

# Sound as Hermeneutic, or Helmholtz and the Quest for Objective Perception

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No doubt is now entertained that beauty is subject to laws and rules dependent on the nature of human intelligence. . . . The principal difficulty in pursuing this object is to understand how regularity can be apprehended by intuition without being consciously felt to exist.

—Hermann von Helmholtz, 1863

Sound is a finely attenuated substance, which is radiated from the sound-producing body by an unknown law of diffusion.

—Alexander Wilford Hall, 1877

On 3 August 1878, Helmholtz gave an hour-long speech at the Frederick William University in Berlin entitled “The Facts of Perception.” It was his final speech as University Rector (commemorating the birthday of the university’s founder), and many colleagues reportedly fell asleep: clad in formal robes amid the baking heat

of high summer, perhaps anticipating the reel of prizes yet to be awarded.<sup>1</sup>

If the occasion was academically banal, the topic could not have been more significant to the speaker. In its published form, it would become of signal importance for conceiving the relation of sense organs to an external world, and colleagues expressed the hope that it would advance the “ideal interests at German universities and thereby avoid the negative consequences

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The epigraphs are cited from: Hermann von Helmholtz, *On the Sensations of Tone*, 4th edn., trans. Alexander Ellis (New York: Dover, 1954), 235; Alexander Wilford Hall, *The Problem of Human Life: Embracing the ‘Evolution of Sound’ and Evolution Evolved* (New York: Hall & Co., 1877), 76–77. This research was made possible by a Starting Grant from the European Research Council.

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<sup>1</sup>David Cahan, *Helmholtz: A Life in Science* (Chicago: University of Chicago Press, 2018), 545.

of a crass materialism."<sup>2</sup> It drew on decades of empirical research into the physiological mechanisms of sight and audition and served as Helmholtz's crowning statement on epistemology. With predictable ecumenism, he positioned as complementary the methods of natural science and philosophy, the former separating off what originates in the material world, the latter what originates in the mind. Combining these perspectives in a grand gesture, he ventured reassurance through objective behavior: "the laws of thought in men who pursue natural science are, of course, ultimately no different than in those who do philosophy."<sup>3</sup> A persuasive point. Yet the key questions driving each endeavor since the university's founding in 1811 remained unanswered, despite decades of enquiry and experiment: "What is truth in our intuitions and thought? And in what sense do our ideas correspond to reality?"<sup>4</sup> Natural science and philosophy approached this problem from opposite sides, he avers, yet "it is a common task of both."<sup>5</sup> Sixty-seven years on and satisfactory answers remained elusive.

In this potentially frustrating situation, the question of culpability was inevitable. Helmholtz sought to distance himself from what he called the "weaknesses of Romanticism," namely, a situation in which the more fantasy freed itself from "the rules of the understanding" the more one had to "admire it as a creative force." Romantic metaphysics, in this reading, became a cipher for disreputable abstraction, a form of "vanity that revelled in high ideals."<sup>5</sup> From the pantheon—or rogue's gallery—of German idealists, Helmholtz associated it above all with Johann Gottlieb

Fichte, his predecessor (as the university's second rector), whom he politely, if wryly, credits with "moral inspiration" and "bold intellectual flights of . . . idealism,"<sup>6</sup> even as he consoled listeners there is no shame if work toward new lawfulness "does not at once succeed in the first assault of a flight of Icarus."<sup>7</sup> It is indicative of the boldness with which he approached this pivot away from speculative philosophy that the original title for his lecture had been simply: "What Is Real?"

This article considers the role of sound within epistemological debates over sense perception and concepts of the real during the later nineteenth century. It examines the ways in which sound's abstract character became co-opted within Anglo-German discourse concerning objective perception and the scientifically real, initially through the lens of Helmholtz's 1878 lecture, but later broadening this focus to include the mid-century architects of a philosophical materialism, as well as their detractors. A closing case study, a closely documented wager about the "real" of sound ca. 1850, demonstrates the imaginative uses of sound as a metonym for philosophical debate, raising questions about the relation of sensation and number, and the underlying desire to possess objects of sensory experience.

#### OBJECTIVITY

Since the 1840s, reaction against Hegel's speculative idealism has spawned a cluster of philosophical writings that laid claim to the authority of natural science. Chief among these were the so-called scientific materialists, Jacob Molleschott,

<sup>2</sup>These words from the jurist Johann Bluntschli, cited in Ludwig Nohl to Helmholtz, 7 August 1878. See Hermann von Helmholtz Nachlass, Akademiearchiv, Berlin-Brandenburgische Akademie der Wissenschaft, Berlin, 332. There are other indications that Helmholtz had prioritized this lecture. He had recently overseen the establishment of the Physics Institute at the University, costing 1,264,000 marks, and the sheer quantity of logistical matters forced him to turn down prestigious invitations, such as the Chemical Society's Faraday Lecture. See Cahan, *Helmholtz: A Life in Science*, 456–57.

<sup>3</sup>Helmholtz, "The Facts in Perception," in *Science and Culture: Popular and Philosophical Essays*, ed. David Cahan (Chicago: University of Chicago Press, 1995), 344 (emphasis added).

<sup>4</sup>Ibid., 344.

<sup>5</sup>Ibid., 343.

<sup>6</sup>Ibid., 342. It is a matter of record that Fichte's *Wissenschaftslehre* (1794) itself opens with an appeal for the unfalsifiable "facts" of consciousness and "the laws (of common logic) whereby one must straightway think [of] this Act [the primordial, absolutely unconditioned first principle of all human knowledge] as the foundation of human knowledge or . . . the rules whereby this reflection is initiated" (93). Yet such laws have not yet been proven valid, Fichte laments, and are dependent on the so-called absolute unconditional principle ("Act"), creating "a circle, though an unavoidable one." See Fichte, *The Science of Knowledge*, trans. Peter Heath and John Lachs (Cambridge: Cambridge University Press, 1982), 93.

<sup>7</sup>Helmholtz, "The Facts," 366.

Karl Vogt, and Ludwig Büchner,<sup>8</sup> who believed in the universal reign of natural law and regarded matter as objectively real, imperishable substance with thought as its by-product: “the immortality of matter is now an established truth.”<sup>9</sup> In less extreme terms, but within a related context, Helmholtz too sought firmer ground. His valediction asked the assembled dons what was objective in perception. In contrast to idealism ca. 1811, with its “inspiration, energy, ideal hopes, and creative thoughts,” he wanted to show how law-like tendencies underpinned sensory experience, which in the context of the natural sciences meant regarding sensation as proximate to “the world of reality, whose laws [science] seeks.”<sup>10</sup> Rather than stimulating an individual’s creative imagination (for Coleridge, a non-mechanical faculty, “the living power and prime Agent of all human Perception”), sense organs were to be governed by natural laws as deterministic and verifiable as those of Newtonian mechanics:

Each natural law says that, given preconditions which are alike in certain respects, consequences which are alike in certain other respects will always follow. Since likeness in our world of sensation is shown by like signs [cf. *Zeichentheorie*], then there will also correspond to the natural-law consequence of like effects upon like causes[,] a regular consequence in the field of our sensations.<sup>11</sup>

The value placed here on “likeness” between sensation and “sign” indicates that it was Helmholtz’s early theory of signs that serves as the platform on which this later quest for objectivity stood. Recall that this concerned the causal relation between sensation and object in the external world. It held that human sensations provide only mediated information about

the peculiar external influence stimulating human bodies: “it can pass for a sign—but not an image,” he explains of vision. “For we require from an image some sort of similarity with the object imaged: from a statue, similarity of form, from a drawing, equality of perspectival projection in the visual field; and from a painting, similarly of colors. A sign, however, need not have any type of similarity with what it is a sign for.”<sup>12</sup> This non-mimetic relation between sign and referent is not arbitrary, however. In fact, it is “so restricted” that the same object takes the same effect under equal circumstances (a principle later taken up by Charles S. Peirce):<sup>13</sup> “hence unequal signs always correspond to unequal effects,” which—in a visualist context—he dubbed: “the imaging of the lawlike in the processes of the *real* world.”<sup>14</sup>

Helmholtz regarded the desire for lawfulness as deeply human. Humans possess an innate “intellectual drive to consider everything that happens as law-like, that is, comprehensible,” he retorted to Jan Pieter Nicolaas Land, a Dutch neo-Kantian who had recently accused him of ignoring essential methodological differences between physics and philosophy.<sup>15</sup> We will return to Land, but for now, the impulse toward objectivity and the application of seemingly objective criteria to the perception of artworks—coeval with the emergence of psychophysics—can be traced across a range of sympathetic writers. Predictably, the usage of terms such as “objectivity,” by the 1850s a vogueish term, shifts markedly by discipline.<sup>16</sup>

<sup>8</sup>See Annette Wittkau-Horgby, *Materialismus: Entstehung und Wirkung in den Wissenschaft des 19. Jahrhunderts* (Göttingen: Vandenhoeck & Ruprecht, 1998); as well as Frederick Gregory’s classic *Scientific Materialism in Nineteenth-Century Germany* (Dordrecht: D. Reidel, 1977).

<sup>9</sup>Ludwig Büchner, *Force and Matter*, ed. and trans. J. Frederick Collingwood (Cambridge: Cambridge University Press, 2011), 17.

<sup>10</sup>Helmholtz, “The Facts,” 342, 345.

<sup>11</sup>Samuel Taylor Coleridge, *Biographia Literaria, or Biographical Sketches of My Literary Life and Opinions*, 2 vols., ed. James Engell and W. Jackson Bate (Princeton: Princeton University Press, 1983), I, 304, 348.

<sup>12</sup>Helmholtz, “The Facts,” 347 (trans. modified).

<sup>13</sup>What Peirce, in 1909, calls the “final interpretant” constitutes nothing less than “the effect the Sign would produce in any mind upon which the circumstances should permit it to work out its full effect.” Charles S. Peirce to Lady Welby, 14 March 1909, in *Semiotics and Significs: The Correspondence between Charles S. Peirce and Lady Victoria Welby* (Bloomington: Indiana University Press, 1977), 110.

<sup>14</sup>Helmholtz, “The Facts,” 348 (emphasis added). The influence of Helmholtz’s thought on Charles Sanders Peirce, who wrote an obituary for Helmholtz in *The Nation*, is briefly explored in M. Gail Hamner, *American Pragmatism: A Religious Genealogy* (Oxford: Oxford University Press, 2003), 25–39.

<sup>15</sup>J. P. N. Land, “Kant’s Space and Modern Mathematics,” *Mind* (1877): 38–46.

