

Pythagoras in the Laboratory

THE WAGNERIAN SOUND OF SENSE

Richard Wagner's insistence on a music *of* language as the only legitimate medium of future art, combined with his willingness to anticipate this fusion in the form of a present-tense, public spectacle, set the stage for more than half a century of music-inflected encounters with the conundrum of expressive sound. The result was a gradual transformation in the nineteenth-century understanding of language-as-system, over the course of which language spirit—for nature-philosophical linguists still a *qualitas occulta*, inaccessible to direct sensory perception—took on the contours of an audibly vibrating, measurable mass. The story begins, unsurprisingly, with the famously intensive reception of Wagnerian tenets among the Symbolist poets of France.¹ I will argue here that the same story culminates, somewhat less intuitively, in a new, natural scientific theory of the mind-matter interaction, associated primarily with the names of early experimental psychologists such as Gustav Fechner and Wilhelm Wundt. Wagner's musical amplification of language spiritual principles receives in the wave-based models of a Wundtian "psychophysiology," which borrows its fundamentally vibratory structure from contemporaneous acoustic theory, an ostensibly "measurable" corroboration. The Romantic hypothesis of *Sprachgeist* reemerges toward the end of the nineteenth century, in consequence, as a viable, language-scientific alternative to the system-denying materialism of the Neogrammarians and their positivist allies.

Charles Baudelaire plays the role of forerunner in this context, as in so many others, when he celebrates Wagnerian opera for demonstrating that musical sound can *mean* independently of all conventional reference. His early, pre-*Ring* essay, “Richard Wagner and *Tannhäuser* in Paris” (1861), which was almost certainly written under the influence of Wagner’s “La musique de l’avenir” from the same year, puts forward the following thesis: “The reader knows the aim we are pursuing, namely to show that true music suggests analogous ideas in different brains.”² Citing lines from one of his own most famous *Fleurs du mal* poems, “Correspondences,” Baudelaire goes on to imply the existence of a deep affinity, or rather analogy, between the sound-sense correspondences of Wagner’s harmonizing, alliterating *Stäbe*, and the musical, but also visual and olfactory, potential of his sonnet’s “living pillars”: “Nature is a temple in which the living pillars / Sometimes yield confused words; / Man passes there through forests of symbols / which observe him with knowing eyes.”³ Both modes of writing seek to express, according to him, an originary experience of the world “as [*comme*] a complex indivisible totality,” where sounds suggest colors, colors melodies, and sense always occurs, “by a reciprocal analogy,” in tandem with sensory transport.⁴ And both therefore also assume, despite the radical modernity of the techniques they presuppose, the timeless shape of primeval trees, through which the winds of an undivided totality, or infinite melody, can be assumed to perpetually whisper.

By the time of the first performance of the complete *Ring* cycle, Baudelaire’s portrayal of Wagner as a patron saint of synesthesia and sound symbolism had become a central tenet of orthodox Wagner reception. In 1876, the Wagner scholar and acolyte Hans von Wolzogen—himself an amateur poet, contributor to Symbolist periodicals, and, later, the editor of Wagner’s house journal, *Bayreuther Blätter*—published a Wagner-approved treatise titled *Poetic Sound Symbolism: Psychological Effects of Language Sounds in the Alliterative Verse of R. Wagner’s “Ring of the Nibelungen”* (*Poetische Lautsymbolik: Psychische Wirkungen der Sprachlaute im Stabreime aus R. Wagner’s “Ring des Nibelungen”*), in which he claimed to deduce the “most essential symbolic meanings” of fifty consonants and consonant clusters directly from the sensory experience of the alliterating *Ring* text.⁵ Under the cluster *st*, for instance, with its hard, *sh*-stopping *t*, he discovered “a movement that reaches a position and remains there, arrested, thus everything still-standing, static, stiff,

stony, and also standing [*daher alles Stillstehende, Stätige, Steife, Starre und auch Stehende*].”⁶ In the “forward-pressed breath” of Wagner’s *w*, he discerned a “wafting (waving) movement [*eine wehende (wallende) Bewegung*].”⁷ Wolzogen’s methods were explicitly antiphilological, in line with the Wagnerian theory of an *unmediated* tonal-emotional relation; his treatise purposely eschewed all historical speculations that could potentially conflict with the psychological impression presumed to communicate itself, immediately, through the sounds (“With certain consonants, we clearly sense a symbolic message conveying certain ideas [*Vorstellungen*]. It does not matter what this is based upon: the effect is there”⁸). Letters operate within the alliterative context of the *Ring*, so the argument goes, according to the same rules as the sound symbols of Wagner’s musical melodies, for which Wolzogen would later propose the term *Leitmotiv*.⁹ In doing so, they prepare the way for an etymological practice that prioritizes universal rules of natural sound-sense affinities over particular laws (like Grimm’s sound shift) of historical phonetic change.

The Baudelaire-Wolzogen interpretation of Wagner’s alliterating letters had particular relevance for the early sound experiments of the French Symbolist poets, whose attempt to discover the sensory sense of sound drove them beyond and beneath the conventional linguistic sign. Rimbaud’s “Vowels” (“Voyelles,” 1871), which assigns a color to each vowel, grew out of this context, as did Mallarmé protégé René Ghil’s *Treatise on the Verb* (*Traité du verbe*, 1866), which follows a paean to Wagner’s “poetic instrumentation” with three lists of letters keyed to musical instruments and a set of instructions for “orchestrating” linguistic music.¹⁰ Both works insist, in a way that seeks to fulfill the avowedly Wagnerian promise of Baudelaire’s living pillars, on the possibility of a meaning somehow inherent to the alphabetic elements themselves, irrespective of their participation in words, and thus also irrespective of any demonstrable philological connection to these words’ “actual” historical trajectories. The Symbolist-affiliated journal the *Wagnerian Review* (*La Revue Wagnérienne*), founded in 1885 with the stated goal of promoting Wagner as the creator of a new kind of linguistic art (Stéphane Mallarmé, Paul Verlaine, René Ghil, and Wolzogen himself were all among the contributors) provided a forum for the consolidation of this perspective. And by the end of the nineteenth century, the fascination had spread to the Symbolist movements in Moscow and Saint Petersburg, where musicians such as Alexander Scriabin, artists such as Wassily Kandinsky, and

poets such as Andrei Bely paid explicit tribute, in the course of their respective synesthetic experiments, to the significance of Wagnerian principles regarding the unity of sense and sound.¹¹

