

Mechanized Metrics: From Verse Science to Laboratory Prosody, 1880–1918

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ABSTRACT: From roughly the 1880s on, a methodical verse “science” was beginning to assert itself. Grippled by the thought of articulating an objective, fact-based metrics, poetry scientists brought to bear on the traditional verse-line principles of observation and, later, on full-blown experimental practices—not to mention a curious array of instrumentation. By the turn of the century, metrical verse was being subjected to a rigorous measurement regime, which employed techniques and apparatuses derived from the new disciplines of experimental physiology and psychology. Proponents of this newly mechanized metrics pitched themselves enthusiastically into the turn-of-the-century prosody fray, believing they could resolve, once and for all, some of the fundamental dilemmas of versification.

Mechanical Meters

In 1857, just a few months before Coventry Patmore published the first version of his influential “Essay on English Metrical Law” in the respectable North British Review, a series of short articles titled “A Chapter or Two on Meters” appeared in a general-interest magazine called The Friendly Companion and Illustrated Instructor. These “meters,” however, were not precisely the kind that Patmore’s essay was given over to theorizing, and readers expecting something along the lines of a prosodical digest may have been perplexed (and quite possibly relieved) to find, in place of remarks on the iambus or dactylic hexameters, an alphabetically arranged catalog of measurement apparatuses. The first of three monthly installments contained three entries: actinometer (“for measuring the intensity of solar or terrestrial radiation”), aerometer (“for correctly ascertaining the mean bulk of gases”), and barometer (“for ascertaining the weight of the atmosphere”). The next “chapter” began with a lengthy entry on the chronometer (“for the correct measuring of time”), before going on to define such things as electrometer, eudiometer, galactometer, and gasometer. The

concluding number surveyed goniometer, hydrometer, manometer, pedometer, pluviometer, pyrometer, and saccharometer, before finally closing with a long explanation of the now-familiar thermometer.¹

However fanciful they are in name, these mechanized meters speak demonstrably of fact. Coordinating The Friendly Companion's metrical miscellany is the idea of measurement as an objective and precise science that necessitated the use of accurate calculating devices. Through a process centering on what the British chemist Sir Humphry Davy called “the art of experiment and observation,” the measure of “the visible and tangible external world” could be objectively established.² As this essay will show, a similar process would allow a new breed of prosodists to assess the world of poetic meters. By the 1880s, a methodical verse “science” was exerting its empirical energies. Gripped by the thought of articulating an objective, fact-based metrics, verse scientists brought to bear on the traditional verse-line principles of observation and, later, on full-blown experimental practices—as well as a curious array of instrumentation. By the turn of the century, metrical verse was being subjected to a rigorous measurement regime that employed techniques and apparatuses derived from the new disciplines of experimental physiology and psychology. Proponents of this newly mechanized metrics pitched themselves enthusiastically into the turn-of-the-century prosody fray, believing they could resolve, once and for all, some of the fundamental dilemmas of nineteenth-century versification.

The Science of Verse

The late nineteenth century saw a burgeoning of attempts to firm up, disambiguate, and otherwise rationalize the study of verse form.³ In 1885, for example, Francis Gummere, writing in his A Handbook of Poetics for Students of English Verse, lamented that the existing prosody manuals were “aesthetic and vague,” arguing that “there is really no established standard by which we can try true poetry, as a chemist tries gold.” Calling for a “science of verse [that] aims to formulate, as far as it can, the principles of poetic expression,” Gummere adumbrated a prosody that was at once “historical and analytical.”⁴ Thinking along similar lines, Mark Liddell, in An Introduction to the

Scientific Study of English Poetry (1902), proposed a “method of study . . . like that of biology.”⁵

Like Gummere and Liddell, Sidney Lanier, author of The Science of English Verse (1880), held that because the study of verse “involves mainly the observation of sensible appearances, [it can] be carried on with the confidence attaching to the methods of physical science. . . . the basis of a science of verse,” Lanier insisted, was the need “to recognize verse as in all respects a phenomenon of sound.”⁶ Indeed, as Edmund Gurney maintained in The Power of Sound (1880), a physics of sound would provide a firm grounding for prosodic study: the material properties of the verse line—rhythm, pitch, color, and so on—could be established, like those of music more generally, on a methodical, “scientific basis” by an expert verse scientist.⁷

For these and other late-nineteenth-century verse theorists, emphasis on a more analytical and ostensibly scientific prosody was bound up with a desire to rethink one of the fundamental preoccupations of versification: namely, how to conceptualize, measure, and represent the English verse line. As Emily Harrington and others have demonstrated, disputes about prosody’s “origins and rules” figured significantly in nineteenth-century metrical discourse, and throughout the century variant theories emerged regarding the function of accent, the role of time or quantity, and the part played by classical terminology in the definition of metrical effect.⁸ In the 1830s, for example, Edwin Guest had attempted to establish a provenance for accent as the rhythmical “index” of English poetry.⁹ From the 1850s on, however, prosodists such as E. S. Dallas and Patmore were theorizing English meter not in accentual, but rather in temporal terms. In his “Essay on English Metrical Law,” Patmore asserted that meter was properly a measurement of “the time occupied in the delivery of a series of words,” and he set out a complex “law” based on the division of lines into units of equal time, which he called “isochronous intervals.”¹⁰

Central to debates about accent and time was what Gummere termed the “difficult matter of nomenclature.”¹¹ In the second half of the nineteenth century, prosodists were growing increasingly skeptical about the “application . . . of classic [i.e., Greek and Roman] prosody to English rhythms.”¹² While Patmore felt that the “word foot . . . may be usefully retained in the criticism of modern verse, inasmuch as it indicates a reality, though not exactly that which is indicated by it with

regard to classical metre,”¹³ later metrists struggled to accommodate what Liddell called a “wrong and misleading”¹⁴ vocabulary within their new “scientific” methodologies. Somewhat hesitantly, Gummere, for example, advised weighing “the old [classical] terms” against a putatively new vocabulary, which “substitute[s] the ‘rising’ foot of two or three syllables (iamb, anapaest), and the ‘falling’ foot of two or three syllables (trochee, dactyl).”¹⁵ Others, Liddell and Lanier among them, took a more radical approach. Pushing beyond conventional foot-based metrics, they set out a nomenclature and a notation that not only extended existing temporal theories, but also posited new modes scansion.

