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Gustav Fechner

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A HENRY HOLT EDITION IN PSYCHOLOGY



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GUSTAV THEODOR FECHNER (1801-1887)

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Editor's Introduction

Gustav Theodor Fechner

1801—1887

Gustav Theodor Fechner's *Elemente der Psychophysik* of 1860 stands at the head of the new science of psychology. Actually the history of thought and of science is continuous, and new ways of thinking emerge only gradually as they make possible the discovery of new knowledge in the vast sea of ignorance and also the escape of the natural philosopher from the restraints of established habits of thinking.

The new experimental psychology, when it was being "founded" in the middle of the nineteenth century, already had a long past. It had a past in mental philosophy, which stems from Aristotle, if you wish, or more directly from Descartes (1650), who divided the world of experience into matter (extended substance) and mind (unextended substance). That is a dualism that has troubled psychologists for 300 years, a dualism that Fechner condemned in his philosophical war defending spiritualism against materialism. For the most part, on the philosophical side, the line of descent to the new psychology had been through the British empiricists — Hobbes, Locke, Berkeley, Hume, James Mill, John Stuart Mill. All these men, being empiricists, wrote in the atmosphere of an accepted dualism: sense-stimulation in the material world gives rise by way of the nerves to sensations, which, patterned and structured by association, constitute the furniture of the mind. Berkeley, however, reversed the genetic order and held that experience, being primordial, is given in the mind and that the conception of matter is derived from experience. John Mill's view was similar and so was Fechner's, but Fechner's formulation of the psychophysical relation nevertheless suggests the conventional view of the period that stimulus is prior to sensation, being the independent variable in the psychophysical experiment, and that sensation is measured as to its magnitude only indirectly by reference to the stimulus. He might be said to be epistemologically a dualist and metaphysically a panpsychist. The natural world, he said, is like a circle that can be viewed from the outside or from the inside and yet remains always the same circle.

The other line of descent for the new psychology is through physics and physiology. At first physics, with its standard problems of optics and acoustics, seemed nearer to the analysis of experience than did physiology. It was

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Newton, a physicist, who in 1704 made the fundamental analysis of visual sensation into the spectral colors. It was Pierre Bouguer, another physicist, who in 1729 determined the discriminatory threshold for illumination, and C. E. J. Delezenne, also a physicist, who in 1827 measured the first thresholds of pitch discrimination. At this time the physiologists entered the field through the independent discovery by Charles Bell in 1811 and François Magendie in 1822 that sensory and motor nerves constitute different systems, since they are connected with the spinal cord at different roots. That discovery invited physiologists to the separate study of the problems of sensation and of movement, and Johannes Müller, sometimes called "the father of experimental physiology," in 1826 contributed to the body of sensory fact and theory the doctrine of specific nerve energies, the conception that the quality of excitation differs in sensory nerves for each of the five senses. It was another physiologist, E. H. Weber, who in 1834 worked out the discriminatory thresholds for the tactual sense and formulated the generality that this threshold is proportional to the magnitude of the stimulus for which it is observed, a rule that has come to be called Weber's Law. Then, while Fechner was at work on psychophysics in the 1850s, H. L. F. v. Helmholtz, a physiologist, destined to become a famous physicist, turned his attention to the sensory problems of vision, publishing his huge and now classical three volumes of physiological optics in 1856-1866, as well as his other classical handbook on the sensations of tone in 1863.

In this atmosphere Fechner conceived and wrote *Elemente der Psychophysik*. Scientific experimental psychology was then all ready to emerge into the world of learning as a new discipline. Did Fechner "found" it? It is hard to say. That was not what he was trying to do. He wanted to confound materialism by disclosing empirically the relationship between mind and body. Did Helmholtz "found" the new science? That is not what he was trying to do. He supported this novel enterprise, but mainly he was concerned with the facts and measurement of visual and acoustic phenomena. Wilhelm Wundt was indeed endeavoring to "found" a new science, but he was younger and had little to say about the matter until 1863, nor very much before 1874, when his soon-to-be-famous text appeared, the first of its six editions.

Actually this matter of "founding" is moot but also unimportant. The growth of a science is inevitably gradual and continuous. "Founders" are created by the student of history as distance-markers to show how far history has come and as other signs of the road to show where there is a fairly sudden, yet never very sudden, change of direction. Great men and their unexpected quick insights are for the most part created *ex post facto* as mnemonic aids for the student of history. In this same manner Fechner himself, 10 years after the event, looked back on his own thinking as he had lain in bed on the morning of October 22, 1850, and chose that moment for the insight that created psychophysics. Great men and crucial dates are useful as they effect an analysis of history, for history, being descriptive, is necessarily analytical.

