6 From Distant Sounds to Aeolian Ears
Ernst Kapp's Auditory Prosthesis

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Introduction

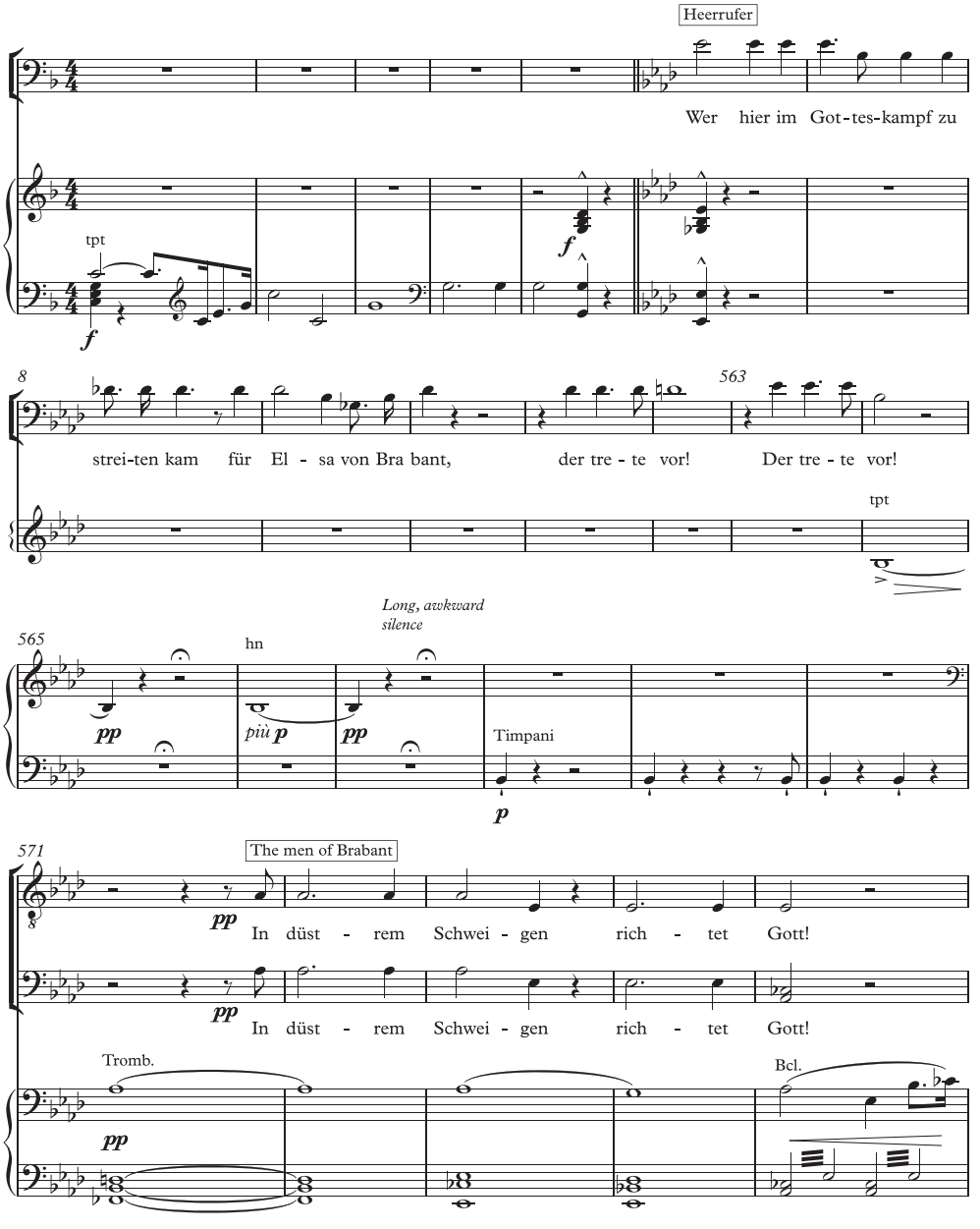
A well-known depiction of collective listening on the operatic stage occurs in Act I of Wagner's *Lohengrin* (1850): the Herald asks the assembled Brabantians whether there is a champion among them to defend Elsa against the accusation by her former suitor, Friedrich, that she murdered her younger brother Gottfried, the Duke of Brabant. These are uncomfortable moments for Elsa. There is an eerie silence after the first question ('he is surely a long way off and could not hear'), and there appears – for a time at least – to be no reply to the second question either (Example 6.1). Wagner's stage directions describe these as a 'long silence' and a 'long, awkward silence' respectively,[1] implying that the growing tension of the second silence – with added tritone in the bass tuba – is akin to that moment after an awkward exchange in public, where the tumbleweed rolls, the wind blows. A doubtful four-part chorus enters *piano* after both points of asking, confirming retrospectively that it was principally the collective that had been listening.

Quite how the Herald's question, via a four-strong trumpet call, reaches Lohengrin nearly 400 miles away has intrigued media theorists for some time – with suggestions ranging from the use of radio waves to the telephone and an extended organic nervous system.[2] For present purposes, I am more concerned with the theories of listening that such a moment suggests, and how the emergent concept of aurality, defined for our purposes as the phenomenal and discursive field of sounding culture, establishes common ground and even a certain reciprocity with contemporary discourses of signalling within the physical and biological sciences.

