wundt's views.

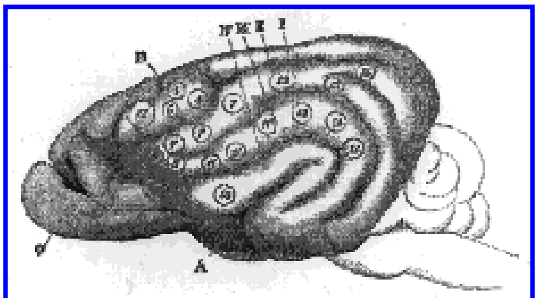

Figure 21
Localization of function in the dog, from Ferrier's *The Functions of the Brain* (1876).

On his return, Ferrier completed his medical training at the University of Edinburgh and served, for a short time, as assistant to Thomas Laycock, who had been the first (see Laycock, 1860 for a priority claim) to articulate the concept of "unconscious cerebration." Among other appointments, Ferrier, like Jackson, served as physician to the National Hospital, Queen Square. Influenced as Jackson had been by Bain and Spencer, Ferrier set out to test Jackson's notion that sensory-motor functions must be represented in an organized fashion in the cortex and to extend Fritsch and Hitzig's experimental localization of motor cortex in the dog. Employing very carefully controlled ablations and faradic stimulation of the brain, an advance over the galvanic techniques available to Fritsch and Hitzig, Ferrier succeeded in mapping sensory and motor areas across a wide range of species [see figure 21]. His first paper, "Experimental researches in cerebral physiology and pathology," appeared in 1873 in the *West Riding Lunatic Asylum Medical Reports;* but it was the impact of the cumulated cross-species research brought together in 1876 in *The Functions of the Brain* [18] that served to confirm the installation of sensory-motor analysis as the dominant paradigm for explanation in both physiology and psychology.

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MIND AND BODY: René Descartes to William James

by Robert H. Wozniak

6. Trance and Trauma: Functional Nervous Disorders and the Subconscious Mind


Figure 22
Franz Anton Mesmer (1734-1815)

Franz Anton Mesmer (1734-1815) [see figure 22] was born in the German town of Iznang. At the age of 32, he completed his medical training at the University of Vienna with a dissertation on the influence of the planets on human disease. In 1773, a twenty-seven year old patient, Fräulein Oesterlin, came to Mesmer suffering from a variety of recurring physical ailments. In the spirit of his dissertation, Mesmer set about trying to relate the periodicity of Fräulein Oesterlin's symptom manifestations to tidal fluctuations and, in the course of this effort, decided to see whether he could induce an artificial tide in his patient.

On the 28th of July, 1774, he asked the fräulein to swallow a solution containing iron and affixed magnets to her stomach and legs. The results of this treatment were to change the course of Mesmer's life. As Fräulein Oesterlin felt a mysterious fluid coursing throughout her body, her symptoms started to disappear. With continued treatment, she recovered completely, and Mesmer's fame began to spread. Unfortunately, however, controversy over the effectiveness of his techniques spread as well; and in 1777, under somewhat dubious circumstances, Mesmer left Vienna for Paris. There he established a lucrative practice in magnetic healing and completed the *Mémoire sur la découverte du magnétisme animal* [19]. Influenced by physical theories of gravitational force and by the work of Franklin and others on electricity, Mesmer developed what was for the period a reasonable explanation of magnetic cure.


Figure 23
In Mesmer's (1779) view, cure was effected through "magnetic passes" of the physician's hands.

Hypothesizing the existence of a physical magnetic fluid interconnecting every element of the universe, including human bodies, Mesmer argued that disease resulted from a disequilibrium of this fluid within the body. Cure required the redirection of the fluid through the intervention of the physician who served as a kind of conduit by which animal magnetism could be channeled out of the universe at large and into the patient's body via "magnetic passes" of the physician's hands [see figure 23]. In the process of treatment, patients experienced a magnetic "crisis," something akin to an electric shock, from which they recovered cured. In imitation of electrical theory, Mesmer thought of magnetic fluid as polarized, conductible, and able to be discharged and accumulated. Indeed, ever the entrepreneur, he developed the *baquet*, a device for concentrating magnetic fluid in the manner of a Leyden jar. The baquet enabled him to treat as many as twenty patients at a time, each patient connected to the fluid through contact with an iron rod

Mesmer's fall was as meteoric as his rise. About 1785, after several spectacular therapeutic failures and the publication of the *Rapport des Commissaires chargés par le Roy de l'examen du magnétisme animal* (Bailly, 1784) which concluded that the evidence in favor of the existence of mesmeric fluid was inadequate, Mesmer left Paris under a cloud and lived the remainder of his life in relative obscurity, dying in 1815 near the place of his birth.


Figure 24
Puysegur and the "magnetized" elm of Buzancy. The patient seen falling into a state of somnambulistic sleep as he leans on the Marquis is Victor Race. From the third edition (1820) of Puysegur's *Memoires ... du magnetisme animal.*

If Mesmer the man disappeared from public view, his ideas did not. By far the most important of Mesmer's disciples was Armand-Marie-Jacques de Chastenet, Marquis de Puységur (1751-1825), a wealthy aristocrat and landowner who had begun, even before Mesmer's fall, to experiment with magnetic healing. If anyone can justifiably be said to be the founder of modern psychotherapy, it is Puységur. Working with Victor Race, a young peasant on the family estate near Soissons [see figure 24], the Marquis discovered the "perfect crisis," a somnambulistic sleep state in which patients carried out the commands of the magnetizer and upon reawakening exhibited no memory for having done so. When Victor, who would never normally have dared to confide his personal problems to the lord of the manor, admitted in magnetic sleep that he was disturbed by a quarrel that he had had with his sister, Puységur suggested that he act to resolve the quarrel; and, upon reawakening, without memory for Puységur's words, Victor acted on the Marquis' suggestion.

From these experiences, Puységur gradually arrived at the recognition that magnetic effects depend on the force of the magnetizer's personal belief in the efficacy of magnetic cure, will to cure, and rapport with the patient. In 1784, Puységur embodied these ideas in his *Mémoires pour servir a l'histoire et a l'établissement du magnétisme animal* [20], a work which can be considered the point of origin of modern psychotherapy. It is of more than passing interest that as early as 1784, right from the inception of psychotherapeutic procedure, it was recognized that belief in the efficacy of cure, desire to cure, and the nature of the relationship between patient and therapist are fundamental factors in psychotherapeutic success.

With the technique developed by Puységur (but often with the accompanying explanation of Mesmer), Mesmerism spread rapidly. In the United States it arrived from France with Charles Poyen de Saint Sauveur [see 52] and became allied briefly with phrenology and more extensively with spiritualism, eventuating in the New Thought movement that exerted an impact on William James [see 61].

In Europe, mesmerism continued to develop at the hands of a number of major figures such as the Abbé José Custodio de Faria, Général François Joseph Noizet, Étienne Félix, Baron d'Hénin de Cuvillers, and Alexandre Bertrand. Faria, in his *De la cause du sommeil lucide* (1819), developed the modern trance induction ("fixation") technique, emphasized the importance of the will of the subject rather than that of the magnetizer, recognized the existence of individual differences in susceptibility to somnambulistic sleep, and first articulated the principle of suggestion, which he believed to be effective not only in magnetic sleep but in the waking state as well. In 1820, Noizet, in a *Mémoire sur le somnambulisme* presented to the Berlin Royal Academy but only published in 1854, and Hénin de Cuvillers, in his *Le magnétisme éclairé*, presented more extended accounts of mesmeric effects in terms of suggestion and belief; while Bertrand's *Traité du somnambulisme* (1823) was the first systematic scientific study of magnetic phenomena.

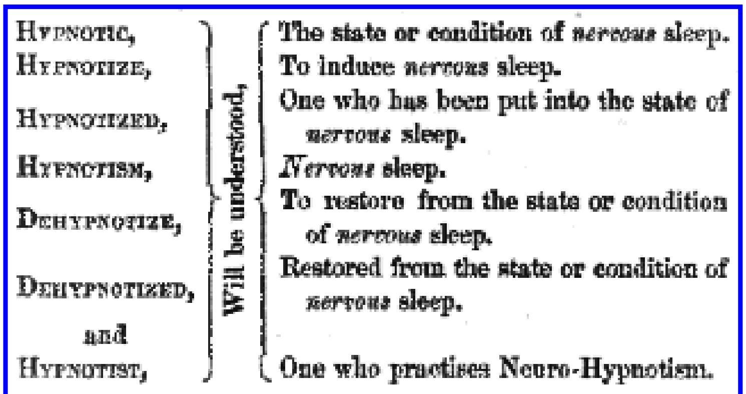

Figure 25
To distinguish his views from those of mesmerism, Braid employed a new vocabulary to refer to phenomena of nervous sleep, from Braid's *Neurypnology* (1843).

The year 1843 marked an important turning point in the way in which mesmeric effects were conceptualized. In that year James Braid (ca. 1795- 1860) published *Neurypnology; or, the Rationale of Nervous Sleep, Considered in Relation with Animal Magnetism* [21]. Born in Fifeshire about 1795 and educated at the University of Edinburgh, Braid moved to Manchester early in his career. There, as he describes it in the *Neurypnology*, a visit to a stage demonstration by the Swiss mesmerist, Charles Lafontaine, convinced him of the reality of the physical phenomena induced by mesmerism. After several days of private experiment, Braid came to the conclusion that these physical effects were produced by "a peculiar condition of the nervous system, induced by a fixed and abstracted attention ..." (p. 94) and not through the mediation of any special agency passing from the body of the operator to that of the patient. To distinguish his views sharply from those of mesmerism, he named the state of nervous sleep "hypnotism" [see figure 25], and substituted fixation of a luminous object, a variant of Faria's old induction technique, for the mesmerists' "magnetic passes."

