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WUNDT AND GERMAN PSYCHOLOGY

The book which I here present to the public is an attempt to mark out a new domain of science.

Wilhelm Wundt, 1874

Preview

Chapters 2 and 3 describe the context out of which modern psychology emerged in the nineteenth century. Philosophers, interested in the same fundamental questions about the human mind and behavior that occupy psychologists today, began to speculate about the need to examine these issues scientifically. At least one nineteenth-century British philosopher, John Stuart Mill, explicitly called for a scientific psychology. Meanwhile, physiologists and physicians in Europe made great strides in furthering our understanding of the physiology of the nervous system and, in particular, of the brain. This chapter examines how this experimental physiology combined with philosophical inquiry to create a new experimental psychology in Germany in the late nineteenth century. The chapter opens with a brief discussion of some aspects of German education that made it attractive to American students, then continues with a look at how Gustav Fechner's psychophysics provided a standardized set of methods for studying the mind. The creation of the New Psychology and its first laboratory by Leipzig's Wilhelm Wundt forms the focus of the middle of the chapter. The chapter ends with consideration of three other important German psychologists, Hermann Ebbinghaus, G. E. Müller, and Oswald Külpe. The Original Source Excerpt is from Ebbinghaus's famous book about his experiments on memory.

AN EDUCATION IN GERMANY

American students have always looked to European universities as a way to further their educations. Even today, a semester abroad is a valued experience. In the nineteenth century, Germany was an especially attractive location for young scholars; it has been estimated that in the 100-year span beginning in 1820, at least 9000 American students enrolled in one German university or another (Sahakian, 1975), usually to study medicine or one of the sciences. By the end of the century, they were going there to study psychology.

One reason for the popularity of German universities was mere quantity. Between the time of the 1815 Congress of Vienna and the unification of Germany under Bismarck in 1871, Germany did not exist as a "country," but was a loosely organized federation of 38 autonomous "principalities" (e.g., Bavaria, Hanover, Saxony) (Palmer, 1964). Each ministate wanted to keep up with its neighbors, of course, and one means of accomplishing this goal was to have its own university. Hence, universities proliferated throughout the federation of principalities, although many of them were little more than a building with some classrooms and a few professors. Several gained international stature, however, and drew students from all over Europe as well as from America.

Circumstances in nineteenth-century Germany were especially conducive to the development of a new and more scientific approach to psychology. Beginning in the middle of the century, and originating at the University of Berlin, German universities developed a distinctive philosophy of education known as *Wissenschaft*. It was an approach that emphasized scholarly research combined with teaching and academic freedom for professors to pursue their research interests without fear of censure. Students were free to wander from one university to another, and earning a degree resulted more from the passing of special exams and the defense of a research thesis than from the completion of a specific curriculum.

For the professors who would create a new scientific psychology, many of whom you will meet in this chapter, the timing was perfect. The success of the physiologists (Chapter 3) reinforced the *Wissenschaft* emphasis on a research-based atmosphere and contributed directly to the growth of the new experimental approach to psychology in Germany, especially at Leipzig. As Blumenthal has pointed out, the methods being developed by the physiologists, "involving measurement, replicability, public data, and controlled tests" (1980, p. 29), which were being applied to the study of the nervous system, might just as well be applied to other aspects of human behavior. Gradually the term "physiological" in German came to mean "experimental." When Wilhelm Wundt referred to the new psychology as a "physiological psychology," he meant it in this broader sense of psychology being a discipline based on scientific methodology.

For the American student of the 1880s who desired to learn about this new field of study firsthand, several choices were available (e.g., Gottingen, Heidelberg, Berlin: see map in Figure 4.1), but Wundt's laboratory was the best equipped and had the strongest reputation, so traveling to Leipzig became the most fashionable option. During Wundt's tenure, approximately three dozen Americans completed doctorates under his supervision and a number of others at least sampled the Leipzig environment (Benjamin, Durkin, Link, Vestal, & Accord, 1992). Before considering Wundt and his influence on the development of American psychology, however, some important preliminaries are in order.

ON THE THRESHOLD OF EXPERIMENTAL PSYCHOLOGY: PSYCHOPHYSICS

A strong case can be made that scientific research on psychological topics began as a natural extension of the physiological research being done in the nineteenth century. Later in this chapter you

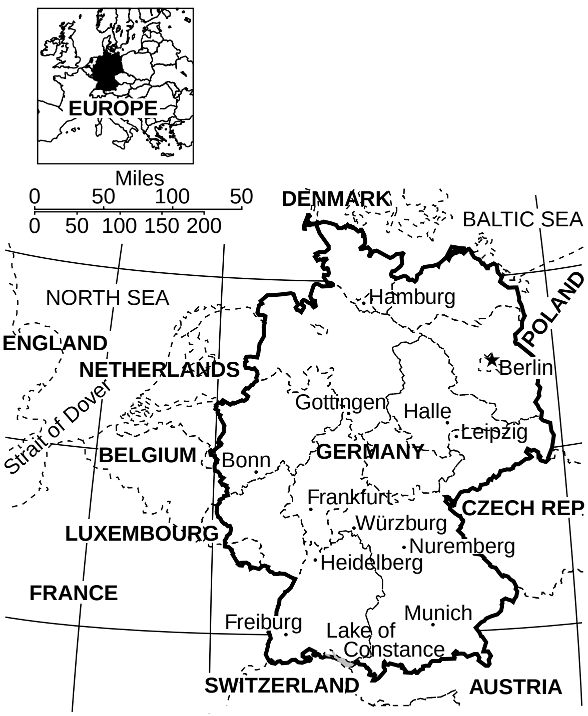


Figure 4.1 Map of Germany, showing locations of the universities relevant for psychology's history.

will encounter one example of this in the connection between Helmholtz's physiological studies of nerve impulse speed and the psychological method of reaction time. In this section, we examine an association between physiological research on sensory processes and the development of **psychophysics**, the study of the relationship between the perception of a stimulus event ("psycho") and the physical dimensions of the stimulus being perceived ("physics"). Psychophysics originated in the sensory research of Ernst Weber and became clearly defined with the enigmatic Gustav Fechner.

ERNST WEBER (1795–1878)

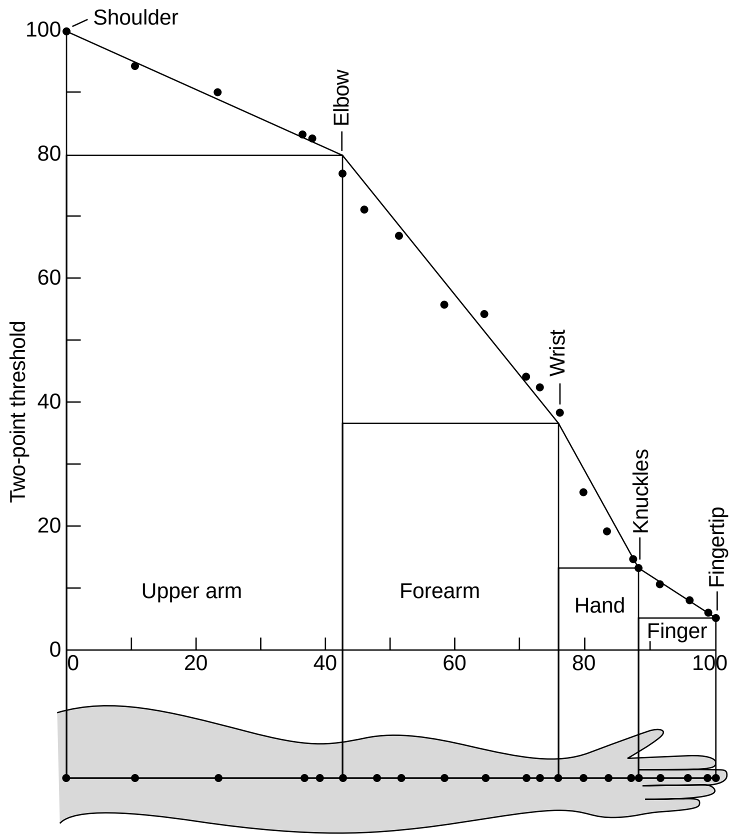
Weber spent most of his academic career at the University of Leipzig, first as a student and then as a professor of anatomy and physiology from 1818 until his retirement in 1871. In the 1820s physiologists were beginning to learn a great deal about visual and auditory sensation, but little was known of the other senses. Weber set out to correct the imbalance by becoming the leading authority on the tactile senses (Dorn, 1972). He made two major contributions: mapping the relative sensitivity of various locations on the skin, and demonstrating a mathematical relationship between the psychological and the physical that would later be known as Weber's Law.

Two-Point Thresholds

To examine tactile sensitivity, Weber used a technique in which he touched the skin with a simple device resembling a two-point compass. The distance between the points could be varied, and the blindfolded observer's task was to judge whether one or two points were being felt. For any specific area of the skin, there exists a **two-point threshold**—the point where the perception changes from "one" point to "two." For skin areas of great sensitivity, the thumb for instance, Weber found the threshold to be quite small. That is, the points didn't have to be very far apart before being noticed as two distinct points rather than one. On the other hand, for areas of less sensitivity, the upper arm for instance, the points would have to be placed farther apart before they were perceived as being two separate ones. Figure 4.2 shows a series of two-point thresholds from shoulder to fingertip, taken from a later (1870) study by Vierordt (cited in Boring, 1942, p. 478).

Weber believed that the different two-point thresholds resulted from differences in the sizes of what he called "sensory circles," shown as hexagons on Weber's sketch in Figure 4.3 (Weber, 1852, shown in Boring, 1942, p. 476). These were areas of the skin that were sensed by the branching fibers of a single sensory nerve. If two points of a compass would both touch the skin within a single sensory circle, the perception would be of a single point, Weber thought. When the two points touched two different cir-

Figure 4.2 Two-point thresholds for various locations between shoulder and fingertip, from Boring (1942).



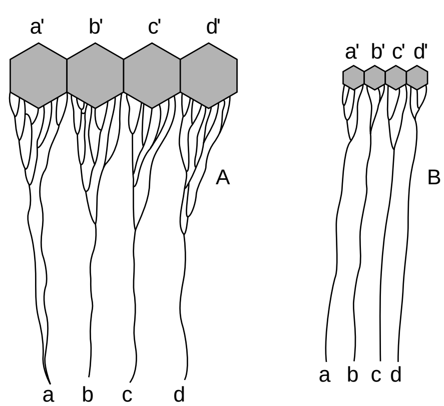


Figure 4.3 Weber's conception of sensory circles, from Boring (1942).

cles, two points would be felt. Skin areas of greater sensitivity had smaller circles. Thus, the set of four sensory circles on the left in Figure 4.3 might be from an area near the shoulder, while the circles on the right might be closer to the fingertip. The sense of touch turns out to be more complicated than this, but Weber's model had the beneficial effect of generating considerable research on just how the tactile senses worked. Also, although he did not think of the research in these terms, Weber was measuring mental events (perceptions).

Weber's Law

Weber's second contribution derived from his interest in the "muscle sense," what we would today call kinesthesis. He wanted to know how important this sense was for making judgments about the comparative weights of objects (Heidbreder, 1933). Picture two tasks. In the first, your hand is resting on a table and first one then another weighted cylinder is placed in your palm. Your task is to judge which cylinder is heavier. In the second task, the two cylinders are on the table and this time you lift each one before making the same judgment. In performing such an experiment, Weber found that he and other observers could make finer discriminations when they lifted the weights, which brings the muscle sense into play. More important for the history of psychology, Weber also discovered that the ability to discriminate between two weights did not depend on the absolute difference between them in weight, but on a more complicated relationship. This relationship later became known as Weber's law.