[1] 'Langes Stillschweigen' / 'Wiederum langes, gespanntes Stillschweigen', *Lohengrin*, Act I scene 2. See Wagner 1911–14, 2:72.

[2] On radio waves, see Kittler 1987, 206. On the telephone, see Rehding 2006, 266. On the extended organic nervous system, see Trippett 2013, 377–9.

Example 6.1 Richard Wagner, *Lohengrin*, Act I scene 2, bb. 551–575



Petitions to 'listen' in a libretto are happily ignored by characters within opera plots. Dramaturgically, this stokes narrative tension. Witness the Rhinemaidens' forlorn entreaty against taking the gold ('Höre, was wir dich heissen!') or Wotan's threat against Loge to keep

his word ('Jetzt hör', Störrischer! Halte Stich!'). When warnings *are* taken seriously, they tend merely to fulfil established plot lines, e.g. the Queen's caution for Anna to abandon her son in Marschner's *Hans Heiling* ('Hör' auf mein Wort, Betörtes Menschenkind, Ich bin gekommen dich zu warnen'). Anna had already rediscovered her love for Konrad before the Queen warded her away from Heilig; her words become a redundant prop that brings about what was already in train. The imperative to *listen!* is rarely diagnostic, in other words, and remains on the surface of an operatic narrative.

With diegetic objects to listen *to*, moments of listening in opera can also convey a character's sensory orientation, placing them in spatialised, tactile communication with their environment: Tamino hears a flute ('Was hör ich? Wo bin ich? Welch' unbekannter Ort!'); Siegfried hears a bird ('Du holdes Vöglein! Dich hört' ich noch nie: bist du im Wald hier daheim?'); Gurnemanz hears Christian bells as Kundry receives her baptism ('Mittag: – Die Stund ist da'); Pelléas asks Mélisande if she hears the closing of the castle doors ('Écoute! Écoute!'). Such statements direct the audience's attention to sonic objects as much as the character's. By drawing attention to the non-diegetic scene as something artificial they arguably give rise to a certain self-consciousness, making listeners self-aware of being listening subjects within a performance. In each case, sensory immersion on stage conveys a character's proprioception, serving as a point of orientation wherein characters cannot control their reaction; the conventions of stage realism dictate that they must ask after sound or noise rising above the non-diegetic threshold, ever that *frisson nouveau* for an audience.

As inserted layers of media, diegetic sounds provide tactile moments of distraction, then, moments that for Walter Benjamin 'should be conceived as a physiological phenomenon'.[3] He reads sensory attention and distraction as part of the currency of epiphany, a kind of corporeal catharsis inherent within our relation to any media where distraction is accompanied by cognitive realisation. Beyond an idealist metaphysics that understands 'listening as thinking', in other words, modern concepts of listening relate to sense organs and must harbour an irreducibly physical element, what Helmholtz – perhaps the most widely read acoustician and physiologist of the nineteenth century – called 'the corporeal ear' (*das körperliche Ohr*) in contradistinction to 'the mental ear' (*das*

[3] Benjamin 2008, 56.

geistige Ohr).[4] Yet *how* a character on stage listens, and the physiological status – if any – of their ears, is less easy to grasp.[5] It relates in the first instance to contemporary discourses of audition, itself a reflexive historical category, but one that draws together in a continuous movement the separate discursive layers of operatic narrative and empirical science. By positing a structural link between activities of the stage and in the stalls, this approach offers up a liminal space wherein each can be read in terms of the other: historical operatic narrative vis-à-vis contemporary scientific understanding; acts of performance vis-à-vis acts of witnessing.

Even if we accept this approach, to listen is, at first blush, to be attentive, passive and, by implication, silent.[6] Yet the fabric of nineteenth-century opera, as a continuous audio-visual experience, is bound to active powers of expression, movement and persuasion – qualities basic to the semiotic exchange within which opera's narrative structures can function: from non-diegetic topoi to *Leitmotive*, or – adopting contemporary language – what E. T. A. Hoffman called the combination of opera's 'individualized language' of word, action, and music 'with the universal language of music'.[7] In the context of music's expressive powers, traceable to the hypertrope of Orpheus, to depict the sound of *listening* in opera would be to depict music's negative or opposite – the silent condition of one's openness to receiving auditory expression. It is music's vacuum. Such logic holds that it is counterintuitive to portray auditory attention because sound itself is both its object and its principal means of expression.[8] The channels are in conflict.

[4] On listening as thinking see Bonds 2006, 29–43; Helmholtz 1863, 456. For an extensive discussion of Helmholtz's dualism and his positioning between discursive fields, see Steege 2012, 58–79.

[5] In an enquiry into the semiotic levels of Wagner's *Leitmotive*, Edward Cone asked what level of awareness characters have of the 'denotative significance – nay the very existence – of the motifs they employ'. His concept of 'motivic emergence', where symbolic sounds emerge into the world of actual sounds while retaining their symbolic character (e.g. Siegfried's horn call), is based on a deductive reading of individual characters' psychology – awareness, memory, comprehension – across the history of such motives. See Cone 2010, 80–105.