Patmore had conceived of meter as being principally a mental phenomenon: it is, as he wrote, “imaginary.” Later generations of prosodists, however, whose science of verse demanded not only something concrete to quantify and analyze but also a correlative metrical schema, were more inclined to assert the “material and external existence” of meter.¹⁶ It is perhaps not surprising then that their systems of notation often rely on “an appeal to the eye.”¹⁷ Objecting that conventional prosody’s notations were “not particularly graphic” enough, Liddell proposed a new method for representing the rising and falling “rhythm-waves” that comprise a line of verse. English lines, he argued, combine to form “a more or less regular series of rhythm-pulses determined by stress and arranged in certain numerical groups.”¹⁸ Applying his wave theory to passages from *Paradise Lost*, Liddell illustrated his new “wave” model of scansion (fig. 1). Lanier, as Yopie Prins notes, went even further, “circumvent[ing] nineteenth-century debates about accentual versus quantitative verse by positing musical time as the basis for poetic rhythm.”¹⁹ The scansions he included in his *Science*—for example, one for Tennyson’s “Break, Break, Break” (fig. 2)—forsake both the contested *longa* and *ictus* for a “diversity of [musical] bars.”²⁰

By foregrounding meter “as a complex graphic phenomenon”²¹ and by beginning to tease out the equally complex relationship between metrical abstraction and concrete sound patterning, Liddell’s rhythm-waves and Lanier’s musical bars gestured toward a more scientific, quantifiable prosody. Nevertheless, both scansions stopped short of capturing fully the material properties of what people vocalize and hear when reciting and listening to metrical verse. While they may have

avoided the contested symbols of classical foot-based notation, they remained what Lanier himself called “signs of sounds”—merely alternative ways of signifying (and systematizing) “the actual vibratory impact on the tympanum.”²² But what if the actual vibratory impact itself could be measured? A more experimental prosody, one that could get beyond the signs of sounds to the sounds themselves, could perhaps resolve the contest of accent and time and settle questions about the duration of proximate feet or intervals.

Experimental Measures

If the scientific self-fashioning of prosodists such as Liddell and Lanier provides a counterpoint to the “rigid and ahistorical contrast between abstract poetic idealism and empirical scientific positivism,”²³ then the fulfillment of prosody’s scientific fantasy—accomplished by its transit to the laboratory—explodes such solecisms. In fact, the experimental phase of verse science, which I examine below, was materially assisted not so much by literary critics or philologists—the figures who had been largely responsible for the promotion of a more professionalized prosody from the mid-nineteenth century on—as by members of the scientific community itself, where experimental research methods were rapidly establishing themselves alongside (and, in some cases, in place of) other, more conventional models of scientific inquiry. From the 1880s on—when analytical research methods and ideas about professional training began to emerge from German universities—“questions lying on the borderland of the physical and the æsthetic enquiry”²⁴ would attract the attention of experimental psychologists, in whose revolutionary workspaces metrical analyses would reach new levels of scientific specialization.

The advent of an experimental, laboratory-based metrics was a direct corollary of the rise of experimental psychology, which was born in mid-nineteenth-century Germany and characterized by an epistemological shift from Naturphilosophie to Naturwissenschaft. In 1867, William James wrote that “the time has come for psychology to begin to be a science. . . . [Hermann von] Helmholtz and a man named [Wilhelm] Wundt at Heidelberg are working at it.”²⁵ Helmholtz and Wundt were indeed working to bring physiology and, as a result, psychology more in line with the objective,

investigative methods of the physical sciences. In the 1840s, Helmholtz—in collaboration with Emil du Bois-Reymond, Ernst Brücke, and Carl Ludwig—was instrumental in formulating the principles and practices of a new experimental physiology, which “attempted to explain all vital phenomena through the laws of physics and chemistry.”²⁶ Wundt, who had trained with Helmholtz at Heidelberg during the 1850s, would bring aspects of his mentor’s research methods to bear on psychology. In 1879, he established the first psychological laboratory in Leipzig, thereby inaugurating an “[e]xperimentalism [that] proposed a fundamental reorientation of psychology’s methods, a steep reduction in its aims, and a radically altered sense of its public role.”²⁷ In works such as Physiologische Psychologie (1874) and “Ueber psychologische Methoden” (1883), Wundt developed an inductive method that signaled a break with psychology’s “origins in the philosophy of mind” in favor of a positivist practice grounded in empirical observation, statistical analysis, and “above all a consolidated ‘scientific’ outlook, based upon detailed measurement.”²⁸

Detailed measurement procedures, as well as instruments (in some cases, first cousins of the meters surveyed by The Friendly Companion), were integral to the experimental method of Wundt and his heirs.²⁹ As James McKeen Cattell explained in 1888, every aspect of “mental phenomena” would come under the quantifying gaze of the psychologist and his apparatuses: researchers could “with scientific accuracy specify and measure a sensation and the physical stimulus causing the corresponding cerebral commotion”; with equally satisfactory results, they could employ the techniques of “psychometry” to ascertain “the measurement of the duration of mental process.”³⁰ Not just in Leipzig, but also in other purpose-built laboratories, psychologists utilizing “a collection of special appliances”³¹ drew on contemporary work in anatomy and physiology to “photograph,” as Cattell put it, a range of putatively “transient phenomena,” including, as we shall see, “the rhythm used in music and poetry.”³²

Many of the “appliances” used in psychological experimentation were inherited directly from physiology. As W. F. Bynum notes, “German physiologists developed many new instruments to record and analyze data.” Bynum singles out the kymograph, an apparatus designed in the 1840s by Carl Ludwig: “[T]he recording device that more than any other can be identified with nineteenth-

century physiology,” the kymograph enabled “the graphic recording of a variety of physiological phenomena, such as blood pressure fluctuations or muscle contractions.”³³ As Edward Bradford Titchener explained in 1901, the kymograph was “well adapted” by experimental psychologists “to record any process whose course is a function of time elapsed” (fig. 3).³⁴ Tuning forks (for “recording vibrations and marking time”),³⁵ chronographs (used for measuring reaction time in relation to sense impressions), phonautographs (for making graphic recordings and taking measurements of speech),³⁶ and other apparatuses were used both independently and in conjunction with kymographs in a range of experiments.³⁷ Well before the turn of the century, these and related instruments enjoyed application across the disciplinary boundaries of not only physiology and psychology, but also phonetics, acoustics, and prosody. The methods and technologies developed by Helmholtz and others for analyzing frequency, harmony, and related aspects of speech physiology would have a direct impact on the way metrists would conceive of and represent the verse line. The scientific laboratories of the mid- to late nineteenth century thus played a crucial role in the development of a “physiological poetics.”³⁸