<sup>16</sup>On the application of psychophysics to music, see Alexandra Hui, *The Psychophysical Ear: Musical*

In the context of music aesthetics, the pianist and writer Adolf Kullak defined “general objectivity” in 1856 as “the true, first, primitive factor of music.”<sup>17</sup> In practice this objectivity was explicitly defined in relation to the sensorium;<sup>18</sup> it referred first to what was rational in the organization of sound that differentiated musical composition from the disordered sounds of nature; second, to the specifying factor in auditory sensations by which music could depict, or otherwise objectify emotional states (in the spirit of Franz Brendel’s future *neudeutsche Schule*, and not unrelated to claims for program music: “to show that true music suggests analogous ideas to different minds,” in Baudelaire’s formulation):<sup>19</sup>

Here objectivity emerges in its most detailed form within music. Whereas before, general impressions of music on our inwardness, or the objectivity of music in individual situations were *abstractly* passed over into appearance, now the tones’ expression accompanies an objective course in its details, even if this course consists purely in the subjective formation of a soul-process, in a narration of objective facts of greater or lesser use for our inwardness.<sup>20</sup>

If Kullak’s concept was defined in opposition to an unruly human subject (“the *objectivity* of *subjectivity* is the task of music”),<sup>21</sup> a call to uncover the hidden rationality of sensations was later voiced by Gustav Engel, a Berlin-based

teacher of aesthetics and singing, who echoed Helmholtz in declaring that music rests not on caprice or blind necessity “but on the unconscious operation of the same laws of reason that are active in its later course.”<sup>22</sup> The pinnacle of aesthetic perception, for Engel-as-pedagogue, was not understanding voice leading or polyphonic texture, chord progression, and modulation, i.e., harnessing sensation to taste after Baumgarten, rather “the ability to contemplate the rational and, while giving ourselves over to the full sensuous effect, to have a clear insight into the inner web, into its coherence”<sup>23</sup> (a view oddly similar to Wordsworth on the aesthetic appreciation of plant and animal anatomy).<sup>24</sup> Certain theorists embraced a purely physical origin of the sense of beauty,<sup>25</sup> while for others the answer lay in mathematics. It is indicative of Engel’s desire for a numerate objectivity that in a later article, entitled “A Mathematical-Harmonic Analysis of Mozart’s *Don Giovanni*,” he asked to what extent Mozart’s opera remained tonally unified when performed in just intonation. By translating intervals into numerical values and calculating the accumulation of pitch discrepancies arising through tuning, he posited corresponding adjustments during modulations

*Experiments, Experimental Sounds, 1840–1910* (Cambridge, MA: MIT Press, 2012).

<sup>17</sup>“Genau genommen ist die Objektivität in ihrer Allgemeinheit der wahre, erste, primitive Factor der Tonkunst.” Adolf Kullak, “Die Tonkunst und ihre Factoren. Zweiter Abschnitt: Die allgemeine Objektivität,” *Neue Zeitschrift für Musik* 45 (17 October 1856): 17–20, 169–74, 181–84, 193–98, 205–08, here 17 (17 October 1856): 169.

<sup>18</sup>“Die allgemeine Objectivität, ohne Hörbares gedacht, würde zu unnatürlicher Abstraction verleiten.” Kullak, “Die Tonkunst,” 169.

<sup>19</sup>Charles Baudelaire, *Selected Writings on Art and Literature*, trans. Patrice Édouard Charvet (London: Penguin, 1992), 330.

<sup>20</sup>“Die Objektivität tritt hier in ausführlichster Gestalt an die Musik hervor, während vorher allgemeine Eindrücke derselben auf die Innerlichkeit, oder die Objectivität der letzteren in einzelnen Situationen, *abstract* in die Erscheinung übertrat, begleitet jetzt der Ausdruck der Töne einen objective Verlauf in seine Einzelheiten, sei es daß dieser Verlauf rein in der subjectiven Gestaltung eines Seelenprocesses besteht, der in einer Erzählung objective Thatsachen von größerer oder geringerer Verwerthung für das Innerliche.” Kullak, “Die Tonkunst,” *Neue Zeitschrift für Musik* 17 (17 October 1856): 174.

<sup>21</sup>“Also die Objektivität der Subjectivität ist die Aufgabe der Tonkunst,” Kullak, “Die Tonkunst,” 172.

<sup>22</sup>“Sondern auf der unbewußten Thätigkeit derselben Vernunftgesetze, welche in ihrem spätem Verlauf wirksam sind.” Gustav Engel, *Aesthetik der Tonkunst* (Berlin: Wilhelm Hertz, 1884), 37.

<sup>23</sup>“Wir [vermögen] das Vernünftige *anzuschauen* und, indem wir uns der vollen sinnlichen Wirkung überlassen, zugleich den klaren Einblick in das innere Gewebe, in den Zusammenhang desselben.” *Ibid.*

<sup>24</sup>Wordsworth’s letter to Isabella Fenwick reads: “Some are of the opinion that the habit of analyzing, decomposing, and anatomizing is inevitably unfavourable to the perception of beauty . . . we are apt to ascribe to them that insensibility of which they are in truth the effect and not the cause . . . the beauty in form of a plant or an animal is not made less *but more apparent* as a whole by more accurate insight into its constituent properties and powers.” Note to “This Lawn, a Carpet All Alive,” in *The Poetical Works of William Wordsworth*, ed. de Selincourt (Oxford: Clarendon, 1952–59), IV, 425.

<sup>25</sup>The Canadian writer Grant Allen (1848–99), for one, sets out precisely this aim at the outset of his *Physiological Aesthetics*: “to exhibit the purely physical origin of the sense of beauty, and its relativity to our nervous organisation,” continuing that such a study is based on the assumption that “all mental phenomena are the subjective sides of what are objectively cognised as nervous functions.” Allen, *Physiological Aesthetics* (New York: D. Appleton & Co., 1877), 2.

across the score to conclude that, remarkably, Mozart had compensated for any discrepancy in all but two numbers.<sup>26</sup> Practicing musicians balked at such an enterprise, it seems, if also at the mathematical signs densely strewn over sixty-nine pages; Guido Adler, who edited the journal in question, was pointedly mocked by Brahms for going to press: "You call that scholarship?"<sup>27</sup>

More persuasive attempts to apply rational properties to artistic perception, even to define a science of beauty through principles that "are universally felt to exist," were certainly not unprecedented.<sup>28</sup> To take a final example, the Scottish artist and writer David Ramsay Hay published thirteen books on the topic between 1828 and 1856, ranging from *The Laws of Harmonious Colouring* to *The Science of Beauty*.<sup>29</sup> Writing with architecture and visual representation in mind, he argued that "the Geometric principle of Beauty—proportion— . . . is regulated by the harmonic ratios of numbers" and pursued the corollary that shapes bearing the same ratio may be mapped in infinite series, ordered according to proportionality, which produced Hay's unequivocal claim: "the beauty arising from the harmony of form may be, on all occasions, with certainty produced."<sup>30</sup> His artistic references ranged from Greek sculpture and Pythagorean mathematics to units of color and musical harmony; the latter resulted in a presentation of the diatonic scale according to its ratios of vibrations, between scale degrees and the tonic (C), adjacent pitches, and the monochord's

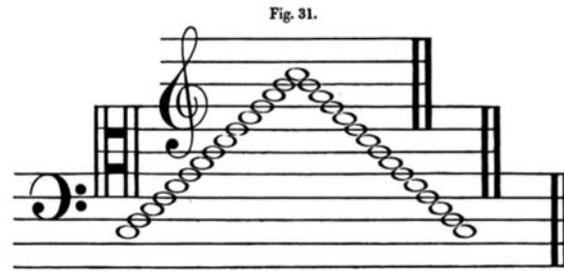
<sup>26</sup>Engel, "Eine mathematisch-harmonisch Analyse des Don Giovanni von Mozart," *Vierteljahrsschrift für Musikwissenschaft* 3 (1887): 491–560.

<sup>27</sup>"Ist das Wissenschaft?" Guido Adler, *Wollen und Wirken: Aus dem Leben eines Musikhistorikers* (Vienna: Universal-Edition, 1935), 32.

<sup>28</sup>David Ramsay Hay, *Proportion, or the Geometric Principle of Beauty Analysed* (Edinburgh and London: Blackwood and Sons, 1843), i.

<sup>29</sup>See Hay, *The Laws of Harmonious Colouring* (Edinburgh: William and Robert Chambers, 1828), and *The Science of Beauty* (Edinburgh and London: William Blackwood and Sons, 1856). For a recent, discursive approach to Hay's work, see Benjamin Morgan, *The Outward Mind: Materialist Aesthetics in Victorian Science and Literature* (Chicago: University of Chicago Press, 2017), 27–132.

<sup>30</sup>Hay, *Proportion*, 69–70. This bold statement heralds a retreat, however, for Hay continues by concluding that any application to the arts must be dealt with elsewhere, that "it would be premature to apply rules until their accuracy were acknowledged." *Ibid.*, 70.



Degrees of Scale.	Vibration.	Relation to Tonic.	Relation to one another.	Relation to Monochord.	String.	Degrees of Scale.
15th cc	1024	4 to 1	15 to 16	1 to 4	512	cc 15th
14th b	960	30 ... 8	8 ... 9	8 ... 30	546 $\frac{2}{3}$	b 14th
13th a	853 $\frac{1}{2}$	10 ... 3	9 ... 10	3 ... 10	614 $\frac{2}{3}$	a 13th
12th g	768	6 ... 2	8 ... 9	2 ... 6	682 $\frac{2}{3}$	g 12th
11th f	682 $\frac{2}{3}$	8 ... 3	15 ... 16	3 ... 8	768	f 11th
10th e	640	10 ... 4	9 ... 10	4 ... 10	819 $\frac{2}{3}$	e 10th
9th d	576	18 ... 8	9 ... 8	8 ... 18	910 $\frac{2}{3}$	d 9th
8th C	512	2 ... 1	15 ... 16	1 ... 2	1024	C 8th
7th B	480	15 ... 8	8 ... 9	8 ... 15	1092 $\frac{2}{3}$	B 7th
6th A	426 $\frac{2}{3}$	5 ... 3	9 ... 10	3 ... 5	1228 $\frac{2}{3}$	A 6th
5th G	384	3 ... 2	8 ... 9	2 ... 3	1365 $\frac{2}{3}$	G 5th
4th F	341 $\frac{2}{3}$	4 ... 3	15 ... 16	3 ... 4	1536	F 4th
3d E	320	5 ... 4	9 ... 10	4 ... 5	1638 $\frac{2}{3}$	E 3d
2d D	288	9 ... 8	8 ... 9	8 ... 9	1820 $\frac{2}{3}$	D 2d
1st C	256	1	8 ... 9	1	2048	C 1st

Plate 1: David Ramsey Hay, *Geometric Principle of Beauty Analysed* (1843), 42.

physical proportions. As plate 1 shows, Hay's diagram sought to translate the staff notation of a scale into stacked, leaning columns of vibrational ratios, encouraging readers to see a numerical order behind the music notation. As though unveiling a secret proof, he explains with bullish confidence: "Thus the only kind of harmony . . . which constitutes the beautiful in sound, owes its excellence to an adherence to certain geometrical rules, which act mechanically upon the ears."<sup>31</sup> From this diatonic excess, Hay's ideas were sufficiently celebrated for *The Anglo American* to describe him as "one of those men who stand prominently out in front of his fellows," and to credit his writings with "the force of original genius."<sup>32</sup> Yet the chasm between his

<sup>31</sup>*Ibid.*, 43.

<sup>32</sup>Anon., "On Decorative Painting," *The Anglo American* 4, no. 15 (1 February 1845): 357.

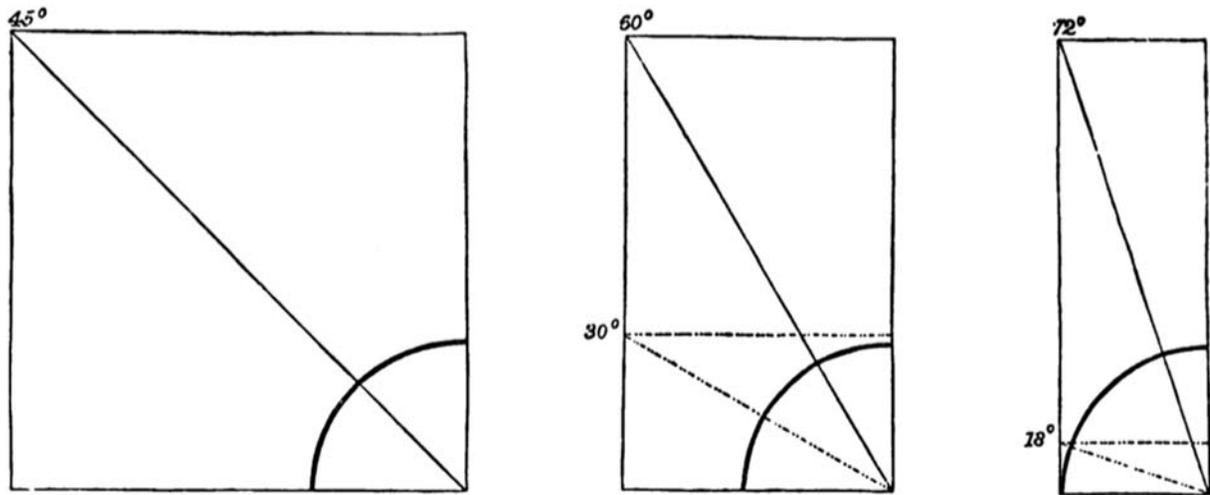


Plate 2: Hay's illustrations of how a rectangle is divided according to harmonic divisions: 1:2, 2:3, and 4:5, in *Geometric Principle*, 47.

platitudinous claim for harmony and the musical praxis of a Brahms et al. remained.