The poetic radicalization of the Wagnerian *Stabreim* at the hands of the French and Russian Symbolists presupposed an understanding of language that may well have remained a quasimystical footnote in the history of language science had it not been for the simultaneous emergence, from within the academe itself, of a theory that could claim to stand guarantor over the sound-sense correspondences of modernist poetic experiments. Most prominently developed by the psychophysicologist Wilhelm Wundt in his laboratory at the University of Leipzig—under the influence of his predecessor and fellow Leipzig scholar, Gustav Fechner—the principle of “psychophysical parallelism” posited that changes in the physical substrate of the body could be shown to correspond, verifiably and predictably, to changes in the psychic condition of the organism. The capacity for speech could then be interpreted, in turn, as one particularly significant modification of a more fundamental, psychophysiological analogy. Wundt’s perspective offered a counterpoint to the materialism of his colleagues in the Leipzig linguistics department, since while Neogrammarians such as Brugmann and Osthoff strove to subtract the “metaphor” of spirit from the study of language sound, Wundt and his students worked to enfold sound *back* into an all-encompassing science of *Geist*. The hypotheses of psychophysiology were designed to be laboratory-testable, its object of investigation measurable, its claims falsifiable, and the result was a respiritualization of language science capable of rivaling the Neogrammarian “literalization” for the allegiance of a profoundly positivist age. By the beginning of the twentieth century, Wundt’s one-room laboratory at the University of Leipzig had become the international center for a new field of study that sought to measure stimulus-response interactions, with the aim of establishing the relational laws governing all facets of mental life. His monumental *Principles of Physiological Psychology* (*Grundzüge der physiologischen Psychologie*) had gone through six separate editions.¹² And the six-hundred-odd students to whom he lectured every semester had carried his central ideas well beyond the confines of German academia, with the result that avant-garde artists all over Europe, from Symbolists to Futurists to Dadaists, could call on the principle of psychophysical parallelism to stand guarantor for their Wagnerian innovations.¹³

WAVE SYSTEMS (ACOUSTICS)

Wundt's theories, then, came to count for his contemporaries as science, in a way that the poetic experiments of the avant-garde Wagnerians, or of Wagner himself, clearly could not. They did so, however, not simply because of Wundt's laboratory, as commonly assumed, but rather because his theories managed to adapt for psychological use—so I will argue here—the enormously powerful physical concept of *naturally occurring wave systems*, particularly as formulated by Wundt's teacher, the great physicist (and Wagner admirer) Hermann von Helmholtz.¹⁴ Helmholtz himself had treated this concept most thoroughly in the context of his midcentury studies on acoustic harmony. Any attempt to render readable the true stakes of the Wundtian perspective for a rethinking of the sound-sense bond must therefore begin by taking into account this surprisingly intimate relationship between a new, nineteenth-century science of spirit and an existing nineteenth-century science of sound, between a science of air waves in motion and a science of (self-)moving *psukhē*.

Helmholtz first turns to the question of acoustic harmony in the 1850s, on the heels of his groundbreaking investigations into light waves and the perception of color, in an attempt to do for the domain of the ear what he had already done for the eye. Beginning with his 1857 lecture “On the Physiological Causes of Harmony in Music” (“Über die physiologischen Ursachen der musikalischen Harmonie”)¹⁵ and concluding with his book-length study *On the Sensations of Tone as a Physiological Basis for the Theory of Music* (*Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik*, 1863),¹⁶ Helmholtz treats the age-old problem of musical pleasure primarily as a kind of case study, to be interrogated for its ability to shed light on the relationship of stimuli to sense perception. By studying the correlation between acoustic phenomena, in the form of sound waves, and the perception of sound, in the form of auditory impressions, he hopes to arrive at an account of what it means, physically and physiologically, to hear.

Helmholtz is perfectly aware, of course, that the “case study” of harmony enjoys a particular philosophical cachet. Ever since the ancient discovery, traditionally attributed to Pythagoras himself, of the relationship between consonant musical intervals and rational numerical ratios, harmonic principles had been understood to model cosmic laws. A string stretched between two points (Pythagorean

tradition calls this a monochord) produces one tone when plucked in its full length, a tone an octave higher when held down precisely at its midpoint, such that the sounding length stands to the original length in a ratio of 1:2, a tone a fifth higher at a ratio of 2:3, and one a fourth higher at a ratio of 3:4. These three most consonant intervals, together with the permutations they make possible (which yield the somewhat less consonant intervals of major and minor third, second, sixth, and seventh), form the basis of what the Greeks called *harmounia*, from *harmos*, “joint,” proto-Indo-European **ar*, “to fit together.” The “joints” in question are the nodes that define the various string lengths, and these nodes “fit together” into an articulated system of sounds (*articulare*, also from proto-Indo-European **ar*, “to fit together”), insofar as they interact with reference to a single, structuring principle or standard of measure. Only lengths that share a common unit can relate to one another in the manner of whole number ratios, which is to say, *rationally*—every “rational” number, mathematically speaking, can be remainderlessly expressed as a ratio of two whole numbers, for which the technical Greek term is “logos”; every “irrational” number fails this test—and only such rational string-length ratios yield compound sounds that please. It is this ability to render aesthetically manifest the configuration of a purely numerical rationality that turns musical tones, together with bodily organs, the letters of the alphabet, and the rational numbers themselves, into time-honored figures for the privileged “joints,” or foundational units, of Being and thought.¹⁷

When, therefore, nineteenth-century Germany’s best-known proponent of an exclusively mechanist physics undertakes to provide a purely physiological account of harmony—why, Helmholtz wants to know in his 1857 lecture, do we *hear* ratios of small whole numbers as pleasurable, whether or not we are actually *aware* that we are hearing a numerically “rational” interval?—his attempt cannot help but intervene in a much larger debate regarding the “naturalness” of conceptual structure. Helmholtz accepts the burden of the problem’s long history (“this is an old riddle, propounded already by Pythagoras, and hitherto unsolved”; *PC*, 47/58), while remaining true to his own quasi-Kantian standpoint, which forbids the presumption of an inherently rational universe, and insists instead on scientific experiments to establish mechanistic causal chains. (“Let us see whether the means at the command of modern science will furnish an answer”; *ibid.*). His methods allow him to demonstrate conclusively, for the

first time, the extent of the ear's capabilities: even the least "mathematical" of listeners turns out to analyze compound sounds according to the mathematical compatibility of their components, and in this sense, the privileged *logoi* of Pythagoras's consonant intervals do indeed appear to originate in the objective reality of nature. These same experimental methods, however, also allow Helmholtz to propose an interpretation of the ear's abilities that depends solely on the physiological makeup of the human organism, without reference to the hypothesis of an ostensibly cosmic "harmony of the spheres."

Since at least the time of the mathematicians Leonhard Euler, Jean d'Alembert, and Daniel Bernoulli, with their respective contributions to the eighteenth-century conversation known as the "vibrating string controversy,"¹⁸ it has been common knowledge among theorists of harmony that the Pythagorean ratios of string lengths correspond to ratios of air vibrations, which have the mathematical structure of periodic functions. Such functions describe continuous yet repetitive movements, like those of a pendulum or a beating heart, and they consequently have continuous yet repetitive, which is to say *wave*-shaped, graphs. Helmholtz agrees that the mathematics of periodic functions must form the foundation of any modern science of harmony, but he takes issue with the idea, proposed by Euler, that an innate psychological preference for the orderly elegance of rational ratios can explain the audible phenomenon of consonance. Euler's understanding, he thinks, fails to account for the way in which the rational order of harmonious sound waves becomes accessible to the human psyche. "We must keep in mind," says Helmholtz in *On the Sensations of Tone*, "that man in his natural state is scarcely aware that tone rests upon vibrations. There exists, moreover, no cognitive means whatsoever for immediately and consciously perceiving the different numbers of vibrations, or for discerning with the senses the fact that these numbers are larger for higher tones than for lower and that they stand in particular relationships for particular intervals."¹⁹ It is difficult to see, in other words, how the pleasure of consonance could be based on the pleasure of simple, rational relationships, if these relationships are never, in any meaningful way, *perceived*.