Laboratory Prosody

The fin-de-siècle poet Alice Meynell opened the titular essay of her 1892 collection The Rhythm of Life and Other Essays (first published in 1892-93) with the following memorable declaration: “If life is not always poetical, it is at least metrical.” For Meynell, rhythm and periodicity were at the heart of all biological, emotional, spiritual, and astronomical processes. “Disease is metrical,” she wrote, and so too are “sorrow, . . . [e]cstasy and desolation.” The moon has “[h]er metrical phases, [and] love itself has tidal times—lapses and ebbs which are due to the metrical rule of the interior heart”; everything, from “a sun’s revolutions [to] the rhythmic pangs of maternity . . . must wake and rest in its phases.” Yet while Meynell insisted upon the “metrical” organization of both the physical world and the corporeal and “mental experience of man,” she nonetheless resisted quantification: “Distances are not gauged, ellipses not measured, velocities not ascertained, times not known.”³⁹

Around the same time, the experimental psychologist and phonetician Edward Wheeler Scripture suggested otherwise. Like Meynell, Scripture found frequency and period in “natural rhythms”: “It has long been known that in such rhythmic movements as walking, running, etc., a certain frequency in the repetition of the movement is most favorable to the accomplishment of the most work”;⁴⁰ unlike Meynell, however, he considered it “highly desirable to get some definite measurement” to reinforce his hypotheses.⁴¹ Providing a battery of equations and referencing a number of experiments—conducted with recording tambours, telegraph keys, dynamometers, and ergographs—Scripture distinguished between “[t]wo entirely different forms of regularly repeated action”: free (which “includes such activities as walking, running, rowing, beating time, and so on”) and regulated (“found in such activities as marching in time to drum-beats, dancing to music, playing in time to a metronome, and so on”).⁴² It would seem that the rhythms of life could be gauged after all, and the scientist, if not the poet, would take their accurate measure, explain their precise periods.

Scripture, of course, was not alone in applying science to the study of rhythms: Wundt, Thaddeus Bolton, Ernst Meumann, Jean Pierre Rousselot, and Henry Sweet were pursuing related inquiries, frequently in relation to aesthetic as well as physical phenomena. As Bolton suggested in 1894: “The experimental study of rhythm . . . is an attempt to push the lines of exact science a little farther forward into a field that borders more closely upon the field of æsthetics than any other that experimental psychologists have tried.”⁴³ For Bolton and other “rhythmists,” then, speech and poetry—overlapping principally in the emerging science of experimental phonetics—increasingly became important objects of inquiry.⁴⁴ Scripture’s The Elements of Experimental Phonetics (1902) cataloged some of the first sustained “pushes” in this direction. Drawing directly on work conducted in Yale University’s psychological laboratory, which Scripture directed from its foundation in 1892, Elements both extended the earlier work of Helmholtz and Wundt (under whose supervision Scripture had studied for his doctorate at Leipzig)⁴⁵ and at the same time established the benchmark for future work in phonetics, the psychology of music, and acoustical prosody.⁴⁶

In The New Psychology (1897), Scripture had codified a methodology—indebted to Wundt—that privileged “observation, statistics, measurement, and experiment.”⁴⁷ In his later

Elements, he extended this method to examine “Vibratory Movement,” “Harmonic Analysis,” and the “Perception of Sounds,” as well as such speech factors as melody, duration, loudness, accent, and rhythm. Synthesizing data amassed by an extensive range of physiologists, psychologists, and phoneticians, Scripture suggested hypotheses regarding syllable grouping, accent detection, “the relations between stress and duration,” and the “actual concrete rhythm” of verse and its relation to “abstract rhythm”;⁴⁸ in addition, he offered the intimations of a “graphic method” of scansion that later verse scientists would elaborate on. Thus Scripture helped to inaugurate a properly mechanized metrics that “attempt[ed] to use laboratory methods for the purpose of settling the controversy in regard to the quantitative character of English verse,”⁴⁹ as debated by earlier metrists such as Guest and Patmore. By capturing mechanically and rendering graphically the fugitive properties of verse rhythm, Scripture and his contemporaries and successors could, they proposed, arrive at an objective understanding of English meter.

It was in relation to the properties of accent and rhythm that experimental psychologists made their most notable contributions to prosodic investigation. In Elements, Scripture devoted entire chapters to “Accent,” “Auditory and Motor Rhythm,” and “Speech Rhythm,” noting that, while considerable work had been carried out, a complete, scientific explanation of these subjects remained to be articulated. “Great unclarity prevails,” Scripture contended, “on account of the confusion among physical, psychological and physiological terms.”⁵⁰ While to some it may have appeared obvious that “an accented sound is . . . one that impresses the hearer more strongly or that requires more mental effort on the part of the speaker,” questions about duration and quantity, as well as loudness and pitch, and their “relations” somewhat complicated the matter.⁵¹ Moreover, Scripture explained, too many of the available propositions regarding accent have been based on subjective and imprecise—and therefore unreliable—sense impressions:

The various treatments of accent rest upon judgments by the unaided ear. It is unquestionably the fact that here, as in all the senses without exception, attempts to specify anything beyond the general outline just given [regarding the function of pitch, tremolo, loudness, duration, etc.] can result only in a statement of illusions. In a

judgment of impressiveness the ear is unable to distinguish with any accuracy, except in extreme cases, the factors of pitch, loudness and length; accents stated to be due to increased stress may often be due to changes in pitch without the possibility of a detection of the fact by the ear.⁵²

What the study of accent required was a range of experimental apparatuses that could detect minute variations in duration and pitch, variations that the unaided human ear could not perceive. The “actual vibratory impact on the tympanum,” it seemed, was not to be trusted.⁵³

Impressions registered by specialized instrumentation, by contrast, could be measured precisely. In Elements, Scripture enumerated a number of experimental procedures involving recording, amplifying, and measurement machinery. Work done with a “ROUSSELOT voice-key,” for example, indicated that in recitations of trochaic verse, “the emphatic syllable [was] usually longer than the unemphatic one.”⁵⁴ Another experiment, which coupled the voice key with a “DEPREZ marker” to record “voice vibrations” on a smoked drum, reinforced the link between stress and duration.⁵⁵ These and other experiments—many of them conducted in his own laboratory at Yale—enabled Scripture to set out a general theory of accent in poetry. “It is safe to say,” he wrote, “that, in English at least, increase in duration and rise in pitch are ordinarily associated with increased stress, and that these associations are essentially mental ones and not interdependent physical or physiological phenomena.”⁵⁶

Here, Scripture hypothesized a possible bridge between the accentual and temporal theories of meter that had been so assiduously debated by earlier generations of prosodists. Duration—what Patmore had described as “the time occupied in the delivery of a series of words”⁵⁷—was not the antithesis of accent, but a fundamental constituent of it. Further, Scripture’s recognition of the “essentially mental” character of stress suggested that Patmore’s speculation regarding the abstract, “imaginary” function of meter might have had some grounding in experimentally demonstrable fact. What the mind “associates” with the patterning of a given line and the “physical or physiological phenomena” of duration and pitch need not be understood as one and the same thing.