In the weight-lifting experiments, Weber was dealing with thresholds again. For example, if observers cannot distinguish between 30 and 31 grams, and between 30 and 32 grams (they judge them to be the same weight), but *can* distinguish between 30 and 33 grams, then clearly some kind of threshold has been passed at 33 grams. Weber referred to the discrimination between 30 and 33 grams as a "just noticeable difference" or **jnd**. What he discovered was that the jnd depended not on the absolute size of the difference between the weights, but on the relationship between this jnd and the smaller of the two weights (called the "standard stimulus," or *S*). As the standard stimulus became heavier, a greater difference between the weights was necessary before the difference was noticed. That is, **Weber's law** was this: $jnd/S = k$. So observers would notice a difference between 30 and 33 grams, but not between 60 and 63 grams. If the standard stimulus is 60 grams instead of 30, no difference can be detected until the second weight is at least 66 grams (3/30 = 6/60). Similarly, if S = 90 grams, the jnd will be 9 grams. Hence, the jnd was proportional to the size of S.

The importance of Weber's law is threefold. First, as with the two-point threshold research, Weber was subjecting mental events to measurement and mathematical formulation. This would eventually make psychophysics an essential element of Wilhelm Wundt's "New Psychology," which would claim to be a science. Science demands objective measurement and threshold research seemed to fit the bill nicely. Second, Weber showed that there is not a one-to-one relationship between changes in the physical world and the psychological experience of those changes. Increasing a weight by 3 grams does not always produce the same sensation. Sometimes differences will be perceived (if S = 30), sometimes not (if S = 60). Consequently, understanding how the mind organizes its experiences requires knowing more than just the physical dimensions of the stimuli to which we are exposed; it also requires an attempt to determine how the mind perceives those physical stimuli. Third, Weber's law showed that mental and physical events could be related mathematically. That insight would be developed more fully by another Leipzig scientist.

GUSTAV FECHNER (1801–1889)

Weber's goal as a physiologist was to understand the nature of the tactile and muscle senses and to do so he used methods that would eventually be known as psychophysical. His younger Leipzig colleague Gustav Fechner had an even more ambitious goal, however. Fechner was obsessed with the idea of resolving the ageless mind-body problem in a way that would defeat materialism, and he thought that psychophysics was the way to do it. Fechner can be considered the first genuine experimental psychologist, even though he was trained as a physician, made his reputation as a physicist, and when he was in the midst of his pioneering research in psychophysics, thought of himself as a philosopher.

Fechner was born in a Lutheran parsonage in southern Germany in 1801; he was a precocious child, familiar with Latin by age five. At age 16 he entered the University of Leipzig to study medicine, and his education included a dose of physiology with Weber. The M.D. was earned in 1822, but Fechner never practiced medicine. During the 1820s, his interests focused on math and physics, and during this time he lectured in these areas (without pay) and earned a living by translating physics and chemistry texts from French to German. He also made original research contributions in the new physics of electricity during this time.[1] His research was notable enough to earn him a position at Leipzig as professor of physics in 1834, the same year that Weber published his research on the sensation of touch.

Fechner's interests in science broadened in the 1830s to include the study of visual afterimages, the kind that occur after a bright light is flashed on and off. He discovered a relationship between the brightness of the light and the strength of the afterimage, which led him to consider the quality of afterimages resulting from a quick glance at the brightest of all lights: the sun. Quick glances become longer glances and even though Fechner wore filters to reduce the effects of staring at the sun, he severely damaged his eyesight. The problem was serious enough to force him to resign his professorship in 1839 and accept a disability pension from the university.

Long before the afterimage episode, Fechner suffered from headaches and an occasional inability to control his thoughts, but the blindness triggered a descent into neurosis that lasted several years (Balance & Bringmann, 1987). Fechner became an invalid, forced to spend long periods of time in total darkness and plagued by a variety of anxiety, depressive, and somatic symptoms. In his words,

> My situation…became even more depressing. Since I was accustomed to using my mind and had few skills in dealing with others merely on a social basis and was not good at anything other than working with pen and textbook, I suffered soon the tortures of deadly boredom.… (cited in Balance & Bringmann, 1987, p. 39)

Fechner's ascent to normality began in 1842 and was complete by the mid-1840s. It was accomplished largely through his own efforts at regaining control over his life, but was facilitated by a steady improvement in his vision. After recovering, he turned his attention to philosophical matters and in 1851 he was reappointed to the Leipzig faculty. It was during this period that he became immersed in the question of the relationship of mind to body and consumed with the idea of defeating materialism. As you recall from the last chapter, materialism, the belief that all events have causes that can be traced to physical and chemical changes, was favored by most of the younger physiologists of the day (e.g., Helmholtz).

Fechner referred to materialism as the *Nachtansicht*, or "Night View," and he hoped to replace it with a contrasting *Tagesansicht*, or "Day View." This Day View derived from an idealism movement then popular in German philosophy which held that the universe as a whole had a form of consciousness to it that went beyond the individual consciousnesses of the organisms within it. Upon death, one's personal consciousness merged with this cosmic

[1] Fechner's research on electricity reveals an interesting connection with his father, a Lutheran minister whose faith extended into the realm of science. The elder Fechner was aware of the famous electricity experiments of Benjamin Franklin, and of Franklin's invention of the lightning rod in 1787. Knowing that church steeples were a favorite target of lightning bolts, he prudently installed one of Franklin's devices on his church steeple. Members of the church felt that their pastor was not showing much faith in God's ability to protect the church, but Pastor Fechner commented that the laws of physics also had to be considered (Boring, 1950). Pastor Fechner died when his son was only five, but young Gustav apparently inherited his father's love of and respect for science.

consciousness. For Fechner, this meant that while mind and body could be considered two aspects of the same fundamental reality, the mind was the primary and dominant feature of that reality. It was in searching for a way to conceptualize the exact mind-body relationship that he created psychophysics. He later claimed that he achieved the insight suddenly, upon waking on the morning of October 22, 1850.[2] It occurred to him that mind and body could be united harmoniously and with mathematical precision by measuring psychological sensations and the physical stimuli that produced the sensations. The insight triggered a decade of intense work, resulting in the publication in 1860 of the *Elements of Psychophysics*, often considered the first book of experimental psychology.

FECHNER'S *ELEMENTS OF PSYCHOPHYSICS*

Fechner was aware of Weber's research on thresholds, but it was only after his great insight of 1850 that he realized its significance. The breakthrough for Fechner was the conviction that sensations could be subjected to exact measurement by assuming that jnd's were subjectively equal in magnitude. Thus, weights of 30 and 33 grams are just noticeably different, as are weights of 60 and 66 grams. The differences in weight between the two pairs of stimuli are 3 and 6 grams, respectively. Psychologically, however, the difference between 30 and 33 feels the same as (i.e., is subjectively equal to) the difference between 60 and 66, according to Fechner. This assumption of subjective equality led Fechner to reformulate Weber's law as

$$S = k \log R$$

where S is the sensation, the perceived size of some stimulus in jnd units, k is a constant, and R is the physical measurement of the stimulus.

By assuming that jnd's could be the unit of psychological measurement, Fechner was able to conceive of a scale that began at the point where sensation was first noticed. This point he called the **absolute threshold**. As stimulus intensity increases above this threshold, the person eventually experiences a just noticeable difference, then another, and so on. These jnd's above the absolute threshold are **difference thresholds**. Consider the familiar example of a light with a dimmer switch. With the light completely off, there is of course no stimulation and no sensation of light. As the dimmer switch is slowly turned, there will continue to be zero sensation for a brief time, but soon we just barely notice the first glimmerings of light. This is the absolute threshold. If the dimmer switch continues to be turned, a point is reached where the light is now just noticeably brighter than a second ago. This is a difference threshold.

Fechner's assumption of equal jnd's was challenged almost immediately, and his mathematical relationship was shown to be true only under limited circumstances. No matter. The enduring legacy of his *Elements of Psychophysics* was his systematization of the methods used to establish thresholds, which are still in use, both in the laboratory and in such applications as vision and hearing tests. These are known today as the methods of limits, constant stimuli, and adjustment.[3] Consider them in the context of a hearing test designed to establish absolute thresholds. In the **method of limits**, a stimulus is presented that is well above threshold, then gradually reduced in intensity until the subject reports that it can no longer be heard.

[2] If you want to impress your professor, send him or her a "Happy Fechner Day" card on October 22. To this day, experimental psychologists, especially those who study sensation and perception, take some time out on that day to raise a glass in honor of Fechner's insight.

[3] Fechner referred to them as the methods of just noticeable differences, right and wrong cases, and average error, respectively.

This is called a descending trial, and it is followed by an ascending trial, in which the stimulus is first presented below threshold, then increased until the subject hears it for the first time. Descending and ascending trials are alternated a number of times, and the threshold is calculated as an average of all the trials. In the **method of constant stimuli**, sounds of varying intensities are presented in a random order and the subject's task is to indicate whether or not they are heard. This method solves a problem with the method of limits, which is a tendency to anticipate the place where the threshold lies. In the **method of adjustment**, the subject directly varies the intensity of the stimulus until it seems to be at threshold. While these examples involve absolute thresholds, all three methods can also be used in experiments on difference thresholds. Of the three techniques, a study using the method of adjustment takes the least amount of time, but is the least accurate; the method of constant stimuli is the most accurate, but takes the longest time (Goldstein, 1996). In an actual hearing test, the method of limits with descending trials is normally used, with "catch trials" inserted to prevent subjects from raising their hands ("I hear it") when there is in fact no stimulus presented.

Boring (1963b) has referred to Fechner as the "inadvertent founder of psychophysics." He believed that Fechner's main purpose was philosophical: to establish his Day View while defeating materialism (the Night View). Unfortunately for Fechner, that goal was not reached and the philosophical implications of his work were largely ignored. Fortunately for psychology, Fechner's efforts resulted in the creation of a program of research and a set of methods that enabled others to see what Fechner did not: that psychological phenomena could be subjected to scientific methodology. By inadvertently creating psychophysics in 1860, Fechner paved the way for another German physiologist, Wilhelm Wundt, to proclaim a "New Psychology" a few years later.

WUNDT ESTABLISHES A NEW PSYCHOLOGY AT LEIPZIG

The quote that opens this chapter comes from the preface of the epoch-making two-volume *Principles of Physiological Psychology*, published in 1873–1874 by the German most often described as the "founder" of experimental psychology, Wilhelm Wundt. To claim, as Wundt did, that one is making an "attempt to mark out a new domain of science" is the kind of statement that separates founders from their contemporaries. Clearly, Fechner's work on psychophysics entitles him to a claim as the first experimental psychologist. We've seen, however, that Fechner had other, more philosophical, purposes. Thus, as Boring (1950) has pointed out, founders are promoters; they might not be the first to accomplish something, but they are the first to proclaim loudly that their accomplishment breaks dramatically new ground. They might make some important scientific contribution, but their talent lies in their ability to propagandize. Wundt had that talent.

WILHELM WUNDT (1832–1920): CREATING A NEW SCIENCE

Experimental psychology's founder had a childhood of modest accomplishment. Excessive daydreaming and marginal performance characterized his early school years, and it wasn't until his late teens that he became interested in the direction of his education. Despite a dismal academic record, family connections enabled him to begin medical studies at the University of Tübingen at the age of 19; after a year he switched to Heidelberg, where he finally began to show promise. By 1855, he had earned an M.D. (summa cum laude) from the University of Heidelberg and had finished first on a state board certifying exam (Bringmann, Balance, & Evans, 1975).