Helmholtz finds the prototype of *perceptible* wave relations in the "instructive spectacle" (*lehrreiches Schauspiel*) of the sea, from which, as he points out, the word "wave" enters the vocabulary of physics in the first place:

I have often spent hours in contemplation on the steep, richly forested coast of Samland, where the sea takes the place of the Alps for us

inhabitants of East Prussia. It is rare not to see there, in incalculable numbers [*in unabsehbarer Zahl*], wave systems of different lengths, propagating themselves in different directions. The longest tend to come from the deep sea and dash against the shore. Shorter ones arise where the larger ones, upon breaking, burst apart, and then run back again out to sea. Perhaps a bird of prey darts after a fish and sets in motion a system of circular waves [. . .]. Thus there unfolds before the spectator—from the distant horizon, where white lines of foam on the steel-blue surface first betray the approaching procession of waves, down to the sand beneath our feet, where the waves draw their arcs in the sand—a sublime image [*ein erhabenes Bild*] of immeasurable power [*unermesslicher Kraft*] and constantly changing variety, which, since the eye easily recognizes therein order and law, captivates [*fesselt*] and exalts [*erhebt*] without confusing the mind [*den Geist*]. (PC, 57/70–71)

Beneath the philosophically loaded image of a lone observer standing in rapt contemplation of the sea—the passage recalls a famous Leibnizian rumination on the relationship between waves, perception, and the harmony of the All,²⁰ but it also restages the Romantic painter Caspar David Friedrich’s most famous, Kant-inspired tableau of an encounter with the dynamic sublime (see figure 8)²¹—Helmholtz provides an almost comically prosaic catalogue of possible wave behaviors. The wave system generated by the lunar tides differs from the wave system generated by the wind, which differs, in turn, from the system set in motion by a diving bird or a passing ship. The waves in each of these systems occur with their own particular frequency or speed (measured in terms of the number of waves-per-time-interval passing through a given point); they have their own particular shapes, and their own particular heights or “strengths” (measured in terms of the distance between crest and trough). Where these different wave types intersect, however, they combine to form a new kind of wave, whose frequency, height, and shape are the sum of the frequencies, heights, and shapes of its components.

By scanning the horizon and taking account of the paths of the various wave systems in play, the interested observer of the ocean surface can actively follow the formation of compound waves with a precision that would be unthinkable, for instance, in the otherwise wholly parallel case of sound waves combining in a dance hall. Sound waves operate by periodically “compressing” the air particles through which they flow, and, like their watery counterparts, they vary in frequency, strength, and shape according to the nature of their sounding source: the ear hears the particular number of air condensations



The particular mathematics of wave combination that Helmholtz has in mind was discovered in the first decades of the nineteenth century by the French physicist Joseph Fourier, in the course of his groundbreaking work on the behavior of heat waves. Fourier's *Analytic Theory of Heat* (*Théorie analytique de la chaleur*), published in 1822, contains the statement of a revolutionary new law pertaining to the structure of compound waves, which Helmholtz paraphrases for the lay audience of his harmony lecture: "Any arbitrary wave-form can be composed out of a definite number of simple waves of different lengths. The longest of these simple waves has the same length as that of the given wave form, the others have lengths one-half, one-third, one-fourth, etc. of this length. One can produce, through different kinds of overlap among the crests and hollows of the simple waves, an infinite variety of forms" (PC, 62/77).

The term "simple or pure wave form" refers here to the perfectly symmetrical, classically wave-shaped oscillations described by the so-called sinusoidal function, of which Helmholtz provides the following graphic illustration (see figure 9). The majority of audible sound waves, including those generally considered to be particularly "musical," do not, as it turns out, share a shape with this most "regular" of all periodic graphs. A bowed violin string, for instance, vibrates periodically according to a function that has a saw-toothed form (see figure 10). And a bowed violin string observed from the perspective of certain "nonnodal" points on the string acquires further "puckers" (*Kräuselungen*; see figure 11). Yet despite the jagged asymmetry of the latter two periodic graphs—and herein lies the power of Fourier's mathematical paradigm—each can be represented as the sum of a certain number of larger and smaller simple sine curves, all of which have the smooth, symmetrical form of the elementary wave (figure 12 illustrates this process for the case of two such "sharp-edged" functions). No matter how irregularly shaped the periods of a given oscillatory graph, in other words, the law guarantees the mathematical possibility of analyzing these periods uniquely and without remainder, into a multiplicity of paradigmatically wave-shaped units. The method thus allows the mathematician to rigorously relate every conceivable kind of oscillation to every other, across the "universal equivalent," or common measure, of the simple sine function.



Figure 9. Hermann von Helmholtz, “On the Physiological Causes of Harmony in Music” (“Die physiologischen Ursachen der musikalischen Harmonie”), 55/68.

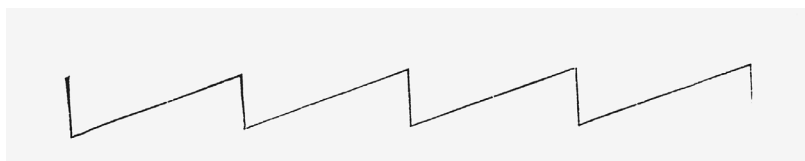


Figure 10. Hermann von Helmholtz, “On the Physiological Causes of Harmony in Music” (“Die physiologischen Ursachen der musikalischen Harmonie”), 57/70.



Figure 11. Hermann von Helmholtz, *On the Sensations of Tone as a Physiological Basis for the Theory of Music* (*Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik*), 84/145.

Helmholtz’s primary contribution to the science of acoustic wave combination resides in the series of ingenious experiments and instruments he designs to demonstrate, beyond all possible doubt, that Fourier’s mathematical analyses have real-world correlates at the level of actual sound waves, both in the air and in the ear. The largest curve in the graph in figure 12, for instance, when interpreted in terms of audible tones, corresponds to what Helmholtz calls a “fundamental tone” (*Grundton*), while the smaller curves with higher frequencies, which “shift” the shape of the base curve in the direction of the final, compound curve, represent “upper partial tones” or “overtones” (*Oberpartialtöne*). Together, the fundamental with its accompanying