Gustav Theodor Fechner was a versatile man. He first acquired a modest fame as professor of physics at Leipzig, but in later life he was a physicist only as a spirit of science penetrated all his work. In intention and ambition he was a philosopher, especially in his last 40 years of life, but he was never famous, or even successful, in this fundamental effort that is, nevertheless, the key to his other activities. He was a humanist, a satirist, a poet in his incidental writings, and an aestheticist during one decade of activity. He is famous, however, for his psychophysics, and this fame was rather forced upon him. He did not wish his name to go down to posterity as a psychophysicist. He did not, like Wundt, seek to found experimental psychology. He might have been content to let experimental psychology as an independent science remain in the womb of time, could he but have established his spiritualistic "day view" of reality as a substitute for the current materialistic "night view." The world, however, chose for him; it seized upon the psychophysical experiments, which Fechner meant merely as contributory to his philosophy, and made them into an experimental psychology. A fascinating life to those who wish to know how Great Men are made!

Fechner was born in 1801 in the parsonage of a little village in southeastern Germany, near the border between Saxony and Silesia. His father had succeeded his grandfather as village pastor. His father was a man of independence of thought and of receptivity to new ideas, who shocked the villagers by having a lightning rod placed upon the church tower, in the days when this precaution was regarded as a lack of faith in God's care of his own, and by preaching — as he urged that Jesus must also have done — without a wig. One can thus see in the father an anticipation of Fechner's own genius for bringing the brute facts of scientific materialism to the support of a higher spiritualism, but there can have been little, if any, direct influence of this sort, for the father died when Fechner was only 5 years old. Fechner, with his brother and mother, spent the next 9 years with his uncle, also a preacher. Then he went for a short time to a *Gymnasium* and then for a half year to a medical and surgical academy. At the age of 16 he was matriculated in medicine at the university in Leipzig, and at Leipzig he remained for the rest of his long life — for 70 years in all.

We are so accustomed to associating Fechner's name with the date 1860, the year of the publication of the *Elemente der Psychophysik*, and with the later years when he lived in Leipzig while Wundt's laboratory was being started, that we are apt to forget how old he was and how long ago he was beginning his academic life. In 1817, when Fechner went to Leipzig, Lotze, later the philosopher-pioneer in speculative physiological psychology, was not even born. Herbart had just published his *Lehrbuch*, but his *Psychologie als Wissenschaft* was still 7 years away in the future. In England, James Mill had barely completed the *History of India* and presumably had not even thought of writing a psychology. John Stuart Mill was 11 years old; Bain was not born. Phenology had only just passed its first climax, and Gall was still writing on

the functions of the brain. Flourrens had not yet begun his researches on the brain. Bell, but not Magendie, had discovered the Bell-Magendie law. It was really, as the history of psychology goes, a very long time ago that Fechner went as a student to Leipzig.

It happened that E. H. Weber, the Weber after whom Fechner named "Weber's Law," went to Leipzig in the same year as *Dozent* in the faculty of medicine and was made in the following year a junior professor of comparative anatomy. After 5 years of study, Fechner took his degree in medicine, in 1822. Already, however, the humanistic side of the man was beginning to show itself. His first publication (1821), *Beweiss, dass der Mond aus Jodine besteht*, was a satire on the current use of iodine as a panacea. The next year he wrote a satirical panegyric on modern medicine and natural history. Both these papers appeared under the nom de plume "Dr. Mises," and "Dr. Mises" was reincarnated in ironical bursts altogether 14 times from 1821 to 1876. Meanwhile Fechner's association with A. W. Volkmann had begun. Volkmann came to Leipzig as a student in medicine in 1821 and remained, later as *Dozent* and professor, for 16 years.