The Heidelberg years also saw the blossoming of Wundt's interests in science. The famous chemist Robert Bunsen (yes, he invented the Bunsen burner) made a lasting impression: When Wundt eventually became a professor himself, he copied Bunsen's technique of illustrating points in class through the frequent use of visual displays and demonstrations. Bunsen also inspired Wundt's first independent research project, an examination of the effects of restricting salt input on the chemical composition of his urine. During these years, Wundt also completed some more sophisticated research, including a study of the roles played by several cranial nerves in breathing. This required an ablation method using live dogs and rabbits, a procedure that Wundt found troubling. He was bolstered by the support of his mother, who assisted in the surgery, which was completed in Wundt's home rather than at the university (Bringmann, Balance, & Evans, 1975). Wundt also conducted an experiment on the touch sensitivity of hysteric patients, using Weber's two-point threshold technique; this study served as his M.D. dissertation research.

Following completion of the M.D. in November of 1855, Wundt practiced medicine for a brief six months as a clinical assistant at Heidelberg's university hospital, but he was already beginning to think that a life of research was more appealing than a life of writing prescriptions and setting bones. He spent a semester in Berlin studying experimental physiology with the great Johannes Müller (Chapter 3), then resolved to become a professor of physiology upon his return to Heidelberg. He was given a position of *Privatdozent* in February of 1857, which in the German system meant that he was entitled to offer courses, but that his entire salary depended on student fees. Wundt's first course attracted only four students and near the completion of the course he fell seriously ill, probably with tuberculosis (Bringmann, Bringmann, & Balance, 1980). After a yearlong recovery, he applied for an opening as the assistant in the laboratory of the esteemed Hermann Helmholtz (Chapter 3), who had just begun his tenure at Heidelberg. Wundt got the job, a major boost for his career.

Wundt toiled as Helmholtz's assistant for six years, from 1858 to 1864, but he did much more with his time than just run the laboratory. He continued to offer courses as *Privatdozent* and he began publishing at a rate that is astounding by any standard.[4] In addition to technical papers and two brief texts based on his lectures, Wundt published two important books that marked him as a emerging experimental psychologist. *Contributions to a Theory of Sensory Perception* appeared in 1862, followed a year later by *Lectures on Human and Animal Psychology*. The first book is noteworthy because it marks the first time that Wundt called for an explicitly experimental approach to basic psychological questions. Thus, he was thinking about the possibility that psychology could be a science long before his famous pronouncement of 1873–1874. The second book repeated the call and described some of the early research in psychophysics and reaction time.

Wundt left Helmholtz's laboratory in 1864 but remained at Heidelberg for another decade. He set up his own private laboratory and earned a livable wage through teaching fees and book royalties. In 1871 his efforts were finally rewarded by the university, which appointed him to the rank of Extraordinary Professor (similar to the associate professor level in American universities). This meant that for the first time in his life, Wundt had full faculty status and a salary that was not tied to student enrollment. Nearing the age of 40, he was finally secure enough to marry his fiancée of many years. During this time he

[4] By one estimate, Wundt published 53,735 pages during his professional years, an average of 2.2 pages per day (Boring, 1950, p. 345)!

wrote the work best-known to psychologists, his two-volume *Principles of Physiological Psychology* (1873–1874/1910), which included the chapter's opening quote in its Preface. The book, which eventually went through six editions, earned him a professorship in "inductive philosophy" at the University of Zurich (academic year 1874–1875). After just a year in Switzerland, Wundt was offered a similar position at the more prestigious University of Leipzig, Germany's largest university at the time, and he accepted immediately. There he remained until his retirement in 1917. He died three years later.

We tend to associate Wundt only with Leipzig, but it is important to realize that when he arrived there in 1875, he was already in his mid-forties and had been an active scientist at Heidelberg for 17 years. He had already written three important books and numerous papers, more than most professors produce in a lifetime. Furthermore, he had announced that at least some aspects of psychology could be experimental, and he had set out a plan for establishing what quickly came to be called the New Psychology. Thus, he had accomplished what would be a life's work for many. Yet Wundt still had more than *40* highly productive years left in him during his time at Leipzig.

During his years at Heidelberg, Wundt had accumulated a private collection of laboratory apparatus, both for his own research and for demonstrating various phenomena during his lectures (in the spirit of his old chemistry professor, Robert Bunsen). Upon arrival at Leipzig, he requested space to store the equipment. Although traditional accounts have it that the university gave him some space upon his arrival in 1875 and that the room eventually became his famous laboratory, careful archival research (Bringmann, Bringmann, & Ungerer, 1980) has shown that Leipzig delayed the assignment for a year, despite Wundt's repeated requests. Nonetheless, that the university granted the request at all is noteworthy, because space was quite limited at the time. This modest beginning, a room with approximately 400 square feet, eventually became experimental psychology's first laboratory and the model for dozens of imitators. Wundt used the lab for demonstrational purposes initially, but by 1879 he and his students were conducting original research in what he now called the *Psychologisches Institut*. The Institute quickly became a magnet, attracting curious students from all over Europe and from America. Additional rooms were added over the years, and in 1897 a new and more elaborate laboratory was built to Wundt's specifications. It was destroyed by an Allied bombing raid in 1943. An inside look at the workings of Wundt's laboratory, a glimpse of which can be seen in Figure 4.4, will follow shortly; first, however, it is necessary to examine Wundt's vision for his New Psychology.

WUNDT'S CONCEPTION OF THE NEW PSYCHOLOGY

The "new domain of science" that Wundt attempted to "mark out" in his *Principles of Physiological Psychology* was a vision first outlined 12 years earlier in his 1862 book on perception (*Contributions to a Theory of Sensory Perception)*. It called for the scientific examination of human conscious experience, using methods borrowed from experimental physiology and supplemented by new strategies. It included two major programs: the examination of "immediate" conscious experience using the experimental methods of the laboratory and the study of higher mental processes, using nonlaboratory methods.

Studying Immediate Conscious Experience

To understand the contrast that Wundt drew between immediate experience and "mediate" experience, consider a simple example. If you look out the window at a thermometer and it reads 15°F, you are not experiencing the phenomenon of temperature directly. Rather, temperature is being *mediated* by a scientific instru-

Key Date 1879

This year marks the date normally associated with the establishment of Wundt's laboratory of experimental psychology in Leipzig.

These events also occurred:

- The first electric tram was exhibited at the Berlin Trade Exhibition
- London established its first telephone exchange
- Ferdinand de Lesseps formed the Panama Canal Company
- The American novelist Henry James, brother of psychologist William James, published *Daisy Miller*
- Anti-Jesuit laws were introduced in France
- Mary Baker Eddy became pastor of the Church of Christ, Scientist, in Boston
- These people were born:

  Joseph Stalin, Soviet dictator

  Albert Einstein, German physicist
- This person died:

  Charles de Coster, Belgian author

ment. On the other hand, if you then step outside without a coat, you have a direct experience of coldness. It is an immediate conscious experience. That is, there is no thermometer standing between you and the weather; you are encountering it firsthand. For Wundt, it was this immediate conscious experience that was to be the subject matter of his laboratory psychology.

Wundt recognized the problem with studying immediate consciousness. To examine mediate experience objectively is simple. Because the temperature reading is a public event, two or more observers can agree on it

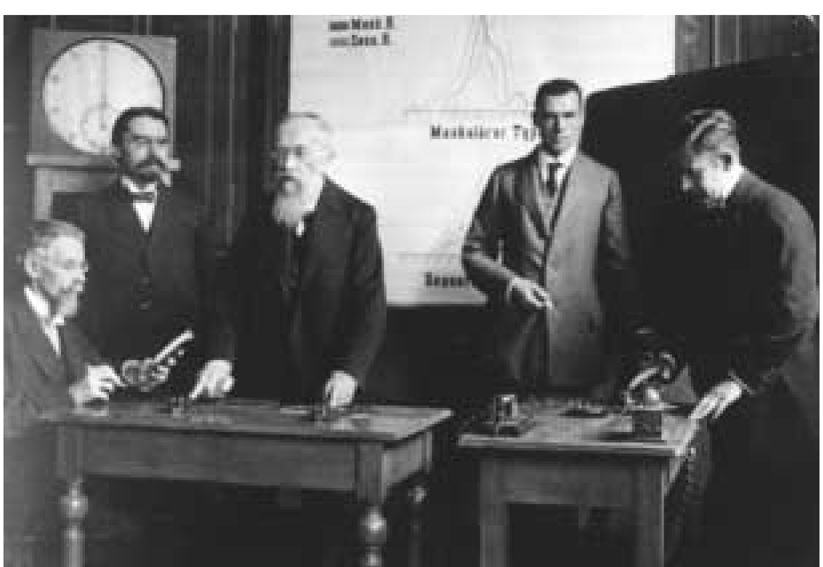


Figure 4.4 An aging Wilhelm Wundt (center) in his laboratory at Leipzig.

and it is a fairly straightforward matter to apply scientific methods. Various aspects of the environment can be manipulated systematically, and the resulting effects on temperature can be assessed with some precision. Describing immediate experience is more difficult, however. How can you be sure that your experience of coldness compares with mine? Here Wundt made a critical distinction between *self observation* and *internal perception*. The distinction has been blurred over the years, according to Danziger (1980), with both terms being called **introspection**. Self-observation is the traditional philosophical attempt to analyze life's experiences through introspective reflection. This was unsystematic and because such observations by definition take place some time after the experienced event has occurred, they rely too heavily on faulty memory. Wundt rejected self-observation as nothing better than philosophical speculation. **Internal perception**, on the other hand, was like self-observation, but a much narrower process of responding immediately to precisely controlled stimuli. The problem of memory was reduced by the immediacy of the response and by using observers (Wundt and his students) trained to respond automatically and without bias. Such precision came with a price, however. Internal perception could only yield valid scientific data if its results could be replicated. For Wundt, this meant that laboratory research had to be limited to a narrow range of experiences. In practice, this amounted to basic sensory/perceptual ones. Such experiences could be controlled by means of sophisticated apparatus used to present stimuli to observers, who in turn would give simple responses to these stimuli. In Wundt's lab, these types of introspective responses were "largely limited to judgments of size, intensity, and duration of physical stimuli, supplemented at times by judgments of their simultaneity and succession" (Danziger, 1980, p. 247). These, of course, are the kinds of judgments made in psychophysics experiments, which comprised a significant portion of the research in Wundt's laboratory. As we will learn, Wundt's conception of introspection as internal perception differed sharply from the "systematic experimental introspection" used by two of his better known students, Oswald Külpe (below) and Edward B. Titchener (Chapter 7).

Studying Higher Mental Processes

Although Wundt believed that laboratory investigation was necessarily limited to the immediate conscious experience of basic mental processes, he also had a broader aim for his psychology. He wished to examine higher mental processes such as learning, thinking, language, and the effects of culture, but he believed that because these processes were so intertwined with an individual's personal history, cultural history, and the social environment, they could not be controlled sufficiently to be examined in the laboratory. Instead, they could only be studied through inductive observational techniques, cross-cultural comparisons, historical analysis, and case study.