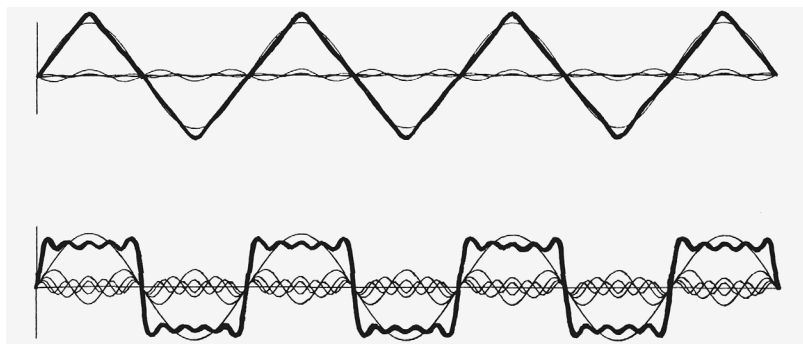
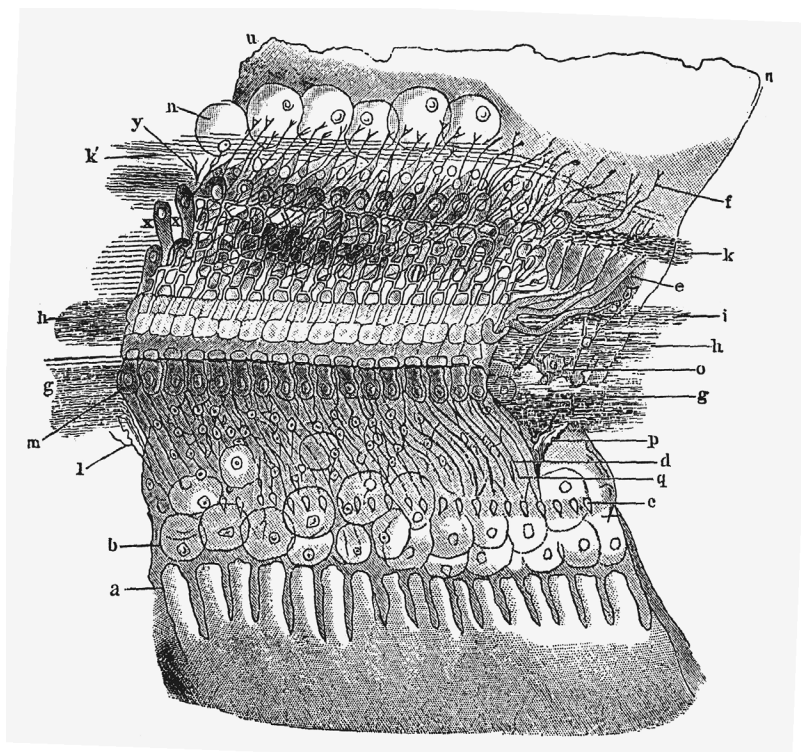


Figure 12. Fourier analyses for two different discontinuously oscillating functions. From Ian Johnston, *Measured Tones: The Interplay of Physics and Music*, 3rd ed. (Boca Raton: CRC Press, 2009), 98.

partials, whose frequencies are always some whole number multiple of the frequency of the fundamental, make up the compound tone, or *Klang*, which corresponds to the sound the ear actually hears. Nearly every acoustic phenomenon is such a compound, according to Helmholtz (exceptions include the simple sinusoidal vibrations produced by tuning forks and pipe organs), and under the right experimental circumstances, the various components can also be made to *sound* by themselves. Helmholtz's principle method of causing partial tones to appear—which is to say, of *analyzing* or *dissecting* the so-called *corps sonore*²²—exploits the long-known but little understood phenomenon of sympathetic resonance: a body with the potential to vibrate at a particular frequency or pitch, like an undamped piano string, will begin to oscillate spontaneously, without itself being struck, in the presence of a second vibrating body of corresponding frequency. The discovery that sympathetic resonance occurs even when the frequency in question is only an upper *partial* of the sound being generated (an undamped G string on the piano will sound, for instance, when a C is played on the violin, since in this case G is one of the overtones of C) makes clear that partials can “act” on their environment independently of the whole they help compose.

Having demonstrated that most sounds are in fact wave *systems*, and that these systems can be analyzed with the help of the phenomenon of sympathetic resonance, Helmholtz proposes that the ability to hear consists in the largely unconscious performance of precisely



pitch frequencies of the partials are low-number multiples of the pitch frequency of the fundamental, or when two different, simultaneously sounding fundamental tones share at least one partial). Compound sounds register as dissonant noise, on the other hand, when their components have little in common.

Since, however, nearly all such wave analyses take place beneath the level of ordinary aural awareness, Helmholtz must go on to explain how this unconscious distinction between structure and chaos, consonance and dissonance, elicits the *conscious* emotions of aesthetic pleasure and displeasure. He finds his answer in the phenomenon of “beats,” which occur whenever component wave curves intersect. Defined as alternations in the amplitude, or volume, of the compound sound, beats function as a perceptible indicator of how often and how haphazardly component wave curves “interrupt” each other’s course. Whereas component waves of a consonant compound will tend to intersect with each other only at relatively infrequent and “natural” intervals, the partials of a dissonant compound will intersect with each other many times over the course of a single, fundamental period. The result, in the former case, will be relatively infrequent variations in the *volume* of the compound sound (given at every point by the sum of the heights of each component curve), while in the latter, such variations will be all but incessant: “While every individual musical tone produces in the auditory nerve a uniformly sustained sensation, two tones of different pitches mutually disturb one another and chop each other up [*sich zerschneiden*] into individual tone jolts [*Tonstösse*], which produce in the auditory nerve a discontinuous stimulation, and which are as disagreeable to the ear as similar, intermittent but rapidly repeated stimuli are to other sensitive organs, for example, flickering and glittering light to the eye, scratching with a brush to the skin. This roughness of tone is the essential character of dissonance” (PC, 71–72/87). Graphically, then, the concept of dissonance describes a scenario in which the component waves fail to “fit together” into the harmonious *corps sonore* of an organic whole. In the absence of a clear common divisor or principle of relation, they cut into each other every which way (*zerschneiden*) rather than dissecting each other cleanly at well-defined, natural “joints” (*zergliedern*). Acoustically, this mathematical disorder makes itself manifest in the perceptual phenomenon of “too many” jolts: the human ear cannot make sense of alternations in amplitude that come too fast to be registered or counted, and the result is a conscious experience of sensory displeasure.²³

Helmholtz's major work on acoustics, *On the Sensation of Sounds*, uses this physical-physiological theory of harmony to undergird a teleological account of musical development that stretches from ancient Greece to modern Germany. The account follows the lines laid out by Wagner himself, with whom Helmholtz would later become personally close, in portraying Germanic music from the eighteenth century onward as the fulfillment of sound's material potential for increasingly complex harmonic combination.²⁴ Like Wagner, Helmholtz locates the turning point of this trajectory in the discovery of a "vertical" dimension to musical composition—the dimension of chords, with their simultaneous sound combinations—and like Wagner, he assumes that this discovery has found its culmination in the innovative Wagnerian techniques of harmonic transition, which bind manifold, seemingly unrelated chords together into an intricate, infinitely melodic whole: "In this way one achieves modulations that lead in a single step to comparatively distant keys [. . .]. These means are often employed by modern composers (in particular *Richard Wagner*)."²⁵

Unlike Wagner, however, Helmholtz retells this triumphalist story in pronouncedly physicalist terms, and in doing so claims its consequences for the domain of natural science. Wagner's image of chords as wave columns reappears, here, literalized, as the foundational structure of all sound—since even single notes can be shown to consist of multiple, superimposed tones—and the introduction of chordal harmonies becomes legible as a technique for rendering conscious, via an act of explicatory redoubling, the demonstrably *physiological* conditions of musical possibility. (The C-major triad of C-E-G, for instance, turns out simply to "highlight" the first and second partials of the fundamental tone C—by converting them into individual notes.) At this new, higher level of harmonic organization, the tonic root of the chord plays the role of the fundamental tone, but the structuring principle remains otherwise the same. A consonant chord is one where only consonant intervals are found, and a consonant interval is one in which two notes share at least a single partial tone.