[6] This obtains principally in relation to listening in the historical age of the musical work, an 'ideology' of aesthetics and etiquette mapped out by Lydia Goehr (2007). But see also Johnson's source-rich account of the shifting listening practices at the Paris Opéra, and the competing hierarchies of attentiveness and individual judgment vis-à-vis the influence of received opinion: 'audiences now paid at least as much attention to the performance as to the notable in the boxes' (Johnson 1995, 69).

[7] Hoffmann 1989, 152.

[8] Illustrating the extent to which listening *within* music is a deceptively simple idea, Jean-Luc Nancy (2008), after considering a composer's tempo marking of *ascoltando* (listening) – music

Yet listening has always been a two-way street. It involves actively making sense of what is heard as well as receiving any intrinsic properties of the sound produced. This is perhaps most pronounced in verbal speech, though structural linguists from Saussure to Jakobson have long maintained that all communication rests on a principle of common coding.[9] In his *Sensualist Philosophy* of 1876, the American theologian Robert Dabney underscored this principle in response to the question: 'Do [physical] sensations cause volitions?' His negative answer was justified by a simple illustration:

> Let us suppose that the sturdy Briton knows only his mother-tongue; and then shout the insult in French. No flush burns in his face; no muscle is moved to strike. But now let a bystander translate the insult into English, reciting it in the softest tone, and the forcible manifestations of anger are at once made. Why this? Evidently because sound was not even the occasion, much less the cause, of resentment, at all: but *an idea*¸ a thought, of which the sound was the symbol.[10]

Beyond the frame of language and representation, Edward T. Cone made much the same point for our comprehension of musical sounds when he identified 'a complicated interchange between hearing the music and knowing the music', which amounts to passively receiving the sound and mentally retracing the composition, which would then recursively feed back into one's experience of future hearings.[11]

Both examples touch on what we could call *listener*-response theory, and while the methods of such criticism emanate from the Constance School of *Rezeptionsästhetik* and reader-response theorists of the 1970s and 1980s, such methods find a number of nineteenth-century precedents. A decade before Charles Wheatstone's playful 'experiments in audition' reported how cranium resonance appears to augment sound, the German political economist Adam Mueller argued in his 1816 essay on 'The Art of Listening' that 'to be receptive, to *receive* with understanding and dignity is everywhere just as great an art as to act, or to *give* with intelligence, with taste, and with power'.[12] In essence, his thesis was that the arts of oratory and listening were interdependent for those on stage. But he also effectively presented a typology of listening – fully a century and a half before Theodor W. Adorno's sociological types – in which he distinguished the phenomenon of collective attention from individual perception.[13] While,

to be played as though listening – concluded that the implied listening subject could only be the music itself, that the 'musical work' is listening to itself.

[9] See Jakobson 1971; 1987, 451. [10] Dabney 1876, 150–1. [11] Cone 2010, 59.
[12] Wheatstone 2011a; A. Müller 1996, 131. [13] Adorno 1989, 2.

in theatres, the best actors listen through social codes of response – laughter, coughing, silence – 'a large assembly may be overwhelmed by the power of speech in such a way that it forgets the conventional response, that it listens as with a single ear and every breath is concerned only with how to fit in the speech's occasional pauses'.[14] This breathless silence would seem to be written into the score in the response Wagner assigns his Brabantian crowd in *Lohengrin*. Its focus on attention to the absence of audible sound (from the grail knight) seemingly foregrounds the need – in Wheatstone's words – for 'an instrument which, from its rendering audible the weakest sounds, may with propriety be named a Microphone'.[15] In such a reading, Elsa's technological problem is as much one of listening as it is of signal transmission, in other words.

Auditory Science and the Lute of 3,000 Strings

Since Ernst Chladni's experiments with sound figures on glass in 1787, the physiology of the ear has been a corollary to the study of acoustics. It was of course Helmholtz who was chiefly responsible for disseminating the view, advanced in a public lecture at Bonn University during the winter of 1857, that there is a physical basis to our perception of harmonic consonance in music. As is well known, he articulated a purely physiological theory for how complex waves were analysed into their constituent periodic forms, after Joseph Fourier's *Théorie analytique de la chaleur* (1822). This explained the impression of consonance and dissonance by a theory of ratios or coincidence between periodic frequencies, that is, by the coincidence or separation of harmonics. Non-coincident harmonics cause beats and unevenness through the mixture of different tones that occur, and these are manifest through physical sensations within the Organ of Corti. By comparison with the work of later researchers, notably Carl Stumpf's theory of fusion (*Verschmelzung*), it becomes clear, however, that this was not a theory of consonance, but a theory of dissonance, in which consonance is defined negatively by the absence of physiologically determinable dissonant features.[16]

[14] A. Müller 1996, 135. [15] Wheatstone 2011a, 32.