Braid's linking hypnotic phenomena to brain physiology, development of a straightforward, less mystical induction technique, and introduction of a terminology that was more acceptable to the medical and scientific establishment, helped prepare the way for the eventual use of hypnosis in research on psychopathology. That this effect was by no means immediate, however, is hardly surprising in light of the fact that between 1848 and 1875 magnetic healing became increasingly involved with mediumistic spiritualism, on the one hand, and stage demonstrations, on the other. Indeed, when Braid died in 1860, "magnetism and hypnotism," as Ellenberger (1970) points out, "had fallen into such disrepute that a physician working with these methods would irretrievably have compromised his scientific career and lost his medical practice" (p. 85).

Yet, even in this climate of opinion, there were a few who continued to work therapeutically with hypnosis. One of these was Auguste Ambroise Liébeault (1823-1904), a physician in rural Pont-Saint-Vincent, a French village in the region of Nancy. In 1866, Liébeault published his *Du sommeil et des états analogues considérés surtout au point de vue de l'action du moral sur le physique*[22]. In the *Du sommeil*, Liébeault argued that concentration of attention on the idea of sleep induces the hypnotic state through the power of suggestion and that the therapeutic effects of hypnosis are, in effect, suggestive phenomena. While neither of these ideas were original with Liébeault, who derived them from the *Mémoire sur le somnambulisme et le magnétisme animal* (1854) of Noizet, it was through Liébeault that they captured the attention of Hippolyte Bernheim and became the cardinal principles of the Nancy school of suggestive therapeutics to which we shall momentarily return.

Before techniques of hypnotic induction could come to serve as a tool for research on functional nervous disorders, however, they had first to be rescued from the domain of pseudoscience to which they had been consigned. Credit for such rescue is generally given to Charles Richet, a young French physiologist whose "Du somnambulisme provoqué"(1875) led to a revival of interest in the scientific use of hypnosis, especially through the work of Jean- Martin Charcot (1825-1893).

Charcot was born and received his medical education in Paris. Awarded the M.D. in 1853, he worked largely as a private physician until 1862, when he was appointed resident doctor at the Salpêtrière. There he created what was to become the world's most influential center for research in neurology. Placed in charge of a ward containing women[1] suffering from convulsions, Charcot set out to distinguish between convulsions that were epileptic in origin and those that were hysterical (hystero-epilepsy), to clarify the hemianaesthetic and hyperaesthetic symptomatology of hystero-epilepsy, and to differentiate between hystero-epilepsy and non-convulsive cases of hysteria.

The first important summary of the conclusions that Charcot drew from this work was presented in Volume I of his *Leçons sur les maladies du système nerveux faites à la Salpêtrière* [23], published in parts between 1872 and 1873. Following Briquet, whose *Traité clinique de thérapeutique de l'hysterie* (1859) is considered to be the first systematic, objective study of hysteria, Charcot conceptualized hysteria as a neurosis of the brain typically brought on in hereditarily predisposed individuals by psychic trauma. In 1878, under the influence of Richet, Charcot began to employ hypnosis in the study of hysteria and discovered that, under hypnosis, he could reproduce not only hysterical symptomatology (amnesias, mutism, anaesthesias) but even post-traumatic phenomena such as the paralyses sometimes occasioned by railway accidents. This led him to group together hypnotic, hysterical, and post-traumatic phenomena, to distinguish these dynamic phenomena from those organic symptoms that arise from lesions in the nervous system, and to suggest the existence of unconscious "idée fixes" at the core of certain neuroses, a notion that exerted a considerable influence on Janet and Freud.

In keeping with his generally physicalistic orientation, Charcot also attempted to describe the somatic phenomena associated with hypnotic induction. This process, he believed, occurred in three successive phases: a) catalepsy with anaesthesia and neuromuscular plasticity; b) lethargy with neuromuscular hyperexcitability; and c) somnambulism. Furthermore, on the basis of work by students, he went on to assert that these somatic manifestations could be transferred from one side of the body to the other by means of magnets.


Figure 26
Charcot demonstrating a case of hysteria. The patient is believed to be Blanche Wittmann

Unfortunately, and despite his numerous important contributions and generally pivotal role, it is for the errors of the three stages and magnetic transfer that Charcot is sometimes best remembered. As the Belgian psychophysicist, Joseph Remi Leopold Delboeuf (1886), suggested in a pointed attack on Charcot's work, the effect of suggestion passes not only from hypnotist to subject but from subject to hypnotist. A particularly striking patient can create expectations in the therapist about the forms that hypnotic manifestations will take. These can then unwittingly be transmitted as suggestions to future patients who will act so as to confirm the therapist's expectations. Such, indeed, seems to have been the case at the Salpêtrière, where patients, most notably the famous Blanche Wittmann [see figure 26], students, collaborators, and Charcot himself, fell victim to the fatal force of mutual expectation.

At Nancy, a group working under the leadership of Hippolyte Bernheim (1840-1919), committed to the view that hypnotic effects were obtained through the power of suggestion, was particularly well situated to recognize the flaw inherent in Charcot's work. Bernheim was born in Mulhouse, France and received part of his medical education at Strasbourg. Upon receiving his agrégation, he accepted a professorship at the Faculté de Médicine at Nancy. In 1882, when he had already become well-established, Bernheim heard of a country physician named Liébeault who was rumored to be treating patients effectively using artificial somnambulism.

Following visits to Liébeault in which he became convinced of the therapeutic effectiveness of hypnosis, Bernheim published *De la suggestion dans l'état hypnotique et dans l'état de veille* (1884) [24] in which he reintroduced Liébeault's neglected view that the effects of hypnosis reflect the power of mental suggestion. Here and in the expanded 1886 edition, Bernheim conceptualized hypnotic phenomena as manifestations of ideomotor suggestibility, a universal human ability to transform an idea directly into an act. Indeed, for Bernheim, hypnosis was simply a state of heightened, prolonged, and artificially induced suggestibility.

Taken by themselves, these views alone would have led Bernheim into conflict with Charcot; but Bernheim and his colleagues at Nancy went much further. Criticizing Charcot's claim that hypnosis is a pathological nervous condition allied to hysteria, Bernheim rejected Charcot's description of the three phases of hypnotism and derided the idea that symptoms could be transferred laterally with magnets. Picking up on the criticisms of Delboeuf, Bernheim asserted that the phenomena discovered by Charcot were simply artifacts of the suggestibility of his patients, the exercise of poor experimental control by his students, and, by implication, Charcot's own suggestibility as well. Indeed, so convinced were they of the suggestive nature of hypnotic therapeutics that, as time passed, the members of the Nancy school abandoned hypnotic induction entirely for direct suggestion in the waking state, a technique they termed "psychotherapeutics."


Figure 27
Pierre-Marie-Félix Janet (1859-1947).
Courtesy of the Archives of the History of American Psychology.

While the debate raged between Nancy and the Salpêtrière, Pierre Janet (1859-1947) [see figure 27] was at work at Le Havre gathering clinical observations on which to base his dissertation. Born in Paris, Janet entered the École Normale Supérieure in 1879, placing second in the extremely competitive examinations of the agrégation. Shortly thereafter he took up a professorial position in philosophy at the Lyceum in Le Havre where he remained until the acceptance of his dissertation. Upon receipt of the degree, he moved to Paris to study medicine and pursue clinical research under Charcot at the Salpêtrière.

Janet's dissertation, *L'automatisme psychologique* [25] brought together a wealth of related clinical information on a variety of abnormal mental states related to hysteria and psychosis. Dividing such states into total (involving the whole personality) and partial (part of the personality split from awareness and following its own psychological existence) automatisms, Janet employed automatic writing and hypnosis to identify the traumatic origins and explore the nature of automatism. Syncope, catalepsy, and artificial somnambulism with post-hypnotic amnesia and memory for prior hypnotic states were analyzed as total automatisms. Multiple personalities, which Janet called "successive existences," partial catalepsy, absent-mindedness, phenomena of automatic writing, post-hypnotic suggestion, use of the divining rod, mediumistic trance, obsessions, fixed ideas, and the experience of possession were treated as partial automatisms.

Most importantly, Janet brought all of these phenomena together within an analytic framework that emphasized the ideomotor relationship between consciousness and action, employed a dynamic metaphor of psychic force and weakness, and stressed the concept of "field of consciousness" and its narrowing as a result of depletion of psychic force. Within this framework, Janet analyzed the peculiar fixation of the patient on the therapist in rapport in terms of the distortion of the patient's perception, and related hysterical symptomatology to the autonomous power of "idées fixes" split off from the conscious personality and submerged in the subconscious. Although careful to avoid direct discussion of the therapeutic implications of his work in a non- medical dissertation, Janet laid the foundations for his own and Freud's later therapeutic approaches through his demonstration of the origins of splitting in psychic traumas in the patient's past history.

Indeed, it was but a short leap from the work of Charcot, Bernheim, and Janet to that of Josef Breuer (1842-1925) and Sigmund Freud (1856-1939). In 1893, Breuer and Freud published a short preliminary communication, "Ueber den psychischen Mechanismus hysterische Phänomene" in the *Neurologische Centralblatt* [26]. The origin of the Breuer and Freud paper lay in Breuer's work with the famous patient Anna O.