While such acoustic knowledge was old, Hay's application of it to order ratios of geometric figures was new, where rectangles were formed through analogous properties: scale degree = number of rectangle in a series; ratio of pitch to the tonic = ratio of diagonals to the right angle; vibrations per second = degrees in diagonals. To illustrate the division of a quadrant by harmonic ratios, reproduced as plate 2, Hay explains: the first is divided by 2, giving 45 degrees (the diagonal of the primary square) and relating to the right angle as 1 to 2 (octave); the second is divided by 3, giving a vertical diagonal of the first oblong of 60 degrees, relating to the right angle as 2 to 3 (perfect fifth); the third is divided by 5, giving the vertical diagonal of the second oblong of 72 degrees, relating to the right angle as 4 to 5 (major third).<sup>33</sup> The resulting "comparative table" is given as plate 3, where the reciprocity between "scales" of pitch and of proportionally related rectangles appears self-reinforcing; each confirmed by the other's force of beauty. Here, sound was being treated as an interpretive key, an ordering function of nature applied to visual forms (not unlike Kandinsky's

later cultivation of a theory of color and form through the idea of sonic vibrations).<sup>34</sup>

The recourse to mathematics in Hay and Engel is indicative of the influence on aesthetics of a professionalizing tendency within the natural sciences, namely the tendency of mid-century scientists to seek to control for the fallibility of human observers, for the effects of subjectivity on empirical observation. When defined in opposition to a human subjectivity (perhaps most ably defined by Coleridge),<sup>35</sup> the

<sup>34</sup>Wassily Kandinsky, *Concerning the Spiritual in Art* [1912], trans. M. T. H. Sadler (New York: Dover, 1977), 20ff.

<sup>35</sup>In 1817 Coleridge provided what would become the most influential definition of an antithetical relation between the terms subjective/objective: "Now the sum of all that is merely OBJECTIVE, we will henceforth call NATURE, confining the term to its passive and material sense, as comparing all the phaenomena by which its existence is made known to us. On the other hand, the sum of all that is SUBJECTIVE, we may comprehend in the name of the SELF or INTELLIGENCE. Both conceptions are in necessary antithesis." While this has been taken at face value by some (e.g., Lorraine Daston and Peter Galison, *Objectivity* [New York: Zone Books, 2007], 30), to regard Coleridge's terms as simple oppositional categories would be reductive, for subjective being and objective phenomena interpenetrate through the unifying activity of the imagination, which—for Coleridge—ultimately renders such categories not absolute. As he puts it: "In short, what I had supposed substances were thinned away into shadow, while everywhere shadows were deepened into substances," continuing to cite Milton: "If substance may be call'd what shadow seem'd, / For each seem'd either!"

<sup>33</sup>Hay, *Proportion*, 47.

MUSICAL SOUNDS.			Relations to one another.	GEOMETRIC FIGURES.		
Degrees of the Scale.	Ratio of Vibrations to the Tonic.	Number of Vibrations in a Second.		Number of degrees in diagonals.	Ratio of dia- gonals to the right angle.	Nos. of rect- angles.
22d	8 to 1	1024	15 to 16	11° 15'	1 to 8	22d
21st	60 ... 8	960		8 ... 9	12	8 ... 60
20th	20 ... 3	833½	9 ... 10	13 30	3 ... 20	20th
19th	12 ... 2	768	8 ... 9	15	2 ... 12	19th
18th	16 ... 3	682½	15 ... 16	16 52 30"	3 ... 16	18th
17th	20 ... 4	640	9 ... 10	18	4 ... 20	17th
16th	36 ... 8	576	8 ... 9	20	8 ... 36	16th
15th	4 ... 1	512	15 ... 16	22 30	1 ... 4	15th
14th	30 ... 8	480	8 ... 9	24	8 ... 30	14th
13th	10 ... 3	426½	9 ... 10	27	3 ... 10	13th
12th	6 ... 2	384	8 ... 9	30	2 ... 6	12th
11th	8 ... 3	341½	15 ... 16	33 45	3 ... 8	11th
10th	10 ... 4	320	9 ... 10	36	4 ... 10	10th
9th	18 ... 8	288	8 ... 9	40	8 ... 18	9th
8th	2 ... 1	256	15 ... 16	45	1 ... 2	8th
7th	15 ... 8	240	8 ... 9	48	8 ... 15	7th
6th	5 ... 3	213½	9 ... 10	54	3 ... 5	6th
5th	3 ... 2	192	8 ... 9	60	2 ... 3	5th
4th	4 ... 3	170½	15 ... 16	67 30	3 ... 4	4th
3d	5 ... 4	160	9 ... 10	72	4 ... 5	3d
2d	9 ... 8	144	8 ... 9	80	8 ... 9	2d
1st	1	128	8 ... 9	90	1	1st

Plate 3: Hay's comparative table of geometric properties and harmonic ratios, in *Geometric Principle*, 50.

concept of objectivity was underwritten by such methods, and for this reason Lorraine Daston and Peter Galison have persuasively argued that "this form of scientific objectivity emerged only in the mid nineteenth century."<sup>36</sup> Within the now standardized scientific method of experiment-observation, this entailed a reliance on precision instruments and mathematical modeling in the hope of achieving a mechanical standard of objectivity, putatively devoid of human bias.

Central to this debate in Great Britain was John Herschel, celebrated mathematician and astronomer, for whom number constituted both a mathematical sign and "an object of sense, because we can count," i.e., it translated the

See *Biographia Literaria*, ed. James Engell and W. Jackson Bate (Princeton: Princeton University Press, 1983), 254–55, and 301.

<sup>36</sup>See Daston and Galison, *Objectivity*, 42, 81–128.

sensory and the symbolic directly into one another to permit quantitative comparison by the senses, a gesture that would presage both Hay's ratios and Helmholtz's impulse to quantify lawful behavior in the sensorium.<sup>37</sup> Yet the reliability of induction, from experimental data to formulae, still depended on human observation that—Herschel worried—may not include the "whole scale of variation of which the quantities in question admit."<sup>38</sup> As Mary Poovey first pointed out in her study of the institutionalization of statistics during the 1830s,<sup>39</sup> Herschel did not try to solve this problem; rather he named it:

Laws thus derived, by the direct process of including in mathematical formulae the results of a greater or less number of measurements, are called "empirical laws." . . . Empirical laws in this state are evidently *unverified inductions*, and are to be received and reasoned on with the utmost reserve. No confidence can ever be placed in them beyond the limits of the data from which they are derived; and even within those limits they require a special and severe scrutiny to examine *how nearly* they do represent the observed facts. . . . When empirical laws are unduly relied on beyond the limits of the observations from which they were deduced, there is no more fertile source of fatal mistakes.<sup>40</sup>

The natural laws Helmholtz prophesied in 1878 as governing perception were thus empirical laws in this sense. And the challenge of induction remained. Like Herschel half a century earlier, rather than "solving" it, he side-stepped it by creating a new category. This time, by recourse to the category of artistic perception.

<sup>37</sup>John Herschel, *A Preliminary Discourse on the Study of Natural Philosophy*, ed. Arthur Fine (Chicago: University of Chicago Press, 1830), 124. The classic account of Herschel's status within Victorian science remains Walter F. Cannon, "John Herschel and the Idea of Science," *Journal of the History of Ideas* 22 (1961): 215–39.

<sup>38</sup>Herschel, *A Preliminary Discourse*, 177.

<sup>39</sup>Mary Poovey, *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society* (Chicago: University of Chicago Press, 1998), 321. Poovey's monograph traces historically the concept of the "fact," as unit of verifiable truth, to the practice of double-entry bookkeeping, inaugurated in 1588.

<sup>40</sup>Herschel, *Preliminary Discourse*, 178.

In fact, Helmholtz concluded his remarkable lecture by figuring art as the ultimate evidence for law-like perception. Works of art—the products of human fingers and sweat, yet artificial by definition—offered evidence of a lawlikeness that is internal to what Helmholtz saw as the closed semiotic scheme of human perception. That is, the value of art had no reference to its capacity to convey what is real in an external world, instead it depended on the effect it had on the collective judgment of witnesses. In this reading, artistic creation becomes law-defining, and might be considered a primary scientific instinct, ultimately scrutable via the numerical affinity of overtones and the ratio of forms, in effect affirming a deep reciprocity between the roles of scientific and artist.<sup>41</sup> Helmholtz's claim is worth quoting at length:

The true researcher must always have something of the artist's insight. . . . Both artist and researcher strive . . . towards the same goal: to discover new lawfulness. . . . Both the true artist and the true researcher know how to work properly and how to give their work a stable form and convincing similitude. . . . There occurs to us a number of cases which show that certainty and rapidity of appearance of certain ideas in the case of certain impressions can also be achieved, even where nothing concerning such a connection is given by name. One of the most striking examples of this sort is the understanding of our mother-tongue. . . . It will not be necessary for me to pile up examples of such processes: daily life is rich enough with them. Art—most obviously poetry and the fine arts—is virtually grounded therein. . . . If the similar traces, which are often left behind in our memories by repeated perceptions, increase, then *it is precisely the law-like that repeats itself most regularly in a similar manner*, while fortuitous change is eliminated. By this means there develops in the loving and attentive observer an intuitive image of the typical behaviour of the objects which interest him, of which he subsequently knows just as little as to how it came about as a child knows by which examples he has learnt the meanings or words. That *the artist has*

*beheld the real* may be concluded from the fact that when he brings before us an example cleansed of accidental disturbances it again fills us with the conviction of truth. He is, however, superior to us in that he knew how to sift out everything accidental and confusing of the doings of the world.<sup>42</sup>

This veneration of artistic instinct was no moment of weakness, a late-career concession to the art and music Helmholtz had cultivated in private and admired in public for six decades. Fifteen years earlier, his treatise on the *Sensations of Tones* (1863) had voiced precisely the same supposition that “a germ of order” slumbers in the “obscure depths” of a healthy human mind, where “we learn to recognise and admire in the work of art . . . the picture of a similar arrangement of the universe, governed by law and reason in all parts.”<sup>43</sup> In this entwinement, the cultural work imputed to art underwrites the methods of empiricism. And the onus of a lawlike reality is here restricted to what the artist perceives, where art becomes the filter of choice for determining unspecified lawlike attributes of sensory perception, and for inducing the resulting “empirical laws” in turn. Cybernetically, this is a closed circuit of human perception: objective to the extent its “laws” are derived through collective empiricism, but still with no claim for direct knowledge of a mind-independent reality. It was a loud silence. As Charles Sanders Peirce remarked in his obituary: “It would seem that something must have happened [following the research on sensation from the early 1850s] . . . which made Helmholtz dread ‘an sich’ as a burnt child does fire.”<sup>44</sup>

Here, finally, the objectivity of perception splits into its constituent associations of the lawlike behavior of sensations and the claim that sense organs access a putative external reality. Untangling these associations would prove difficult during the 1850s–70s. Even Helmholtz's vocabulary spun the entwinement tighter; he spoke of natural science establishing a ground on which to seek “the laws of the real” where the law-like becomes “the

<sup>41</sup>This gesture of valorizing art builds on earlier lectures that applied science—notably: optics and painting (1871), harmony and music (1857)—and reflects a lifelong seat at the piano. See Cahan, *Helmholtz: A Life*, 41–45.