These higher mental processes were a lifelong interest of Wundt's, first outlined in detail in his second major book (*Lectures on Human and Animal Psychology*, 1863). They fully occupied the last two decades of his life and during this time, he enhanced his reputation as a prodigious writer by publishing the massive 10-volume *Völkerpsychologie* ("volker" translates roughly as "cultural," "ethnic," or "communal"). The books include detailed analyses of language and culture, and encompass topics that would today be considered under the headings of psycholinguistics, the psychology of religion and myth, social psychology, forensic psychology, and anthropology. Of the 10 volumes, there were three on myth and religion, two on language, two on society, and one each on culture and history, law, and art (Blumenthal, 1975)

Wundt, like other thinkers of his time, believed that an implication of evolutionary theory was that cultures could be arranged on a continuum, from "primitive" (e.g., Australian aboriginal) to “advanced” (German, presumably). By studying the social customs, myths, religions, and languages of cultures differing in their level of sophistication, Wundt thought that an understanding of the evolution of human mental processes could be attained (Farr, 1983). He was especially interested in language, and his descriptions give him a legitimate claim to the title of founder of modern psycholinguistics. Much of what he wrote about language was ignored at the time, only to be rediscovered in the 1950s and 1960s, when psycholinguistics became a key element in the rise of cognitive psychology (Blumenthal, 1975). For example, Wundt distinguished between the idea that was to be conveyed by a sentence, the actual structure of the sentence itself, and the manner in which the listener took the sentence structure and inferred the speaker’s meaning from it. The relationship between the idea to be conveyed and the sentence structure is similar to the distinction later made by Chomsky between the deep and surface structures of a grammar, and Wundt’s belief that the listener would not recall the actual sentence but the meaning of it is similar to later research on memory for the “gist” of communicated messages.

INSIDE WUNDT’S LABORATORY

Once Wundt’s students began producing original research at Leipzig, the need for a way to publicize the work became apparent. Wundt solved the problem in 1881 by creating the journal *Philosophische Studien* (*Philosophical Studies*). It was the first journal designed to report the results of experimental research in psychology and Wundt served as editor for its first two decades (1881–1903). The journal became a mouthpiece for the work done by Wundt and his students, so a look at its contents reveals the kind of research done at Leipzig during the last two decades of the nineteenth century. According to Boring (1950), who examined the 100 or so experimental studies published in the journal during this time, at least half of the research was in the area of sensation and perception. Of the remaining half, reaction time studies were the most popular, followed by studies on attention, feeling, and association.

Sensation and Perception

Most of the basic information about sensory systems encountered in today’s courses in sensation/perception was known by the turn of the century and some of the research was carried out in Wundt’s laboratory. As mentioned earlier, most of these “internal perception” studies were psychophysical in nature, examining such topics as the abilities to distinguish colors presented to different areas of the retina and tones presented in various combinations of pitch and loudness. In perception, Wundtians studied such topics as positive and negative afterimages, visual contrast, illusions, and the perception of size, depth, and motion (Boring, 1950).

Mental Chronometry

When Helmholtz measured the duration of a nerve impulse and found it to be more leisurely than expected (Chapter 3), he provided the impetus to a method that came to be known as **mental chronometry** in Wundt’s lab. Today we call it reaction time. Wundt was aware of this research long before he arrived in Leipzig. He became Helmholtz’s assistant at Heidelberg shortly after the nerve impulse studies had been carried out and he became very interested in the problem of measuring mental speed in the 1860s. The problem had also been around for a number of years in the form of a practical difficulty faced by astronomers. The creation of tables for calculating longitude required knowing the precise positions of various stars and planets at specific times of a lunar cycle (Sobel, 1995). Identifying these positions involved a complicated procedure which measured the time taken for a planet to make a “transit” from one side of the crosshair of a telescope lens to the other. Humans were making the judgments of course, and even though they were trained astronomers, their judgments of transit times tended to be different because of small differences in their reaction times. To solve the problem, an attempt was made to calibrate one astronomer against another by determining each one's **personal equation**. Thus, if astronomer A was regularly 0.12 second slower than astronomer B, their transit times could be made comparable through a personal equation: $A = B + 0.12$ second.

The individual who developed the reaction time procedure as it came to be used by the Wundtians was F. C. Donders (1818–1889), a Dutch physiologist. Donders reasoned that if nerve impulses take a measurable amount of time and if mental activity is composed of nerve impulses, then various mental events potentially could be determined with some precision. Assuming that mental events could be combined in an additive fashion, Donders developed the **subtractive method** in the late 1860s. First, he would measure the time taken for a simple reaction: holding down a telegraph key, then releasing it as soon as possible after perceiving a light, for example. The procedure would then be "complicated" by adding other mental tasks. For instance, the observer might be asked to respond only if a red light came on; if the light was another color, no response was to be made. This "discrimination reaction time" (DRT) was composed of everything involved in simple reaction time (SRT), *plus* the mental event of discriminating between the colors. Thus:

DRT = SRT + discrimination time

discrimination time = DRT - SRT

Similarly, "choice reaction time" (CRT) involved releasing one key if the light was one color and another key if the light was a second color. In addition to simple reaction time and the time taken to discriminate between the two colors, the observer also had to choose which key to release. Thus:

CRT = SRT + discrimination time + choice time

choice time = CRT - (SRT + discrimination time)

choice time = CRT - DRT

For reasons that are apparent, this procedure was also called the **complication experiment**; studies using it flourished in Wundt's laboratory, especially in the 1880s. The procedure was eventually discarded, however, when it became clear that the additive assumptions underlying the method were overly simplistic. In the above procedures, for instance, certain more complicated reactions should always be longer than less complicated ones, but in actual experiments this outcome did not always occur. Wundt's student Oswald Külpe, to be discussed in more detail below, pointed out that altering the procedure by adding discrimination and/or choice does not simply add elements; rather, it changed the entire experimental situation.

James McKeen Cattell (Chapter 8), perhaps the best known of the American students who studied with Wundt, was an enthusiastic advocate of the reaction time method (Garrett, 1951). He began his research while a student at Johns Hopkins in Baltimore, then continued it after arriving in Leipzig in 1883. An examination of one of his studies (Cattell, 1885/1948) nicely illustrates the logic of the reaction time method and the close attention to detail needed to carry out such research. In the article, Cattell described some research on simple, discrimination, and choice reaction times that were completed with his German colleague Gustav Berger. The research formed the basis for Berger's doctoral dissertation for Wundt on the effects of stimulus intensity on reaction time (Sokal, 1981).

In the first experiment, Cattell and Berger gave simple reaction times to lights that varied in intensity. The experimental setup probably looked something like the one in Figure 4.5 (photo taken at Clark University in 1892). As Cattell described it, "[t]he observer sat in the dark, and looked through a telescopic tube at

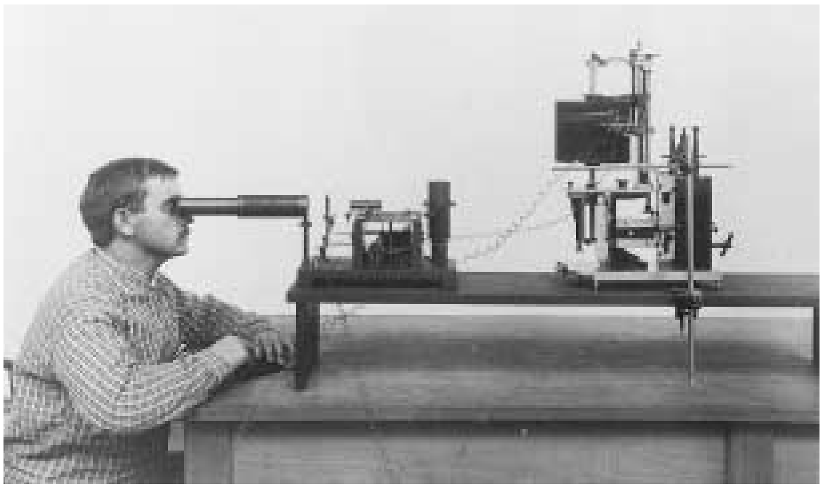


Figure 4.5 Reaction time experiment in progress at Clark University, 1892.

the point where the light was to appear" (1885/1948, p. 323). Cattell and Berger each made 150 reactions for each of eight intensity levels, finding that reaction time generally decreased as the light brightened. They also found individual differences—Cattell was consistently faster.

In a similar manner, Cattell and Berger varied the intensity of an electrical shock to the left forearm, to examine its effect on the reaction time of the right hand. Again, reaction time quickened with increased intensity, although at the highest intensity "the reaction was probably retarded, because the shock was painful" (p. 325). In his data summaries, Cattell described both the mean score and a measure of variability (the average deviation, an early forerunner of today's standard deviation). Also, note that there are just two observers in the study, Berger and Cattell. This was a common situation in early experimental psychology: Very few participants, each person contributing a great deal of data, and no clear distinction between what we would today call the *experimenter* and the *subject*. Furthermore, data from several participants would not be averaged together. Rather, all data from each subject would be reported, with additional subjects serving the purpose of replication.

After reporting the simple reaction times, Cattell described the logic of the complication experiment and, using three of the eight light intensities, reported results for simple RT ("reaction time"), discrimination RT ("reaction with perception time"), and choice RT ("reaction with perception and will time"). Thus, "perception time" means discrimination time and "will time" means choice time. Here is his description of the complication rationale and the data:

> The time is longer when it is necessary to distinguish the colours before the reaction is made. We can determine this time, if instead of always reacting as quickly as possible, we react if it is red, but not at all if it is blue. We thus add to the simple reaction time. We can further let the subject lift his right hand if the light is red, his left hand if it is blue; we then have, besides the time necessary for the simple reaction and for distinguishing the colour, the time it takes to make a choice between two motions. The results of experiments made with three intensities of light (V, III, and I) are given in the table.[See Table 4.1] (Cattell, 1885/1948, p. 325)

As you can see, Cattell used the Donders system to arrive at his "perception" (i.e., discrimi-

Table 4.1

	B[erger]			C[attell]		
	V	*III*	*I*	*V*	*III*	*I*
Reaction Time	189	218	273	189	209	303
Reaction with Perception Time	238	293	373	274	328	417
Reaction with Perception and Will Time	287	320	393	356	388	495
Perception Time	49	75	100	85	119	114
Will Time	49	27	20	82	60	78

nation) and "will" (i.e., choice) times. For example, with Cattell as the observer and the stimulus intensity at V:

discrimination time = DRT - SRT
= 274 - 189
= 85 (i.e., 0.85 sec)

choice time = CRT - (SRT + discrimination time)
= 356 - (189 + 85)
= 82 (i.e., 0.82 sec)

Like Külpe, Cattell eventually became a critic of the complication experiment while continuing to see the usefulness of the reaction time method to test various hypotheses about mental processing. That is, he eventually rejected the additive model while retaining the idea that reaction time could be used to compare mental activities that differed in complexity. This led him to study individual differences in reaction time and such phenomena as recognition times for different letters of the alphabet and reaction times for verbal associations (e.g., Cattell, 1886). Cattell also left a detailed account of day-to-day life in Wundt's laboratory, some of which is described in the Close-Up for this chapter.

c CLOSE-UP

An American in Leipzig

The most prominent of the three dozen or so American students who completed doctorates with Wundt was James McKeen Cattell (1860–1944). In 1886, he became the first American to earn a Leipzig Ph.D. in experimental psychology under Wundt's supervision (Benjamin, Durkin, Link, Vestal, & Accord, 1992). While at Leipzig, Cattell kept a detailed journal and corresponded frequently with his parents in America. These materials have been collected, organized, and annotated with great care by historian of science Michael Sokal, and published as *An Education in Psychology: James McKeen Cattell's Journal and Letters from Germany and England, 1880–1888* (1981). The book is a rich source of information about life in the early years of Wundt's laboratory at Leipzig.