The conclusion that “English verse is [at once] . . . a pitch-verse and a time-verse”⁵⁸ was not the only machine-assisted prosodic principle to emerge from the psychological laboratory. For Scripture and other would-be verse scientists, experiments on accent necessarily intersected with those on rhythm, and here also laboratory experiment underwrote a distinction between the abstraction of meter and the actual properties of voiced rhythm. For example, asking subjects to recite lines of metrical verse, Brücke and Ishiro Miyake used a kymograph to record and measure voice vibrations.⁵⁹ Data compiled in this way would allow Scripture to propose a rhythmical “law” for English poetry that resonated with earlier temporal theories of meter, such as those that Patmore had suggested regarding “isochronous intervals.” As Scripture observed: “The simplest English poetical line seems to consist of a quantity of speech-sound distributed so as to produce an effect equivalent to that of a certain number of points of emphasis at definite intervals.”⁶⁰

Similar to what Patmore had called the “ictus” or “beat,” “which, like a post in a chain railing, shall mark the end of one space, and the commencement of another,”⁶¹ these “points of emphasis”—what Scripture termed “centroids” (i.e., the “center[s] of unification, of speech action”)—define the boundaries of conventional prosody’s basic organizational unit, the foot: “the foot [is] the time between two centroids of speech energy.” Further, “[t]he time of a foot,” according to Scripture, “is approximately constant”;⁶² metrical units, in other words, are more or less equal in time, or “isochronous.” Other experiments examined what Patmore had called the “perpetual conflict between the law of the verse and the freedom of the language.”⁶³ Laboratory data revealed variations in syllable length, and Scripture asserted that the “actual concrete rhythm of a particular piece of verse is a compromise between the natural lengths [of syllables] and those required by abstract rhythm.”⁶⁴

In keeping with Patmore, Liddell, Lanier, and other nineteenth-century prosodic pioneers, Scripture asserted the necessity of moving beyond “classical schemes”⁶⁵ of nomenclature, and his and other researchers’ laboratory studies suggested a way forward. While centroid-spacing may have helped in determining the boundaries of the foot, the foot itself seemed to Scripture an entirely arbitrary and unnecessarily rigid measurement index, especially ill-suited to the rhythms of English

poetry. “The unity of English verse,” he wrote in 1900, “is the line, or the phrase. A line of verse cannot be divided into feet.” One could, however, “divide”—or at least express—the line or phrase in terms of the “flow of speech-energy.”⁶⁶ In fact, Scripture argued that “it would seem preferable” to express the rhythmic properties of poems in a visual, centroidal language—that is, by a scansion that represents graphically the “centers” of speech action. To this end, he proposed a “centroid analysis” and a corresponding notation, which uses small and large dots, together with crosses, to designate “primary centroids,” “line centroids,” and “phrase centroids,” respectively.⁶⁷ Figure 4 provides an example of Scripture’s “centroid” scansion, as applied to lines from Félix Arvers’s 1833 “Sonnet d’Arvers.” A similar scansion, he suggested, could be used to mark out the rhythmic patterns of English metrical verse. Yet while he concluded his chapter on rhythm with lines from poems by Moore, Bryant, Scott, and Tennyson, he offered no further examples of centroidal notation.

The Graphic Method

Laboratory prosody’s real contribution to scansion, it must be said, was not Scripture’s tentative centroid analysis. A more intriguing and authentically graphic way of representing the material properties of verse rhythm resulted from the methods and instruments on which experimental laboratory practice was founded. As Scripture himself pointed out, centroid analysis provided only a provisional system for imaging the conclusions about accent and rhythm that researchers were capable of deriving from the experimental data generated by tuning forks, registering drums, and kymographs. Indeed, speaking about the positioning of centroids in the extract from “Sonnet d’Arvers,” Scripture explained that he has “indicated them only approximately without making measurements.”⁶⁸ In many respects, Scripture’s centroidal notation was no more radical or scientific than the distinctive models suggested around the same time by prosodists such as Liddell and Lanier. Like these diacritical departures, Scripture’s dots and crosses were merely “signs” made to stand in for vibratory impulses, rather than a true record of the vibratory impulses themselves.

Fittingly, it was the laboratory instruments themselves that would generate a more authentically scientific and visual record of verse rhythm. Laboratory practice, including Scripture's own, was underwritten by what was known among experimental physiologists and psychologists as the "chronographic," or simply "graphic," method, which takes its name from the chronograph (which, according to the Oxford English Dictionary, is "an instrument for recording time with extreme exactness"). As Scripture noted, the graphic method prioritized "the attainment of accuracy and trustworthiness" of measurement and demanded the most up-to-date instrumentation, which would be able to produce results "absolutely accurate for all records in thousandths of a second." One apparatus—the Hipp chronoscope, for example, a machine for recording measurements in time-reaction experiments—Scripture simply rejected, arguing that it was "not accurate enough."⁶⁹ He and his contemporaries demanded devices capable not only of taking infinitesimally fine measurements, but also, as the method's name suggests, of translating these measurements into decipherable visible impressions, typically by recording them on smoked paper.

In 1893, the New York Times ran a feature on "Measurement of Thought: Yale's Psychological Laboratory and Its Work," including a description of the method "chiefly employed" by researchers at that institution:

A tuning fork, kept in constant vibration by a current of electricity, is allowed to trace a curve on a revolving drum covered with smoked paper. This gives a representation of a period of time divided according to the rapidity with which the fork vibrates. Using a fork which vibrates 100 times a second, the drum is revolved with such rapidity that the single waves are so long that we make no error in estimating tenths of a vibrations and so reading the results in thousandths of a second.⁷⁰

Pictured alongside this explanation of the graphic process are some of the apparatuses used for taking measurements and producing "waves" that correlate to various vibratory inputs. One is a registering drum, labeled "Made in Laboratory"; another is "Ludwig's Kymograph."⁷¹ With these devices—in particular the kymograph (literally a "wave-writer")—researchers at Yale and elsewhere

were capable of “graphing” all manner of sensory impulses, from fluctuations in “muscular energy” to alterations in the rhythmic frequency of metered verse.⁷²