After he had taken his degree, Fechner's interest shifted from biological science to physics and mathematics, and he settled down in Leipzig, at first without official appointment, for study in these fields. His means were slender, and he undertook to supplement them by the translation into German of certain French handbooks of physics and chemistry. This work must have been very laborious, for by 1830 he had translated more than a dozen volumes and nearly 9000 pages; but it was work that brought him into prominence as a physicist. He was also appointed in 1824 to give lectures in physics at the university, and in addition he undertook physical research of his own. It was a very productive period. By 1830 he had published, including the translations, more than 40 articles in physical science. At this time the properties of electric currents were just beginning to become known. Ohm in 1826 had laid down the famous law that bears his name, the law that states the relation between current, resistance, and electromotive force in a circuit. Fechner was drawn into the resulting problem, and in 1831 he published a paper of importance on quantitative measurements of direct currents, a paper which made his reputation as a physicist.

The young Fechner in his thirties was a member of a delightful intellectual group in the university community at Leipzig. Volkmann, until he went to Dorpat in 1837, was also a member of this group, and it was Volkmann's sister whom Fechner married in 1833. The year after his marriage Fechner was appointed professor of physics. It must have seemed that his career was already determined. He was professor of physics at only 33, with a program of work ahead of him. He was settled in a congenial social setting at one of the most important universities. We shall see presently how far wrong the obvious prediction would have been. Fechner for the time being kept on with his physical research, throughout the still very fertile decade of his thirties. "Dr. Mises," the humanistic Fechner, appeared as an author more than half a

dozen times. Toward the end of this period there is, in Fechner's research, the first indication of a quasi-psychological interest: two papers on complementary colors and subjective colors in 1838, and the famous paper on subjective afterimages in 1840. In general, however, Fechner was a promising younger physicist with the broad intellectual interests of the German professor.

Fechner, however, had overworked. He had developed, as James diagnosed the disease, a "habit-neurosis." He had also injured his eyes in the research on afterimages by gazing at the sun through colored glasses. He was prostrated, and he resigned, in 1840, his chair of physics. He suffered great pain and for 3 years cut himself off from everyone. This event seemed like a sudden and incomprehensible ending to a career so vividly begun. Then Fechner unexpectedly began to recover, and, since his malady was so little understood, his recovery appeared miraculous. This period is spoken of as the "crisis" in Fechner's life, and it had a profound effect upon his thought and his subsequent interests.

The primary result was a deepening of Fechner's religious consciousness and his concern with the problem of the soul. Thus Fechner, quite naturally for a man with such an intense intellectual life, turned to philosophy, bringing with him a vivification of the humanistic coloring that always had been one of his attributes. His forties were, of course, a sterile decade as regards writing. "Dr. Mises" published a book of poems in 1841 and several other papers later. The first book that showed Fechner's new tendency was a book about the mental life of plants, published in 1848. For Fechner, in the materialistic age of science, to argue about the minds of plants, even before Darwin had made the mental life of animals a crucial issue, was for him to court scientific unpopularity, but Fechner now felt himself possessed of a philosophic mission and he could not keep silence. He was troubled by materialism, as his book on life after death in 1836 had shown. His philosophical solution of the spiritual problem lay in his affirmation of the identity of mind and matter and in his assurance that the entire universe can be regarded as readily from the point of view of its consciousness, a view that he later called the "day view," as it can be viewed as inert matter, the "night view." Yet the demonstration of the consciousness of plants was but a step in a program.

Three years later (1851) a more important work of Fechner's appeared. It was called *Zend-Avesta*, and its subtitle declared it was about the things of heaven and the future. Oddly enough this book contains Fechner's program of psychophysics and thus bears an ancestral relation to experimental psychology. We shall return to this matter in a moment. Fechner's general intent was that the book should be a new gospel. The title means practically "a revelation of the word." Consciousness, Fechner argued, is in all and through all. The earth, "our mother," is a being like ourselves but very much more perfect than ourselves. The soul does not die, nor can it be exorcised by the priests of materialism when all being is conscious. Fechner's argument was not rational; he was intensely persuasive and developed his theme by way of plausible analogies, which, but for their seriousness, resemble somewhat the method of

Dr. Mises' satire on the comparative anatomy of the angels (1825), where Fechner argued that the angels, as the most perfect beings, must be spherical, since the sphere is the most perfect form. Now, however, Fechner was in dead earnest. He said later in 1861 that he had then called four times to a sleeping public which had not yet been aroused from its bed. "I now," he went on, "say a fifth time, 'Steh' auf!' and, if I live, I shall yet call a sixth and a seventh time, 'Steh' auf!' and always it will be but the same 'Steh' auf!'"