Cattell first went to Leipzig as part of a European tour in 1881–1882. He then spent the 1882–1883 academic year at Johns Hopkins University in Baltimore, studying in the lab created by G. Stanley Hall (Chapter 6). He returned to Leipzig in the fall of 1883 and emerged with his doctorate three years later. Here are some of the observations he made about working in Wundt's laboratory, all taken from Sokal (1981).

Most of Cattell's research concerned the problem of reaction time. In a letter to his parents in 1884, he briefly described this research. Like others immersed in basic research that might seem trivial to outsiders, Cattell apparently felt a bit defensive and believed it necessary to convince his parents that his work was valuable:

Letter to Parents, 8 October 1884

> In [my research] I determine the time required by simple mental processes—how long it takes us to see, hear or feel something—to understand, to will, to think. You may not consider this so very interesting or important. But if we wish to describe the world—which is the end of science—surely an accurate knowledge of our mind is more important than anything else.... [I]f one thinks that knowledge for its own sake is worth the pursuit, then surely a knowledge of mind is best of all. Not only is the mind of man of infinitely more worth and importance than anything else, but on its nature the whole world depends.
>
> As to my special work—it is surely…in itself interesting to know how fast a man thinks—for on this, not on the number of years he lives depends the length of his life (p. 125)

Cattell's parents were apparently concerned that their son might overwork himself during his time at Leipzig. To reassure them, Cattell described a typical research day with his colleague, Gustav Berger. Only a portion of it required the kind of focused attention that would be fatiguing, Cattell reported:

Letter to Parents, 26 November 1884

> Berger began work with me again this morning. I do not think I shall hurt myself in working, if I keep taking…constant exercise. It is undoubtedly true that making experiments on one's self is trying, but I do not do this continuously. If I spend six hours a day at this work, perhaps two must be given to looking after apparatus, preparing things &c. This is very easy work indeed. Then in two of the other four hours the other man is the subject and my work is not especially difficult. So you see I only spend two hours in work that strains. It were a pity if at twenty–five I could not stand that. (p. 141)

Cattell's observation about the two hours set aside for the apparatus illustrates the difficulty of developing a new science. Most of the apparatus had to be either adopted from the physics or physiology lab or invented on the spot. Apparatus problems were a constant irritant, as Cattell made clear in this letter:

Letter to Parents, 5 January 1885

> Berger turned up early this morning and we started work. By way of variety not one but both of the electric batteries were out of order. You have no idea how much one must fuss over apparatus. The trouble is not that one must know physics, but that he must be an original investigator in physics. For example Prof. Wundt thought that when a magnet was made by passing a current around a piece of soft iron, it was made instantaneously. I find with the current he used it takes over a tenth of a second. All the times he measured were that much too long. Now the time required for magnetism to be developed in soft iron has nothing on earth to do with psychology, yet if I had not spent a great deal of time on this subject all my work would have been wrong.

> Then it is hard to get apparatus made properly.... All this, the getting the apparatus and running it, is very aggravating when one is in a hurry. (pp. 151–152)

Throughout his career, Cattell never hesitated to speak his mind and was not known either for modesty or tolerance. In the following comment, made near the end of his time at Leipzig, he made it clear what he thought of Wundt's laboratory.

Letter to Parents, 22 January 1885

> I worked in Wundt's laboratory this afternoon probably for the last time.... Wundt's laboratory has a reputation greater than it deserves—the work done is decidedly amateurish. Work has only been done in two departments—the relation of the internal stimulus to the sensation [i.e., psychophysics], and the time of mental process [i.e., reaction time]. The latter is my subject—I started working on it at Baltimore [at Johns Hopkins] before I had read a word written by Wundt—what I did there was decidedly original. I'm quite sure my work is worth more than all done by Wundt & his pupils in this department, and as I have said it is one of the two departments on which they have worked. Mind I do not consider my work of any special importance—I only consider Wundt's of still less. (p. 156)

REWRITING HISTORY: THE NEW AND IMPROVED WILHELM WUNDT

In Chapter 1, you learned that histories are continually being rewritten in light of new information, new ways of interpreting information, and so on. Wundt's psychology is a perfect illustration. If you had taken a history of psychology course about 30 years ago, you would have learned this about Wundt:

- He founded the first "school" of psychology, called structuralism.
- The main goal of Wundt's school was to analyze the contents of the mind into its basic structural components or elements, using introspection of mental contents as the chief method.
- He was not really interested in cultural psychology; the 10-volume *Völkerpsychologie* was just a secondary hobby for an old man.
- Wundt's intellectual son was E. B. Titchener, who carried out Wundt's program and spread the Wundtian gospel of structuralism in America.
- His model of the mind was similar to that of the British empiricists; that is, he did not believe in the concept of the mind as an active agent, but as the result of passive associative experiences.

Today, the only time you read descriptions like this one will be in chapter sections pointing out that each of these points is either a serious distortion or just wrong. In the 1970s, historians began taking a closer look at Wundt (e.g., Blumenthal, 1975; Danziger, 1980; Leahey, 1979) and discovered that the traditional accounts were problematic. Since that time, histories have begun to include more accurate descriptions of Wundt's life and work. Three questions arise: How did the distortions occur, why were they discovered only recently, and what did Wundt really say?

The Source of the Problem

Part of the difficulty derives from the fact that Wundt wrote more in his lifetime than most people can read in theirs. Also, much of his work has not been translated from German. Hence, there is a tendency for non-German speakers to rely on what others have written about Wundt, rather than on what Wundt said himself. Most psychologists learned their history from E. G. Boring, Boring learned most of his from Titchener, and therein lies the root of the problem. As you will learn in Chapter 7, Titchener studied with Wundt for two years and earned a Leipzig Ph.D. in 1892. He then spent his academic career at Cornell, where he spread the gospel of structuralism—his school, not Wundt's. Titchener also translated several of Wundt's books and wrote a long obituary shortly after Wundt's death (Titchener, 1921). In essence, Titchener took a portion of Wundt's work and exaggerated its importance, while downplaying or ignoring other parts of Wundt's work. The distortions were reflected in the way he taught about Wundt and in his translations of Wundt's writings. There is no evidence of a deliberate attempt to distort. Titchener was simply emphasizing what was most congenial to his own way of thinking. For example, Titchener's lack of interest in nonexperimental psychology led him to shrug off Wundt's interest in cultural psychology, making the remarkable comment in his obituary that Wundt's 20-years-in-the-making, 10-volume *Volkerpsychologie* was little more than "a grateful occupation for his old age" (Titchener, 1921, p. 175) and that "the dominant idea of Wundt's life…is the idea of an experimental psychology" (p. 175).

Boring was Titchener's best-known student and psychology's most venerable historian (see Chapter 1's Close-Up). His *A History of Experimental Psychology*, written in 1929 and revised in 1950, was the book that informed several generations of psychologists and provided the model for other history texts, until recently. It was dedicated to Titchener and the chapter on Wundt contains many of the distortions perpetuated by Titchener. The *Volkerpsychologie*, for instance, is barely mentioned.

The Rediscovery of Wundt

There are two reasons why Wundt's ideas began to be reexamined in the 1970s. First, as you recall from Chapter 1, it was during the late 1960s and early 1970s that the history of psychology as a discipline gathered new momentum, under the leadership of people like Robert Watson. To some extent, new scholarship directed at Wundt's history reflects the increased interest in psychology's history. The second reason is more subtle and provides another reason why history is continually being rewritten. As you will learn in Chapter 13, during the decade of the 1960s, cognitive psychology happened. That is, psychologists became increasingly interested in the experimental study of mental processes, a topic that languished in America between 1930 and 1960, due to the influence of behaviorism. Some scholars versed in the new cognitive research, most notably Arthur Blumenthal and Thomas Leahey, saw connections between the cognitive psychology of the 1960s and Wundtian psychology. Indeed, some of the cognitive research methods essentially duplicated research completed at Leipzig, even though the modern researchers seemed unaware of it. Blumenthal and Leahey began examining Wundt's work in light of the new cognitive psychology, producing papers that showed the connections between the two (Blumenthal, 1975; Leahey, 1979). The broader lesson is that while not necessarily being presentist, histories can be strongly influenced by the historical context within which they are written. One effect of modern cognitive psychology was to view Wundt in a new light. In the days of behaviorism's dominance, such a reexamination of Wundt would not have occurred.

The Real Wundt

The traditional but erroneous view of Wundt is that he was a structuralist. Now there is no question that one of Wundt's goals for his laboratory work was to identify the elements of immediate conscious experience. After all, he was originally trained in medicine and physiology and had a natural penchant for classification. Thus, his experimental papers include descriptions of the basic elements of consciousness, which he decided were sensations and feelings. Furthermore, each of these elements could be further categorized along certain dimensions. Sensations, for instance, were classified according to such dimensions as quality (e.g., different colors), intensity, and duration.

Analysis and classification, however, were only minor aspects of Wundt's system, and he was relatively uninterested in them. Rather, he was more concerned with the manner in which the mind actively organizes its experiences through an act of will. He labeled his system **voluntarism** to reflect the active nature of the mind. A central concept of his voluntaristic system was the phenomenon of **apperception**, a term borrowed from the German philosopher Leibnitz (Chapter 2). To apperceive some event is to perceive it with full clarity and have it in the focus of one's attention. As you are reading this page, for example, your full attention and focus (let's hope) is on this sentence and its meaning. It is being apperceived. Other information is in the periphery of your attention; Wundt would say that it is being apprehended, but not apperceived. Thus at any given time, there is information that is in the focus of attention, and other information in the margins. The former is said to be apperceived, the latter apprehended. Furthermore, apperception is a process that actively and vigorously organizes information into meaningful wholes. When we see the word "dog," we do not perceive three separate letters; we perceive a single concept that has meaning for us. Our visual sense might be initially processing meaningless lines and symbols, but our mind creates a meaningful whole. Wundt referred to the apperceptive process as a "creative synthesis."

Wundt's concept of apperception is a far cry from a more passive associationism. Yet Wundt did recognize that some elements of conscious experience do combine as passive associations. As the British associationists said, if you see John and Mary together often enough, you will soon come to think of one when you see the other. This happens automatically because of a passively formed association. On the other hand, apperception is occurring if, when you see John and Mary, you bring them into the focus of your attention and perceive them as a special couple, or perhaps as two people who seem completely ill-suited for one another. That is, you are going beyond the information given and perceiving them clearly and distinctly.

The association/apperception difference was the key component of an important theory proposed by one of Wundt's more famous students, the psychiatrist Emil Kraepelin (1856–1926). Kraepelin devised a classification scheme for mental illness not unlike today's and his theory of schizophrenia is similar to modern attentional theories of the disorder. He argued that the thought processes of schizophrenics lack the normal apperceptive ability and their attentional capacity is severely limited. While normal people can focus their attention and direct their mental activity along meaningful paths (i.e., they can apperceive), schizophrenics cannot. Hence, their mental activity resembles random associations. This accounts for one of the common symptoms of schizophrenia: the meaningless strings of phrases ("word salad") often emitted by those suffering from the disorder.