From the 1880s right through the early decades of the twentieth century, a vast array of “records” issued from psychological laboratories. In Elements alone, Scripture included numerous “specimen records” taken during “[e]xperiments on the relations between stress and duration and between stress and pitch.” Figure 5, for example, clearly shows the registrations of “vibrations on the smoked drum” of a kymograph. The white peaks and troughs that stand out against the black background constitute a wave-graph of the sounds made by a subject “repeat[ing] the sound a continuously in what he felt to be a trochaic rhythm (thus, a' a' a' a' a' . . .), or an iambic (a a' a a' a' a' . . .), or dactylic (a' a a' a' a' a' . . .), or an amphibrabic one (a a' a a' a' a' . . .).” Similar records are given for slurred and broken accents, as well as for variations in pitch, loudness, and duration. Scripture and his colleagues used these graphic records to assess “the length of time between successive movements,” reading amplitude in curve height and duration in the horizontal spacing of wave crests.⁷³

Following in Scripture’s footsteps so to speak, Ada Snell, some years later, would adopt the “graphic method” to assess not just isolated metrical sounds and discrete metrical properties, but the rhythmical movement of whole poems. Hoping “to discover by a scientific method the nature of pause [i.e., caesura] as it occurs in English verse,” Snell used a Zimmermann kymograph to capture and analyze the opening lines of Tennyson’s “Break, Break, Break,” as recited by her colleague.⁷⁴ As an appendix to her 1918 study, she included a fold-out plate of her graphic record of the poem. In the bottom left-hand corner, the opening verses have been transcribed by hand as one line: “Break, break, break, [/] On thy cold grey stones, O sea.” Arranged horizontally above these words are what Snell called “recording pointers” or “lines of reference” for the “arcs” inscribed by the stylus of the recording apparatus, as well as the arcs themselves, which rise and fall irregularly from left to right:

The arcs and points of starting are indicated on the plate as follows: 1 represents the arc made by the pointer recording the outflow of air through the nose; 2 represents the one made by the pointer recording the air coming in through the mouth; 3 and 4 represent the

beginning of the lines made by the pointers recording respectively the nose and mouth tones; 5 is the time line.⁷⁵

Taken together, the arcs and points that Snell plotted constitute a mechanized scansion that forsakes the abstract “imaginary” metrical record in favor of an authentic speech record. Also, unlike both Lanier’s musical notation of the same poem and Liddell’s rhythm-waves, which Snell’s arcs bring to mind, her “signs of sounds” had an immediate connection with the sounds themselves. Not only could her apparatus actually “write the sounds from the nose chamber . . . [and] the tones from the mouth”; further, it was capable of “converting the vibrations back again to sound.”⁷⁶

As useful as the graphic method was for her study, Snell nevertheless understood that it was unlikely to produce the unquestionably accurate and objective rhythmical record that Scripture and other turn-of-the-century researchers had confidently anticipated. The sensitivity of the kymograph and the accuracy of its readings notwithstanding, the procedure had “certain limitations,” which Snell and other verse scientists were forced to acknowledge. For example, the instruments were incapable of eliminating “variations in results” among readers and acts of delivery.⁷⁷ If the human ear had been deemed “unable to distinguish” minute rhythmical and tonal fluctuations “with any accuracy,”⁷⁸ then what about the human voice? Could it really be trusted as a delivery medium? Moreover, were these records in fact the objective, visual correlative of the “absolute” rhythm of a poem?

In one obvious sense they were not. While psychologists’ rejection of conventional notation in favor of the graphic method was motivated in part by a recognition of what Eric Griffiths has called “the incapacity of writing unambiguously to transcribe speech,”⁷⁹ kymographic scansion highlighted the converse problem: the incapacity of speech—whether that of a psychological subject or the inimitable Tennyson himself—unambiguously to transmit the metrical abstractions latent in the written poem. For all their accuracy, graphic records render visible only one among the “innumerable small departures from [the] modulus” of meter;⁸⁰ further, they fail to render at all the modulus itself—what Prins has called “an abstract rhythm never quite articulated by human

speech.”⁸¹ What they do privilege and preserve, by contrast, is a unique rhythmic performance, a graphically singular act of meter.

Crests and Troughs

Acoustical prosody reached its apogee in the early decades of the twentieth century, and the graphic method underpinned further investigations into the “true” elements of English meter.⁸² What emerged from this work, however, was not always a vindication of previous laboratory findings. Snell and other experimentally minded prosodists not only inherited and in some cases extended, but just as frequently confounded the “facts” that the psychologists of Scripture’s generation had established. Snell, for example, would use kymography to reopen debate about accent and time. In two PMLA articles published in 1918 and 1919, she produced data to qualify Patmore’s definition of isochrony, claiming that “units can hardly be said to be even approximately equal in length.”⁸³ Providing tables showing the relative durations of iambic, anapestic, trochaic, and dactylic meters, Snell concluded that “it seems more scientific to define verse rhythm not as ‘the recurrence of similar phenomena at equal intervals of time,’ but as the regular arrangement of stressed and unstressed syllables at intervals of time sufficiently equal to produce a clearly perceptible rhythm.” Further, in spite of her articulation of a fully automated notation, she asserted evidence for the material existence of the foot—“[t]he foot is a fact”—and maintained that the only truly “scientific method of scansion . . . is one which uses the symbols conventionally used for indicating quantity and which also uses stress marks.”⁸⁴ Experimental prosody, it would seem, had returned full circle to the unsettled debates of the mid-nineteenth century.

While Scripture, Snell, and other metrists of their ilk had pursued experiments with the hope of establishing beyond all doubt the facts of English verse structure, in the end, their prosodic “science” did not lead them—or later generations of verse theorists, for that matter—to an indisputable metrical law, verified by machines and agreed upon by like-minded experts. The materiality of voiced rhythm and the abstraction of the metrical modulus refused to find resolution in a unified verse theory, scientific or otherwise. Nevertheless, twentieth-century prosodists continued

to work on this and related verse dilemmas; few, however, put their faith in complex measurement apparatuses. With the rise of a more pragmatic criticism, mechanized metrics fell into obscurity, along with most of its practitioners. Just a decade after the publication of Snell's laboratory research, I. A. Richards, in his landmark Practical Criticism (1929), mused wistfully about using a kymograph to resolve the contest between the abstract pattern of meter and what he called the "actual sounds in verse."⁸⁵ If he had seriously thought that an instrument would enable an objective intervention in such debates, then one imagines that he would have just produced its graphic record and left it at that.

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NOTES

¹ "A Chapter or Two on Meters," The Friendly Companion and Illustrated Instructor, March–May 1857.

² Humphry Davy, The Collected Works of Sir Humphry Davy, ed. John Davy, vol. 4 (London: Smith, Elder, 1840), pp. 4:15, 16.