<sup>42</sup>Helmholtz, “The Facts,” 354–55 (emphasis added).

<sup>43</sup>Helmholtz, *Sensations of Tone*, 366–67.

<sup>44</sup>Charles Sanders Peirce, “Helmholtz,” *The Nation* 59 (13 September 1894): 191–93, here 192.

essential presumption for the character of the real."<sup>45</sup> By proposing that what is real depended on perceptual laws, Helmholtz's lecture was also responding to criticism. In 1877 Land—the Dutch philosopher we encountered earlier—had publicly cautioned Helmholtz that whoever committed the "fundamental error" of straying over the border between philosophy and physics "shifts his problem as well as his method." In physics, he continued, "we must adopt a standard of truth, which in philosophy is the very thing to be settled."<sup>46</sup> The thinking, imagining perceiving subject of philosophy is not the same as that of the man of science "fresh from the physiology of the senses." It was a direct attack. Helmholtz—Land implied—is "unaccustomed to this kind of abstraction" and so remains unaware "that he has crossed the fatal border; and much of the reasoning current in his own domain is no longer acceptable as lawful tender." Specifically, the question came down to whether, with sufficient accurate observations and correct reasoning, physicists can regard the result to be the "adequate expression of real existence"; Helmholtz did, but this is because "science has no suspicion of a distinction between 'objectivity' and 'reality'":

The notions of "objectivity" and "reality," hitherto equivalent, must be carefully kept asunder, or else it becomes impossible even to understand the questions at issue. We must be prepared to examine opinions like these: that there is nothing real except mind, whereas space and bodies are merely its object; or, that besides mind there is a reality, impressing it so as to produce an object wholly dissimilar from the reality itself.<sup>47</sup>

This distinction, broached here in relation to the perception of non-Euclidean sorts of space, would shape epistemological discussion of sound relentlessly. In passing, Helmholtz had casually designated "objective light" as "vibrations of the aether," yet the corollary, objective sound as oscillating compressions of a similarly static medium, seemed less satisfactory, which

is to say: he left it unsaid.<sup>48</sup> Given art's new role in determining laws of the real, and given Helmholtz's view that "music stands in a much closer connection with pure sensation than any of the other arts,"<sup>49</sup> it is perhaps unsurprising that a new question arose in this drive for objectivity, namely: *what was the "real" of sound?*

#### EPISTEMOLOGY OF THE REAL

In his monumental *History of Materialism* (1865), Friedrich Albert Lange cited Helmholtz's study of vowel frequencies to bridge perception and the putative reality of matter. Here, it is sound that forms the interface: "The extension of acoustics by the resolution of the vowels into the effect of co-operating over-tones is at the same time a complement of the mechanical principle of explaining nature. The sounds, as product of a number of sensations of tone, still remains as *an effect of the movements of matter*."<sup>50</sup> This passing comment was in line with more strident assertions from materialists like Büchner, that all "imponderables," i.e., light, sound, heat, electricity, and magnetism, "are neither more nor less than changes in the aggregate state of matter," i.e., referable to a theory of substance.<sup>51</sup> Yet Lange's observation sets up a dead end: quite how a unified idea, image or sound arises from sensations that result from the variegated "atomic" movements of matter—he continues—is nothing short of a "metaphysical riddle," a synthesis that remains "inexplicable."<sup>52</sup>

Running into this buffer (the problem of consciousness) is one reason he characterized the physiology of the sense organs as the field of human inquiry in which the empirical method had celebrated its highest triumph yet also "leads us to the very limits of our knowledge, and betrays to us at least so much of the sphere beyond it as to convince us of its existence."<sup>53</sup> As an avowed Kantian, Lange's second point

<sup>45</sup>Helmholtz, *Sensations of Tone*, 364, 362.

<sup>46</sup>J. P. N. Land, "Kant's Space and Modern Mathematics," 38.

<sup>47</sup>*Ibid.*, 40, 41, 39–40.

<sup>48</sup>Helmholtz, "The Facts," 345.

<sup>49</sup>Helmholtz, *Sensations of Tone*, 2.

<sup>50</sup>Friedrich Albert Lange, *History of Materialism and Criticism of Its Present Importance* [1865], 3 vols., 2nd edn. (London: Kegan Paul, 1925), III, 203 (emphasis added).

<sup>51</sup>Büchner, *Force and Matter*, 4.

<sup>52</sup>Lange, *History of Materialism*, 213.

<sup>53</sup>*Ibid.*, 202.

was significant. Historically, materialism positioned itself as the philosophy of the real.<sup>54</sup> (For Büchner, famously, the “objective world” was exclusively a world of force and matter.)<sup>55</sup> Lange saw this as an irremediable weakness, an act of intellectual stubbornness: the mind-independent reality imagined by materialists “does not exist and cannot exist.”<sup>56</sup> As the venerable physiologist Johannes Müller had shown in his *Elements of Physiology* (1833–40), sensory organs produced specific “sense energies,” meaning that sunlight is perceived as light by the eye, but heat by the skin. Sensory stimuli were translations of mind-independent objects according to the body’s cognitive and sensory apparatus (“sense substances”); any stimulation of the ear is felt as sound, of the eye, as light and so on. An uncontroversial corollary—Lange continues—would be that we experience effects of objects rather than unaltered copies of objects: “colours, sounds, smells etc. do not belong to things in themselves, but . . . are peculiar forms of excitation of our sensibility, which are called forth by corresponding but qualitatively very different phenomena in the outer world.”<sup>57</sup> Visual examples of modified sensory effects, including the inverted image projected onto the retina, and the brain’s imperfect compensation for the blindspot, generated only affirmations that sensory stimuli offer no route to the “real” as such. “Must we not conclude,” he asks, “that the passage of the effects of a thing-in-itself into the medium of our being probably also involves important, perhaps incomparably more important, modifications?”<sup>58</sup> The conscious experience of perception might be lawlike, in other words, but it does not follow that what is perceived is real in the manner Helmholtz suggested (cf. Land). Building on Müller’s epistemological insight, Lange proceeded to strike at the heart of the physicalist doctrine of materialism with the view that even if we assume the presence of lawlike physical mechanisms within the body (mechanisms that produce mental “conclusions” arising from sensations), we must

then ask: “What is the Body? What is Matter? What is the Physical? And modern physiology, just as much as philosophy, must answer that *they are all only our ideas*; . . . ideas resulting according to natural laws, but still never the things themselves.” Matter itself, on such terms, becomes “a factitious principle” and so a “consistently materialist view” is revealed to be nothing but “a consistently idealistic view.”<sup>59</sup> Perhaps the dance between perception and matter was all merely a closed loop, a recursive causality of thought.

This moment of reckoning may seem logical, and as a skewer for materialism it would prevail within the history of philosophy. But in the same decade, several commentators, including prominent materialists, argued precisely the opposite: that objects of sense—including sound—were real, knowable physical entities. A contemporary case is Heinrich Czolbe, perhaps the most fanatical academic physician of the nineteenth century to pursue a worldview exclusively through the principle of sensation. Czolbe’s *Neue Darstellung des Sensualismus* (1855) explained the doctrine of what he called sensualism (*Sensualismus*), a monist stance that defined reality at the level of sensation and so excluded as unreal everything that is “supersensible,” i.e., what could not be sensed or experienced. In this way, all concepts would attain precise meaning by becoming intuited via experience. It was a form of naïve realism through which he hoped to establish a more principled, systematic foundation for materialism than the fragmented arguments advanced hitherto.<sup>60</sup>

<sup>59</sup>Ibid., 215, 223 (emphasis added).

<sup>60</sup>In this enterprise he failed, when a number of public criticisms by Rudolf Herrmann Lotze found no answer. Beyond the argument that sense energies remained unchanged, morphologically, in their passage from the external world to the nervous system, the Lockean proposition that thought was explicable physiologically, determined by laws of association, was criticized by Lotze for failing to acknowledge the material of intuition and the unity of consciousness, neither of which can be demonstrated by empiricism. Czolbe responded first with a lengthy rebuttal (*Entstehung des Selbstbewußtseins: Eine Antwort an Herrn Professor Lotze* [Leipzig: Costenoble, 1856]). This again was reviewed by Lotze (“Recension von Heinrich Czolbe, Entstehung des Selbstbewußtseins. Eine Antwort an Herrn Professor Lotze,” *Göttingen gelehrte Anzeigen* 32 [1857]: 313–20), but in 1865 he relinquished

<sup>54</sup>Compare Lange, *History of Materialism*, 335ff.

<sup>55</sup>Büchner, *Force and Matter*, 174.

<sup>56</sup>Lange, *History of Materialism*, 336.

<sup>57</sup>Ibid., 217.

<sup>58</sup>Ibid., 226.

Significantly, for present purposes, he argued the effects of stimuli are propagated mechanically in precisely the form in which they are created and received, i.e., they remain unchanged; hence the quality of sound (or color, or heat) is somehow inherent in the very form of its propagation along nerves and through the atmosphere.<sup>61</sup> This argument held that sensory qualities are fully present and fully formed as they shift from external stimuli to internal experience. Where sensation stimulates imagination indirectly, as in the case of music that might prompt us to think of images or colors, this steer becomes a determinate process; for Czolbe: “the length or speed of [vibratory] movement must be the same in the imagination as in perception.”<sup>62</sup>

Returning briefly to aesthetics, two essays on the new sensory experience of Richard Wagner’s Romantic operas frame the publication of Czolbe’s theory and are arguably substantiated by the principles it claims to advance. Both Franz Liszt (1852) and Charles Baudelaire (1861) invoke an audiovisual sense acuity when discussing the Prelude to *Lohengrin* in which listeners seemingly experience the presence of light, space, and iridescent color, distantly reflecting associations of the Holy Grail, through the high frequencies of the opening upper strings. For Liszt:

Wagner . . . displays to our gaze the dazzling temple built of incorruptible woods, whose walls are sweet-smelling, and doors of gold, whose lintels are of greenish chrysolite, whose columns are of opals and partitions of cymophane. . . . Not in its imposing structural reality, but as if sparing the weakness of our senses, he shows it to us first reflected in blue waters or shimmering as though in an iridescent haze. . . . The trumpets and trombones . . . repeat the melody for the fourth time with a dazzling brilliancy of coloring, as if at this very instant the sacred edifice shone forth before our astonished gaze in all

its luminous and radiant magnificence. But its bright sparkling, increased by degrees to an intensity equaling the brilliancy of the sun, suddenly goes out like a heavenly meteor. The transparent mist of the clouds shuts it in again, the vision disappears by degrees in the same variegated fragrance, in the midst of which it first appeared.<sup>63</sup>

A year later, Wagner described his own vision of the Grail’s passage from heaven to earth in similar terms:

At the beginning, the clearest blue air of Heaven seems to condense into a mysterious vision, barely perceptible by the eye of utmost unearthly yearning, yet holding the enraptured gaze with a magic spell; in infinitely soft, but ever more distinct outline appears the wonder-bringing host of angels, descending imperceptibly from ethereal heights, and bearing in its midst the sacred vessel. As the vision becomes ever more discernable and apparent, and hovers down towards this vale of Earth, the sweetest fragrance wafts out from its wings: entrancing vapors stream from it in clouds of gold.<sup>64</sup>

<sup>63</sup>“Wagner . . . il fait miroiter à nos yeux ce temple de bois incorruptible, aux murs odorans, aux portes d’or, aux solives d’asbeste, aux colonnes d’opales, aux ogives d’onyx, aux parvis de cymophane. . . . Il ne nous le fait point appercevoir, dans son imposante et réelle structure, mais comme ménageant nos faibles sens, il nous le montre d’abord reflété dans quelque onde azurée, ou reproduit par quelque nuage irisé. . . . l’entrée des trompettes et des trombones, qui répètent la mélodie pour la quatrième fois, avec un éclat éblouissant de coloris, comme si dans cet instant unique l’édifice saint avait brillé devant nos regards aveuglés, dans toute sa magnificence lumineuse et radiante. Mais le vif étincellement amené par degrés à cette intensité de rayonnement solaire, s’éteint avec rapidité, comme une lueur céleste. La transparente vapeur des nuées se referme, la vision disparait peu à peu dans le même encens diapré, au milieu duquel elle est apparue.” Liszt, “Lohengrin: Grand opera romantique de R. Wagner,” *Sämtliche Schriften*, 9 vols. (planned), ed. Rainer Kleinertz and Detlef Altenburg (Wiesbaden: Breitkopf and Härtel, 1989), IV, 32.