We need not go further into Fechner's philosophy. He did call a sixth and a seventh time, and there are seven books from 1836 to 1879 that show the persistence and the extent of Fechner's belief in his own gospel. As it happened, the public never "sprang out of bed," not even at the seventh call. His philosophy received some attention; many of these books of his were reprinted in later years; but Fechner's fame is as a psychophysicist and not as a philosopher with a mission.

It was one thing to philosophize about mind and matter as two alternative ways of regarding everything in the universe, and another thing to give the idea such concrete empirical form that it might carry weight with the materialistic intellectualism of the times or even be satisfactory to Fechner, the one-time physicist. This new philosophy, so Fechner thought, needed a solid scientific foundation. Thus he has told us that it was on the morning of October 22, 1850, while he was lying in bed thinking about this problem, that the general outlines of the solution suggested themselves to him. He saw that the thing to be done was to make "the relative increase of bodily energy the measure of the increase of the corresponding mental intensity," and he had in mind just enough of the facts of this relationship to think that an arithmetic series of mental intensities might correspond to a geometric series of physical energies, that a given absolute increase of intensity might depend upon the ratio of the increase of bodily force to the total force. Fechner said that the idea was not suggested by a knowledge of Weber's results. This statement may seem strange, for Weber was in Leipzig and had written about this matter only in 1846. We must remember, however, that Weber himself had not pointed out the general significance of his law and may have seen its most general meaning only vaguely. He had hinted at a generality in his manner of talking about ratios as if they were increments of stimulus, and in extending his finding for touch to visual extents and to tones. He had formulated no specific law. It was Fechner who realized later that his own principle was essentially what Weber's results showed, and it was Fechner who gave the empirical relationship mathematical form and called it "Weber's Law." In recent times there has been a tendency to correct Fechner's generosity, and to give the name *Fechner's Law* to what Fechner called "Weber's Law," reserving the latter term for Weber's simple statement that the just noticeable difference in a stimulus bears a constant ratio to the stimulus.

The immediate result of Fechner's idea was the formulation of the program of what he later called psychophysics, a program that, as we have already noted, was worked out in the *Zend-Avesta* of 1851. There was still the program

to carry out, and Fechner set about it. The methods of measurement were developed, the three psychophysical methods which are still fundamental to much psychological research. The mathematical forms both of the methods and of the exposition of the general problem of measurement were established. The classical experiments on lifted weights, on visual brightness, and on tactual and visual distances were performed. Fechner the philosopher proved to have lost none of the experimental care of Fechner the physicist. His friend and brother-in-law, A. W. Volkmann, then at Halle, helped with many of the experiments. Other data, notably the classification of the stars by magnitude, were brought forth to support the central thesis. For 7 years Fechner published nothing of all this. Then in 1858 and 1859 two short anticipatory papers appeared, and then in 1860, full grown, the *Elemente der Psychophysik*, a text of the "exact science of the functional relations or relations of dependency between body and mind."

It would not be fair to say that the book burst upon a sleeping world. Fechner was not popular. *Zend-Avesta* and similar writings had caused the scientists to look askance at him, and he was never accepted as a philosopher. No one suspected at the time what importance the book would come to have. There was no furor; nevertheless the work was scholarly and well grounded on both the experimental and mathematical sides, and, in spite of philosophical prejudice, it commanded attention in the most important quarter of all, namely, with the other scientists who were concerned with related problems. Even before the book itself appeared, the paper of 1858 had attracted the attention of Helmholtz and of Mach. Helmholtz proposed a modification of Fechner's fundamental formula in 1859. Mach began in 1860 tests of Weber's law in the time-sense and published in 1865. Wundt, in his first psychological publications in 1862 and again in 1863, called attention to the importance of Fechner's work. A. W. Volkmann published psychophysical papers in 1864. Aubert challenged Weber's law in 1865. Delboeuf, who later did so much for the development of psychophysics, began his experiments on brightness in 1865, inspired by Fechner. Vierordt similarly undertook in 1868 his study of the time-sense in the light of the *Elemente*. Bernstein, who had just divided with Volkmann the chair of anatomy and physiology at Halle, published in 1868 his irradiation theory, a theory that is based remotely on Herbert's law of the limen, but directly on Fechner's discussion. The *Elemente* did not take the world by the ears, but it got just the kind of attention that was necessary to give it a basic position in the new psychology.