³ The scientific impulse that gripped prosody toward the end of the nineteenth century can be understood in the context of the development of new scientific methodologies. Jonathan Smith discusses the complex interrelation of fact and theory in what he calls the nineteenth-century "science of science"; see Smith, Fact and Feeling: Baconian Science and the Nineteenth-Century Literary Imagination (Madison: University of Wisconsin Press, 1994), pp. 11–44. Mary Poovey also explores the significance of fact-oriented thinking and outlines the creation of "a new social position—the expert," who brought an unflinching numeracy and an abiding belief in empirically demonstrable fact to bear on "abstractions like society, the market, and poverty"; see Poovey, A

History of Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society (Chicago: University of Chicago Press, 1998), p. 15. The figure of the “expert” prosodist, as I go on to show, would fix a similarly quantifying gaze on a variety of aesthetic phenomena. Not all turn-of-the-century prosodists, however, were prepared to take the scientific turn. George Saintsbury, for example, defined his own approach as follows: “the subject of our enquiries will be Architecture, not Petrology; Painting, not the enquiry into the chemical constitution of colours; Art, not Science”; see Saintsbury, A History of English Prosody from the Twelfth Century to the Present Day, vol. 1 (London: Macmillan, 1906), p. 1:6.

⁴ Francis B. Gummere, A Handbook of Poetics for Students of English Verse (Boston: Ginn, 1885), pp. 4, 133, 167.

⁵ Mark H. Liddell, An Introduction to the Scientific Study of English Poetry: Being a Prolegomena to a Science of English Prosody (London: Doubleday, Page, 1902), pp. 28–29. Liddell hoped to counter the “vague definition of ‘poetry’” with a more precise, scientific verse theory; he contended “that Language and Literature presented a field for scientific study much like that of Economics or Ethics, inasmuch as the phenomena which they furnished were neither accidental nor capricious, but the result of the operation of certain fundamental laws as definite and formulable in the one case as in the other provided one took the trouble to investigate the phenomena in a scientific spirit” (p. vii).

⁶ Sidney Lanier, The Science of English Verse (New York: Scribner, 1880), pp. 24, 23.

⁷ Edmund Gurney, The Power of Sound (1880; reprint, New York: Basic Books, 1966), p. xix. Gurney adopts a musical approach to prosody, similar to that of Lanier. “The fundamental principle of verbal metre,” he contends, “is identical with that of the rhythmic factor of melodic forms” (p. 425).

⁸ Emily Harrington, “The Measure of Time: Rising and Falling in Victorian Meters,” Literature Compass 4:1 (2007): 337. See also Dennis Taylor, Hardy’s Metres and Victorian Prosody (Oxford: Clarendon Press, 1988), pp. 7–48; Yopie Prins, “Victorian Meters,” in The Cambridge Companion to Victorian Poetry, ed. J. Bristow (Cambridge: Cambridge University Press, 2000), pp. 89–113; and

Jason David Hall, “Popular Prosody: Spectacle and the Politics of Victorian Versification,” *Nineteenth-Century Literature* 62:2 (2007): 230–235.

⁹ Edwin Guest, *A History of English Rhythms* (1838; reprint, London: George Bell, 1882), p. 2.

¹⁰ Coventry Patmore, *Coventry Patmore’s “Essay on English Metrical Law”: A Critical Edition with a Commentary*, ed. M. A. Roth (1857; reprint, Washington, DC: Catholic University of America Press, 1961), p. 15.

¹¹ Gummere, *Handbook of Poetics* (above, n. 4), p. 167.

¹² Liddell, *Introduction to the Scientific Study of English Poetry* (above, n. 5), p. 15.

¹³ Patmore, *Essay on English Metrical Law* (above, n. 10), p. 20.

¹⁴ Liddell, *Introduction to the Scientific Study of English Poetry* (above, n. 5), p. 15. As T. S. Omond remarks: “Prof. Liddell pushes this [difference between modern English and classical Greek verse] to a denial of quantitative relations in our meter”; see Omond, *English Metrists: Being a Sketch of English Prosodical Criticism from Elizabethan Times to the Present Day* (Oxford: Clarendon Press, 1921), p. 242.

¹⁵ Gummere, *Handbook of Poetics* (above, n. 4), p. 167. Nonetheless, Gummere’s prosody remains more or less indebted to a classical, foot-oriented taxonomy.

¹⁶ Patmore, *Essay on English Metrical Law* (above, n. 10), p. 15.

¹⁷ Yopie Prins, “Historical Poetics, Dysprosody, and *The Science of English Verse*,” *PMLA* 123:1 (2008): 231.

¹⁸ Liddell, *Introduction to the Scientific Study of English Poetry* (above, n. 5), pp. 305, 164, 251 (emphasis in original). Liddell refuses to discard out of hand “the whole system of [classical] nomenclature” (p. 305).

¹⁹ Prins, “Historical Poetics” (above, n. 17), p. 231.

²⁰ Lanier, *Science of English Verse* (above, n. 6), p. 138. While Lanier may have promulgated a more graphic scansion, he nevertheless remained convinced, like Patmore, that meter is principally a mental phenomenon. Although he argues that “[a] ‘bar’ in music—or a ‘foot’ or ‘measure’ in verse—is exactly one of the ‘groups’ . . . only made, not by the imagination, but but [*sic*] by an

actual stress clearly calling the ear's attention to some given tone of each group," he goes on to state in a footnote that "the mind constructs . . . the rhythm of the piece" (p. 67, emphasis added).

²¹ Yopie Prins, "Robert Browning, Transported by Meter," in The Traffic in Poems: Nineteenth-Century Poetry and Transatlantic Exchange, ed. Meredith L. McGill (New Brunswick, NJ: Rutgers University Press, 2008), p. 206.

²² Lanier, Science of English Verse (above, n. 6), pp. 21, 22.

²³ As Gowan Dawson and Sally Shuttleworth point out, this contrast has for too long "distorted" scholars' understanding of the nineteenth century's interrelated knowledge communities, and "it is only in the last decade or so," they argue, "that sustained attention has begun to be paid to the subject"; see Dawson and Shuttleworth, "Introduction: Science and Victorian Poetry," Victorian Poetry 41:1 (2003): 1.

²⁴ Gurney, Power of Sound (above, n. 7), p. xviii.

²⁵ William James, in Ralph Barton Perry, The Thought and Character of William James, 2 vols. (Boston: Little, Brown, 1935), p. 2:1.

²⁶ W. F. Bynum, Science and the Practice of Medicine in the Nineteenth Century (Cambridge: Cambridge University Press, 1994), p. 98.

²⁷ Rick Ryland, Victorian Psychology and British Culture, 1850–1880 (Oxford: Oxford University Press, 2000), p. 6.

²⁸ Ibid.