[16] Stumpf's concept of fusion is first advanced in the second volume of *Tonpsychologie* (1883–90); the two tones of perfect consonances are perceived as a single entity, where their degree of consonance is determined by the integer ratios of their frequencies. For the relationship between Helmholtz and Stumpf, see Motte-Haber 2012, 3–16.

On this material basis, John Tyndall, the English physicist remembered principally for his work on heat and infrared radiation, gave a series of public lectures at London's Royal Institution in 1867 entitled 'Sound' in which he described the laws that determine the physical behaviour of vibrational frequencies under different conditions, their propagation through air, water and solid matter, as well as the physiological structure of the ear and its means of transmitting sound to the auditory nerve. (It may be no coincidence that earlier that year, Giuseppe Verdi's latest opera *Don Carlos* would open by establishing an auditory perspective within space and time; the eponymous bass first becomes rooted, dramaturgically, by listening to the dying strains of an offstage horn-call: '[*he stops and listens*] . . . the sound . . . dies away among the deep shadows . . . [*he listens*] All is silent!') Tyndall had read Helmholtz's *Die Lehre von den Tonempfindungen* (1863) with its diagnosis of the automatic mechanism of sympathetic resonance, and praised the 'thoroughness and excellence of the work' in his preface.[17] By co-opting the physiology of the ear within a system of physical laws, his approach tacitly rejected the contemporary doctrine of psychophysics, representing instead a mechanical epistemology of sound perception in which the ear becomes a physical instrument, representative of a view traceable to the French monists from Julien Offray de la Mettrie to the positivism of August Comte: that the human body is a self-regulating machine that obeys the same Newtonian laws as must any matter.

Here is Tyndall's summary of the transmission of force that results in the perception of sound:

> when the tympanic membrane receives a shock, that shock is transmitted through the series of bones [hammer, anvil, and stirrup], and is concentrated on the membrane against which the base of the stirrup bone is planted. That membrane transfers the shock to the water of the labyrinth, which, in its turn, transfers it to the nerves.[18]

Based on the principle of blind causality, this is little more than a summary of existing knowledge. But it is the stark absence of mental activity that gives us pause, for the interior perception of music is intimately, and not straightforwardly, linked to its material status as vibrational stimuli – it's easy to get lost in this inward space, in other words, and the inner ear has, for centuries, been likened to a 'labyrinth' for reasons poetic as well as

[17] Tyndall 1867, viii. [18] Tyndall 1867, 324.

mimetic.[19] ('The Labyrinth' is of course the anatomical term for this region of the inner ear.)

Yet following the work of Ernst Heinrich Weber on tactile sense perception during the 1830s, the question of how sound sensations were transmitted to the brain attracted a number of mechanistic theories from Anglo-German scientists that rejected the basis of sensory perception in the psyche alone.[20] And there is flinty common ground here between the so-called scientific materialists (Ludwig Büchner, Jacob Moleschott, Karl Vogt) and the more respected academic psychologists centred at the Berlin Academy of Sciences (Helmholtz, Emil du Bois-Reymond, Ernst von Brücke and Carl Ludwig – the so-called 'physiological reductionists'). The latter unveiled a new programme for physiology in 1847 that denounced *Naturphilosophie*, vitalism and speculative metaphysics just as vehemently as did materialists, even if materialists constituted 'intellects of a lower order' due to their insufficiently critical attitudes towards empirical methods.[21] Such distinctions detracted little from the fact that an array of scientists involved in anatomy had been working on the assumption of a mechanical body conceivable as an assemblage. This material model of the body had the character of orthodoxy, rather than radicalism, within non-theological circles, lending credibility to Hoffmann's playful deceit of Olympia as a passable, lovable human in *Der Sandmann* (1816) or Carlo Collodi's animate puppet *Pinocchio* (1883).[22]

But materialism is perhaps a misleading term to the extent that its mid-century proponents were still driven by *ideas* in their pursuit of an understanding of the world. And as Frederick Gregory argued long ago, they were all scholarly children of Ludwig Feuerbach, for whom: 'Truth, reality, and sensation are identical.'[23] A striking case – coeval with Helmholtz's research into the physiology of the ear at Bonn University between 1855 and 1858 – is Heinrich Czolbe, perhaps the most fanatical academic physician of the century to pursue a worldview exclusively through principles of sensation. Czolbe's Sensationalism (*Sensualismus*) constituted a monist stance – advanced in his *Neue Darstellung des Sensualismus* (1855) – that sought to consolidate into a single worldview what he felt had been advanced only in discontinuous fragments by figures such as Feuerbach, Vogt and Moleschott. 'Clear concepts' are only accessible via direct sensations, he maintained, where what is super-sensible amounts to an 'unclear concept':

[19] Politzer 1907/13, 1:27. [20] Weber 1834. [21] Merz 1903–14, 3:560. [22] See Pizzi 2012.
[23] Feuerbach 1986, 51.