The gradual accumulation and systematization of knowledge regarding the principles of this second-order capacity for combination provides new insight into the relationships among individual notes, since two notes that have little in common at the most basic level of the interval could turn out to relate to one another in significant, useable ways at the level of the various chords in which they participate: "We shall consider two compound tones [*Klänge*] to be related in the

first degree when they have two identical partial tones, and related in the second degree when they are both related in the first degree to the same third compound tone [*Klang*].”²⁶ This new insight, in turn, prepares the way for a transformation in the structure of the scale. Where once there had been many different options from which the composer could feel free to choose (Ionian, Dorian, Phrygian, Lydian, Mixolydian, Aeolian, Locrian), the requirements of rational chord relation distill the abundance down to two privileged types—the “genders” (*Geschlechter*) of major and minor—whose scale steps, or *Stufen*, carve up the sound continuum according to the criteria of a higher-level sound kinship, or *Klangverwandtschaft*.

The resulting musical analysis of the acoustic given is not, in itself, “natural,” in the sense that it could be said to exist, independently of cultural preference, within the realm of artistically unmanipulated sound; Helmholtz makes very clear that the winnowing process he describes occurs exclusively at the hands of European artists, on the basis of an idiosyncratically European prioritization of chordal harmony. If it is true, however, that all musical systems are necessarily the product of culturally contingent, aesthetic selection, it does not thereby follow that certain choices are not *objectively* more compelling than others, in the sense that they manage to more comprehensively actualize the possibilities available within nature: the music of eighteenth- and nineteenth-century Austro-German composers, culminating in Wagner, represents for Helmholtz a particularly emphatic realization of the physical-physiological principles that govern all tonal relationships, and the possession of a more sophisticated system for rendering sound relationships comprehensible to the listener allows, in turn, for greater freedom in the use of combinatory means. A composer who need not worry that more distant relations will register only as noise can afford to employ more dissonance, and to modulate more radically, in the process of unfolding a musical thought.²⁷ The result will be a compositional “concept” capable of subsuming many different kinds of relation under a single principle of development: “It is obvious that the great breadth and wealth of expressive gradations, with which modern compositions can be endowed without endangering their artistic unity, rests essentially on this state of affairs.”²⁸

The question of what, exactly, such a compositional concept conceptualizes—and hence also the question of what cognitive status should be assigned to the unprecedented integrative power of

Wagnerian music—is the topic to which Helmholtz turns at the conclusion of his public harmony lecture. (The same reflections reappear, slightly reformulated, at the end of the later monograph, under the heading “Relationship to Aesthetics” [“Beziehungen zur Ästhetik”].²⁹)

For the higher, spiritual beauty of music, harmony and disharmony are only means, but they are essential and powerful means. In disharmony the auditory nerve feels tormented by the beats of incompatible tones. It longs for the pure outpouring [*Abfluss*] of tones in harmony, and pushes toward this state in order to linger there, appeased. Thus both harmony and disharmony alternatively drive and subdue the flow [*Fluss*] of tones, in whose incorporeal movement the mind [*das Gemüth*] beholds an image of its own stream [*Strömung*] of ideas and moods. As with the undulating [*wogende*] sea, the mind is here captivated [*fesselt*] and carried along by the rhythmically repeated and yet ever-changing mode of movement. But whereas in the case of the sea only blind, mechanical powers of nature are at work [*während dort nur mechanische Naturkräfte blind walten*], and the impression of chaos [*der Eindruck des Wüsten*] thus, finally, prevails over the spectator's mood, in the musical artwork the movement in question follows the currents [*Strömungen*] of the artist's agitated soul [*der erregten Seele des Künstlers*]. Now gently flowing along [*sanft dahin fliessend*], now gracefully springing about, now intensely excited [*heftig aufgeregt*], punctuated by or working violently upon the natural sounds of passion [*Naturlauten der Leidenschaft*], the flow of tones transmits to the soul of the listener, in their originary vitality [*in ursprünglicher Lebendigkeit*], unsuspected moods that the artist has overheard within his own soul—in order, finally, to carry the listener upward [*emportragen*] into the peace of eternal beauty, of which God has allowed but few of his elect favourites to be the heralds [*zu dessen Verkündern unter den Menschen die Gottheit nur wenige ihrer erwählten Lieblinge geweiht hat*].

Here, however, lie the boundaries of natural science, which force me to halt. (PC, 75/91)

In this remarkable passage, with its uncharacteristically flowery prose and reckless profusion of speculative inferences, lies the kernel of a tentative, Helmholtzian account of psycho-physical interaction, which definitively distinguishes the cultural experience of musical wave systems from the natural spectacle (*Schauspiel*) provided by the surface of the sea. The fact that every musical development is experienced as an expressive trajectory has to do, for Helmholtz, with the universal human tendency to (falsely) interpret *all* movement, regardless of origin, as the “expression” of a teleological moving force. Where the source of the movement is known to be human, however, as in the

“moving tones” of music or language, greater familiarity with the mental (and thus truly teleological) forces in play renders legitimate this otherwise dubious interpretive tendency.³⁰ The composer’s carefully calibrated alternation between the acoustic phenomena of consonance and dissonance—between the physiological experiences of pleasure and pain—sets in motion for the listener a temporal dynamic of desire and fulfillment, of conflict and resolution, that in this case can be *reasonably* presumed to mirror the movements of the composer’s own soul.

Such a mirroring effect possesses no referential, representational content, according to Helmholtz, since the sounds of music, unlike those of language, never transcend themselves to become symbols of particular emotions or things. Rather, musical sounds relate to one another as moments in a continuous, undulating flux (“the rhythmically repeated and yet ever changing mode of movement”), reflecting in the course of their stuttering progression those fluctuations of mood (*Stimmung*) that form the necessary backdrop for all specific, conceptual determinations (*Bestimmungen*). Musical *rhythm*, in other words—for Helmholtz as for Wagner—has less to do with some externally imposed and in this sense ultimately arbitrary “tact,” like the naturally occurring rhythm of ocean waves, than it does with the irregular periodicity of the composer’s own tonal-emotional oscillations. And this latter ordering principle has more power to structure experiential time for the composer’s audience precisely because the rhythm of affect need not conform, as waves do, to the blind governance of mechanical forces, which, for all their metrical predictability, still leave behind an impression of chaos in the mind of the human observer.³¹ The rhythm of affect shapes time according to the trajectory of a purposive consciousness, with the goal of transmitting the experience of the artist’s specifically psychological inspiration (“unsuspected moods, which the artist has overheard within his own soul”) from the soul of the divinely favored source to the souls of the less emotionally-acoustically attuned.

THE UNDULATING ALL (PSYCHOPHYSICS)

Helmholtz himself, true to his fundamentally Kantian commitments, refuses to speculate further about the actual, scientific foundations of the motion-emotion analogy he postulates (“Here lie the boundaries of natural science”). The nature of the link between sound

waves and affect fluctuations remains vague throughout all of his writings on the topic of harmony, as does the nature of the relationship between mechanical and teleological modes of movement, matter and mind, physical law and volition. It therefore falls to others to explicitly explore these relationships—and, in the process, to reject the Helmholtzian-Kantian schism between *ratio* and world—by turning Helmholtz's submerged Pythagorean promise of an empirical-harmonic parallelism (back) into the foundation for a physics of the human psyche.