<sup>64</sup>“Dem verzückten Blicke höchster, überirdischer Liebe-sehnsucht scheint im Beginne sich der klarste blaue Himmelsäther zu einer wundervollen, kaum wahrnehmbaren, und doch das Gesicht zauberhaft einnehmenden Erscheinung zu verdichten; in unendlich zarten Linien zeichnet sich mit allmählich wachsender Bestimmtheit die wunderspendende Engelschar ab, die, in ihrer Mitte das heilige Gefäß geleitend, aus lichten Höhen unmerklich sich herabsenkt. Wie die erscheinung immer deutlicher sich kundgibt und immer ersichtlicher dem Erdentale zuschwebt, ergießen sich berauschend süße Düfte aus ihrem Schoße: entzückende Düfte wallen aus ihr wie goldenes Gewölk hernieder.” Wagner, “Vorspiel zu *Lohengrin*” [1853], *Sämtliche Schriften und Dichtungen*, ed. Richard Linnemann, 12 vols. (Leipzig: Breitkopf & Härtel, 1911), V, 180.

his claim that materialism could explain the phenomenon of consciousness (*Die Grenzen und der Ursprung der menschlichen Erkenntnis im Gegensatz zu Kant und Hegel* [Leipzig: Costenoble, 1865]). The full episode is summarized in Frederick C. Beiser, *Late German Idealism: Trendelenburg & Lotze* (Oxford: Oxford University Press, 2014), 243–47.

<sup>61</sup>Heinrich Czolbe, *Neue Darstellung des Sensualismus: Ein Entwurf* (Leipzig: Hermann Costenoble, 1855), 13–14.

<sup>62</sup>*Ibid.*, 46.

For his part, Baudelaire recorded his own experience of listening to the Prelude and proceeds to marvel at the commonality between his, Wagner's, and Liszt's visions:

Soon I became aware of a heightened brightness, of a light growing in intensity so quickly that the shades of meaning provided by the dictionary would not suffice to express this constant increase of burning whiteness. Then I achieved a full apprehension of a soul floating in light, of an ecstasy compounded of joy and insight, hovering above and far removed from the natural world. . . . Even if the [similarities between visions of the music] were few in number, they would still be proof enough, but by good fortune they are superabundant and striking even to excess.<sup>65</sup>

If we take the three authors at their word, these accounts may be read as a kind of knowing through sound, an acoustemology ("acoustic epistemology"), in which perceiving the Holy Grail—metonym for the opera's subject, a medieval Grail knight—becomes almost tactile, a matter of sensory perception in the same way that, for Czolbe, not only is vibratory movement identical in perception and imagination, but even abstractions such as metaphor or mathematical axioms are sensory perceptions.<sup>66</sup>

More traditionally, we might read such literary reactions in terms of a discourse network, perhaps simply a trope that alloys dazzling, brilliant whiteness to the Holy Grail. Witness Tennyson's "Sir Galahad" (1834), whose vision is prompted by a sound:

A gentle sound, an awful light!  
Three angels bear the Holy Grail,  
With folded feet in stoles of white.

If Czolbe's pseudoscientific coupling between narrative and sensation ultimately invites skepticism (his theories were publicly denounced by R. H. Lotze, eventually leading to a retraction),<sup>67</sup>

a later, steadfast advocate of what was termed a "substantialist" theory of sound positively anticipated readers' disbelief: "I am well aware that [refuting the theory of sound after Helmholtz and Tyndall] . . . will naturally awaken in the scientific mind a feeling of contempt for its author, mingled perhaps with commiseration."<sup>68</sup> Alexander Wilford Hall, a Methodist minister in New York and editor of two scientific journals on the margins of respectability, argued that sound was an immaterial substance, similar to odor. All so-called forces—light, heat, gravity, sound, magnetism—are substances made of smaller particles than "material" substances. To talk of essential differences between the nature of material and immaterial substances would be "irrational, as well as unnecessary," he explains.<sup>69</sup> With pugnacious, driving prose, his popular book on science, *The Problem of Human Life* (1877), took aim at Darwinian evolution, but along the way reproached prevailing theories of sound, arguing against a theory of wave motion ("purely visionary . . . a pure fallacy of science"). He claimed that sound is "a finely attenuated substance, which is radiated from the sound-producing body by an unknown law of diffusion" where "corpuscular emissions" are radiated "in sonorous pulses or discharges, instead of continuous streams, each discharge synchronising with the vibratory movement of the string."<sup>70</sup> It was a striking regression to pre-Newtonian theories of sense substances that underscored the residual ambiguity of sound beyond university-based physics.<sup>71</sup>

In particular, the assumption that undulating waves pass seamlessly through successive media

<sup>68</sup>Hall, *The Problem of Human Life*, 75.

<sup>69</sup>*Ibid.*, 33.

<sup>70</sup>*Ibid.*, 76–77.

<sup>71</sup>In prefacing his assault on contemporary physics, Hall pointed out that he was less severe against scientific authority than Thomas Edison, who is cited thus: "There are more frauds in science than any where else. . . . Take a whole pile of them that I can name and you will find uncertainty *if not imposition* in half of what they state as scientific truth. . . . Professor this or that will controvert you out of the books, and prove out of the books that it can't be so, though you have it right in the hollow of your hand all the time and could break his spectacles with it." See Hall, *The Problem of Human Life*, viii.

<sup>65</sup>Baudelaire, "Richard Wagner and *Tannhäuser* in Paris," *Selected Writings on Art and Literature* (London: Penguin 1972), 329–30.

<sup>66</sup>"[Die Mathematik] ist eine abstrakte Wissenschaft, da sie von den Qualitäten der Körper abstrahiert, ihr Gegenstand ist aber verschieden sinnlich, oder anschaulich. Die mathematischen Axiome sind nichts anderes, als sinnliche Wahrnehmungen." Czolbe, *Neue Darstellung*, 39.

<sup>67</sup>For Czolbe and Lotze, see n. 60.

left Hall incredulous, for they “must travel undistorted the entire distance the sound is heard.”<sup>72</sup> Back in 1830, Herschel had clarified that, with sound, it was “not a case of the propagation of motion at all.” Rather, every particle of a medium “receives its whole motion from those which were moving before, and transmits it to others previously at rest. . . . Sounds transmitted through a smoky or dusty atmosphere cause no visible motion in the smoke or floating dust.”<sup>73</sup> His analogy of choice was a breeze passing through a field of corn, successively bending pliable ears of corn into motion before each springs back and returns to stasis. In its reception, Herschel’s idea prompted clarifications over “*what it really is that passes from one point to another, when we say sound is transmitted.*” Neither sensation nor any “absolute thing” is transmitted, explained Alexander Ellis in 1845, but “a certain *state* of the [static] particles of the atmosphere.”<sup>74</sup>

Hall’s fallacies are perhaps less important than his firm belief in a *sound material*, a physical matter of sound beyond the reach of empirical understanding, extant not in the mind but as immaterial substance: a glorious oxymoron.<sup>75</sup> He had overturned modern physics, in part, to demonstrate the plausibility of a soul similarly constituted of “immaterial substance,” and thereby to refute the atheistic consequences of materialism. On the one hand, sound substance might therefore be dismissed simply as a necessary corollary in this scheme. On the other hand, the book seemingly went through twenty editions (self-published) in three years, with Chicago’s *Inter Ocean* crediting it as “strong in ‘horse’

sense”—aka common sense—through “the clearest, keenest, most scholarly writing,” while offering “the most complete refutation of Darwinism, Huxleyism and their class which we have anywhere met.”<sup>76</sup> It even spawned a high-school textbook on “substantial” acoustics.<sup>77</sup> Here an appetite for the semi-imaginary stands apart from the more prudent thinkers who pointedly refused to engage Hall despite his provocations.<sup>78</sup>

When abstracted from its religious motivations, the claim for a tangible sound substance is only a *reductio ad absurdum* of the claim that objects of perception were directly passed in proportionate form from external stimulus to mental representation (cf. Czolbe). This latter claim was more common among respected scientists. It implied, *pace* Kant, that we do have knowledge of a “real” external world through our senses. Büchner, for one, advocated as much, where sensory mechanisms convey external impressions to a brain that “receives, digests, and reproduces them.” The result, he continues, is our creation of an “internal picture of the external world.”<sup>79</sup> Just as Lange acknowledged that a sphere beyond the limits of our knowledge is “betrayed” by our sensations, the young Helmholtz brushed against the materialist argument in oddly similar terms in his lecture on human vision from 1855:

In what way, then, did we first emerge from the world of nervous sensation into the world of reality? Obviously only by virtue of an inference: we must presuppose the presence of external objects as the cause of our nerves’ stimulation, for there can be no effect without cause. . . . We see now that we need this principle before we have *any kind of knowledge of things in the external world*. We need it simply in order to realise that objects exist in

<sup>72</sup>Ibid., 77.

<sup>73</sup>John Herschel, “Sound,” *Encyclopaedia Metropolitana*, vol. IV (London: B. Fellowes, 1830), 747–824, here 756–57.

<sup>74</sup>Alexander John Ellis, *The Alphabet of Nature: Or, contributions Towards a More Accurate Analyses and Symbolization of Spoken Sounds* (London: S. Bagster, Bath: I. Pitman, 1845), 9.

<sup>75</sup>Among Hall’s numerous arguments against wave theory is the claim that a piano’s fixed sound board can only amplify a single pitch because it exhibits a “molecular tremor” rather than vibrations, where the wave-theory must assume a capability for “no less than eighty-five separate systems of air waves.” Hall, *The Problem of Human Life*, 84–85. The only comprehensive tract discrediting Hall’s work was by a Michigan-based Professor of Physics, John A. Graves, *Substantialism: The Philosophy of A. Wilford Hall Examined* (Washington DC: Terry Bros., 1891).

<sup>76</sup>*The Daily Inter Ocean*, no. 49 (Saturday 21 May 1881): 11.

<sup>77</sup>John I. Swander and Alexander Wilford Hall, *A Text-Book on Sound: The Substantial Theory of Acoustics Adapted to the Use of Schools, Colleges etc.* (New York: Hall & Co., 1887).

<sup>78</sup>This included numerous articles in the journals Hall edited, *Microcosm* and *The Scientific Arena*, and well as moments of heightened rhetoric in *The Problem of Human Life* at apparent contradictions in scientist’s reasoning (e.g., John Tyndall on the capacity of the piano’s sound board to vibrate simultaneously at different frequencies), and a full-page portrait gallery of the six scientists whose theories he sought to overturn. See *The Problem*, 84–87.