If we want to clarify by deduction what is unknown, this can only occur through mediation with what is known, not through what is again unknown. If someone wishes to make a fluid clear, and at the same time casts something unclear into it, one would naturally call him foolish. Yet a similar absurdity appears to govern our common logic.[24]

It is on the basis of such logic that Czolbe articulated a worldview based exclusively on immediate sensation. He argued that this, or sensory qualities, are the effect of stimuli propagated mechanically in precisely the form in which they are created and received, i.e. unchanged; hence the quality of sound (or colour, or heat) is somehow inherent in the very form of its propagation along nerves.[25] It was, in effect, a theory of psychic automatism – the 'making-material' of thought and expression – half a century before André Breton's surrealist manifesto.[26]

In his subsequent monograph, *Die Grenzen und der Ursprung der menschlichen Erkenntniss im Gegensatze zu Kant und Hegel* (1865), Czolbe ignored the complaint that there was a great discrepancy between the tiny area of stimulation within the optical and auditory nerves compared to the powerful impression received by our eyes and ears, declaring simply that the discrepancy 'seems to me explicable through the mechanical propagation of disturbance or outward projection'.[27] He also maintained that the world in its physical condition is eternal, and disregarded the counter-proofs of science as 'mere illusion, which on further investigation would disappear'.[28] These arguments failed to persuade a majority of respondents, and Friedrich Lange, the leading mid-century historian of materialism, impugned the theories of unchanging matter and individual character of sense propagation as two 'incurable weaknesses' of Czolbe's philosophy.[29]

[24] 'Wenn wir Unbekanntes durch Schlüsse erklären wollen, kann dies doch nur durch Vermittelung des Bekannten, nicht aber wiederum durch Unbekanntes geschen. Will jemand eine Flüssigkeit klar machen und wirft dabei Unklares hinein, wird man ihn doch thöricht nennen. Eine ähnliche Absurdität aber scheint in der gewöhnlichen Logik zu herrschen.' Czolbe 1855, 2.

[25] Czolbe 1855, 13–14.

[26] Czolbe's philosophy should be distinguished from the more recent concept in social psychology of conscious automatism, a deterministic philosophy that holds humans are conscious but respond as automata according to prior conditioning; free will, in this context, is seen as illusory. See particularly Kane 2011.

[27] 'Die gewaltige Größe des Sehfeldes beim Sehen und auch des Tonraumes bem Anhören von Musik im Verhältnis zu den ungemein kleinen gereizten Stellen im Verlaufe des She- und Hörnerven scheint mir durch obige mechanische Ausbreitung der Störung, oder Projection nach Aussen erklärlich.' Czolbe 1865, 205.

[28] Friedrich A. Lange's ([1865] 1880, 2:291) characterisation .

[29] Lange [1865] 1880, 2:291.

Could directed attention also become explicable through physiology? With a similar reluctance to embrace concepts of a supersensible mind in dialogue with the sensory world, the philosopher-psychologist Georg Elias Müller offered a more metaphysical theory of perception in his *Zur Theorie der sinnlichen Aufmerksamkeit* (1873). Relying on neurophysiological speculation, Müller argued that 'the capacity to affect the soul, which *certain physical processes in the brain* possess, will be increased or decreased or entirely suspended under the influence of the activity of sensory attention'.[30] In other words, attention directed to sounds – whether internally or externally directed thinking: the Brabantians listening out for Elsa's champion – enacts physical changes in the listening body, rendering auditory perception, at root, still a material form of perception in Müller's schema.

There is, of course, a rich array of possible contributors to the Anglo-German discourse on theories of audition; returning to Tyndall's mechanical epistemology, it is perhaps with such debates in mind that he admits the process of sound transmission is 'not direct' within the inner ear but in passing through the membranous labyrinth, where the numerous hair-like appendages are set in motion according to their individual periodic frequencies, he refers to the central agent of signal processing, the Organ of Corti, as a kind of mechanical technology, namely:

> a wonderful organ, which is to all appearance a musical instrument, with its chords so stretched as to accept vibrations of different periods, and transmit them to the nerve filaments which traverse the organ. Within the ears of men, and without their knowledge or contrivance, *this lute of 3,000 strings* has existed for ages, accepting the music of the outer world and rendering it fit for reception by the brain. Each musical tremor which falls upon this organ selects from its tensioned fibres the one appropriate to its own pitch, and throws that fibre into unisonant vibration.[31]

While a more common metaphor was the overstrung piano (traceable to 1737, and notably employed in Helmholtz's *Tonempfindungen*),[32] Tyndall's 'lute of 3,000 strings', poetically responsive to the slightest external stimulation by each string's predetermined frequency response,

[30] 'Die Wirkungsfähigkeit auf die Seele, welche gewisse physische Vorgänge im Centralorgane besitzen, [wird] durch die Thätigkeit der sinnlichen Aufmerksamkeit beeinflusst, vermehrt oder vermindert oder ganz aufgehoben.' G. Müller 1873, 1–2. Emphasis added.

[31] Tyndall 1867, 325. My emphasis.