THE WUNDTIAN LEGACY

Because it was his intention to create a new way of conceptualizing psychology, Wundt is justifiably considered the first true psychologist of the modern era. Although it is difficult to identify a single Wundtian among the early American psychologists, he had a strong influence on the origins of American psychology. The Americans who studied with Wundt may not have returned as disciples, and Blumenthal (1980) has suggested that most came back with little more than a floor plan and an equipment list. Nonetheless, they emerged from Leipzig convinced that something new and exciting was in the air and they wanted to be a part of it. American psychology quickly established its own distinctive and non-Wundtian shape, but much of the motivation for it derived from Wundt's example.

THE NEW PSYCHOLOGY SPREADS

It should not be surprising to learn that Wundt did not hold a monopoly on the New Psychology. As you recall from the opening of the chapter, the *Wissenschaft* environment created an atmosphere conducive to the creation of an empirically-based examination of psychological phenomena. Sure enough, several German contemporaries of Wundt were actively engaged in exploring this new approach to understanding the human mind. We will examine three of them: Hermann Ebbinghaus, G. E. Müller, and Oswald Külpe.

HERMANN EBBINGHAUS (1850–1909): THE EXPERIMENTAL STUDY OF MEMORY

One indirect effect of Fechner's *Elements of Psychophysics* is that it helped launch the experimental study of human memory. This occurred sometime in the mid-1870s when a young German philosopher named Hermann Ebbinghaus stumbled on an English translation of Fechner's book while browsing in a used bookstore in Paris. Fechner's demonstration that the mind could be subjected to scientific methods inspired Ebbinghaus, who was wrestling with the philosophical problem of the association of ideas at the time.

Not much is known about the formative years of Hermann Ebbinghaus. After finishing a gymnasium education, he studied at several universities and fought briefly for the German side in the Franco-Prussian War in the early 1870s. His academic interests shifted from history to philology (the historical study of language) to philosophy, and he eventually earned a doctorate in the latter from the University of Bonn in 1873. His dissertation topic was an analysis of "Hartmann's Philosophy of the Unconscious." During the mid-1870s he traveled in England and in France, discovered Fechner's *Elements* along the way, and evidently began to think about how to study the formation of associations.

As a philosopher, Ebbinghaus was thoroughly familiar with the British empiricist/associationists and their analysis of association processes. As you recall from Chapter 2, they considered association to be analogous to gravity as a force that attracted and bound together ideas. The British philosophers all considered association to be an essential component of the mind's organizational structure, but they argued over the basic laws of association (e.g., is contiguity sufficient to explain associations or are other principles necessary?). For Ebbinghaus, Fechner's scientific approach to the mind apparently triggered a creative leap. If sensations could be measured, why not other mental processes? Why not association? Sometime during the late 1870s, Ebbinghaus became resolved to study the formation and retention of associations scientifically. By the middle of the next decade, he had produced *Memory: A Contribution to Experimental Psychology* (1885/1964). This brief book (123 pages in a 1964 reprinting) inaugurated a research tradition that continues today and includes results that are still described in textbooks of general psychology. As Ernest Hilgard pointed out in an introduction to the 1964 reprinting, "[f]or the experimental study of learning and memory there is one source that is pre-eminent over all others: this small monograph by Ebbinghaus" (Hilgard, 1964, p. vii). Let us consider this remarkable achievement in more detail, through the following excerpt (page numbers from the 1964 reprinting of a 1913 English translation).

c ORIGINAL SOURCE EXCERPT

Ebbinghaus on memory and forgetting

Ebbinghaus opened his book by considering the various forms of memory and the difficulty of studying the process experimentally. He pointed out that what little was known about memory was known through common sense and from anecdotes about “extreme and especially striking cases” (p. 4). As for more fundamental questions about the exact relationships between our experiences and our memories, however, “[t]hese and similar questions no one can answer” (p. 5).

For Ebbinghaus, the only way to understand memory was through the “method of natural science” (p. 7). In his opening description of this method, Ebbinghaus did not use the exact terms you might have learned in a research methods course, but you will recognize the following as a description of the essential components of the experimental method: manipulating an independent variable, holding extraneous factors constant, then measuring the outcome, the dependent variable:

> We all know of what this method consists: an attempt is made to keep constant the mass of conditions which have proven themselves causally connected with a certain result; one of these conditions is isolated from the rest and varied in a way that can be numerically described; then the accompanying change on the side of the effect is ascertained by measurement or computation. (p. 7)

Ebbinghaus recognized that keeping the “mass of conditions” under control was no easy task. In one of psychological science’s more notable acts of creativity, he hit upon the idea of using materials that did not meaningfully relate to each other and were not especially meaningful in themselves. That is, he created **nonsense syllables**, three-letter units comprised of two consonants with a vowel in the middle:

> Out of the simple consonants of the alphabet and our eleven vowels and diphthongs all possible syllables of a certain sort were constructed, a vowel sound being placed between two consonants.
>
> These syllables, about 2,300 in number, were mixed together and then drawn out by chance and used to construct series of different lengths, several of which each time formed the material for a test.
>
> ...The syllables used each time were carefully laid aside till the whole number had been used, then they were mixed together and used again.
>
> The aim of the tests carried on with these syllable series was, by means of repeated audible perusal of the separate series, to so impress them that immediately afterwards they could voluntarily just be reproduced. This aim was considered attained when, the initial syllable being given, a series could be recited at the first attempt, without hesitation, at a certain rate, and with the consciousness of being correct. (pp. 22–23)

Ebbinghaus realized that memorizing meaningful materials like poems or prose would be a problem; these materials would already carry with them innumerable meaningful associations that would affect how quickly they could be learned:

> The nonsense material, just described, offers many advantages, in part because of this very lack of meaning. First of all, it is relatively simple and relatively homogeneous. In the case of the material nearest at hand, namely poetry or prose, the content is now narrative in style, now descriptive, or now reflective; it contains now a phrase that is pathetic, now one that is humorous; its metaphors are sometimes beautiful, sometimes harsh; its rhythm is sometimes smooth and sometimes rough. There is thus brought into play a multiplicity of influences which change without regularity and are therefore disturbing. Such are associations which dart here and there, different degrees of interest, lines of verse recalled because of their striking quality or their beauty, and the like. All this is avoided with our syllables. Among many thousand combinations there occur scarcely a few dozen that have a meaning and among these there are again only a few whose meaning was realized while they were being memorized. (p. 23)

Thus, Ebbinghaus recognized that some of the syllables would have meaning, but he was not overly concerned about it. Also, it is important to keep in mind that his main interest was in how associations *between* syllables were formed, not the relative meaningfulness of individual syllables. Individual syllables might have some meaning, but the chances were quite remote that two successive syllables would be meaningfully related to each other. Gundlach (1986) has pointed out that one of Ebbinghaus's phrases was translated as a "series of nonsense syllables"[5] when a better translation might have been "meaningless series of syllables." That Ebbinghaus chose **serial learning** as his task is a further indication of his intent to analyze the buildup of associations between elements of a fixed sequence. Serial learning, in which correct recall includes accurately reproducing a set of stimuli in the exact order of their presentation, is well suited for examining associations between a "meaningless series of syllables."

How Ebbinghaus actually hit upon the idea to use nonsense syllables is not clear, but Hilgard's (1964) analysis makes the most sense. Familiar with the mechanistic and atomistic assumptions of British empiricism/associationism, Ebbinghaus would have looked for the simplest possible unit that would still yield a large number of stimuli. Individual letters or numbers were too few, words too meaningful. Syllables of words comprise the simplest pronounceable unit in the language, so they would be a logical choice. The fact that Ebbinghaus called his stimuli nonsense "syllables" suggests that he was deliberately thinking of this reduction to a small functional unit.

[5] The phrase appears at the bottom of page 23, in the context of a comparison with memorizing poetry.

Once he had created the materials, Ebbinghaus turned to other control problems and set up a standardized set of procedures:

> The following rules were made for the process of memorizing.
>
> **1.** The separate series were always read through completely from beginning to end; they were not learned in separate parts which were then joined together; neither were especially difficult parts detached and repeated more frequently. There was a perfectly free interchange between the reading and the occasionally necessary tests of the capacity to reproduce by heart. For the latter there was an important rule to the effect that upon hesitation the rest of the series was to be read through to the end before beginning it again.
>
> **2.** The reading and the recitation of the series took place at a constant rate, that of 150 strokes per minute. A clockwork metronome placed at some distance was at first used to regulate the rate; but very soon the ticking of a watch was substituted, that being much simpler and less disturbing to the attention....
>
> **3.** During the process of learning, the purpose of reaching the desired goal as soon as possible was kept in mind as much as was feasible. Thus, to the limited degree to which conscious resolve is of influence here, the attempt was made to keep the attention concentrated on the tiresome task and its purpose. It goes without saying that care was taken to keep away all outer disturbances in order to make possible the attainment of this aim. The smaller distractions caused by carrying on the test in various surroundings were also avoided as far as that could be done.
>
> **4.** There was no attempt to connect the nonsense syllables by the invention of special associations of the mnemotechnik type; learning was carried on solely by the influence of the mere repetitions upon the natural memory. As I do not possess the least practical knowledge of the mnemotechnical devices, the fulfillment of this condition offered no difficulty to me. (pp. 24–25)

This last point reveals an important feature of the study—Ebbinghaus was the *only* subject. He completed the research during two yearlong periods: 1879–1880 and 1883–1884, with the second set of experiments serving primarily to replicate those of the first. Also, in order to become proficient at the task, he spent an unspecified "long time" (p. 33) practicing before he began the 1879–1880 studies. Thus, for more than two years, he devoted a significant portion of his time to memorizing lists of nonsense syllables (about an hour or two per day), by his own admission a "tiresome task." On just one set of experiments, the ones that produced his famous forgetting curve (below), Ebbinghaus memorized just over 1300 different lists. One attribute said to characterize famous scientists is a total immersion in their research. Ebbinghaus was certainly a case in point.

Ebbinghaus described the results of his research in several different chapters. First, he examined how quickly a series of syllables could be learned as a function of the number of syllables per list. *Quickly* meant the number of repetitions needed before the list could be produced without errors. He reported the results in a table (p. 47):

Number of syllables in a series	Number of repetitions necessary for first errorless reproduction (exclusive of it)	Probable Error
7	1	
12	16.6	+/- 1.1
16	30.0	+/- 0.4
24	44.0	+/- 1.7
36	55.0	+/- 2.8

There are two things to note here. First, although it might not be surprising that it takes more repetitions to learn longer lists, this marks the first time that anyone had documented, with precision, the exact relationship between the length of material to be learned and the amount of effort required to learn it. Second, very little effort was needed when the list had just seven syllables.

> The question can be asked: What number of syllables can be correctly recited after only one reading? For me the number is usually seven. Indeed I have often succeeded in reproducing eight syllables, but this has happened only at the beginning of the tests and in a decided minority of the cases. In the case of six syllables on the other hand a mistake almost never occurs. (p. 47)

This result has recurred frequently in experimental psychology's history, and George Miller's (1956) systematic investigation of this "magic number seven" became a landmark paper in the rise of cognitive psychology (see Chapter 13). You probably recall learning about the number "7 plus or minus 2" in your general psychology course in the memory chapter under the heading "capacity of short-term memory."

After showing that it takes more repetitions to learn longer lists, Ebbinghaus wondered whether increasing the number of *original* repetitions would strengthen memory. Thus, he repeated lists of 16 syllables 8, 16, 24, 32, 42, 53, or 64 times, and discovered that the ease of relearning the list 24 hours later was directly proportional to the number of original repetitions. He apparently considered extending the number of repetitions beyond 64 , but thought better of it:

> An increase of the readings used for the first learning beyond 64 repetitions proved impracticable.… For with this number each test requires about 3/4 of an hour, and toward the end of this time exhaustion, headache, and other symptoms were often felt which would have complicated the conditions of the test if the number of repetitions had been increased. (p. 55)

Some aspects of the research were too intense even for the redoubtable Ebbinghaus.