Although actual details of the case of Anna O. as described by Breuer, who undoubtedly took pains to disguise his patient, and many years later by Jones (1953/1957) are at considerable variance with one another and probably with the actual facts of the case (see Ellenberger, 1970), it is known that the alleviation of Anna O's symptoms occurred only as the patient, under hypnosis, provided Breuer in reverse chronological order with an account of the exact circumstances under which each symptom appeared. Only when she had traced the final symptom back to the traumatic circumstances of its occurrence was she cured. Anna O's cure by this "cathartic" method, which involved bringing the trauma to consciousness and allowing it to discharge through affect, words, and guided associations, has often been seen, and was thought by Freud, to be the starting point for psychoanalysis.

In the seminal work of Janet and in the critical transitional paper of Breuer and Freud, we see the culmination of developments that had begun with Puységur's elaboration of the doctrines of Mesmer. In a little over a hundred years, a huge corpus of evidence and related neurological and psychological theory had led irrevocably to the belief that mental events -- mesmeric trance states, rapport, the therapist's will to cure, the concentration of attention, mental suggestion, psychic trauma, the dissociation of consciousness, and catharsis -- could effect radical alterations in the state of the body. No psychologist writing in the 1890s could afford to ignore this rich material and its implications for conceptualization of the nature of the mind/body relationship. William James, as we shall see, was no exception.

The Rise of Experimental Psychology

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Fig. XLVII
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MIND AND BODY:
René Descartes to William James

by Robert H. Wozniak

INTRODUCTION

The common sense view of mind and body is that they interact. Our perceptions, thoughts, intentions, volitions, and anxieties directly affect our bodies and our actions. States of the brain and nervous system, in turn, generate our states of mind. Unfortunately, the common sense notion appears to involve a contradiction. The brain and nervous system seem clearly to be part of the physical world: tangible, visible, public, extended in space. Thoughts, feelings, consciousness, and other states of mind strike us as mental: intangible, invisible, private, arrayed in time, but not in space. If brain and mind are of fundamentally different kinds and if, in addition, the laws of causality require causes and effects to be of a similar kind, then it is clearly impossible for brain to generate mind or mind to affect brain. So phrased, this contradiction constitutes one half of the mind/body problem -- that of the relation of mind to brain.

If the distinction between intangible and unextended mind and tangible and extended physical nature is maintained, however, the mind/body problem is also the problem of the relation of the mind to the world around us. The natural environment, after all, is just as much a physical entity as is the brain, and how we become conscious of the environment is no less obscure than is the relation of consciousness to the function of the nervous system.

Much of the intellectual history of psychology as both a scientific and a clinical enterprise has involved the attempt to come to grips with these two problems of mind and body. Through this exhibit and in the discussion to follow, we will trace this history as we identify major contributions to theories of mind, body and their relationship. Starting with Descartes, whose formulation of the problem has in one way or another affected all later views, we will note the way in which 17th and 18th century ideas developed in direct response to the Cartesian challenge, and then relate 19th century mind/brain theorizing to progress in understanding the brain as the "organ of mind" and the mind as a powerful source of physical illness and cure.

With this as background, we will outline the rise of experimental psychology as it occurred at the interface between philosophical analyses of the mind/world relationship and physiological conceptions of the nervous system as a sensory-motor device mediating between the mind and the world. In this regard, we will focus not only on European but on early and often overlooked American contributions. We will conclude with a brief discussion of some of the most important influences on the thought of William James, whose *Principles of Psychology* (1890) gathered all of these various threads together in what is probably the greatest single work in psychology.

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FATHER *MALEBRANCHE'S*

TREATISE

CONCERNING

The Search after Truth.

THE WHOLE WORK COMPLEAT.

To which is Added

The AUTHOR'S TREATISE of

NATURE, and GRACE.

BEING

A Consequence of the PRINCIPLES

Contain'd in the SEARCH:

Together with

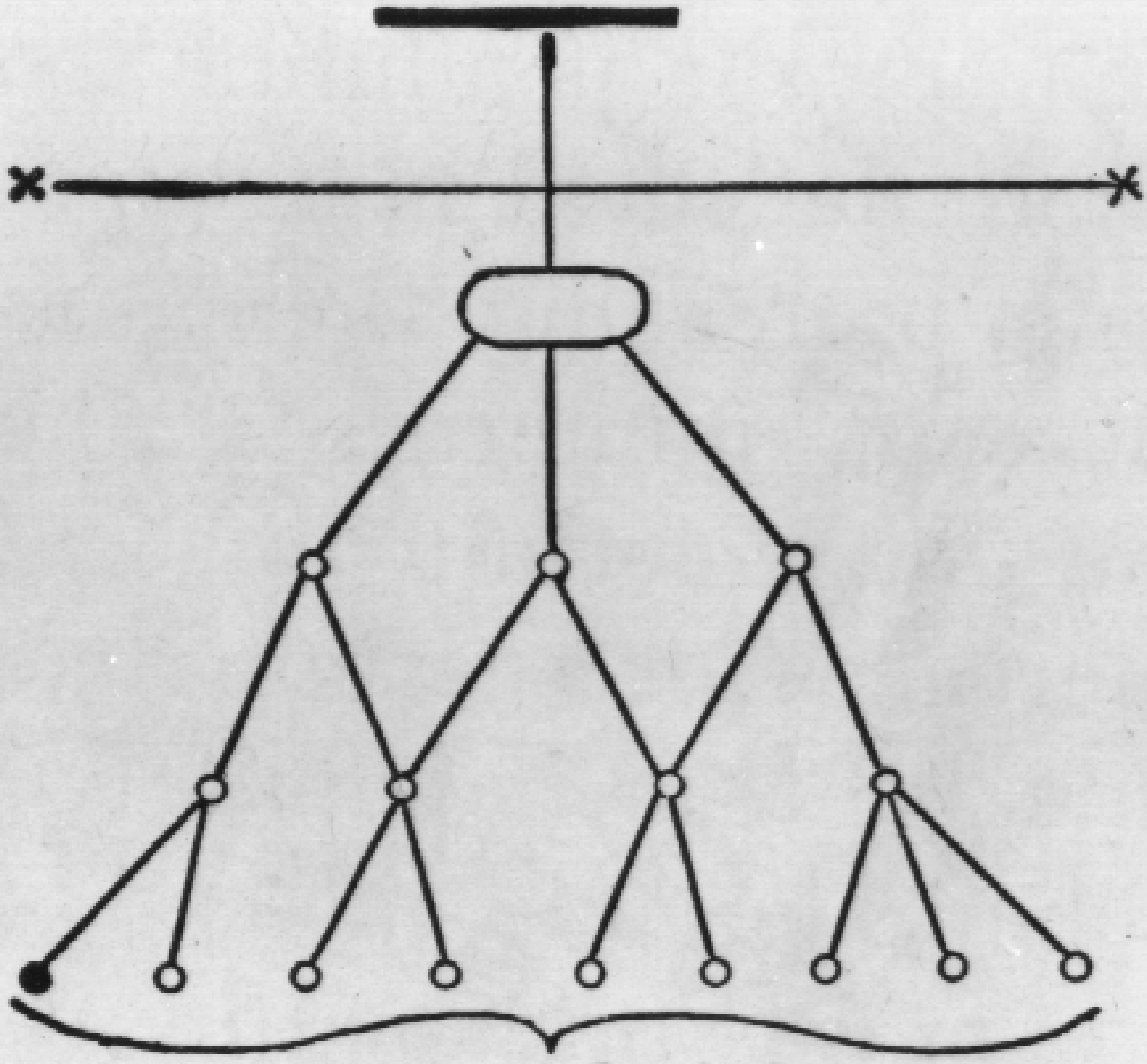
His ANSWER to the ANIMADVERSIONS upon the First Volume: His DEFENSE against the Accusations of *Mr De la Ville, &c.* Relating to the same Subject.