[32] The metaphor of the piano's set of tensile strings, progressively ordered by resonating frequency, and hence capable of analysing the mass of acoustic vibrations projected onto a piano – per a Fourier analysis – would be adopted by Helmholtz, Herbert Spencer and James Sully among others.

belongs to a broader archetype of instruments that draw on naturally occurring sound. The oldest model is more familiar under a different name, that most natural and most automatic of instruments: the Aeolian harp. Other scientists made the same connection more directly. The German acoustician Franz Josef Pisco asked rhetorically: 'Can we not conceive of the hairs of Corti as a harp in the ear that is excited to sympathetic vibration through resonance?'[33] The Leipzig-based physiologist Johann N. Czermak mooted the same analogy in a series of popular lectures from 1869: 'while the rods of Corti, corresponding to the narrowing of the lamina spiralis from bottom to top, gradually decrease in length, they thereby form a kind of regular, graded stringing that we recognise in the *harp* and in the piano. The cochlea is in fact a type of miniature piano with nerves that we have in our ears.'[34] And even from the other side of the Atlantic, in a quite separate discursive field, a Pittsburgh-based medical doctor, William Henry Winslow, declared simply in a treatise on diseases of the ear from 1882, that 'the organ of Corti *is* the Aeolian harp, which responds to every vibration of the tympanic membrane, and furnishes the music of the universe'.[35]

Aeolian Ears

With this substantialist claim, the impulse towards automatic audition voiced by Pisco, Czermak, Winslow et al. broaches the expansive literary trope of the Aeolian harp as the romantic analogue of mind – that figurative mediator between outer motion and inner emotion. In this pairing, both pieces of apparatus – ear and Aeolian harp – are at once deterministic and inscrutable. The harp's response to vibrating air is automatic, irresistible, just like the microscopic hairs lining the cochlea duct; yet the harp brings forth sounds whose emotional effect within the mind are as physically untraceable as the source of the harp's stimulation.

[33] 'Und kann man die *Corti*'schen Fasern nicht auch als Harfe im Ohr auffassen, welche durch die Resonanz zu Mitschwingungen angeregt wird?' Pisco, *Die Akustik der Neuzeit* (n.d.). Cited in Kapp 1877, 92.

[34] 'Indem die *Corti*'schen Stäbchen, entsprechend der Verschmälerung der Spiralplatte von unten nach oben, allmälig an Länge abnehmen, so bilden sie eine Art regelmässig abgestufter Besaitung, wir [sic] wir eine solche an der *Harfe* und am Clavier kennen. Ein solches Miniaturclavier mit Nerven ist in der That die *Schnecke*, die wir im Ohre haben.' In Czermak 1869, 51.

[35] Winslow 1882, 73.

The same tension arguably pervades the many poetic evocations of wind harps within European poetry of the early nineteenth century. Samuel Taylor Coleridge lucidly connected nature to the creative imagination through the emblem of a harp that itself is physically part of nature:

> And what if all of animated nature
> Be but organic Harps diversely fram'd,
> That tremble into thought, as o'er them sweeps
> Plastic and vast, one intellectual breeze,
> At once the Soul of each, and God of all? *('The Eolian Harp', 1795–96)*

And the concealed origins of the breeze, the metaphor par excellence for divine stimulation, finds voice in Novalis's claim for artworks that are ontic, sensorially complete in themselves, independent of any viewers' perception: 'The phenomena must be there, like the notes on an Aeolian harp, all at once, without origin – without revealing their instrument.'[36]

This is not the place to retrace the rich metaphor of the harp in all its poetic resonance.[37] Suffice it to say that in its earliest instantiation in Western literature, the wind harp was a scientific instrument coupled to automation; Athanasius Kircher referred to it a 'self-operating harmonic device' (*machinam harmonicam automatam*) in his *Musurgia Universalis* (1650).[38] Hence the poetic valency of the device, typified in Percy Bysshe Shelley's call to 'make me thy lyre, even as the forest is' or William Wordsworth's *Prelude*, which speaks of 'Aeolian visitations', can be considered chronologically secondary to the scientific principle of an automatic sounding instrument.

By the 1870s, the poetic associations of this fabled instrument were consonant, if also contrastive, with the modern scientific discourse of the wind-harp. Its principle of air-powered sound was not structurally distinct to Cagniard de la Tour's siren, which emitted tiny puffs of air through a perforated rotating disc to create the desired pitch. And in an earlier lecture, Tyndall explains the wind harp as a purely physical apparatus, as a mechanical process, devoid of poetic association:

[36] Novalis 1967, 446.

[37] See Brown 1970, 3: 73–90; and Hankins and Silvermann 1995. For a specific study of breeze as a signifier for mental creativity, see M. H. Abrams (1957, 113), for whom it comes as no surprise that the poetry of Coleridge, Wordsworth, Shelley and Byron should be 'so thoroughly ventilated'.

[38] Kircher [1650] 1970, 2:352.

The sounds of the Eolian harp are produced by the division of suitably stretched strings into a greater or less number of harmonic parts by a current of air passing over them. The instrument is usually placed in a window between the sash and frame, so as to leave no way open to the entrance of the air except over the strings.[39]

As if to underscore the de-poeticised conception, he even passes on practical advice about how to build one. Drawing on Wheatstone's writings, he recommends readers find an ill-fitting door, and place a violin string at the bottom of it. 'When the door is shut, the current of air entering beneath sets the string in vibration', he explains, 'and when a fire is in the room, the vibrations are so intense that a great variety of sounds are simultaneously produced.'[40] Practical exemplification here sits alongside poetic association without implying any synthesis.