Wilhelm Wundt is preceded in this attempt by his older colleague, Gustav Fechner, who began his career as an avowed disciple of Schelling's nature-philosophy,³² and whose monumental *Elements of Psychophysics* (*Elemente der Psychophysik*, 1860)³³ cites Helmholtz's nearly contemporaneous work on harmony in support of a profoundly un-Helmholtzian hypothesis: *All* cosmic movement, including that of the psyche, possesses for Fechner a periodic form, and *every* cosmic complex therefore arises for him as a superimposition of simple waves, in the manner of a compound sound. Fourier's discovery that any movement, no matter how arbitrary and irregular, can be represented in terms of sinusoidal curves, merges here with Helmholtz's demonstration of the acoustic reality of such representations, to yield the basis for Fechner's combining-wave model of the universe.³⁴ He begins his elaboration of the theory by noting that the intensity of human consciousness can be conceived as periodic, due to the daily rhythm of sleep and waking. He calls this overarching oscillation the "total wave," or *Gesamtwelle*, and proceeds to offer a representation of mental life that interprets this total as the sum of numerous smaller vibrations—from the underlying oscillations of conscious attention and distraction (this is the fundamental wave, or *Unterwelle*, which corresponds to the fundamental tone of a compound sound), to the vibrations caused by individual sensations or mental events (these are the harmonic overtones, or *Oberwellen*).³⁵ He compares the wave patterns of consciousness to the wave patterns that can be observed on the surface of the sea ("The sea presents us with the reality of our scheme, as it were *in itself*"³⁶) before going on to ascribe to all Being the character of rhythmic undulation: "[F]or the whole activity of the earth's system can be represented under the schema of one large wave, to which the systems of activity of the individual organic beings belong as small surface ripples [*Oberwellen*]."³⁷ The waves of mental attention play the role of upper-level overtones to the more basic

waves of organic life, which in turn provide harmonic embellishment for the fundamental tone of Nature (“of the universal system of all the movements of nature”³⁸) in all its vibrating, pulsating entirety.

Though Fechner seldom makes the connection to music explicit, his theory thus quite clearly reformulates the Pythagorean principle of cosmic harmony, using terms intended to attract and persuade a generation of Helmholtz-reading scientists. In the process, he repeatedly draws the kind of conclusions that Helmholtz himself had explicitly refused to consider, but he does so—and herein lies the appeal of his work for more cautious successors, such as Helmholtz’s student Wilhelm Wundt—without jettisoning a commitment to natural scientific modes of investigation. Citing the laboratory experiments of his own teacher and fellow Leipzig physiologist, Ernst Weber, Fechner argues that the psychological experience of sensation can be shown to vary proportionally with the physical phenomenon of the stimulus, in a mathematical correlation now frequently referred to as Fechner’s Law.³⁹ Such a correlation implies that the psyche moves *in measurable tandem* with its more accessible, physiological substrate. (The algebraic equation, on which Fechner founds his entire project of a quantitative psychophysics, dictates a geometric increase in the intensity of the sensation for every arithmetic increase in the intensity of the stimulus.) Whereas Helmholtz, therefore, feels compelled to remind his audience that the psychological meaning of musical pleasure must forever remain a question of subjective aesthetics rather than objective science, despite its demonstrable foundation in the nonnegotiable physiology of the ear, Fechner happily interprets the discovery of harmony’s bodily basis as (further) proof that both the subject and the aesthetic can in fact be objectively quantified.

True knowledge of nature, Fechner then goes on to claim, is always and only possible on the basis of an underlying unity that binds the structure of the mind *analogically* to the structure of the world: “The consequence of this view leads to the belief in a conscious God, omnipresent in nature, in which all minds/spirits [*Geister*] live, move, and exist [*leben, weben, und sind*], as God does in them, with the individual spiritual levels [*geistigen Zwischenstufen*] inherent to the astronomical bodies standing between him and us [. . .]. This belief can be further developed and supported on the basis of the analogies and connections provided to us by the hierarchical, steplike structure [*Stufenbau*] already present in humans themselves.”⁴⁰ The notion of analogy, however—and with it the notion of the human

as microcosm—has acquired a new precision in light of Helmholtz’s acoustic experiments, since an organism built to resonate *sympathetically* with the universe can now be expected to mirror nature’s vibratory combinations in a manner at least potentially accessible to future laboratories. Fechner, for whom the “brain” is no isolated organ but rather a network of nerves extending throughout the entire somatic apparatus, views the Helmholtzian ear as a model for the physiological substrate of sense production *per se*. The body as a whole thus comes to operate, on his account, like Helmholtz’s undamped piano, its various nerve strings constructed to vibrate in tune with particular external phenomena, and to combine—or rather, to harmonize—in chordal concepts of unlimited scope and variety:

A piano, despite its relatively small number of fixed keys, allows for the possibility of executing the widest variety of melodies and harmonies, and no matter how various or how elevated the thoughts a human might conceive, 25 letters suffice to express them; in both cases success depends only on the connections and on the order in which one runs through the keys or the letters. The brain, with its countless fibers, all of which operate in different ways, contains in this sense incomparably richer resources, so that there cannot be any barrier to presuming it capable of accomplishments, internally, at least as great as those we execute externally by means of it.⁴¹

The mysterious phenomenon of concept formation becomes legible here, in Fechner’s Helmholtzian adaptation of the Platonic letter-note analogy, as the product of a vibratory *brain writing*, its combinatory power a microcosmic reflection of nature’s own boundless capacity to self-articulate. Fechner’s entire theory thus reveals itself to be, in turn, an extension of the nineteenth century’s various Pythagorean, world-spiritual fantasies: Schelling’s notion of an oscillatory *Logos*, the Grimm brothers’ “living, trembling movement” of sticks and letters, Liliencron’s world-moving incantations, and Wagner’s alliterative wave pillars all find their (ostensibly) laboratory-ready realization in the sinusoidal swinging of Fechner’s human psyche.

Wilhelm Wundt’s primary contribution to the science of psychic harmony—a science in which he tellingly nowhere explicitly admits to being involved—is to render Fechner’s model acceptable to a scientific mainstream concerned with observable facts. By disavowing the quasimystical, esoteric language of world souls and communion, on the one hand, and proposing techniques for actual testing, on the other, the *Principles of Physiological Psychology* paves the way

for a respectable, experimentally reproducible investigation into the structure of the psychic substrate. What for Fechner had remained an “image” with the potential for future concretization, thus becomes, for Wundt, a working hypothesis to be affirmed or discredited in the present, with the help of experiments designed to *measure* fluctuations in the intensity of mental attention. If these fluctuations turn out to possess a periodic structure, then mental life as such, and with it, all phenomena of consciousness, from the most elemental emotions to the most abstract concepts, will assume the nonmetaphorical shape of a Helmholtzian compound wave.