AS TRANSLATED By

T. TAYLOR, *M. A.* of *Magd.* Coll. in OXFORD.

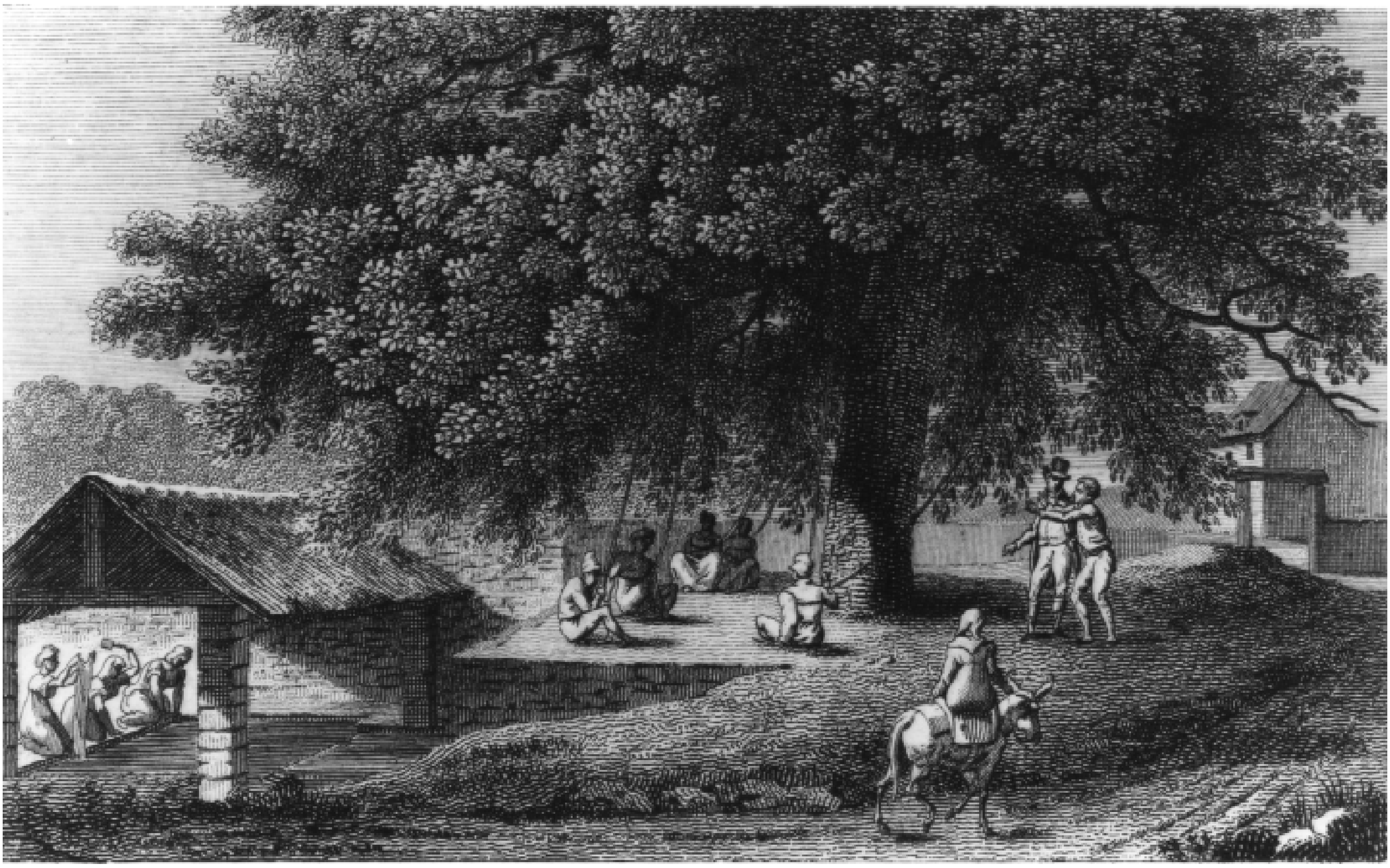
OXFORD,
Printed by L. LICHFIELD, for THOMAS BENNET Bookseller, at the *Half-Moon* in St. *Paul's* Church-yard, *LONDON.* M. DC. XCIV.

BARUCH SPINOZA



One second of time.

Term		Meaning
HYPNOTIC,	Will be understood,	The state or condition of *nervous* sleep.
HYPNOTIZE,		To induce *nervous* sleep.
HYPNOTIZED,		One who has been put into the state of *nervous* sleep.
HYPNOTISM,		*Nervous* sleep.
DEHYPNOTIZE,		To restore from the state or condition of *nervous* sleep.
DEHYPNOTIZED,		Restored from the state or condition of *nervous* sleep.
and HYPNOTIST,		One who practises Neuro-Hypnotism.



MIND AND BODY: René Descartes to William James

by Robert H. Wozniak

THE RISE OF EXPERIMENTAL PSYCHOLOGY

The Rise of Experimental Psychology

7. The 17th and 18th Centuries: The Epistemology of Mind

According to the received view (Boring, 1950), scientific psychology began in Germany as a physiological psychology born of a marriage between the philosophy of mind, on the one hand, and the experimental phenomenology that arose within sensory physiology on the other. Philosophical psychology, concerned with the epistemological problem of the nature of knowing mind in relationship to the world as known, contributed fundamental questions and explanatory constructs; sensory physiology and to a certain extent physics contributed experimental methods and a growing body of phenomenological facts.

In one version of this story that can be traced back at least to Ribot (1879), the epistemology of the 17th and 18th centuries culminated in the work of Kant, who denied the possibility that psychology could become an empirical science on two grounds. First, since psychological processes vary in only one dimension, time, they could not be described mathematically. Second, since psychological processes are internal and subjective, Kant also asserted that they could not be laid open to measurement. Herbart, so the tale goes, answered the first of Kant's objections by conceiving of mental entities as varying both in time and in intensity and showing that the change in intensity over time could be mathematically represented. Fechner then answered the second objection by developing psychophysical procedures that allowed the strength of a sensation to be scaled. Wundt combined these notions, joined them to the methods of sensory physiology and experimental phenomenology and, in 1879, created the Leipzig laboratory.

While there is undoubted truth in the received history, like all rationalizing reconstructions, it tends greatly to oversimplify what is an exceptionally complex story. Within the past 20 years, as primary resource materials have become more widely available and as larger numbers of historians have entered the arena, the received view has been amended many times. Within the context of this exhibit catalogue, it will not, of course, be possible to address this complexity. The reader who is interested, however, is referred to the *Journal of the History of the Behavioral Sciences* and to Bringmann & Tweney (1980), Danziger (1990), Rieber (1980), and Woodward & Ash (1982) among others.

Because so many psychologists are at least broadly familiar with the lines of Boring's story of the rise of experimental psychology, because the story has been so frequently retold in the many other textbook histories, and because it is a much more complex tale that it at first appears, this section and the two to follow will sketch only the barest outlines of the intellectual developments that led from Locke to Kant, from Bell to Müller, and from Fechner to Wundt. Psychologists who have not read Boring are strongly encouraged to do so. Despite its limitations, it is still the point of origin from which much of contemporary scholarship proceeds; and, perhaps even more importantly, it is the history of psychology that has become part and parcel of American psychology's view of itself.

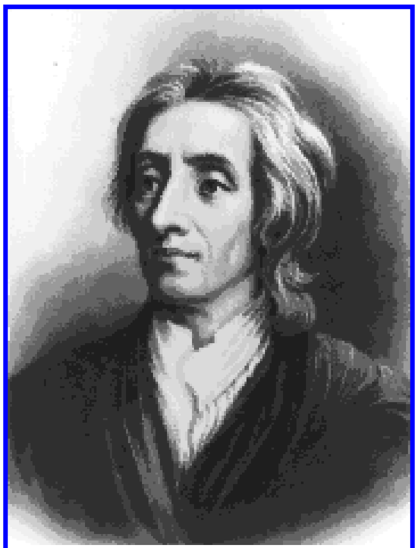


Figure 28
John Locke (1632-1704)

Since we have already discussed Descartes and briefly touched on Leibniz, we can pass directly to the founder of both empiricism and associationism, John Locke (1632-1704) [see figure 28]. Locke was born in Wrington, Somerset, England. reared in a liberal Puritan environment, and educated at Christ's Church, Oxford. His *Essay Concerning Humane Understanding* [27], dated 1690 but actually published in 1689, like much of the rest of 17th century philosophy, is a reaction to Descartes. Unlike Spinoza, who attacked the mind-body dichotomy metaphysically, Locke moved the discussion into the purely psychological realm of experience, contrasting inner sense (the mind's reflective experience of its own experience of things) with outer sense (the mind's experience of things). While Bacon (1605) and Descartes had both raised the question of the method suitable for attaining knowledge, Locke, from his empiricist perspective, was the first to propose the epistemological question of the limits of knowledge.

Employing a very general notion of "idea" that incorporated a disparate set of entities among which modern psychologists would distinguish perceptions, mental images, and concepts, Locke concerned himself with both the certainty of our ideas experientially attained through reflection or the inner sense and the truth of our ideas insofar as they depend on the outer sense. After Locke, it would be possible to emphasize either the vivid character of the ideas transmitted by the outer sense or the intuitive certainty of the inner sense. The former view would lead to the sensationalism of Condillac [see 30], the later to the intuitional realism of Reid and the Scottish school of faculty psychology [see 31]. In the 60 or more years intervening between Locke and Condillac, however, others, most notably George Berkeley and David Hartley, also made use of notions contained in Locke's *Essay*.

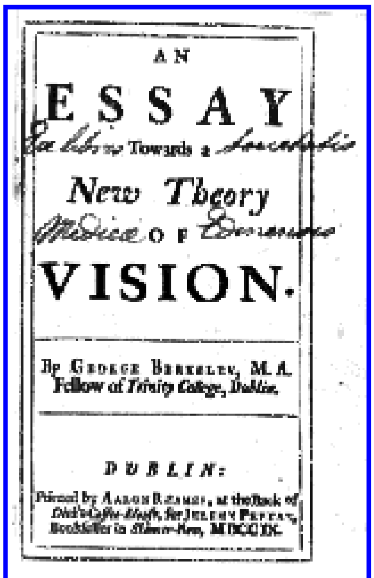


Figure 29
In his *New Theory* (1709), Berkeley proposed a mechanism for the perception of distance that became a prototype for later associationist accounts.

In the *Essay on Humane Understanding*, Locke had distinguished between *primary* and *secondary* qualities. Primary qualities such as solidity or extension are completely inseparable from the bodies in which they inhere and are simply perceived by the senses. Secondary qualities are the powers inherent in objects to produce sensations in the perceiver such as color, odor, or sound. The colors, odors, and sounds, however, do not themselves inhere in the objects. Berkeley's "immaterialism" [see section III] was simply the notion of secondary qualities expanded to include primary qualities and taken out of objects and placed in God.