Fechner, however, had now accomplished his purpose. He had laid the scientific foundation for his philosophy and was ready to turn to other matters, keeping always in mind the central philosophical theme. Moreover, he had reached his sixties, the age when men begin to be dominated more by their interests and less by their careers. The next topic, then, that caught the attention of this versatile man was esthetics, and, just as he had spent 10 years on psychophysics, so now he spent a decade (1865-1876) on esthetics, a decade that was terminated when Fechner was 75 years old.

If Fechner "founded" psychophysics, he also "founded" experimental esthetics. His first paper in this new field was on the golden section and appeared in 1865. A dozen more papers came out from 1866 to 1872, and most of these had to do with the problem of the two Holbein Madonnas. Both Dresden and Darmstadt possessed Madonnas, very similar although different in detail, and both were reputed to have been painted by Holbein. There was much controversy about them, and Fechner plunged into it. There were several mooted points. The Darmstadt Madonna showed the Christchild. The Dresden Madonna showed instead a sick child and might have been a votive picture, painted at the request of a family with the image of a child who had died. There was the general question of the significance of the pictures, and there was also the question of authenticity. Which was Holbein's and which was not? Experts disagreed. Fechner, maintaining the judicial attitude, was inclined to believe that they might both be authentic, that if Holbein had sought to portray two similar but different ideas he would have painted two similar but different pictures. And finally, of course, there was the question as to which was the more beautiful. These two latter questions were related in human judgment, for almost everyone would be likely to believe that the authentic Madonna must be the more beautiful. Some of these questions Fechner sought to have answered "experimentally" by a public opinion poll on an auspicious occasion when the two Madonnas were exhibited together. He placed an album by the pictures and asked visitors to record their judgments; but the experiment was a failure. Out of over 11,000 visitors, only 113 recorded their opinions, and most of these answers had to be rejected because they did not follow the instructions or were made by art critics or others who knew about the pictures and had formed judgments. Nevertheless the idea had merit and has been looked upon as the beginning of the use of the method of impression in the experimental study of feeling and esthetics.

In 1876 Fechner published an introduction to esthetics, a work that closed his active interest in that subject and laid the foundation for experimental esthetics. It goes into the various problems, methods, and principles with a thoroughness that rivals the psychophysics.

There is little doubt that Fechner never would have returned either to psychophysics or to esthetics, after the publication of his major book in each subject matter, had the world let him be. The psychophysics, however, had immediately stimulated both research and criticism and, while Fechner was working on esthetics, was becoming important in the new psychology. In 1874, the year of the publication of Wundt's *Grundzüge der physiologischen Psychologie*, Fechner had been aroused to a brief criticism of Delboeuf's discussion of psychophysics (1873). The next year Wundt came to Leipzig. The following year Fechner finished with esthetics and turned again to psychophysics, publishing in 1877 his *In Sachen der Psychophysik*, a book which adds but little to the doctrine of the *Elemente*. Fechner was getting to be an old man, and his philosophical mission was still in his mind. In 1879, the year of Wundt's initiating research in the new Leipzig psychological laboratory,

Fechner issued his seventh and last call to the somnolent world on the "day view" and the "night view." He was then 78 years old. Finally, in 1882, he published the *Revision* of the psychophysics, a very important book, in which he took account of his critics and sought to meet the unexpected demand of experimental psychology upon him. In the following years there were half a dozen psychophysical articles by him, but actually his work was done. He died in 1887 at the age of 86 in Leipzig, where for 70 years he had lived the quiet life of the learned man, faring forth, while keeping his house, on these many and varied great adventures of the mind.

This then was Fechner. He was for 7 years a physiologist (1817-1824); for 15 years a physicist (1824-1839); for 12 years an invalid (1839 to 1851); for 14 years a psychophysicist (1851-1865); for 11 years an experimental estheticist (1865-1876); for at least 40 years throughout this period, recurrently and persistently, a philosopher (1836-1879); and finally, during his last 11 years, an old man whose attention had been brought back by public acclaim and criticism to psychophysics (1876-1887) — all told 70 years of varied intellectual interest and endeavor. If he founded experimental psychology, he did it incidentally and involuntarily, and yet it is hard to see how the new psychology could have advanced as it did without an *Elemente der Psychophysik* in 1860. It is to this book, therefore, that we must now turn our attention, and that we can do best in terms of the text itself, at last after 100 years available in English translation, a centennial celebration for a man who brought psychology around a corner in its history.

Boston, Mass.

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