²⁹ Experimental procedures deriving from Wundt's writing and laboratory served as a model for subsequent facilities, which sprang up elsewhere in Europe (e.g., Berlin, Bonn, Göttingen, and Copenhagen) during the 1880s and '90s, as well as in North American and Britain. As Audrey B. Davis and Uta C. Merzbach note, G. Stanley Hall, who did postgraduate work at Leipzig, set up a laboratory (often regarded as the first facility in America) at The Johns Hopkins University in 1883. "By 1888," they observe, "there were five formal psychology laboratories in the United States: at Harvard, at The Johns Hopkins University, and at the universities of Pennsylvania, Indiana, and Wisconsin. After another five years, there were twenty, and by the turn of the century this number

had doubled”; see Davis and Merzbach, Early Auditory Studies: Activities in the Psychological Laboratories of American Universities (Washington, DC: Smithsonian Institution Press, 1975), p. 2. According to Edward Bradford Titchener, a laboratory opened at Cornell University in 1891; see Titchener, “A Psychological Laboratory,” Mind 7:27 (1898): 314. Among the most well-known facilities in North America was the Yale Psychological Laboratory, directed by Edward Wheeler Scripture from 1892 (discussed in detail below). According to Rylance, things were a bit slower in Britain: the first psychological laboratories, not opened until 1897, were housed at Cambridge and University College London; see Rylance, Victorian Psychology (above, n. 27), p. 5. For a comprehensive list of laboratories established in the United States between 1883 and 1900, see Ludy T. Benjamin, “The Psychological Laboratory at the Turn of the Twentieth Century,” American Psychologists 55:3 (2000): 318–321; see also Alfred H. Fuchs and Katharine S. Milar, “Psychology as a Science,” in Handbook of Psychology, vol. 1, ed. D. K. Freedheim and I. B. Weiner (London: Wiley, 2003), p. 1:8.

³⁰ James McKeen Cattell, “The Psychological Laboratory at Leipsic,” Mind 13:49 (1888): 40, 45.

³¹ Titchener, “Psychological Laboratory” (above, n. 29), pp. 313, 311.

³² Cattell, “Psychological Laboratory at Leipsic” (above, n. 30), pp. 38, 50 (emphasis in original).

Wilbur Lang Schramm would later outline a “phonophotographic study” of English metrics, which involved “photographing the poem” and its “sound waves”; see Schramm, Approaches to a Science of English Verse (Iowa City: University of Iowa Press, 1935), pp. 68, 15.

³³ Bynum, Science and the Practice of Medicine (above, n. 26), pp. 98–99.

³⁴ Edward Bradford Titchener, Experimental Psychology: A Manual of Laboratory Practice, 2 vols. (New York: Macmillan, 1901), p. 1:172.

³⁵ Davis and Merzbach, Early Auditory Studies (above, n. 29), p. 10.

³⁶ For a thorough account of phonautograph experiments, from Helmholtz’s work with musical beats to Franciscus Cornelis Donders’s research into speech sounds, see Henning Schmidgen, “The Donders Machine: Matter, Signs, and Time in a Physiological Experiment, ca. 1865,” Configurations 13:2 (2005): 211–256.

³⁷ See Edward Wheeler Scripture, ed., Studies from the Yale Psychological Laboratory (New Haven, CT: Yale University Press, 1893–98). Issued annually, Studies contains “monographs” by researchers at the Yale facility. Scripture, the laboratory’s director, included a note on “new psychological apparatus” in each installment.

³⁸ See Jason R. Rudy, Electric Meters: Victorian Physiological Poetics (Athens: Ohio University Press, 2009). From the 1850s on, Helmholtz had been experimenting with sound, using a variety of apparatuses—even a functional model of the inner ear. His work on theories of sound vibration and resonance was carried forward by succeeding physiologists and psychologists, who employed tuning forks, harmoniums, vowel apparatus, phonographs, and, later, telephone receivers (see Davis and Merzbach, Early Auditory Studies [above, n. 29], p. 11). Helmholtz’s thinking on sound—including his wave theories and investigations into tone and perception—is gathered in “The Physiological Causes of Harmony in Music,” a lecture given in 1857, and Die Lehre von den Tonempfindungen (1863). See also John Picker, Victorian Soundscapes (Oxford: Oxford University Press, 2003), pp. 84–99.

³⁹ Alice Meynell, The Rhythm of Life and Other Essays (London: John Lane Bodley Head, 1896), pp. 1, 4–6.

⁴⁰ Edward Wheeler Scripture, “The Law of Rhythmic Movement,” Science 4:93 (1896): 535.

⁴¹ Edward Wheeler Scripture, “Observations on Rhythmic Action,” Science 10:257 (1899): 809.

⁴² *Ibid.*, p. 807.

⁴³ Thaddeus L. Bolton, “Rhythm,” American Journal of Psychology 6:2 (1894): 146. Bolton was a demonstrator and fellow in psychology at Clark University in Worcester, Massachusetts. While Scripture does not reference Bolton’s “Rhythm” in his 1896 and 1899 articles, he does, in his later The Elements of Experimental Phonetics (1902), acknowledge Bolton’s contribution to the subject.

⁴⁴ For more on Bolton and “rhythmics,” see Michael Golston, Rhythm and Race in Modernist Poetry and Science (New York: Columbia University Press, 2008), pp. 12–17.

⁴⁵ As Scripture would later remark: “Entering Wundt’s psychological laboratory in Leipzig in 1888, I learned to listen to little ivory balls striking a board and to say whether I perceived a difference

between two sounds or not. . . . The logical conclusion is: only statements based on measurements are reliable. The corollary is: ‘Statements without measurements are not worth listening to’”

(emphasis in original) (see John W. Black, “Scripture, Language and Human Behavior,” in Edward Wheeler Scripture, The Elements of Experimental Phonetics (1902; reprint, New York: AMS, 1973), n.p.

⁴⁶ Friedrich Kittler has suggested 1857 as the point at which “[p]honetics and speech physiology became a reality.” That date marks the patenting of Edouard Léon Scott’s phonautograph, but it is also the date of Hermann von Helmholtz’s well-known Bonn lecture “The Physiological Causes of Harmony in Music” (1857); see Kittler, Gramophone, Film, Typewriter, trans. Geoffrey Winthrop-Young and Michael Wutz (Stanford, CA: Stanford University Press, 1999), p. 27. As we shall see, there is certainly a clear line of descent from Helmholtz’s tuning-fork experiments—not to mention his graphic “waves”—and the work of later generations of experimental psychologists-cum-prosodists such as Scripture and Snell.

⁴⁷ W. G. Smith, “Review of Edward Wheeler Scripture’s The New Psychology,” Philosophical Review 7 (1898): 101.