Perhaps the apex of profane adaptions of the Aoelian harp or 'voice of nature' is the so-called weather harp. Already eighty years old by the time of Tyndall's lectures, this apparatus is indicative of the scientific identity that persisted alongside the poetic conception of automatic harps among Romantic poets in the early decades of the nineteenth century. It had been invented by Giulio Cesare Gattoni in Como back in 1785, and replicated by Wilhelm Hass in Basel two years later. This saw the device adapted to barometric purposes where changes in weather were announced through sound. Haas trained fifteen iron wires – each 320 feet in length, of varying thickness, and positioned two inches apart – from atop his garden house to the bottom of the garden. As Georg Lichtenberg, put it in 1797: 'with every change in the weather, the strings resonate, sometimes we think we hear the sound of a tea kettle before the water come to the boil, sometime a harmonica, here a distant chiming of bells, there an organ. Often the sound is so loud that it disturbs the garden-room concert.'[41] Such comic utilitarianism contrasts with the Greek heritage of Aeolus, ruler of the winds, and his instrument's iconographic precursor, the lyre, which, as Friedrich Kittler once argued, is not to be regarded as a simple tool or instrument for illustrating harmonic ratios but a gateway between what exists and what is perceptible. It is 'a magical thing that connects mathematics to the domain of the senses' because it translates the sensual and the symbolic directly into one another.[42] Likewise, the jangling weather harp, automatically

[39] Tyndall 1867, 123. [40] Tyndall 1867, 123.

[41] 'Bey jeder Veränderung des Wetters tönen diese Saiten, bald glaubt man den Ton eines Theekessels zu hören, ehe das Wasser in demselben zum Sieden kommt, bald eine Harmonika, bald ein fernes Geläute, bald eine Orgel. Oft wird das Getöne so stark, daß das Concert im Garten-Saale gestört wird.' Lichtenberg 1789, 130.

[42] Kittler 2006, 56.

responsive to nature's inconstant breezes, was more profound as a gateway between nature and expression than as acoustic sound.

However unlikely the ear-as-automatic-harp may appear alongside emerging theories of psychology, what Helmholtz called 'the mental ear of the imagination', the cultural work accomplished by the analogy presents an unfamiliar model of the listening subject.[43] Listening – in this view – approached the automatism of a mechanical reflex; its pretext was the morphological kinship between the centre of the inner ear and the fabled scientific instrument, but the correspondence exceeds morphology alone, as we shall see.

Organprojektion as Prosthesis

The conceptual basis for reading human organs in terms of technologies – whether mythic or scientific – in the late nineteenth century was established by Ernst Kapp, often credited as the first modern philosopher of technology, after Robert Willis's rhetoric about human mechanics. Kapp was a philologist and historian, who, after being exiled from Germany in 1849, spent sixteen years in Texas before returning to his homeland. Twelve years later he published what would become his most influential work, *Grundlinien einer Philosophie der Technik* (*Principles of a Philosophy of Technology*), a philosophical study of the effects on human society of the use of technology.-[44] In this text Kapp first coined the phrase 'philosophy of technology', and for this reason is commonly cited as the originator of this field of inquiry.[45]

In his second chapter, Kapp argued that tools and technologies are projections of human organs: the eye is the model for the camera obscura, the teeth provide a formative image of the saw, the forearm with clenched fist does the same for the stone hammer, the crooked finger becomes a hook, etc. Such relationships, as Kapp puts it, constitute 'a projection of organs [*Organprojektion*] or the mechanical after-image of an organic form'.[46] The book drew broadly on Aristotelian principles of *techné*,[47] and more specifically on Democritus' view of technology as the imitation of nature, in which human house-building and the craft of weaving were

[43] '*das geistige Ohr des Vorstellungsvermögens*', Helmholtz [1857] 1884, 1:103. [44] Kapp 1877.

[45] Accounts that cite Kapp as the originator of the field of Philosophy of Technology include: Rapp 1981, 4; Ferré 1988, 10; Fischer 1996, 309; Zoglauer 2002, 9; de Vries 2005, 68; Ropohl 2009, 13.

[46] 'eine Organprojektion oder die mechanische Nachformung einer organischen Form.' Kapp 1877, 71.

[47] The ability to make (something) that depends on correct awareness of, or reasoning about, the thing to be made.

first invented by imitating swallows building their nests, and spiders weaving their webs.

Before going further, there are two aspects of Kapp's projection of organs that need to be separated: on the one hand, he is concerned with technological genesis, where the technical means are seen as unconscious after-images (*Nachbilder*) of human organs. On the other hand, he thematises the cultural dimension of technology, wherein this technical means is posited as a medium through which we recognise ourselves.