Wundt quietly unfolds the consequences of this hypothesis—via a series of punctual reflections scattered seemingly at random throughout the thousands of pages of the later editions of the *Principles*—into a full-blown theory of brain rhythm. While comparing, for instance, the patterns of attentional intensity associated with adding single-digit numbers and memorizing meaningless syllables, he allows himself the following general remarks regarding the oscillatory structure of thought:

Since the fluctuations that appear in both cases recur in all curves, no matter what the type of task may be, it becomes permissible to relate them back to those oscillations of apperception that can already be observed whenever the attention is directed toward a single, homogeneous impression, and which then recur in a similar way in all possible forms of apperceptive functions. [. . .] These apperception waves then likely also correlate with the tendency to *rhythmically* analyze [*gliedern*] mental as well as physical performance [*Arbeitsleistungen*], a tendency that becomes more pronounced the more that physical and psychological performance coincide: namely, everywhere that the articulatory movements of the language organs, or other expressive movements, accompany mental labor, as in reading, writing, memorizing, adding, and the like.⁴²

The graphs, or “work curves,” of the two laboratory-friendly activities in question have markedly different shapes (see figure 14). Both oscillate, however, at regular temporal intervals between maxima of concentration and minima of distraction, and Wundt claims in this passage that they do so necessarily rather than contingently. Consciousness consists, for him, in an energy of attention that can also be characterized as the energy of a *tension*: a concentration, or *Verdichtung*, of powers by which the mind gathers itself together around a singular point of focus, and without which no experience of any kind, whether sensory or conceptual, could occur (“The

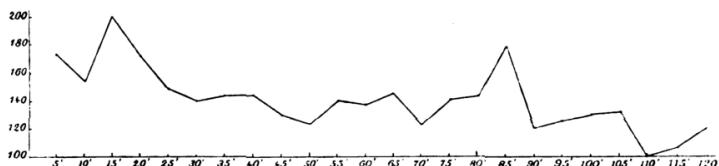


Fig. 381. Arbeitscurve bei der Addition einstelliger Zahlen, nach KRAEPELIN.

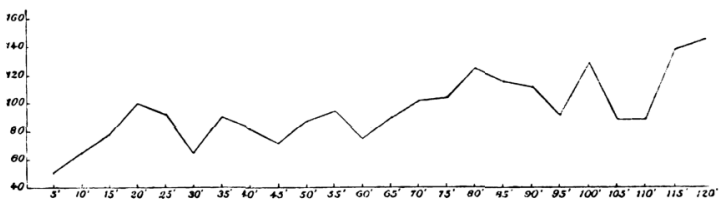


Fig. 382. Arbeitscurve beim Erlernen sinnloser Silben, nach KRAEPELIN.

Figure 14. Work curves for the addition of single-digit numbers and the memorization of meaningless syllables. From Wilhelm Wundt, *Principles of Psychological Psychology* (*Grundzüge der physiologischen Psychologie*), vol. 3, 5th ed., 616.

fundamental phenomenon underlying all intellectual performance is the so-called *concentration of attention*⁴³). Such energy comes in pulses, or waves, meaning that mental activity itself must always unfold according to an underlying, all-encompassing *rhythm*, beneath and before the various patterns imposed by any particular cognitive tasks.

This rhythm can be experimentally discerned, Wundt thinks, at every conceivable level of consciousness. And it can therefore be presumed to *precede* all encounters with the ostensibly unstructured chaos of a mechanistic universe. An experience of the world as a collection of randomly colliding parts, and of world time as a seamless, arrhythmic flow of moments, presupposes on the part of the experiencing subject the ability to strip away—and thus to retroactively abstract from—an always prior experience of the All as periodically *articulated* into waves.⁴⁴ Concepts form and develop as an outgrowth of the “gathering” power exerted by the intensificatory energy of attention, a force Wundt will explicitly, if cautiously, go on to identify with the directional striving of an underlying “will.”⁴⁵ This volitional

tendency toward *Verdichtung* drives the mind of humankind ever further away from mere associative inferences and ever closer to the ideal of total synthesis, through a trajectory of increasingly complex and capacious *self*-articulations, whose task is effectively to explicate the potential of the most originary psychic rhythms. Conceptual collections therefore operate, for Wundt as for Fechner, according to the logic of Helmholtz's Austro-German chords, which is to say they parse and, in parsing, render "audible" the diverse capacities for combination that would otherwise remain hidden within the simple shapes of the foundational brain waves.

What this means is that the mechanist worldview so energetically promulgated by prominent nineteenth-century scientists such as Helmholtz can now be seen, from Wundt's unspoken perspective, to stand in conflict with the fundamental tone of all scientific thought. And just as artificially imposed "task rhythms" provide demonstrably suboptimal conditions for the intellectual labor of adding or memorizing—"in general, mental work is qualitatively most supported when the individual follows a self-chosen rhythm, while this same work [. . .] displays errors and imprecision when the rhythm is externally dictated"⁴⁶—so, too, can mental production more generally be expected to suffer in cases where the conceptual superstructure fails to harmonize with the tonic. If the essence of rationality consists in a teleological striving for ever more encompassing "harmonic" arrangements, then any nonteleological theory of the universe must necessarily falsify the activity of thought: the mechanist perspective eliminates the scientist's ability to reflect on his or her own teleological, because rational, methods of inquiry.

At his most daringly un-Helmholtzian, Wundt will then go on to suggest that the conflict between a mechanist science and its own essentially teleological conditions of possibility bears witness to a fundamental inadequacy in the mechanist conception of matter. Since, in the case of minded beings, psychic changes can be shown to correspond to physical ones, as mathematically expressed by the Fechner-Weber law, a properly scientific concept of matter must be able to accommodate the *potential* for psycho-physical, teleological-mechanical interaction, even in cases where this potential has not (yet) been realized: "Since, in the end, we must presuppose that the life-expressions [*Lebensäußerungen*] developed by complex substances of organic nature have their preconditions in the simpler configurations of inanimate nature, so we also cannot escape the assumption

that in the simplest element of substance, the atom, the most elemental drive-forms [*elementarste Triebformen*] are already preformed [*vorgebildet*].”⁴⁷ Every atom of physical substance, in other words, must actually bear within itself, in the form of a built-in proto-telos, or *Trieb*, the conditions of possibility for its eventual participation in the rhythmically articulated, volitional flow of the psyche. Wundt elaborates on the large-scale implications of such a teleological physics in the final lines of the fourth edition of the *Principles*—one of the only places in his entire oeuvre where he makes (almost) explicit the fundamentally nature-philosophical premises on which his oscillatory theory of the psyche depends:

This view of the problem of interrelation [between physiology and psychology] unavoidably leads, moreover, to the presupposition that mental Being [*das geistige Sein*] is the reality of things [*die Wirklichkeit der Dinge*], and that the most essential feature of this reality is development [*Entwicklung*]. Human consciousness is for us the apex of this development: it forms the node in the flow of nature [*bildet den Knotenpunkt im Naturlauf*], through which the world reflects upon itself [*sich auf sich selber besinnt*]. Not as simple Being, but as the developed product [*Erzeugnis*] of countless elements, does the human soul become what Leibniz called it: *a mirror of the world*.⁴⁸

At stake, for Wundt, in his experimental investigation of vibrating brains, is thus never a science of human Being in contradistinction to the science of its natural counterpart, as dictated by the mechanist perspective of his teacher, Helmholtz, but rather a science of human Becoming that reflects the true essence of the physical universe—by microcosmically rearticulating a truly *universal* propensity to progress.