⁴⁸ Scripture, Elements of Experimental Phonetics (above, n. 45), pp. 509, 552.

⁴⁹ Albert S. Cook, “Prosody” (review of Edward Wheeler Scripture, ed., Studies from the Yale Psychological Laboratory), Modern Language Notes 16:1 (1901): 28.

⁵⁰ Scripture, Elements of Experimental Phonetics (above, n. 45), p. 506.

⁵¹ *Ibid.*, p. 507.

⁵² *Ibid.*, pp. 507–508.

⁵³ Citing the recording instruments of Thomas Young and Charles Wheatstone, Thomas L. Hankins and Robert J. Silverman remark: “It is worth noting that if one wants to measure and record the quantitative features of sound, one must employ a visual image. The ear detects pitch, loudness, and timbre, but not the frequency, amplitude, and shape of sound waves. Recording instruments give us this information by representing the sound visually.” See Hankins and Silverman, Instruments and the Imagination (Princeton, NJ: Princeton University Press, 1995), p. 133. Not all procedures proved

accurate enough for Scripture, however. “Most of the experiments on auditory rhythm,” he notes, “have been made . . . by use of sharp clicks.” Contemporary studies of verse rhythm that “measured” verse recitations by marking beats independently of pronunciation—for example, the finger-tapping experiments of Albert S. Hurst and John McKay, as well as those of Norman Triplette and E. C. Sanford—did not provide adequate results, according to Scripture, because “the investigators did not take any records of the spoken sounds, but only of the rhythmic strokes of the hand.” Thus “conditions [that] do not closely resemble those of the flow of speech” were of only limited use when attempting to theorize linguistic sound patterning and, consequently, poetic rhythm. See Scripture, Elements of Experimental Phonetics (above, n. 45), pp. 520, 538. See also Hurst and McKay, “Experiments in Time Relations of Poetic Meters,” University of Toronto Studies, Psychological Series 1 (1900): 155–175; and Triplette and Sanford, “Studies of Rhythm and Meter,” American Journal of Psychology 12 (1901): 361–387.

⁵⁴ Scripture, Elements of Experimental Phonetics (above, n. 45), p. 508.

⁵⁵ *Ibid.*, p. 509.

⁵⁶ *Ibid.*, p. 513. Although Scripture insisted that he would “confine” his chapter on accent to “a summary of the disconnected experimental results with no attempt to work them into a theory,” he nevertheless went on to offer general conceptual remarks that resonate with existing prosodic theories.

⁵⁷ Patmore, Essay on English Metrical Law (above, n. 10), p. 15.

⁵⁸ Cook, “Prosody” (above, n. 49), p. 28.

⁵⁹ Scripture, Elements of Experimental Phonetics (above, n. 45), p. 539; see also Ishiro Miyake, “Researches on Rhythmic Action,” in Studies from the Yale Psychological Laboratory (New Haven, CT: Yale University Press, 1902), pp. 1–48.

⁶⁰ Scripture, Elements of Experimental Phonetics (above, n. 45), p. 553.

⁶¹ Patmore, Essay on English Metrical Law (above, n. 10), p. 15.

⁶² Scripture, Elements of Experimental Phonetics (above, n. 45), pp. 451–452, 553.

⁶³ Patmore, Essay on English Metrical Law (above, n. 10), p. 9.

⁶⁴ Scripture, Elements of Experimental Phonetics (above, n. 45), p. 552; see also Patmore, Essay on English Metrical Law (above, n. 10), p. 9. “The best poet,” Patmore stated, “is . . . he whose language combines the greatest imaginative accuracy with the most elaborate and sensible metrical organization, and who, in his verse, preserves everywhere the living sense of metre, no so much by unvarying obedience to, as by innumerable small departures from, its modulus.”

⁶⁵ Scripture, Elements of Experimental Phonetics (above, n. 45), p. 555.

⁶⁶ Edward Wheeler Scripture, “Researches in Experimental Phonetics,” PMLA 15 (1900): vii.

⁶⁷ Scripture, Elements of Experimental Phonetics (above, n. 45), pp. 553, 555.

⁶⁸ *Ibid.*, p. 555 (emphasis added).

⁶⁹ Edward Wheeler Scripture, “Accurate Work in Psychology,” American Journal of Psychology 6:3 (1894): 428, 429.

⁷⁰ “Measurement of Thought: Yale’s Psychological Laboratory and Its Work,” New York Times, December 10, 1893.

⁷¹ The latter is a variation on the device that was instrumental in the development of experimental physiology from the 1840s on, when Carl Ludwig (its inventor), Helmholtz, and others used it to take somatic measurements.

⁷² Scripture, Elements of Experimental Phonetics (above, n. 45), p. 523.

⁷³ *Ibid.*, pp. 509, 510, 523.

⁷⁴ Ada L. F. Snell, Pause: A Study of Its Nature and Its Rhythmical Function in Verse, Especially Blank Verse (Ann Arbor: University of Michigan Press, 1918), p. 8

⁷⁵ *Ibid.*, pp. 4–5.

⁷⁶ *Ibid.*, p. 2 (emphasis added).

⁷⁷ *Ibid.*, pp. 2, 3. Snell attempted “to obtain a somewhat greater variety” by stipulating that “readers [should be] changed at various times”; further, she avoided using “only trained readers,” though she did select readers “accustomed to reading poetry” (p. 3).

⁷⁸ Scripture, Elements of Experimental Phonetics (above, n. 45), p. 507.

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- ⁷⁹ Eric Griffiths, The Printed Voice of Victorian Poetry (Oxford: Oxford University Press, 1989), p. 67.
- ⁸⁰ Patmore, Essay on English Metrical Law (above, n. 10), p. 9.
- ⁸¹ Yopie Prins, “Voice Inverse,” Victorian Poetry 42:1 (2004): 57.
- ⁸² See Schramm, Approaches to a Science of English Verse (above, n. 32), pp. 76–82.
- ⁸³ Ada L. F. Snell, “An Objective Study of Syllabic Quantity in English Verse,” PMLA 33:3 (1918): 408.
- ⁸⁴ Ada L. F. Snell, “An Objective Study of Syllabic Quantity in English Verse,” PMLA 34:3 (1919): 428, 429, 435.
- ⁸⁵ I. A. Richards, Practical Criticism: A Study of Literary Judgment (1929; reprint, New Brunswick, NJ: Transaction, 2004), p. 219. Richards imagines using a kymograph “to record (by curves drawn on squared paper)” the rhythms of poetry—“all the physical characters of the sequences of sounds emitted, their strength, pitch, duration, and any other features we choose to examine” (p. 216).