<sup>79</sup>Büchner, *Force and Matter*, 162, 166.

space around us, between which a relation of cause and effect can exist.<sup>80</sup>

This reference to knowledge of “things in the external world” (i.e., a mind-independent reality) has led some to align Helmholtz with Büchner during this period, accepting the intuitions of causality and spatiality that, for sensation, Helmholtz felt needed to be treated as *a priori*.<sup>81</sup> But even the space in which we presume sound and light to move “is called [space] only by courtesy,” as Land had reminded Helmholtz, i.e., we all had to learn to conceive of objective space as something in which bodies are able to move.<sup>82</sup>

Prompted by Hall’s polemic, a related question would be: on what terms does scrutiny of the perception of sound constitute scrutiny of the “real” of sound? The assumption underlying such a question, that sound only becomes such when striking a human ear, is here laid bare as a form of “anthropic bias,” i.e., a filtering effect for data limited not only by the particular affordances of measuring instruments and search methods used, but also “by the precondition that

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<sup>80</sup>“Auf welche Weise sind wir denn nun zuerst aus der Welt der Empfindungen unserer Nerven hinübergelant in die Welt der Wirklichkeit? Offenbar nur durch einen Schluss; wir müssen die Gegenwart äusserer Objecte als Ursache unserer Nervenerregung voraussetzen; den es kann keine Wirkung ohne Ursache sein. . . . [A]ber wie man sieht, brauchen wir diesen Satz, ehe wir noch irgend eine Kenntniss von den Dingen der Aussenwelt haben; wir brauchen ihn, um nur überhaupt zu der Erkenntniss zu kommen, dass Objecte im Raume um un giebt, zwischen denen ein Verhältnis von Ursache und Wirkung bestehen kann.” Helmholtz, *Vorträge und Reden*, vol. 1, 4th edn. (Brunswick: Friedrich Vieweg & Sohn, 1896), 115–16. See also Patrick J. MacDonald, “Helmholtz’s Methodology of Sensory Science, the *Zeichentheorie*, and Physical Models of Hearing Mechanisms,” in *History of Philosophy of Science: Vienna Circle Institute Yearbook*, ed. M. Heidelberger and F. Stadler (Dordrecht: Springer, 2001), IX, 159–83, and Michael Friedman, “Helmholtz’s *Zeichentheorie* and Schlick’s *Allgemeine Erkenntnislehre*: Early Logical Empiricism and Its Nineteenth-Century Background,” *Philosophical Topics* 25 (1997): 19–50.

<sup>81</sup>The apparent dovetailing of concept with Büchner was sufficient for Scott Edgar to argue that Büchner and Helmholtz “agree that the content of our objective knowledge consists in images that resemble spatially-arrayed matter and causal forces in the external world.” Scott Edgar, “The Physiology of the Sense Organs and Early Neo-Kantian Conceptions of Objectivity: Helmholtz, Lange, Liebmann,” *Objectivity in Science*, ed. Flavia Padovani, Alan Richardson, Jonathan Y. Tau (Heidelberg: Springer, 2015), 103.

<sup>82</sup>Land, “Kant’s Space and Modern Mathematics,” 42.

somebody be there to ‘have’ the data yielded by the instruments and to build the instruments in the first place.”<sup>83</sup> At a minimum, it marks claims for the real as contingent on more than spatiality and causality. And what is consistent in the scientific and pseudo-scientific accounts above is a recursive interest in sound: as metaphor, object, inspiration, means of knowing.

As mooted earlier, sound became a prism through which to explore precisely this ambiguity over matter in the second half of the century. Sound was intangible, untouchable, and—as a medium—reveals the ontological indiscernibility of medium and world. In the wake of the Jena Romantics, it also co-opted the human subject by unveiling a natural language of feelings. Recall that, from the earliest decades of the century, it became attractive as the complement for a Romantic metaphysics rooted in the ideal. “We cannot accept sounds as constituent of the physical world interpreted by the sense of sight and of touch,” Christian Friedrich Michaelis had argued in 1806. “Sounds are to a certain extent *un-physical*, although they originate from bodies in motion; and just as spiritual things are invisible, so too are sounds.”<sup>84</sup> Acoustic sound is also quintessentially impermanent; as Hegel famously put it, sound disappears by being.<sup>85</sup> The following case study offers some perspective on how this ambiguity over the object of sound played out within the epistemological debates outlined above, and how it helped establish sound’s role as a hermeneutic within contemporary scientific culture. A hermeneutic that in turn would make Helmholtz’s later claim possible that it is the artist who had “beheld the real.”

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<sup>83</sup>Nick Bostrom, *Anthropic Bias: Observation and Selection Effects in Science and Philosophy* (New York: Routledge, 2002), 2.

<sup>84</sup>“Wir können sie nicht als Bestandtheile der Körperwelt gelten lassen, für welche das Gesicht und der Betastungssinn zeugt. Die Töne sind insofern etwas Unkörperliches, ob sie gleich durch gewegte Körper entstehen; mit dem Geistigen haben wie wenigstens das Unsichtbare gemein.” Christian Friedrich Michaelis, “Ein Versuch, des innere Wesen der Tonkunst zu entwickeln,” *Allgemeine musikalische Zeitung* 9, no. 43 (23 July 1806): 674 (emphasis added).

<sup>85</sup>G. W. F. Hegel, *Aesthetics*, trans. T. M. Knox, 2 vols. (Oxford: Clarendon Press, 1988), II, 905.

In 1850 a wager was struck between an English philosopher in London's leafy Hyde Park, Thomas Simon, and a French geologist living in Manchester, Antoine Jobert: for Jobert to prove that sounds "are not pure sensations." The sum of £500 (£66,119 / \$87,386 in 2019)<sup>86</sup> was offered as reward by Simon with no penalty for failure, and the challenge duly taken up. A short book records the correspondence, arguments, and result. If the individuals are otherwise undistinguished, historically speaking, their interaction is emblematic of how sonic ambiguity informed wider debate. A summary of the episode runs as follows.<sup>87</sup>

In 1847 Mr. Simon anonymously authored a monograph, *Universal Immaterialism*, and had sought to stoke debate by issuing an uncommon challenge: "A prize of one hundred pounds for a conclusive disproof of Universal Immaterialism" to be presented within twelve months of publication.<sup>88</sup> Simon's book resurrected George Berkeley's philosophy for the mid-nineteenth century, and after his challenge attracted no interlocutors, he solicited first a public discussion with Jobert, who had commented upon the book in passing, then a wager in which sound should serve as the central object:

Make a statement of your argument upon SOUND, in a pamphlet not exceeding sixteen octavo pages, in clear print, at your own expense, and publish it, sending me three copies. Let us then submit these arguments to six umpires, three of whom shall be chosen by you, and three by me (but I approving of your choice and you of mine). Then if these six gentlemen admit that you have proved *sounds not to be pure sensations*, I am ready to pledge myself to pay you £500 at once, you incurring no risk whatever, except the expense of a

little pamphlet, which ought to be as short as possible, not to give the umpires unnecessary trouble.<sup>89</sup>

In accepting the wager, Jobert clarified the challenge in a tenuous syllogism drawn from their correspondence. It points to nothing less than the substance of the universe, pointedly failing to delimit the scope:

1. Sounds are pure sensations;
2. There are vibrations of a medium which are not sounds, but the cause of sounds;
3. Therefore it is physically impossible that there should be a material substance in our universe.<sup>90</sup>

Initially, the proposition that sounds are pure sensations hinged on the question of definition: if "sound" was not the physical vibrations that cause the sensory experience of sound for humans (2), it must be the sensory experience itself (1). Jobert's sample of contemporary definitions, given in Table 1, offered little consensus except to deny Simon's claim that "what unscientific people call sound" is pure sensation. He concluded the first portion of his argument by claiming that if "sound" only means the sensations of sound produced in a listener, then the proposition was circular: it "has no more meaning than the affirmation that 'the sensation of sound is a pure sensation.'"<sup>91</sup> As such, it could easily be laughed off.

Beneath the syntactical surface, however, Simon had argued that sound as such has no physical existence in the external world: "every sound in the universe subsists spiritually, and can only so subsist . . . thunder, for instance, is a thing solely within the mind."<sup>92</sup> Beyond the question of definition, this appears to have been an imperfect extrapolation from Müller's insight that what is perceived by the sensorium, via the medium of our senses, "is indeed merely a property or change of condition of our nerves," i.e., the experience of sensation and sense modality is determined by the architecture of our nervous

<sup>86</sup>Sums calculated using the Bank of England's online inflation calculator: <https://www.bankofengland.co.uk/money-policy/inflation/inflation-calculator>.

<sup>87</sup>Antoine Claude Gabriel Jobert, *Pure Sounds against Pure Immaterialism; or, That Sounds Are Not Pure Sensations* (London: Simpkin, Marshall and Co., 1850); a second edition was published in 1851 containing "new arguments and general conclusions" in an additional chapter.

<sup>88</sup>Anon. [Timothy Collyns Simon], *On the Nature and Elements of the External World: or Universal Immaterialism, Fully Explained and Newly Demonstrated* (London: John Churchill, 1847), front matter.

<sup>89</sup>Simon to Jobert, ca. December 1849, cited in Jobert, *Pure Sounds*, 5.

<sup>90</sup>Jobert, *Pure Sounds*, 6.

<sup>91</sup>Ibid., 13.

<sup>92</sup>Simon, *On the Nature and Elements of the External World, or Universal Immaterialism*, 97.

Table 1  
The Motley Definitions of Sounds Cited in Jobert's *Pure Sounds Against Pure Immaterialism*  
(London: Simpkin, Marshall & Co., 1850), 10–11.  
Unscientific Definitions of Sound ca. 1850

JOBERT'S REFERENCE	DEFINITION
Johnson's Pocket Dictionary	"Sound, anything audible" <sup>1</sup>
Walker's Dictionary	"Sound, that which is perceived by the ear" <sup>2</sup>
Bailey's Dictionary	"Sound, the object of hearing" <sup>3</sup>
Boyer's Dictionnaire	"Son, ce qui frappe l'ouïe" <sup>4</sup>
Boiste's Dictionnaire	"Son, vibration des corps sonores" <sup>5</sup>
Rider's Dictionary	"Sound, a perception raised in the soul by means of air put in motion and vibrating on the drum of the ear" <sup>6</sup>
Blackie's Imperial Dictionary	"Sound, the object of hearing; that which strikes the ear, or, more philosophically, an impression, or the effect of an impression, made on the organs of hearing by the vibrations of the air, &c" <sup>7</sup>
Encyclopaedia Britannica	"Sound arises from a sort of concussion or agitation which takes place amongst the bodies from which the sound is emitted. . . . It is transmitted through the medium of the surrounding air." <sup>8</sup>

<sup>1</sup>Published in multiple editions in the wake of Samuel Johnson's 1755 *Dictionary of the English Language*.

<sup>2</sup>John Walker, *The Critical Pronouncing Dictionary* (1st edn. 1775) was later retitled, *The Rhyming Dictionary*, on account of words being grouped, not phonetically, but alphabetically in accordance with the reversed spelling of the word.

<sup>3</sup>Nathan Bailey, *Dictionarium Britannicum* (1st edn. 1730).

<sup>4</sup>Abel Boyer, *Dictionnaire royal français et anglais, divisé en deux parties* (1st edn. 1702).

<sup>5</sup>Pierre Claude Victor Boiste, *Dictionnaire universel de la langue française* (1st edn. 1800).

<sup>6</sup>Bishop John Rider, *Bibliotheca Scholastica, a Double Dictionarie* (1st edn. 1589); this was known in the early seventeenth century as *Rider's Dictionary*, in an edition augmented by Francis Holyoke.

<sup>7</sup>Reverend John Ogilvie, *The Imperial Dictionary of the English Language: A Complete Encyclopedic Lexicon, Literary, Scientific, and Technological*, 2 vols. (1st edn. 1847–50).