George Berkeley (1685-1753) was born at Kilkenny, Ireland and educated at Trinity College, Dublin. In 1709, he published his first book, *Essay Towards a New Theory of Vision* [28, see figure 29]. Although Berkeley did not explicitly discuss his immaterialism in the *New Theory*, it was everywhere implicit in his views and combined with a proto-associational view of the importance of connections between ideas, it provided him with the basis for a theory of the perception of distance which became a prototype for later associationist accounts. For Berkeley, distance is not immediately perceived by vision. Rather, when "the mind has, by constant experience, found the different sensations corresponding to the different dispositions of the eyes to be attended each with a different degree of distance in the object...(and) there has grown an habitual or customary connexion between those two sorts of ideas, ... distance ... is ... the idea ... immediately suggested to the understanding" (parag. 17). Here, among other things, Berkeley anticipated the "context theory" of meaning popular in associationist accounts almost two hundred years later.

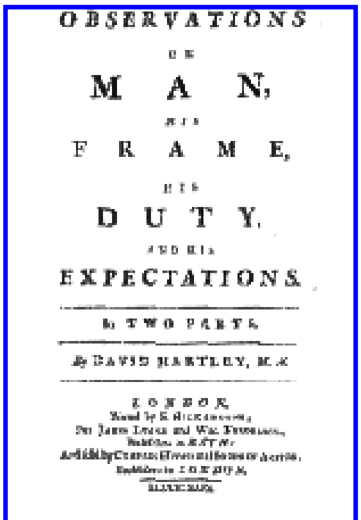


Figure 30
The principle of association was first employed as the fundamental explanatory device by Hartley in his *Observations on Man* (1749).

David Hartley (1705-1757) was born at Luddenden, Halifax, England and educated at Jesus College, Cambridge. In 1749, he published his two-volume *Observations on Man* [29, see figure 30]. While the general principle of association was in use long before Hartley and the phrase, "the association of ideas," can be traced to the Appendix of the 4th edition of Locke's *Essay*, it is with Hartley, as Young (1970) tells us, that "the association psychology first assumed a definite form and a psychological character not wholly derived from epistemological questions. Hartley was the first to apply the association principle as a fundamental and exhaustive explanation of all experience and activity ... Moreover he joined his psychological theory with postulates about how the nervous system functions. His sensations were paralleled by vibrations ... or 'elemental' particles in the nerves and brain ... In relating the phenomena of sensation, ideation, and motion to the nervous system he lays down the principles of physiological psychology which Ferrier would later combine with the concept of cerebral localization" (p. 95-97).

Étienne Bonnot de Condillac (1715-1780) [see figure 31] was born in Grenoble, educated in theology at Saint-Sulpice and at the Sorbonne, and ordained to the priesthood in 1740. Of the two sources of knowledge in Locke, sensations transmitted through the outer sense and reflection through the inner sense, Condillac focused exclusively on the former. His *Traité des sensations* [30], published in 1754, was designed to show that external impressions through the outer senses, taken by themselves, can account for all ideas and all mental operations. Using the famous example of a statue endowed with no other property than a single sense, smell, he attempted to derive attention, memory, judgment, imagination, the whole of mental life. Condillac's views are, clearly, the most extreme form of the *tabula rasa* perspective. Like all *tabula rasa* views, no matter how powerful the correlative principle of association, Condillac's extreme sensationalism runs afoul of the obvious fact of variation (species differences, individual differences) in biological constitution.

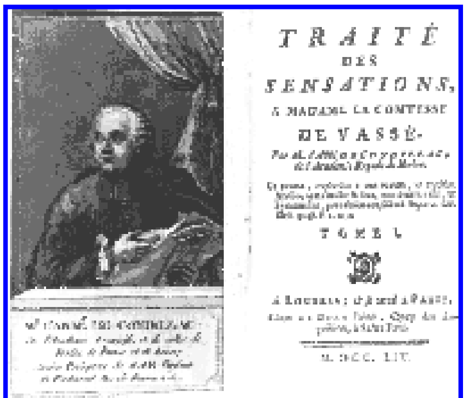


Figure 31
Condillac's *Traité des sensations* (1754) was designed to show that external sense impressions can account for all ideas and mental operations.

In direct contrast to Condillac, Thomas Reid (1710-1796) chose to emphasize Locke's inner sense, building on the simple notion of reflection to develop an elaborate theory of the intuitions and faculties of the human mind given by its fundamental constitution. Reid was born near Aberdeen and educated at Marischal College. Initially influenced by Berkeley, his antipathy to the implicit assumptions in Hume's *Treatise of Human Nature* (1739) turned him away from both Berkeley and Hume and toward the reformation of philosophy. His major work, *An Inquiry into the Human Mind on the Principles of Common Sense* [31], was published in 1764, the year in which he accepted appointment as Professor of Moral Philosophy at the University of Glasgow.

In the *Inquiry* Reid articulated the basic intuitional postulate of the "common sense" philosophy on which the Scottish faculty psychology was to be built. Intuitions are native tendencies to mental action, aspects of the fundamental constitution of the human mind which regulate the conscious experience of all human beings from birth. Because intuitions require the presentation of appropriate objects in order to be called forth in mental action, the Scottish philosophy is a realism. Intuitions do not project the mind into reality, they allow the mind access to it. Although intuitionalism is a nativism of psychological process, it is a methodological empiricism in that inquiry into the nature and existence of natively given principles of mind takes place by induction from observed facts in self-consciousness. It was this view, coupled with Reid's (1785,1788) later analysis of specific faculties that dominated 19th century academic American mental philosophy. It was also indirectly from Reid that Gall obtained the original list of 27 powers of the mind that guided his attempt to map the localization of function in the brain.

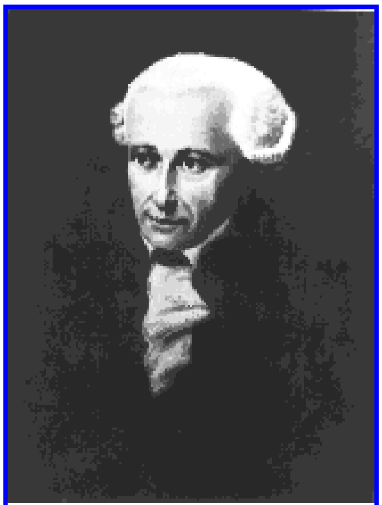


Figure 32
Immanuel Kant (1724-1804)

Immanuel Kant (1724-1804) [see figure 32] was born, lived, and died at Königsberg, in East Prussia. It is said that in the entire course of his life, he never traveled more than forty miles from the place of his birth. The suggestion from Ribot that 18th century philosophy culminated in the work of Kant was probably not an unreasonable one; although it might be an even fairer appraisal of Kant's influence to say that 19th and 20th century philosophy followed Kant much as the earlier philosophy had followed Descartes. Kant's indirect influence on scientific psychology was therefore enormous. His direct contributions, although admittedly more circumscribed, were also of considerable importance.

One such contribution, as we have already noted, was Kant's defining the prerequisites that would need to be met for psychology to become an empirical science. Another consisted of a bonafide psychological treatise, *Anthropologie in pragmatischer Hinsicht* [32], published in 1798. Long ignored, probably in part because of its pronounced sympathy for a soon to be discredited physiognomy, the *Anthropologie* is, nonetheless, a fascinating little book. Here Kant analyzes the nature of the cognitive powers, feelings of pleasure and displeasure, affects, passions, and character in the context of a denial of the possibility of an empirical science of conscious process. The *Anthropologie* went through two editions during Kant's lifetime and several later printings and helped to define the context within which not only Herbart and Fechner but phenomenologically oriented physiologists such as Purkyne, Weber, and Müller worked to establish the science of conscious phenomena that Kant was unable to envision.

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MIND AND BODY: René Descartes to William James

by Robert H. Wozniak

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2. The 19th Century: The Epistemology of the Nervous System

Boring (1950) has pointed out that between 1800 and 1850 discoveries in physiology helped lay the foundation for the eventual rise of experimental psychology. The events of particular interest to us are: a) the first elaboration of a distinction between sensory and motor nerves; b) the emergence of a sensory phenomenology of vision and of touch; and c) the articulation of the doctrine of specific nerve energies, including the related view that the nervous system mediates between the mind and the world. While these discoveries were being made, two major developments in philosophical psychology were also occurring: the elaboration of secondary laws of association and the first attempt at a quantitative description of the parameters affecting the movement of ideas above and below a threshold.

Figure 33
Charles Bell (1774-1842)

The first of the relevant physiological discoveries, that of the distinction between sensory and motor nerves, is credited to Charles Bell (1774-1842). Bell [see figure 33] was born in Edinburgh and educated informally. Although he attended lectures at the University of Edinburgh, most of Bell's anatomical and surgical instruction was received from his older brother John, a noted physician. By the time Bell was in his twenties, he was already a well-respected surgeon and by 1799 he had been admitted to the Royal College of Surgeons in Edinburgh. In 1806, he moved to London and five years later became affiliated with the Hunterian School of Anatomy. It was in that same year, 1811, that Bell printed one hundred copies of his 36 page *Idea of a New Anatomy of the Brain* [33] for private circulation among his friends and colleagues.