A PHILOLOGY OF THE EAR (POETICS)

Language plays a familiar role in the context of this new paradigm (“It is the responsibility of physiological psychology to investigate the outer and inner conditions under which language, as the highest form of human life-expression, emerges”⁴⁹), with the crucial difference that Wundt no longer feels bound by the ban against primal sound-sense speculations. Where Bopp and Grimm had viewed the question of ultimate origins, and of the nature of the bond tying first sounds to first senses, as forbidden territory beyond the purview of a rigorous language science, Wundt believes the principle of psycho-physical

correspondence provides him with the beginnings of a testable hypothesis. This principle, which effectively turns *every* physical movement into the “expression” of a psychic shift, and thus into a representative of the category Wundt calls *Ausdrucksbewegung*, or “expressive movement,” paves the way for a theory about the emergence of language from gesture. Just as the originary humans instinctively moved their limbs in response to various forms of psychic stimulation, so they also moved their larynx in tune with the interior vibrations of their emotions: “The sounds of language [*der Sprachlaut*], like the gesture, arise out of the innate human drive to accompany feelings and affects with movements, which stand in immediate relation to emotion-arousing impressions.”⁵⁰ The result is the *Klanggebärde*, or sound-gesture, a primitive, immediately comprehensible form of articulation that precedes the separation of Language into languages and in doing so resists all attempts at traditional, etymological explanation. Wundt’s later, more expansive work on language origins offers as the paradigmatic example of such sound gestures-turned-words the near-universal pairing of “mama” and “papa,” which—so the argument goes—aligns an inherently “weak” consonant with the inherently “weak” sex across a wide swath of historically unrelated idioms.⁵¹

Only the methods of a physiological psychology, according to Wundt, can give access to these most original of all roots, and to the true meaning of the further developments they presage, since only the methods of a physiological psychology can subject the actual, expressive *dynamics* of such sound-sense parallels to the scrutiny of laboratory testing. Wundt himself does not devote a great deal of experimental energy to the project of charting particular sound-sense relationships. He does, however, make explicit the direction that any such future project must take:

The development of language is intimately bound up with the development of musical sound-expressions [*Lautäußerungen*]. [. . .] The deeper psychological reason behind this connection lies, however, in the universally human disposition toward rhythmic analysis [*Gliederung*] of impressions and harmonious sound sequences, which reveals itself in numerous guises beyond the realm of specifically musical production. The linguistic expression of thought and song thus likely have a common point of origin in a song-like form of speech, which was neither singing nor regular speech in our contemporary sense, and which for precisely this reason could develop both of these latter forms out of itself.⁵²

The sounds of language, in other words, represent a form of music that runs parallel to the underlying “music” of the intellect (“The movement of rhythm thus corresponds to the progression of the affects, the feeling of harmony to the resolution [*Lösung*] of this progression”⁵³). For where the conundrum of the sound-sense bond crystallizes into a question of vibratory correspondence—Wundt refers the reader in a footnote to his various discussions of mental periodicity—language roots becomes audible, or rather, experimentally *realizable*, as the manifestation of originary mental rhythms. The details of these rhythms, which are governed by the oscillations of a subjective mood, or *Stimmung*, and not by the objective time of tact, can therefore be recovered, despite their lack of a fixed standard of measure, by an interpreter sufficiently versed in the psychophysical principles of expression. And the developmental trajectory they turn out to follow, which mirrors the developmental trajectory of the mind itself, can be explained in the terms of a teleological psychology. Sound shifts occur, according to Wundt, whenever a group of people requires easier and more efficient forms of phonetic articulation to correspond to their faster and more complex processes of mental analysis. Similarly, poetic meter progresses from the stringency of syllable counts to the flexibility of free verse, with an intermediary stop at the *Stabreim*, in response to the ever-increasing expressive power of the modern poet’s structuring mind.⁵⁴

Wundt’s own rather tentative attempts to draw specific, language-scientific consequences from his theory of mind-matter correspondence—as formulated, for instance, in the volumes titled *Language* (*Die Sprache*), from his monumental study of collective consciousness or *Völkerpsychologie*—sufficed to provoke several exasperated responses from his Neogrammarian colleagues in Leipzig, whose mechanist-materialist perspective prohibited all such explanatory recourse to the “telos” of a progressively developing collective psyche.⁵⁵ The Wundtian principles found perhaps their most ambitious linguistic application, however, at the hands of the one-time Neogrammarian phoneticist and *Stabreim* analyst Eduard Sievers, who did not shrink back, as Wundt had done, from putting psychophysiological principles into actual philological practice (or from proclaiming the obsolescence of the mechanistic Neogrammarian alternative). By the time Sievers arrived at the Wundt-inspired methods of his *Rhythmic-Melodic Studies* (*Rhythmisch-Melodische Studien*, 1912),⁵⁶ he had directly confronted both the philological

dilemma of a definitive *Stabreim* meter (in the volume *Old High German Metrics* [*Altgermanische Metrik*], 1893, as discussed in Chapter 3), and the phonetic impossibility of an adequate alphabetic transcription (in his magnum opus *Principles of Phonetics* [*Grundzüge der Phonetik*], 1876, as discussed in Chapter 1). From Sievers's perspective, therefore, the notion of experimentally recoverable sound-sense vibrations held out the promise of a much-needed new approach to language science. Sievers dubbed this approach "ear philology" (*Ohrenphilologie*), to distinguish it from his predecessors' exclusively text-based "philology of the eye," and he conceived of it as a quest for the original tonal-emotional "substance" of transmitted works. More important for the practice of philological critique than the genealogical rules of textual transformation—because more immediately connected to the originary *movement* of meaning that animates every text—became for him the honing of a specifically physiological sensibility to the phenomenon of psychological resonance.⁵⁷ The only truly legitimate interpretation of a poetic text, he argued, must take the form of an archeological "sound analysis" (*Schallanalyse*), which requires the reader to submit as fully as possible, in accordance with a series of teachable "listening" techniques, to the particular vibratory rhythms of an originary "tone writing" buried beneath and before all conventional modes of transcription.⁵⁸

Sievers's decision to realize this fantasy of total recovery on the thorniest of all nineteenth-century philological problems—by *aurally* reconstructing the genetic history of the *Nibelungenlied* manuscripts, together with the most "original" text of the *Edda*⁵⁹—testifies to the radicality of his psychophysiological conversion. It also, of course, links his proposal for the philological future to the musical language of its Wagnerian past, and, by extension, to the "deployment" of Wagnerian-Wundtian principles already long since under way in the domain of avant-garde poetics. For Sievers, as for Wundt, the expressive "will" that courses through poetic compositions, giving rhythmic direction to the harmonic whole and turning collections of psyche-sound waves into microcosmic articulations of an undulating, developing cosmos, becomes newly accessible to direct, natural scientific observation in the context of the psychophysiological laboratory. Privileged insights into the tonal-emotional "stuff" of language spirit, which Wagner and Grimm and even Schelling had attributed to the mysteries of an artistic or linguistic inspiration, can therefore now be produced at will with the help of proper experimental conditions

and techniques (“Experience shows that these kinds of observations can only be set up, carried out, and controlled with sufficient dependability inside the quiet little chamber of one’s own office, or in the most intimate and trusted community of a laboratory”⁶⁰). The result is a nature-philosophical equation of language system with language spirit, and an etymological project of deducing spiritual-systemic roots, that have been updated to reflect early twentieth-century concerns. Sievers’s psychophysiological theory of poetry as a vibratory *corps sonore*, and of reading as an exercise in sympathetic resonance, holds out to his contemporaries the promise of a realized “scientific poetry” (Ghil), and of a corresponding “science of sound symbolism” (Wolzogen).⁶¹ It can therefore claim to herald the beginning of that infinitely melodic future toward which Wagner himself was presumed to have so clairvoyantly gestured.⁶²