<sup>8</sup>*Encyclopaedia Britannica*, 7th edn. (1830), entry on "Acoustics."

system.<sup>93</sup> In other words, Müller's profoundly physiological insight was here enlisted to support the most abstract of philosophical propositions: an immaterial world. That Müller himself added a caveat that "imagination and reason stand ready to interpret the modifications in the state of the nerves" was simply evidence—

for Jobert—that metaphysics had continued unduly to influence Müller's thought.<sup>94</sup>

Müller's basic insight concerning sound had been parroted by a range of scientific figures, including the botanist and cell biologist Matthias Schleiden, who worked in Müller's lab in Berlin before being appointed at Jena. Schleiden's valedictory *Studien* included the statement: "If a sound exists neither in the external world nor in those parts of our nervous system that are just

<sup>93</sup>Cited in Jobert (1851), *Pure Sounds*, 41. See also Johannes Müller, *Handbuch der Physiologie des Menschen* (Coblenz: J. Hölscher, 1834–40); English trans. William Baly, *Elements of Physiology* (London: Taylor and Walton, 1838–42).

<sup>94</sup>Jobert (1851), *Pure Sounds*, 41.

as external to our actual self, our soul, as the most distant star, it follows that a sound is nothing but the way our mind perceives certain states of the nervous system."<sup>95</sup> This formulation persuaded Kullak, for whom there "is something true in Schleiden's adage. . . . Every physicist knows quite well that sound [Ton] is objectively something else."<sup>96</sup> Ostensibly, the debate begged the question of the independent existence of sounds, but the ramifications were more widely understood. Sound—invisible, tactile, acting on objects at a distance—was openly serving as a microcosm for the broader clash between material and immaterial existence. In the context of a Romantic aesthetics, Schleiden attributed deep-rooted connections between sound and the imagination (*Phantasie*) simply to the imprecision of our spatial hearing, which implied a feedback loop between mental abstraction and the approximate discernment of a sound source's location, i.e., a lack of precise information drove the impulse toward abstraction.<sup>97</sup> It is telling for the wider controversies implied that although the one matter Jobert and Simon agreed upon gestured in this direction—"what is true of sounds is true of the effect upon our four other senses"<sup>98</sup>—neither felt able to relinquish the focus on sound and the sensorium. As an unstable object and an intellectual prism, it had become a necessary rhetorical limit.

#### THE LAST GNAT

The second main plank of Jobert's argument against the proposition that sound is pure

sensation is the so-called last gnat thesis. Again he summarizes the challenge with a syllogism:

1. [sounds] are sensations and therefore subsist only within the substance of our minds;
2. Our senses teach us that the [sounds of sonorous bodies] are identically in the same place in which the sonorous bodies themselves are;
3. Therefore all [sonorous bodies] in the universe subsist only within the substance of our minds.<sup>99</sup>

For Jobert, this renders sound mind-dependent, and his rebuttal first observes that if all human life were wiped out, animal hearing would endure; second, that even if the "last gnat" were crushed by an errant stone, or:

the whole population of the earth was suddenly destroyed by a great natural catastrophe, still the stormy waves of the sea rushing upon the cliffs of its shore, and the tempestuous winds sweeping over the surface of dear continents would rend the air with their usual conflict of disorderly noises and sounds. / SOUNDS, THEREFORE, ARE NOT PURE SENSATIONS.<sup>100</sup>

Physical vibration and mechanical compressions would subsist, in other words, but whether this constituted sound remained an unprovable hypothesis; no human, Jobert included, could demonstrate positively the existence of sound as a mind-independent object (cf. anthropic bias). As an aside, Aristotle's distinction between *potential* and *actual* sensory properties might have offered some clarity here; stormy waves in the absence of listening ears have the potential to be heard as sound, even if they are not actually heard, just as a "sounding thing" has the potential to be heard when struck, even while it is silent.<sup>101</sup> But this distinction operates at the level of logic, and it is perhaps unsurprising that a geologist should oppose a philosopher on this topic: the one deals ultimately in the dusty, solid matter underfoot, the other in degrees of mental

<sup>95</sup>"Gibt es also einen Ton weder in der Außenwelt, noch in den Theilen unseres Nervensystems, die im Grunde für unser eigentliches Ich, unsere Seele, ebenso äußerlich sind als der fernste Stern, so folgt daraus, daß der Ton nichts Anderes ist, als die Art und Weise, wie unser geistiges Ich gewisse Zustände unseres Nervensystems zur Vorstellung bringt." *Schleiden's Studien*, 2nd edn. (1857), 100. [https://reader.digitale-sammlungen.de/de/fs1/object/display/bsb10135778\_00021.html?zoom=0.6500000000000001].

<sup>96</sup>Kullak, *Die Tonkunst und ihre factoren*, 171.

<sup>97</sup>"Diese räumliche Unbestimmtheit der Gehörserscheinungen trägt wesentlich mit dazu bei, daß dieselben einen so auffallenden Einfluß auf die Belebung der Phantasie ausüben." *Schleiden's Studien*, 97.

<sup>98</sup>Jobert, *Pure Sounds*, 10.

<sup>99</sup>Ibid., 14.

<sup>100</sup>Ibid., 19.

<sup>101</sup>In his chapter on listening, he famously asserts at the outset: "Now sound is in two ways, one in actuality, the other in potentiality." Aristotle, *De Anima*, trans. Hugh Lawson-Tancred (London: Penguin, 1986), 176.

abstraction. Jobert had sought a middleground in his ambitiously titled *Philosophy of Geology* (1846) and by 1850, his primary training steered the argument about sound toward a more persuasive concrete analogue: “Phosphorous and lime *existed* previously to, and therefore independently of, the formation of our bones, and in remounting backwards, up to the time of the creation, we must believe that these substances had a mineral existence before they were employed to constitute the organic frame of our first parents. Where were then the organised beings who could *know* this existence?”<sup>102</sup> In other words, objects must exist without a perceiving subject to know them as such. Even sound objects, if not their effects.

Just how close this physicalist view is to its immaterialist counterpart can be gleaned from the language used in a plenary address at a meeting of German scientists and physicians in Leipzig during 1874. Emil Du Bois-Reymond, a leading voice within Germany’s scientific community and another former assistant to Müller, spoke about “the limits of our knowledge of nature.” It was the second such “limits” speech he had given (two years earlier he had famously addressed the same meeting on “the limits of science”). And here, with a dash of blasphemy, he flits between the objectivity of perception and the “in itself” of objects, taking the argument forward by positioning it as a straightforward question of belief. “The Mosaic dictum, ‘There was light,’ is physiologically false,” he asserts:

Light first was when the first red eye-point of an infusorial animal for the first time distinguished light from darkness. In the absence of the sense-substance [Müller’s term] of sight and hearing, this bright, glowing, resonant world around us would be dark and voiceless. / And voiceless and dark in itself, i.e., property-less, as the universe is on[e] subjective decomposition of the phenomena of sense, so is it also from the mechanical stand-point, gained by objective contemplation. Here, in place of sound and light, we have only the vibrations of a primitive, undifferentiated matter, which here has become ponderable, and there imponderable.<sup>103</sup>

<sup>102</sup>Jobert, *Pure Sounds*, 20.

<sup>103</sup>Emil du Bois-Reymond, “The Limits of our Knowledge of Nature,” *Popular Science Monthly* 5 (1874): 17–32, here 20.

Ostensibly, nothing here is new, but Bois-Reymond’s summary lent coherence—and official sanction—to otherwise stratified lines of argument. Objective contemplation (the “ponderable”) would seem closely aligned with Helmholtz’s longstanding aspiration to uncover what is lawlike in perception, while the imponderability of real “primitive, undifferentiated matter,” i.e., vibrating matter in the absence of a knowing subject, had been Jobert’s central argument in 1850. Beyond the individuals involved, it is this acceptance of vibrations of primitive matter that finally breaks the back of the (neo-Berkeleyian) immateriality propounded by Simon: vibrations of atomic matter exist prior to perception, but not as sound because there is no ear to make sense of them. Aptly, the anti-Mosaic gambit has more than a whiff of the “end of metaphysics” here (not dissimilar to the kind Heidegger would link to Nietzsche’s *fröhliche Wissenschaft* of 1882).

This essentially modern conclusion would hold until the theory of relativity undermined the common-sense view of matter as something that “persists in time and moves in space.” Writing about Lange’s text in 1925, Bertrand Russell eagerly confirmed the demise of this kind of materialism. “By merging time into space-time, [relativity] has damaged the traditional notion of substance more than all the arguments of philosophers,” he argued. “A piece of matter has become . . . a system of inter-related events.”<sup>104</sup> Russell’s visualist inclination is palpable through observations like “sound is less important than light, and in any case raises exactly the same problems.”<sup>105</sup> But even at this juncture the rhetorical limit of sound is not exhausted. It would seem more than poetic that his dismissal of materialism describes the condition of acoustic sound just as Hegel had: “Nothing is permanent, nothing endures.”<sup>106</sup>

<sup>104</sup>He continued: “The old solidity is gone, and with it the characteristics that, to the materialist, made matter seem more real than fleeting thoughts.” Bertrand Russell, “Materialism, Past and Present” (1925), rpt. in *The Basic Writings of Bertrand Russell*, ed. Robert E. Egner and Lester E. Denonn (New York: Routledge, 2009), 215. Russell would expand on this short text two years later in *The Analysis of Matter* [1927], rpt. (Nottingham: Spokesman, 2007), xii.

<sup>105</sup>Russell, *The Analysis of Matter*, 133.

<sup>106</sup>Russell, “Materialism, Part and Present,” 215.

The twinned history of sound and matter endures through literary device, perhaps, if not through the aging scheme of realism.

As a further aside, it bears remembering that Berkeley's original proposition, in his *Principles of Human Knowledge* (1710), sought to refute the unknowability of material creation implied in the Lockean account of perception. "If it be demanded why I make use of the word *idea*," he had explained, "and do not rather in compliance with custom, call them *things*, I answer . . . because the term *thing*, in contradistinction to *idea*, is generally supposed to denote somewhat existing without the mind."<sup>107</sup> That is, he wanted to allow for the possibility of ideas that were not merely outcomes of unknowable physiological or sensory processes, an eighteenth-century notion still present among belletrists as much as scientific materialists in the mid-nineteenth century.<sup>108</sup> Ideas independent of bodies had offered the certainty of being known, in other words. The neo-Berkeleyian philosophy advocated in his name ca. 1847 was not reactionary in this way; instead it almost certainly responded to Müller's research into specific sense energies, as noted earlier, though Müller is never named by Simon. Jobert, upon discovering Müller's writings in the months before the second edition of his short book, transforms his value for the debate by moving away from nerves and sensation (the centerpiece of his research), and toward logic. We all admit "we do not know HOW the fact of perception is accomplished," he explains. "To affirm that the object of perception is not an external object, but only the state of our nerves—is to decide that we know something of the How, which it is unreservedly admitted that

we do not know."<sup>109</sup> Given his adherence to a world of matter, this intellectual pirouette cannot avoid appearing as sophistry.

And it leads us to Jobert's final argument: that blind, dumb and deaf witnesses "hearing" the same chord would each perceive a separate element from it, i.e., it would exist in different sensory modalities for each witness. Even if the same individual was simultaneously blind, dumb, and deaf, s/he would still have a tactile "feel," i.e., sensation of the chord, Jobert argues, presumably through vibrations on the skin. "Since, therefore, the chord is proved separately to have an existence independently of ear and eye and of [tactility], it has an absolute existence independent of all sensations."<sup>110</sup> (A similar argument for causality would be put forward by Russell concerning the content of an overheard conversation.)<sup>111</sup> Following a brief "disquisition" that broadens the topic, a conclusion, a postscript and some further correspondence, the book of thirty-one pages ends confident of victory.