In the *New Anatomy*, Bell employed anatomical evidence to support the assertion that the ventral roots of the spinal cord contain only motor and the dorsal roots only sensory fibers. In so doing, he overturned centuries of tradition in which it was implicitly assumed that nerve fibers were indiscriminate with respect to sensory or motor function and established the fundamental distinction between these two types of nervous processes. When, as we have already seen, this distinction was combined with a parallel sensory-motor associationism, it led in the hands of Bain and Spencer to the first properly psychophysiological psychology and, through Jackson and Ferrier, to the establishment of the sensory-motor paradigm as the basis of functional localization in the cortex.

The first of the relevant philosophical advances was provided by Thomas Brown (1778-1820). Brown was born at Kirkmabreck, Scotland and educated in philosophy and medicine at the University of Edinburgh where he took courses with Dugald Stewart, a disciple of Reid. In 1810, he was appointed to share the professorship of moral philosophy with Stewart and within a short time he had become renowned for the brilliance of his lectures. In 1820, after his premature death, these lectures were published in four volumes as *Lectures on the Philosophy of the Human Mind* [34]. Their impact was immediate, undoubtedly because Brown managed to unite elements of two disparate traditions, the Scottish intuitionalism of Reid and the empiricism of Condillac. In so doing, he helped redirect both traditions.

Among a number of novel contributions, including an important critique of introspection based on Brown's belief in the absurdity of the idea that one and the same indivisible mind could be both the subject and the object of the same observation, Brown made two conceptual advances of fundamental importance in the history of experimental psychology. The first was to emphasize the "muscle sense." Before Bain, as we have earlier suggested, the associationists had neglected movement and action in favor of the analysis of sensation. Brown was the first philosopher in that tradition to move toward a more balanced sensory-motor view by including the sensory side of movement in his conceptualization of the problem of objective reference in perception.

Brown's second contribution involved his detailed elaboration of the secondary laws of association, which he termed "suggestion." Brown's formulation of these laws, which involved the relative duration, strength (liveliness), frequency, and recency of the original sensations as well as the reinforcement of one idea by others, provided later learning theorists with a basis for the attempt to explain not only the facts but the quantitative parameters of association.

Figure 34
Johann Friedrich Herbart (1776-1841). Courtesy of the Archives of the History of American Psychology.

During almost the same period, in Germany, another philosopher of mind, Johann Friedrich Herbart (1776-1841) was also concerning himself with quantitative relationships among ideas. Herbart [see figure 34] was born in Oldenburg and studied at the University of Jena under Johann Gottlieb Fichte, with whom he found himself in some disagreement. Provoked by Fichte's ideas, Herbart decided to work toward his own systematic philosophy and upon completion of study at Jena, went to Göttingen where he took the doctorate in 1802. There he remained until 1809 when he moved to Königsberg to assume the chair formerly occupied by Kant.

At Königsberg, Herbart began work on his psychology, publishing his *Lehrbuch* in 1816 and *Psychologie als Wissenschaft* [35] in 1824/1825. As is evident from this later title, Herbart believed that psychology could be both empirical (although he denied the possibility of experiment) and mathematical. Arguing that ideas ("presentations") are arrayed in time and vary in intensity, he attempted to create both a statics and a dynamics of mind and employed complex mathematical equations to describe an hypothesized system of principles of interaction among ideas.

Specifically, Herbart assumed that ideas of the same sort oppose one another while ideas of different sorts do not. Opposition progressively weakens the original idea in consciousness and, as a result, it eventually sinks below the threshold of awareness where it remains until the appearance of a similar idea in experience causes the original to rise at a speed proportional to the degree of similarity between the two ideas. Furthermore, as the original is pulled up by the new idea, similar ideas cling to it. Thus no idea can rise except to take its place in the unitary mass of ideas already present in consciousness. This is Herbart's famous concept of "apperception" in which an idea is not only made conscious but assimilated to the whole complex of conscious ideas, the *apperceptive mass*.

In these views, Herbart took several giant strides along the path that the new scientific psychology would eventually follow toward a complex, carefully worked out, quantitative recognition of the critical distinction between ideas above and below the threshold of consciousness. As the received history suggests, he was a transitional figure between Kant and Fechner; but in his rejection of the possibility of experimental verification and his inability to link his philosophy of mind to the physiology of the brain, he travelled only part of the way toward the "new" psychology. Before psychology could be taken into the laboratory, it needed methods; and the primary source of the early methods lay not in the philosophy of mind, but in the work of physiologists such as Purkyne and Weber, who made fundamental contributions to the experimental phenomenology of sensation, and Müller, who elaborated the doctrine of specific nerve energies that systematized the epistemological role of the nervous system as intermediary between the mind and the world.

Jan Evangelista Purkyne (1787-1869) was born in Libochovice, in Northern Bohemia and received his first formal education at a Piarist monastery. After completing the novitiate, he spent a year in study at the Piarist Philosophical Institute. In 1807, under the influence of the writings of Fichte, he left the order and traveled to Prague. Two years of work at the University of Prague and an additional three years as a private tutor preceded his decision to return to the university to study medicine. In 1819, at the completion of his medical studies, he published his doctoral dissertation, *Beiträge zur Kenntnis des Sehens in subjectiver Hinsicht*. This led in 1823 to his appointment as Professor of Physiology at the University of Breslau. In that same year, he reprinted his dissertation as the first volume of *Beobachtungen und Versuche zur Physiologie der Sinne* [36]. The second volume, which followed in 1825, was sub-titled *Neue Beiträge zur Kenntnis des Sehens in subjectiver Hinsicht*.

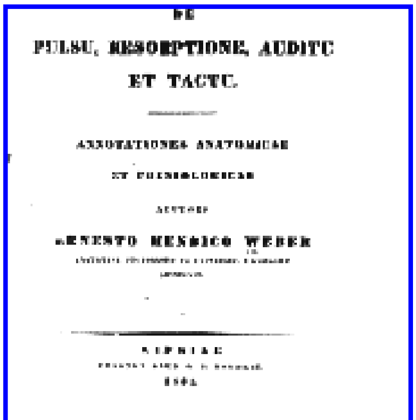
PULSU, RESORPTIONE, AUDITU
ET TACTU.

Figure 35
In that portion of the *De pulsu* (1834) devoted to touch, Weber presented an extensive experimental exploration of the sensory phenomenology of tactile experience.

The two volumes of the *Beobachtungen* are among the great intellectual achievements of the period and constitute a major point of transition in the emergence of experimental psychology. With extraordinarily acute ability to observe phenomenological detail, Purkyne explored the psychological consequences in visual experience of a series of experimental manipulations of the conditions of stimulation, including application to the eyeball of pressure and electrical current, alteration in point of light exposure relative to the fovea, degree of eye movement, and variation in the intensity of light. While Purkyne is best known to psychologists for his classic descriptions of phenomena such as the change in apparent luminosity of colors in dim as opposed to bright daylight (the so-called "Purkyne effect"), it was the breadth and systematicity of his use of the experimental method to explore the parameters of sensory experience that helped lay the foundation for future laboratory work.

Ernst Heinrich Weber (1795-1878) was born in Wittenberg and educated at Leipzig, where he remained to serve as Professor of Anatomy from 1818 and of Physiology after 1840. In 1834, he published *De pulsu, resorptione, auditu et tactu* [37, see figure 35]. In that portion of the work devoted to touch, Weber presented an extensive experimental exploration of the sensory phenomenology of tactile experience. Whereas Purkyne had shown the value of applying the experimental method to the phenomenology of sensation, Weber extended the approach beyond experimentation to quantification.

Coining the phrase, *just noticeable difference* (JND) to refer to the smallest perceptible difference between two sensations, Weber amassed data in support of the general principle that a JND in the intensity of a sensation is a function of the change in the magnitude of a stimulus by a constant factor of its original magnitude (ÆR/R). Although it has since been shown that there are significant limitations in the generality of this relationship not only across other sensory systems but even within touch itself, it would be hard to overestimate the importance of Weber's discovery for the emerging science of psychology. In articulating the relationship which Fechner later termed "Weber's Law," Weber provided an existence proof for the possibility of establishing quantitative relationships between variations in physical and mental events. By linking these relationships to the nervous system, he helped, with Müller, to establish the epistemological function of the nervous system in mediating the relationship between mind and the physical environment.


Figure 36
Johannes Müller (1801-1858)

Johannes Müller (1801-1858) [see figure 36] was born in Coblenz and educated at the University of Bonn. He received his medical degree in 1822 and, after a year in Berlin, was habilitated as *privatdozent* at Bonn, where he rose eventually to the professoriate. In 1833, he left Bonn to assume the prestigious Chair of Anatomy and Physiology at the University of Berlin. His most important contributions to the history of experimental psychology were the personal influence that he exerted upon younger colleagues and students, including Hermann von Helmholtz, Ernst Brücke, Carl Ludwig, and Emil DuBois-Reymond, and the systematic form he gave to the doctrine of the specific energies of nerves in the *Handbuch der Physiologie des Menschen für Vorlesungen* [38], published between 1834 and 1840.

Although Müller had enunciated the doctrine of specific nerve energies as early as 1826, his presentation in the *Handbuch* was more extensive and systematic. Fundamentally, the doctrine involved two cardinal principles. The first of these principles was that the mind is directly aware not of objects in the physical world but of states of the nervous system. The nervous system, in other words, serves as an intermediary between the world and the mind and thus imposes its own nature on mental processes. The second was that the qualities of the sensory nerves of which the mind receives knowledge in sensation are specific to the various senses, the nerve of vision being normally as insensible to sound as the nerve of audition is to light.