The most famous of the studies completed by Ebbinghaus concerned the rate of forgetting for information that had already been learned. Here, Ebbinghaus relied on an ingenious measure of recall that he called the **savings method**, which enabled him to measure memory after the passage of time, even if nothing could be recalled after the interval. He described the logic of it early in the book:

> A poem is learned by heart and then not again repeated. We will suppose that after a half year it has been forgotten: no effort at recollection is able to call it back into consciousness. At best only isolated fragments return. Suppose that the poem is again learned by heart. It then becomes evident that, although to all appearances totally forgotten, it still in a certain sense exists and in a way to be effective. The second learning requires noticeably less time or a noticeably smaller number of repetitions than the first. (p. 8)

To examine the effects of time on memory, Ebbinghaus memorized lists of syllables, tried to relearn them after the passage of a fixed amount of time, and applied his savings method to assess the outcome.

> The investigations in question fell in the year 1879–1880 and comprised 163 double tests. Each double test consisted in learning eight series of 13 syllables each…and then in relearning them after a definite time. The learning was continued until two errorless recitations of the series in question were possible. The relearning was carried to the same point; it occurred at one of the following seven times—namely, after about one third of an hour, after one hour, after 9 hours, one day, two days, six days, or 31 days. (pp. 65–66)

Ebbinghaus recorded the total time for the original learning of the eight lists, which was typically about 20 minutes, and the time for relearning. Original learning minus relearning yielded a measure of savings, which was converted to a percentage by dividing by the time of original learning. Thus, if original learning took 20 minutes and relearning took 5 minutes, 15 minutes or 75% (15/20 3 100) of the original learning time was saved.

Ebbinghaus reported the results for each of the 163 separate experiments (i.e., “double tests”) that he completed over the different retention intervals, then summarized the results as follows (p. 76):

After X hours	**So much of the series learned was retained that in relearning a saving of Q% of the time of original learning was made**	**The amount forgotten was thus equivalent to v% of the original in terms of time of learning**	
X =	Q =	v =	
0.33	58.2	41.8	
1.	44.2	55.8	
8.8	35.8	64.2	
24.	33.7	66.3	
48.	27.8	72.2	
6 x 24	25.4	74.6	
31 x 24	21.1	78.9	(p. 76)

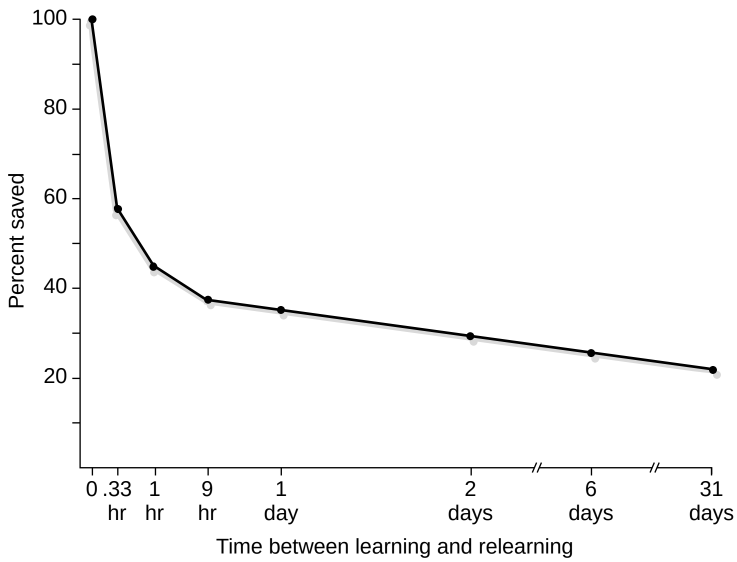


Figure 4.6 The Ebbinghaus forgetting curve, constructed from data in the excerpt.

The information found in this table has made its way into almost every introductory psychology textbook of the twentieth century. It is normally shown as a graph like the one in Figure 4.6, but Ebbinghaus did not include a graph in his book. Either way, the results are clear—forgetting was very rapid at first, then slowed in its rate. Thus, after just 20 minutes (0.33 hour), Ebbinghaus's memory held only about 60% of the learned material; 40% had been lost. After an hour, 55% was lost, and after just a day, about two-thirds was lost.

The forgetting curve is Ebbinghaus's most recalled result, but he also studied other memory phenomena. For example, he provided an early example of the advantages of distributed over massed practice by showing that:

> For the relearning of a 12-syllable series at a definite time, accordingly, 38 repetitions, distributed in a certain way over the three preceding days, had just as favorable an effect as 68 repetitions made on the day just previous.… It makes the assumption probable that *with any considerable number of repetitions* a suitable distribution of them over a space of time is decidedly more advantageous than the massing of them at a single time. (p. 89, italics in the original)

A final example of the Ebbinghaus research program is his investigation of **remote associations**. When the sequence of syllables A, B, and C, is to be learned in order, direct associations are formed between A and B and between B and C, but are they also formed (remotely) between A and C? If so, then the association concept extends beyond the idea of two immediately contiguous events. Ebbinghaus devised a clever procedure to test for these potential remote associations. He first learned a list of 16 syllables in the usual serial order:

LIST A. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Next he would relearn the list in an order that skipped a syllable:

LIST B. 1 3 5 7 9 11 13 15 2 4 6 8 10 12 14 16

Similarly, for other lists he would relearn a list that skipped two syllables:

LIST C. 1 4 7 10 13 16 2 5 8 11 14 3 6 9 12 15

If remote associations had been forming during the original learning of syllables 1 through 16 (list A), then the relearning of lists B and C would be faster than learning a new list of 16 syllables, and this is exactly what Ebbinghaus found. Furthermore, there was a direct relationship between the ease of relearning and the degree of remoteness of the associations. As Ebbinghaus put it,

> …the associative threads, which hold together a remembered series, are spun not merely between each member and its immediate successor, but beyond intervening members to every member which stands to it in any close temporal relation. The strength of the threads varies with the distance of the members, but even the weaker of them must be considered as relatively of considerable significance. (p. 94)

In Chapter 13, you will learn about the development of modern cognitive psychology. One of its recent trends is a tendency to criticize the narrowness and artificiality of the "Ebbinghaus tradition." For modern cognitive psychologists, the memorizer is actively processing information, not passively strengthening associations through mindless repetition. Also, there is more emphasis today on **ecological memory**: memory for more realistic everyday events rather than for abstract lists. One prominent contemporary researcher lamented the "terrible struggle our field has had just to overcome the nonsense syllable" (Kintsch, 1985, p. 461). The criticism has some merit, but for the historian it has a distinctly presentist tone. Considering the Ebbinghaus memory research in the context of its time, a more apt evaluation of its importance comes from a retrospective review of *On Memory* by Roediger, written 100 years after its original publication:

> In sum, the corpus of Ebbinghaus's experimental results is large. Considering that he only began his research in the same year that Wundt founded his psychology lab and that he performed all experiments on himself and still produced such regular and compelling results, his achievement is nearly incredible. (Roediger, 1985, p. 522)

Other Contributions by Ebbinghaus

The memory research was Ebbinghaus's greatest accomplishment, but not his only one. He was also a pioneer in the field of mental testing, inventing a sentence completion test in 1895 that was similar in spirit to the intelligence test soon to be developed in France by Binet (see Chapter 8). Ebbinghaus held academic positions in the German universities at Berlin and Breslau, creating the psychology laboratories at each university, and at Halle, where he rebuilt an existing but inadequate lab. In 1890, he started the *Zeitschrift für Psychologie und Physiologie der Sunnesorgane* (*Journal of Psychology and Physiology of the Sense Organs*). While Wundt's *Philosophische Studien* was primarily a means for publishing the work completed in his Leipzig laboratory, Ebbinghaus's *Zeitschrift* filled its pages with research from laboratories throughout Germany. The journal's catholicity of interests and the prestige of its contributing authors (e.g., Helmholtz, G. E. Müller) led one historian to describe it as "the most important psychological organ in Germany" (Shakow, 1930, p. 509). Ebbinghaus also wrote two popular introductory psychology texts, including a brief version (just before his sudden death from pneumonia in 1909) that included the famous opening sentence, quoted at the start of this book's Chapter 2: "Psychology has a long past, yet its real history is short" (Ebbinghaus, 1908, p. 3).

G. E. MÜLLER (1850–1934): THE EXPERIMENTALIST PROTOTYPE

Although Wundt is rightly given credit as experimental psychology's founder, the psychology of the laboratory occupied only a small portion of his interest. This is a theme that will be repeated: Many of the early pioneers of laboratory psychology actually spent little time in the laboratory. An exception is G. E. Müller,[6] an experimenter's experimenter, who devoted 40 years of his professional life to the psychology laboratory at the University of Gottingen. From 1881 to his retirement in 1921, Müller's laboratory rivaled the other German facilities in terms of the quality of research produced. Studies completed in Müller's lab were known for their precision, experimental control, and meticulous attention to detail. That Müller is not well known today is primarily because little of his work was translated into English. Also, none of his research broke radically new ground; rather, it systematically replicated and extended the research of others. Thus, he made important contributions in extending Fechner's work in psychophysics,[7] Hering's work on color vision, and Ebbinghaus's work on memory. In this last area, Müller was a worthy successor to the venerable Ebbinghaus.

During the decade of the 1890s, Müller and his students replicated many of the Ebbinghaus findings, added several refinements, and reached different conclusions about the formation of associations. Whereas Ebbinghaus concluded that associations were formed automatically and mechanically as a result of stimulus factors such as the number of repetitions and list length, and that the memorizer played a relatively *passive* role in the process, Müller believed that the individual forming the associations played a more *active* role. The conclusion resulted from a procedural modification—Müller added introspection to the process, and his observers reported that they engaged in a number of active strategies to learn the nonsense syllables. For example, they found themselves grouping nonsense syllables in clusters, organizing them by different degrees of meaning, and in general doing much more than just associating them by contiguity. This outcome foreshadows the modern view of memory, which assumes that the learner is actively involved in the memorizing process.

Müller and his students also made some discoveries that went beyond what Ebbinghaus had found. For example, with Alfons Pilzecker he discovered that if a second list is learned between the learning of list 1 and the subsequent attempt to relearn list 1, the second list interferes with the relearning. They named the phenomenon **retroactive inhibition**, thus initiating a long line of research that eventually produced the interference theory of forgetting. With another student, Adolph Jost, Müller discovered that if two associations have equal strength, further practice will strengthen the

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[6] No relation to Johannes Müller, the famous physiologist you met in Chapter 3. The name Müller is a very common one in Germany, a bit like their version of "Smith."

[7] According to Boring (1950), E. B. Titchener held up publication of the second volume of his famous laboratory manual (Chapter 7) until Müller had published a handbook of psychophysics in 1903. Titchener had to rewrite the psychophysics portions of his manual after Müller's book appeared, and the second volume of the lab manual was not published until 1905, four years after volume 1.

older of the associations more than the recent one. This phenomenon, later called **Jost's law**, was based on rather meager evidence, but was considered important as part of the explanation for the advantage of distributed practice over massed practice, another phenomenon studied in Müller's lab (Woodworth, 1938).