#### THE RESULT

In the event, Jobert lost the wager. His book was sent only to the first umpire, Hensleigh Wedgwood, a celebrated etymologist, cousin of Charles Darwin and author of two minor treatises on psychology.<sup>112</sup> Somewhat ingloriously, its second edition explains: "In Mr Wedgwood's opinion I have failed because and only because, I have not proved that '*the ringing of the ears is not a pure sensation*' . . . The verdict bears its condemnation in its own wording. . . . How could we have the sensation of ringing in the ear without being possessed of one ear at least?

<sup>107</sup>George Berkeley, *A Treatise Concerning the Principles of Human Knowledge*, Part 1, section 39, in *The Works of George Berkeley, Bishop of Cloyne*, ed. T. E. Jessop and A. A. Luce, 9 vols. (London: Nelson, 1948–57), II, 57.

<sup>108</sup>One example is the writer William Hazlitt, who likened Berkeley's text to a fine gallery, as a "palace of thought—another universe, built of air, of shadows, of colours." See Hazlitt, *Sketches of the Principal Pictures Galleries in England*, in *The Complete Works of William Hazlitt*, ed. P. P. Howe, 21 vols. (London: J. M. Dent: 1930–34), X, 19. Regarding material thought, Hazlitt, in "A Farewell to Essay-Writing," explains: "I have brooded over an idea till it has become a kind of substance in my brain" and later, "my ideas, from their sinewy texture, have been to me in the nature of realities." *Uncollected Essays*, XVII, 317, 320.

<sup>109</sup>Jobert, *Pure Sounds*, 42.

<sup>110</sup>*Ibid.*, 18.

<sup>111</sup>"Two men are conversing in a room, recorded by a camera and by a dictaphone, while a third man observes secretly from behind a curtain. If the dictaphone and the hidden man give the same report of the conversation," he observes, "one must suppose some causal connection, since otherwise the coincidence is in the highest degree improbable." Russell, *The Analysis of Matter*, 209–10.

<sup>112</sup>Hensleigh Wedgwood, *The Principles of Geometrical Demonstration* (London: Taylor and Walton, 1844), and *On the Development of the Understanding* (London: Taylor and Walton, 1848).

Is not a material ear a condition *sine qua non* of a sensation of sound?"<sup>113</sup> Experiments on bone conduction as early as 1858 indicate Jobert was on the wrong path,<sup>114</sup> but for the purposes of his philosophical argument, imagined sound and auscultation do not preclude the existence of real sound, and by extension, a real external world. And he closed defiantly by challenging his opponent to offer a positive doctrine for sound *as* pure sensation, rather than hiding behind a negation.

In the end, the questions driving this extraordinary wager come down to two principal matters: that scientific authorities such as Bois-Reymond accepted the existence of a real material world—including sonic vibrations—in the absence of a perceiving subject; that sound's place in this "real" external world is both ponderable (when perceived, and hence potentially empirical) and imponderable (when witnessed by no perceiving subject). The scattered discourse of sonic ambiguity is retrievable largely via the resources of non-canonical writings on acoustics, and might simply be taken as a way station in the reception history of Müller's specific sense energies. As such we may not regard it as particular to sound and acoustics. But sound runs like a red thread in the discussion: it is "sonically haunted" as Veit Erlmann said of the modern condition.<sup>115</sup> And if we return one last time to Helmholtz's lecture on the facts in perception, it becomes clear that affordances particular to auditory perception distinguish sound from other modalities. Human hearing is at once implicated as more precise in its relation to a putative external reality than vision, and as uniquely structured to differentiate unique pitches, i.e., its one-to-one physiological (and tonotopic) mapping of vibration onto hair cell (and brain fiber) is direct. Whereas it is possible for cone cells to form the same shades of white and black from different combinations of the three primary colors, frequencies of pitch are unique, repeating at the

<sup>113</sup>Jobert, *Pure Sounds*, 33–34.

<sup>114</sup>Dr. Erhard, "The Diagnosis of Deafness," *American Journal of the American Sciences* 36 (1858): 536–37.

<sup>115</sup>Veit Erlmann, "But What of the Ethnographic Ear?" *Hearing Cultures: Essays on Sound, Listening and Modernity*, ed. Erlmann (Oxford: Berg, 2004), 5.

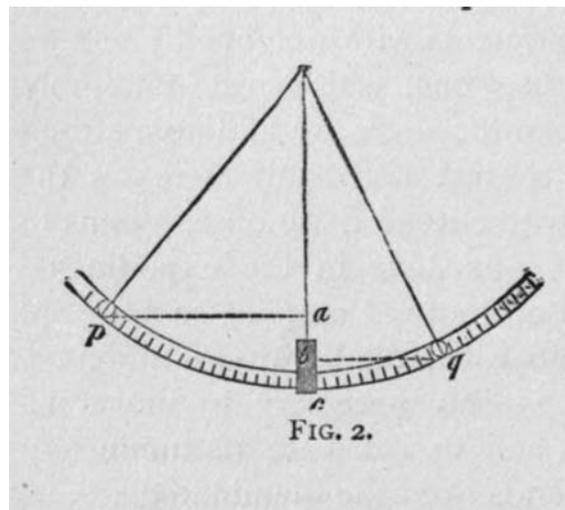


Plate 4: Wilhelm Wundt's *sound pendulum*, in *Lectures on Human and Animal Psychology*, 30.

octave, but not identically.<sup>116</sup> Second, as Wilhelm Wundt pointed out in 1863, the capacity of different sense organs to detect differences of stimulus intensity varies significantly. While vision requires only a 1/100 change in intensity, and muscles require 1/17, sound and heat require a difference in intensity of 1/3 for the change to be noticeable.<sup>117</sup> (His *sound pendulum*, a schematic device in which suspended ivory balls [P/q] fall onto a woodblock [b] from determinate heights, shown as plate 4, illustrates the banality of measuring the threshold for perceiving changes in sound intensity.)<sup>118</sup> Such relative imprecision, following Schleiden's complaint about

<sup>116</sup>"No chord sounds like any other chord which is composed of different sounds, while in the eye precisely the analogue is the case: for a similar shade of white can be produced by red and green-blue of the spectrum; by yellow and ultramarine blue; by green-yellow and violet; by green, red, and violet; or in any case, by two, three or all of these mixtures together. Were the relations in the ear similar, then the chords C and F would be equal-sounding with D and G, with E and A, or with C, D, E, F, A, G, A, etc." Helmholtz, "The Facts," 346–47.

<sup>117</sup>Wundt adduces this comparison to support a general law for apprehending sensation differences: "that the increase of stimulus necessary to produce an equally noticeable difference of sensation ears a constant ratio to the total stimulus-intensity." Wundt, *Lectures on Human and Animal Psychology* [1863], 2nd German edn., trans. J. E. Creighton and E. B. Titchener (New York: Macmillan, 1907), 31.

<sup>118</sup>*Ibid.*, 30.

our poor capacity to determine the direction of a sound source, lends weight to the notion that sound and abstraction were associable on the grounds of imprecision. By positioning artistic instinct as law-defining for perception, Helmholtz inverted this characteristic imprecision into a monumental strength, and thereby sought a means of reconciling no less than the physicalist and experiential account of sound, a materialist and phenomenological account of the world.

Sound's lack of intuitively tangible matter during this period set it up as a troublesome object for epistemology. It would remain so, prompting recent studies in sonic virtuality to address wholly related tangles over definition, disciplinary perspective, and reality principle.<sup>119</sup> During the late nineteenth century, the perception of space remained perhaps one of the most closely related phenomena in that both space and sound are invisible, intangible, and inferred at a distance by sense tactility in the absence of touch. It is no coincidence, then, that the Land-Helmholtz debate arose in the context of whether intuitions of non-Euclidian space are possible via mathematical axioms. At stake was nothing less than the discipline of philosophy itself. If it were established beyond doubt that the "object" and the "real" are simply one and the same, Land had protested, "all examination of [philosophical] questions and theories could become an empty ceremony."<sup>120</sup> The liminal condition of sound and space resisted any such conflation, safeguarding—by implication—the enterprise of philosophy, no less, in the late century. In a modern context, something of this condition is captured in Jean-Luc Nancy's concept of the areal, defined as both: "the nature and specificity of an *aire* [area]" but also suggestive of "a lack of reality, or rather a slight, faint, suspended reality."<sup>121</sup> Perhaps the slight reality of nineteenth-century sound—

traceable as neither immaterial substance nor pure sensation—could only crystallize in relation to spatial intuition, as an invitation to abstraction.

If, as Helmholtz claimed, the impulse to rationalize experience into laws is innately human, the complementary impulse to possess the object of sensory fascination is no less relevant. Underlying the quest for understanding sonic experience after the dam of idealism had broken was therefore in part a desire for tactile ownership, for possessing the object of musical experience. As Nancy puts it: "We're obsessed with showing a *this*, and with showing (ourselves) that this *this*, here, *is* the thing we can't see or touch, either here or anywhere else—and that *this* is *that*, not just in any way, but *as its body* . . . that's our obsession. . . . We shall have wanted the assurance, the unconditional certainty of a *THIS IS: here it is*, nothing more, absolutely, here it is, here, this one, *the same thing*."<sup>122</sup> If such comments mock the quest for the absolute as a problem of possession, Helmholtz ultimately aligned himself with a quest for the real, but as a problem of lawfulness. By using this to bridge the epistemology of sense organs and artistic perception, he envisaged drawing artistic knowledge into the methods of empiricism. But in a reciprocal gesture, this also achieved an unspoken corollary: it justified a quantitative platform for aesthetics. 

### **Abstract.**

In 1878, at the height of his fame, Helmholtz asked what was objective in perception, declaring that—in contrast to empirical science—it is the "artist [who] has beheld the real." His lecture sought to show how sensory perception can be law-like, and how the effects of art are ultimately grounded in such law-likeness. Such a claim for an objective measure of perception was not unprecedented, yet it failed to distinguish cleanly between what is objective and what is real, opening up a discursive space regarding what sound "is," and what its objective perception may be. Its arguments followed calls for "a science of beauty" based on number, and was motivated, in part, by Helmholtz's attempt to distance himself from the "weaknesses of Romanticism." This article argues that Helmholtz's

<sup>119</sup>See most obviously Mark Grimshaw and Tom Garner, *Sonic Virtuality: Sound as Emergent Perception* (New York: Oxford University Press, 2015); and as well as Holger Schulze, *The Sonic Persona: An Anthropology of Sound* (New York: Bloomsbury, 2018), 3–30ff.

<sup>120</sup>Land, "Kant's Space and Modern Mathematics," 40.

<sup>121</sup>Jean-Luc Nancy, *Corpus*, trans. Richard A. Rand (New York: Fordham University Press, 2008), 43.

<sup>122</sup>*Ibid.*, 3.

bold claims were only possible on the basis of the writings of German materialists during the 1840s and 50s, and because sound had been figured for decades as an ambiguous object.

On this basis, the article considers the role of sound within epistemological debates over sense perception and concepts of the real during the later nineteenth century. It examines the ways in which sound's abstract character became co-opted within Anglo-German discourse concerning objective perception and the scientifically real, initially through the lens of Helmholtz's 1878 lecture, but later broadening this focus to include

the mid-century architects of a philosophical materialism, as well as their detractors. A closing case study, a closely documented wager between a geologist and a philosopher about the "real" of sound ca. 1850, demonstrates the imaginative uses of sound as a metonym for philosophical debate. This raises questions about the relation of sensation and number, the contested affinity between sound and concepts of the absolute, and the underlying desire to possess objects of sensory experience. Keywords: Helmholtz, objectivity, perception, sound, reality, materialism