As Boring (1950) pointed out, there was nothing in this view that was completely original with Müller. Not only was much of the doctrine contained in the work of Charles Bell, the first of Müller's two most fundamental principles was implicit in Locke's idea of "secondary qualities" and the second incorporated an idea concerning the senses that had long been generally accepted. What was important in Müller was his systematization of these principles in a handbook of physiology that served a generation of students as the standard reference on the subject and the legitimacy he lent the overall doctrine through the weight of his personal prestige.

After Müller, the two problems of mind and body, the relationship of mind to brain and nervous system and the relationship of mind to world were inextricably linked. Although Müller did not himself explore the implications of his doctrine for the possibility that the ultimate correlates of sensory qualities might lie in specialized centers of the cerebral cortex or develop a sensory psychophysics, his principle of specificity lay the groundwork for the eventual localization of cortical function and his view of the epistemological function of the nervous system helped define the context within which techniques for the quantitative measurement of the mind/world relationship emerged in Fechner's psychophysics.

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MIND AND BODY: René Descartes to William James

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3. Mind, Brain, and the Experimental Psychology of Consciousness

It is in the work of Gustav Theodor Fechner (1801-1887) that we find the formal beginning of experimental psychology. Before Fechner, as Boring (1950) tells us, there was only psychological physiology and philosophical psychology. It was Fechner "who performed with scientific rigor those first experiments which laid the foundations for the new psychology and still lie at the basis of its methodology" (p. 275).

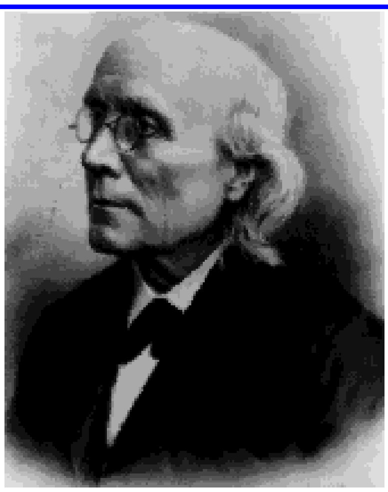
Figure 37
Gustav Theodor Fechner (1801-1887). Courtesy of the Archives of the History of American Psychology.

Fechner [see figure 37] was born in Gross-Sächen, Prussia. At the age of 16 he enrolled in medicine at the University of Leipzig where he studied anatomy under Weber. No sooner had he received his medical degree, however, than his interest began to shift toward physics and mathematics. By 1824, he was lecturing in physics and in 1834, with over 40 publications to his credit, including an important paper on the measurement of direct current, he was appointed Professor of Physics at Leipzig.

Fechner's psychological interests began to manifest themselves toward the end of the 1830s in papers on the perception of complementary and subjective colors. In 1840, the year in which an article on subjective afterimages appeared, Fechner suffered a nervous collapse. Exacerbated by a painful injury to the eyes sustained while gazing at the sun during his research, Fechner's ailment manifested itself in temporary blindness and prostration. He resigned his position at

Leipzig and went into a lengthy period of virtual seclusion during which his interests turned increasingly toward metaphysics. In 1848, the year of his return to the University as Professor of Philosophy, he completed *Nanna, oder Über das Seelenleben der Pflanzen*, a metaphysical treatise that contains his first explicit, philosophical treatment of the problem of the relationship of mind to body.

In *Nanna*, and in the more important *Zend-Avesta* (1851), Fechner sketched out a dual-aspect, monistic, pan-psychical mind/body view. In a famous metaphor, later adopted by Lewes, Fechner likened the universe, which is at one and the same time both active consciousness and inert matter, to a curve that can be regarded from one point of view as convex and from another as concave yet still retains its essential integrity. In line with this approach to mind/body, Fechner laid out a future program for psychophysics -- to demonstrate the unity of mind and body empirically by relating increase in bodily energy to corresponding increase in mental intensity.

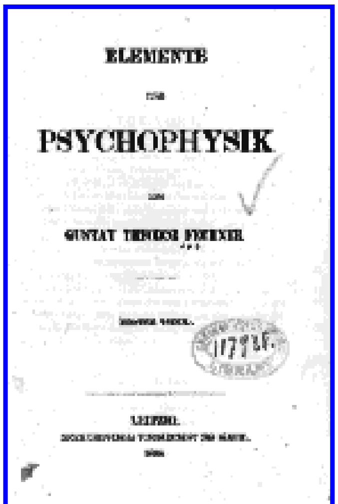

Figure 38
Publication of Fechner's *Elemente der Psychophysik* (1860) is generally considered to mark the formal beginning of experimental psychology.

Between 1851 and 1860, Fechner worked out the rationale for measuring sensation indirectly in terms of the unit of just noticeable difference between two sensations, developed his three basic psychophysical methods (just noticeable differences, right and wrong cases, and average error) and carried out the classical experiments on tactual and visual distance, visual brightness, and lifted weights that formed a large part of the first of the two volumes of the *Elemente der Psychophysik* [39, see figure 38]. Fechner's aim in the *Elemente* was to establish an exact science of the functional relationship between physical and mental phenomena. Distinguishing between inner (the relation between sensation and nerve excitation) and outer (the relation between sensation and physical stimulation) psychophysics, Fechner formulated his famous principle that the intensity of a sensation increases as the log of the stimulus ($S = k \log R$) to characterize outer psychophysical relations. In doing so, he believed that he had arrived at a way of demonstrating a fundamental philosophical truth: mind and matter are simply different ways of conceiving of one and the same reality.

While the philosophical message of the *Elemente* was largely ignored, its methodological and empirical contributions were not. Fechner may have set out to counter materialist metaphysics; but he was a well-trained, systematic experimentalist and a competent mathematician and the impact of his work on scientists such as Helmholtz, Ernst Mach, A.W. Volkmann, Delboeuf, and others was scientific rather than metaphysical. By combining methodological innovation in measurement with careful experimentation, Fechner moved beyond Herbart to answer Kant's second objection regarding the possibility of scientific psychology. Mental events could, Fechner showed, not only be measured, but measured in terms of their relationship to physical events. In achieving this milestone, Fechner demonstrated the potential for quantitative, experimental exploration of the phenomenology of sensory experience and established psychophysics as one of the core methods of the newly emerging scientific psychology.

Figure 39
Wilhelm Max Wundt (1832-1920)

As Fechner was putting the finishing touches on the *Elemente*, a young physiologist, Wilhelm Wundt (1832-1920), was settling into a position as assistant to Helmholtz, who had come to Heidelberg from Bonn to direct the Physiological Institute. Wundt [see figure 39] was born at Neckarau, in the vicinity of Mannheim and received his early education at the hands of a private tutor and at the Bruchsal Gymnasium. At age 19, he set off to study medicine at Tübingen, where his uncle, Friedrich Arnold, held the Chair in Anatomy and Physiology. During his first summer semester, he worked intensively on the study of cerebral anatomy under Arnold's guidance and by the end of the summer he had decided to make physiology his career. When his uncle moved to Heidelberg to direct the Institute of Anatomy, Wundt followed, completing his medical studies in 1855. After a year of hospital work and a journey to Berlin for a semester of study under Müller and Du Bois-Reymond, Wundt returned to Heidelberg in 1857 as *Dozent* in Physiology, becoming assistant to Helmholtz in the following year.

During this period, Wundt seems to have availed himself but little of his contact with Helmholtz. Carrying out much of his experimental work in his own home and on his own time, Wundt began the study of sense perception that led to a series of publications collected, in 1862, as his *Beiträge zur Theorie der Sinneswahrnehmung* [40]. The *Beiträge* consisted of six previously published articles on sense perception preceded by a methodological introduction. In these articles, Wundt provided the basics of a psychological theory of the perception of space (including some discussion of the need for unconscious inference, apparently arrived at in independence of Helmholtz), reviewed the history of theories of vision, analyzed the psychological function of sensations arising from visual accommodation and eye movement, presented the results of experiments on binocular contrast effects and stereoscopic fusion, and argued, contra Herbart, that the content of consciousness at a given instant always consists of a single, unconsciously integrated, percept.

Although the body of the *Beiträge* is important in its own right for exemplifying the direction that Wundt' work was taking, it is his introduction on method, written specifically for the *Beiträge*, which marked the emergence of Wundt's plan for an experimental psychology. Rejecting a metaphysical foundation for psychology, Wundt argued for the need to transcend the limitations of the direct study of consciousness through the use of genetic, comparative, statistical, historical, and, particularly, experimental methods. Only in this way, he suggested, would it be possible to come to a needed understanding of conscious phenomena as "complex products of the unconscious mind" (p. xvi). As the young Wundt was engaged in thinking through the prerequisites of an experimental psychology, Helmholtz, his immediate superior, the Director of his Institute, was in many ways already engaged in carrying out such a program.

Figure 40
Hermann Ludwig Ferdinand von Helmholtz (1821-1894)

Hermann Ludwig Ferdinand von Helmholtz (1821-1894) was born in Potsdam and educated at the Potsdam Gymnasium and at the Friedrich Wilhelm Medical Institute in Berlin. In Berlin, he came under the influence of Müller and in 1842, at 21 years of age, he graduated with a degree in medicine and entered the service as a Prussian Army physician. In reaction to Müller's vitalism, which he rejected, Helmholtz [see figure 40] became interested in clarifying the physiological basis of animal heat, a phenomenon that was sometimes used to help justify vitalism. This led in 1847 to a famous paper on the conservation of energy, which in turn brought Helmholtz the offer of a Professorship of Physiology at Königsberg, where he remained from 1848 to 1855. In 1855, he moved to Bonn and from Bonn, in 1858, to Heidelberg to serve as Director of the Institute of Physiology.