Another contribution of Müller to the experimental study of memory was the invention of the **memory drum**, which automated the presentation of stimulus materials. Müller and his assistant Friedrich Schumann cleverly altered a kymograph, a rotating drum normally used to record data (as shown in the reaction time photo of Figure 4.5). Stimuli were mounted on the drum which revolved at a fixed speed, thereby displaying stimuli for measured amounts of time (Popplestone, 1987). Memory drums were standard laboratory equipment until recently, when computer presentation of stimuli became more efficient.

One final point is that although the University of Gottingen did not award degrees to women, Müller welcomed several notable American women psychologists into his laboratory, including Christine Ladd-Franklin of Columbia (Chapter 6), Lillien Martin of Stanford, and Eleanor Gamble of Wellesley.

OSWALD KÜLPE (1862–1915): THE WÜRZBURG SCHOOL

After flirting with history and philosophy, Oswald Külpe became interested in psychology after taking a course from Wundt in the early 1880s. He then went to Berlin to study history and to Gottingen, where a year and a half in G. E. Müller's lab convinced him that psychology was to be his career. He eventually returned to Leipzig and earned a doctorate under Wundt's supervision in 1887, then remained with his mentor for another seven years, earning a living as a *Privatdozent* and as Wundt's assistant in the laboratory (he succeeded Cattell). It was during this time that he developed a lifelong friendship with E. B. Titchener (Chapter 7), who was at Leipzig during this time. In 1894, Külpe was called to Würzburg, where he created a laboratory sometimes considered second only to Wundt's and certainly a match for Müller's at Gottingen. It was at Würzburg that Külpe created a brand of experimental psychology distinctive enough to earn the label "Würzburg school." It investigated topics and produced outcomes that put Külpe at odds with both his mentor Wundt and his friend Titchener.

Wundt had declared higher mental processes (e.g., memory, thinking) off limits for laboratory research. He believed them to be too complex and too heavily influenced by one's language and culture to be controlled adequately. Instead, such topics needed to be investigated with nonlaboratory methods, while the lab was to be restricted to such topics as sensation/perception and mental chronometry. Yet Ebbinghaus and Müller had managed to control conditions reasonably well in their studies of memory. It was up to Külpe, however, to challenge his former mentor directly by studying thought processes in the lab and by significantly elaborating upon the introspective procedure.

Külpe published little experimental research under his own name, but he exercised close but congenial supervision over his students. According to one of his American students, Robert Ogden, Külpe

> …was intimately engaged in all that went on in his laboratory. It was a matter of principle to him to act as observer in the experimental work of his students. In the instance of my own study…he came almost daily to the laboratory for what must have been weary hours of committing nonsense syllables to memory. His influence upon his students was never dominating. Instead, they were engaged together in a joint enterprise of scientific discovery. (Ogden, 1951, p. 9)

In order to study thought processes in the laboratory, Külpe found it necessary to expand the Wundtian concept of introspection. Recall that Wundt distinguished between "self-observation," in which someone experiences some event, then from memory describes the mental processes that occurred during the event, and "inner perception," a more controlled introspective procedure in which simple stimuli are presented many times (i.e., replicated) and responses are given immediately after stimulus presentation. For Wundt, only the latter procedure was appropriate in the laboratory. In Külpe's laboratory, however, introspection was more like Wundt's concept of self-observation. It came to be called **systematic experimental introspection**. Observers would experience more complicated events than in Wundt's laboratory, then give a full description of the mental processes involved. This created a potential memory problem, because as Woodworth (1938) later pointed out, the mental experience of a 10-second event might take 10 minutes to describe. To deal with the fact that giving an introspective account of a complicated event might be distorted by memory, Külpe and his students developed a procedure called **fractionation**, a separation of the task into its components, each of which could be introspected. For example, in a study on word association by Watt (i.e., given a stimulus word, say the first word that comes to mind), the task was fractionated into "the preparation for the experiment, the appearance of the stimulus-word, the search for the reaction-word (if such search occurred), and finally the cropping up of the reaction-word" (Watt, 1904, cited in Sahakian, 1975, p. 162).

Külpe believed he was improving the introspective procedure, enabling it to be applied to higher mental processes, but Wundt rejected the Würzburg technique, calling it nothing but the unsystematic self observation he had rejected years earlier. Thus, because he believed them to be built on unsound methods, Wundt dismissed the results of the Würzburg research. What were those results?

Mental Sets and Imageless Thoughts

The Würzburg research on thinking produced several surprising results. For example, in a study by Narziss Ach, observers were shown pairs of numbers after first being instructed that they would be performing some specific operation (e.g., add them, subtract them). Ach measured reaction time and also asked for detailed introspections. What he found was that reaction time was the same, regardless of the type of operation asked of subjects, and that observers reported no conscious awareness of the instructions themselves, once the task had begun. In other words, after receiving the instructions, their mind was "prepared" to function in a specific way (e.g., adding), so that once the number pair was presented, the addition occurred automatically and without further thought. Thus, the instructions created what the Würzburgers called a determining tendency or **mental set**. This concept would eventually become important for the German gestalt psychologists (Chapter 9). The absence of a difference in reaction time was also significant, because Külpe used it to question the validity of the subtractive assumption underlying the mental chronography experiments that were such an important part of the Leipzig laboratory. Because instructions create a mental set, he argued, discrimination reaction time cannot be equal to simple reaction time plus the mental event of discrimination. Rather, DRT results from a different kind of "set" than SRT.

A second important finding of the Würzburg lab, and a controversial one, concerned the phenomenon of **imageless thought**. According to Titchener (and Wundt), a close analysis of thought processes reveals that the essential element in all thinking is an image of some form. In a psychophysics weight-lifting experiment, for example, the standard description was that the observer would lift one weight and form a kinesthetic image of it, then lift the second weight and compare the sensation of it with the image of the first one in order to decide if the weights were the same or different. The judgment process was composed of sensory and image components from the two weights. In a weight-lifting study by Karl Marbe, however, no sensations or images occurred at the moment of judgment. Observers reported sensations and images while lifting the weights, but the judgment seemed to occur automatically and without images. That is, the judgment was an imageless thought. Furthermore, Marbe's observers reported other mental processes occurring just before the judgment and these didn't seem reducible to sensations and images either. These processes included things like hesitation, doubt, and vacillation; collectively they were referred to as **conscious attitudes**.

The potential existence of imageless thoughts, mental sets, and conscious attitudes posed an especially serious threat to Külpe's colleague E. B. Titchener, who believed that all mental content under analysis would be found to contain the basic elements of conscious experience. If some thoughts occur without images, however, then not all thinking can be reduced to the elements. This imageless thought controversy was never resolved; its most notable side effect, however, was to raise questions about the validity of introspection as a method and to help pave the way for a radical new movement in psychology that you will learn about in Chapters 10 and 11: behaviorism.

SUMMARY

An Education in Germany

- In the nineteenth century a large number of American students studied the sciences in Europe, especially in Germany. In the latter half of the century, many students went to Germany, in particular to Leipzig, to study a new approach to psychology that was developing there.
- The German educational system promoted a philosophy of *Wissenschaft*, which emphasized academic freedom and research. This created an environment conducive to new ideas, including the idea of a new psychology.

On the Threshold of Experimental Psychology: Psychophysics

- Psychophysics is the study of the relationship between physical stimuli and the psychological reaction to them. The first research in this tradition was completed by Ernst Weber, who investigated the relative sensitivity of various areas on the surface of the body using the two-point threshold. In experiments in which observers made comparisons between two weights, Weber discovered that the ability to distinguish between them depended on the relative rather than the absolute differences in their weights (Weber's Law).
- Gustav Fechner elaborated Weber's research and his *Elements of Psychophysics* is considered experimental psychology's first text. Although more interested in using his research to defeat materialism, Fechner is known for developing several important psychophysics methods in use today (limits, constant stimuli, adjustment) and for the precision of his work in measuring absolute and difference thresholds.

Wundt Establishes a New Psychology at Leipzig

- Wundt is generally known as the founder of experimental psychology. He explicitly set out to create a new psychology that emphasized the experimental methods borrowed from physiology, and he created the first laboratory of experimental psychology and the first journal devoted to describing the results of psychological research.
- Wundt's new science involved studying immediate conscious experience under controlled laboratory conditions. Because they could not be subjected to experimental control and replication, higher mental processes (e.g., language) had to be studied through nonlaboratory methods (e.g., observation).
- In Wundt's laboratory, most of the research concerned basic sensory and perceptual processes. The lab also produced a large number of "mental chronometry" studies, which attempted to measure the amount of time taken for various mental activities. James McKeen Cattell, an American student, and Wundt's first official lab assistant, com-

pleted a number of these studies, which utilized a subtraction procedure developed by F. C. Donders.

- Recent historical scholarship has uncovered serious distortions in the traditional accounts of Wundt's theories. Rather than being a structuralist, seeking to reduce consciousness to its basic elements, Wundt was more interested in the mind's ability to actively organize information. One of his main interests was the process of apperception, an active, meaningful, and attentive perception of some event. He called his system voluntarism to reflect the active nature of mental processing.

The New Psychology Spreads

- One of the most important programs of research carried out in psychology's history involved the study of memory by Hermann Ebbinghaus. To investigate the development of new associations between unassociated stimuli, he invented nonsense syllables. Ebbinghaus measured retention in terms of the amount of effort "saved" in relearning. His famous forgetting curve showed that forgetting occurs at a very rapid rate shortly after initial learning, then tapers off. He also documented the benefits of distributed practice and the effects of remote associations.
- G. E. Müller and his students significantly extended contemporary research on color vision, the psychophysics research of Fechner, and the memory research of Ebbinghaus. By adding introspection to the nonsense syllable experiments, he argued that memory was an active process, not the passive buildup of associative strength. He was the first to identify retroactive inhibition (i.e., forgetting results from interference from events occurring between initial learning and recall), and he invented the memory drum.
- Oswald Külpe and his students created the Würzburg school of psychology, which defied Wundt by studying thinking under laboratory conditions and liberalizing the method of introspection. In their research they found evidence for mental sets, imageless thought, and conscious attitudes.

FOR FURTHER READING

BLUMENTHAL, A. L. (1975). A reappraisal of Wilhelm Wundt. *American Psychologist, 30,* 1081–1086.

Probably the most frequently cited of the articles appearing in the 1970s that pointed out the errors in the traditional accounts of Wundt; draws comparisons between Wundt's research and theorizing and modern concepts from cognitive psychology.

EBBINGHAUS, H. (1964). *Memory: A contribution to experimental psychology* (H. A. Ruger & C. A. Bussenius, Trans.). New York: Dover. (Original work published 1885)

A very readable, and brief (123 pages), account of the famous experiments by Ebbinghaus; the Dover republication includes a helpful foreward by Ernest Hilgard; a good retrospective review of the book can be found in Roediger (1985).

SOKAL, M. M. (Ed.). (1981). *An education in psychology: James McKeen Cattell's journal and letters from Germany and England, 1880–1888*. Cambridge, MA: MIT Press.

A fascinating and highly detailed account of Cattell's years with Wundt at Leipzig, Hall at Johns Hopkins, and Galton in England. The entries are from letters written by Cattell, usually to his parents, and a diary/journal; the annotations by Sokal are highly detailed and as informative as Cattell's firsthand accounts.

BRINGMANN, W. G., & TWENEY, R. D. (Eds.).(1980). *Wundt studies: A centennial collection*. Toronto: C. J. Hogrefe, Inc.

A collection of 21 articles about Wundt's life and work, ranging from biographical treatment to interpretation; main sections are the Heidelberg years, the Leipzig period, and impact and assessment.