It was during the Bonn and Heidelberg periods that Helmholtz made his most fundamental contributions to the newly emerging experimental psychology. From 1856 to 1866, the *Handbuch der physiologischen Optik* [41] appeared in parts that were gathered into a single volume in 1867. In 1863, while the *Optik* was still appearing, Helmholtz published *Die Lehre von den Tonempfindungen*. While we will focus on the *Optik* here, these two works taken together defined the problematic for the experimental psychology of visual and auditory perception for decades to follow.

In the *Optik*, Helmholtz extended Müller's doctrine of the specific energies of nerves to offer a comprehensive theory of color vision and a famous unconscious inference theory of perception. In the theory of color vision, Helmholtz reasoned that just as the differences between sensations of sound and light reflect the specific qualities of auditory and visual nerves, sensations of color may depend on different kinds of nerves within the visual system. Since the laws of color mixture suggest that virtually all hues can be obtained by various combinations of three primary colors, it seemed to Helmholtz that the perceived hue, brightness, and saturation of color must be derived from varying activity in three primary kinds of nerve fibers in the eye.

In his theory of perception, Helmholtz started from the recognition that Müller's doctrine of specific nerve energies implied the fact that sensations do not provide direct access to objects and events but only serve the mind as signs of reality. Perception, on this view, requires an active, unconscious, automatic, logical process on the part of the perceiver which utilizes the information provided by sensation to infer the properties of external objects and events. In this regard, Helmholtz anticipated much of later top-down cognitive psychology.

In an earlier period, Helmholtz had also made another major contribution to physiology. Stimulating nerves at various distances from a muscle and measuring the time it took for muscular contraction, he estimated the rate of travel of the nervous impulse, and in the process incidentally introduced the technique of reaction-time into physiology. Between 1865 and 1868, another great physiologist, Franciscus Cornelis Donders (1818-1889) assimilated the reaction-time procedure to psychology, employing it to study the time taken up by mental operations.


Figure 41
Franciscus Cornelis Donders
(1818-1889)

Donders [see figure 41] was born in the town of Tilburg, in the Netherlands, and entered the University of Utrecht as a medical student at the age of 17. Upon receipt of the degree, he joined the military as a surgeon and, at the age of 24, was invited to teach at the Military Medical School at Utrecht. Five years later Donders was offered a position as *extraordinarius* at the University of Utrecht, which he accepted, remaining there for the remainder of his career.

In 1865, Donders published a preliminary communication in which he reported work carried out with a student, Johan Jacob de Jaager, and summarized more fully in de Jaager's doctoral dissertation, *De physiologische tijd bij psychische processen* (1865). Reasoning that reaction time was additive, Donders separately assessed the time taken to respond to a stimulus under conditions of choice and simple non-choice. Subtracting simple from choice reaction-time, Donders computed the interval taken by the decision process. In 1868, in a classic paper appearing in German, "Die schnelligkeit psychischer Processe" [42], Donders provided the definitive report of the results of this work and its extension to discrimination times. Although the specifics of Donder's findings are of little interest today, his use of the reaction technique to measure the time taken by mental processes exerted a major impact on his contemporaries and reaction-time was installed, along with psychophysics, as a method of choice in the early experimental laboratory.

As Donders investigated reaction-time, Wundt, still at Heidelberg, began to work toward the conception of physiological psychology that was to serve as the basis for his systematic approach to experimentation. In 1867, in a new quarterly journal of psychiatry founded by Max Leidesdorf and Theodor Meynert, Wundt published an invited article, "Neuere Leistungen auf dem Gebiete der physiologischen Psychologie." Under the banner of physiological psychology, he reviewed recent literature on visual space perception and the measurement of the time taken by mental operations. As an outgrowth of this review, Wundt offered a series of lectures on physiological psychology in the Winter of 1867/1868. These lectures he repeated only once again, in 1872/1873, as he was preparing the text that Boring (1950), steeped as he was in the Wundt-Titchener tradition, called "the most important book in the history of modern psychology" (p. 322).

Issued in two parts, in 1873 and 1874, the *Grundzüge der physiologischen Psychologie* [43] was the first comprehensive handbook of modern experimental psychology. It was, as Boring tells us, "on the one hand, the concrete result of Wundt's intellectual development at Heidelberg and the symbol of his metamorphosis from physiologist to psychologist, and, on the other hand ... the beginning of the new 'independent' science" (Boring, p. 323). Although the theories elaborated in the *Grundzüge* changed over the five major revisions during which it grew from one to three volumes, the essential structure of Wundt's system, "his great argument for an experimental psychology" (Boring, p. 323), had been reasonably well worked out by 1874.

In that year, Wundt accepted a call to the University of Zurich, where he remained only a year, moving in 1875 to Leipzig to assume the chair in philosophy. Although Boring (1950) claimed that upon his arrival in Leipzig Wundt was allocated space for experimental demonstrations adjunctive to his lectures, there is no evidence to that effect (Bringmann et al., 1980). Indeed, it would appear that from 1875 to 1879, Wundt devoted himself largely to the duties entailed in his new teaching position.

Figure 42
Wilhelm Wundt, surrounded by students and colleagues at Leipzig, site of the first experimental laboratory devoted to psychological research.

On the 24th of March, 1879, however, Wundt submitted a petition to the Royal Saxon Ministry of Education in which he formally requested a regular financial allocation for the establishment and support of a collection of psychophysical apparatus. Although his request was denied, Wundt seems as early as the Winter of 1879/1880 to have nonetheless allowed two students, G. Stanley Hall and Max Friedrich, "to occupy themselves with research investigations" (Wundt, 1909, p. 1). This research took place in a small classroom in the Konvict Building that had earlier been assigned to Wundt for use as a storage area. Humble though it may have been, this small space constituted the first laboratory in the world devoted to original psychological research [see figure 42].

Experimental psychology, born with Fechner, nurtured by Helmholtz and Donders, was to be raised by Wundt. Over the years until his retirement in 1917, Wundt served as the *de facto* parent of the "new" psychology. Students from all over the world, especially from the United States, journeyed to Leipzig to learn experimental technique and to return to their home institutions imbued with the spirit of scientific psychology.

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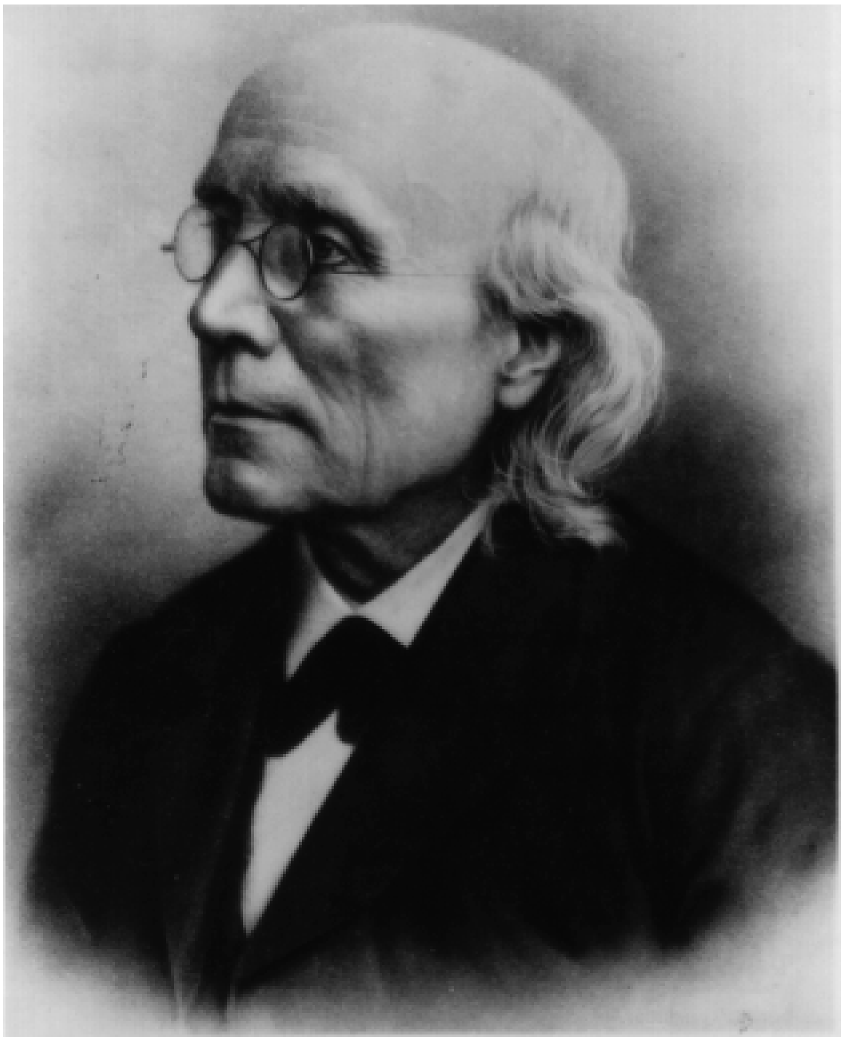

GUSTAV THEODOR FECHNER

BORN APRIL 19, 1801; DIED NOVEMBER 18, 1887