The latter is illustrated most clearly in Kapp's view that the locomotive is not distinct from the animal system in principle. Like animals, it 'needs feeding' in order to power the system of locomotion through heat produced by the chemical oxidation process. Helmholtz had made much the same point in the context of thermodynamics (and is cited as *auctoritas* by Kapp),[48] and as early as 1848, du Bois-Reymond's study of animal electricity had emphatically laid the ground for a new organic physics with his conclusion that:

> It can no longer remain doubtful what is to be made of the question of whether the difference we recognize as the sole possible one between the processes of dead and inanimate nature in fact actually does exist. *No such difference exists*. . . . The separation between so-called organic and inorganic nature is an entirely arbitrary one.[49]

But for our purposes, it is Kapp's theory of technological genesis that pertains to the fragile notion of automatic listening under discussion. The most widely accepted instance of organ projection, one that Kapp cites simply as 'obvious', is that between the nervous system and the networks of telegraphic communication being established throughout Europe and North America during the middle of the century. This parallel – asserted by such respected academic physiologists as du Bois-Reymond, Helmholtz and Werner Siemens – serves to authenticate his conception of organ projection: 'nerves *are* cable installations of the animal body,

[48] Helmholtz's view, at least in the context of thermodynamics, was on the brink of a non-humanist subject in 1854: 'the animal body . . . does not differ from the steam engine as regards the manner in which it obtains heat and force, but . . . in the manner in which the force gained is to be made use of.' Helmholtz, 'On the Interaction of the Natural Forces' [1854], in Cahan 1995, 37.

[49] 'Es kann daher nicht länger zweifelhaft bleiben, was zu halten sei von der Frage, ob der von uns als einzig möglich erkannte Unterschied zwischen den Vorgängen der todten und unbelebten Natur such wirklich bestehe. *Ein solcher Unterschied findet nicht statt*. . .. Die Scheidung zwischen der sogenannten organischen und der anorganischen Natur ist eine ganz willkürliche.' du Bois-Reymond 1848, xliii.

telegraph cables *are* human nerves. And, we might add, so must they be, for the characteristic feature of organ projection is the unconscious occurrence.'[50]

Auditory media historians studying Kapp's discussion of the ear will encounter a cache of sources that, after Helmholtz, liken the Organ of Corti to both the harp and the piano. While Kapp felt it unnecessary to deliberate between these, to decide upon a single technology or after-image (*Nachbild*) to which the ear gave rise, he cites the accumulation of sources itself as proof of concept:

> We have hereby persuaded ourselves afresh that a mechanism pieced together by human hands [wind harp] can be construed as being in the most striking accordance with an organic entity without the slightest knowledge of that organ's functions. . . . What had been an earlier unconscious model to humankind, is revealed in its precedence by means of the later after-image.[51]

At this juncture, I want to draw together the separate discursive fields of materialist and psychological (cf. romantic) theories of listening here by asking what cultural work Kapp's analogy performs. What is at stake, in other words, when historical ears become a formative model for the Aeolian harp – in Kapp's specific sense of projections of bodily organs? The list must exceed the space available, but might include: a critical methodology that involves thinking *both in and of* mediality; modes of hearing we attribute to historical audiences; aspects of a work ideology figured through such works' historical recipients; a materialist challenge, perhaps an affront, to the nascent foundations of experimental psychology in Germany under figures like Wilhelm Wundt and Carl Stumpf; and a tool for rereading the music of the period, particularly moments of listening within a narrative or (opera) plot. To take our earlier example from Wagner: in the context of opera, we might ask, with due hermeneutic licence, why three successive instruments play the 'long, awkward silence' after Elsa's second call for a champion – three expectant dominants, three

[50] 'Die Nerven *sind* Kabeleinrichtungen des tierischen Körpers, die Telegraphkabel *sind* Nerven der Menschheit! Und fügen wir hinzu, sie müssen es sein, weil das charakteristische Merkmal der Organ projection das unbewußte Vorsichgehen ist.' Kapp 1877, 141. For a detailed, discursive study of the parallelism between nerves and networked telegraphic cables in nineteenth-century Germany, see Otis 2001.

[51] 'Wir haben uns hierdurch aufs neue überzeugt, dass ein von Menschenhand aus Stücken zusammengesetzter Mechanismus in auffallendster Uebereinstimmung mit einem organischen Gebilde ohne die geringsten Kenntnisse von dessen Functionen construirt werden konnte. . . . [W]as als das Frühere dem Menschen ein unbewusstes Vorbild gewesen war, mittels der späteren Nachbildung in seiner Priorität zur Erscheinung kommt.' Kapp 1877, 93.

different vibrations of the same string, three gusts of thwarted expectation? The music thematises musical silence, whose sonic void also points to an absence of conscious activity in the listener. Might we, at an interpretative push, think of this as a thematic depiction of auditory automatism – the sound of attentive expectation unfulfilled?

When Winslow remarked that 'the organ of Corti *is* the Aeolian harp', his bald metaphor was literary rather than media-technological, yet it imbricates, carrying overlapping associations. While the Kappean reading of listeners' ears as unconscious acoustic technologies is unappealing to a liberal model of the human subject, the soft bed of Romantic poetry that cushions our understanding of the Aeolian or wind harp during the nineteenth century has had wider treatment within a musical context.

To take a second opera as an example, Franz Schreker's *Der ferne Klang* (1903) is far more discursively concerned with the idea of listening than is Wagner's *Lohengrin*. Fritz, the protagonist, is in need of a hearing aid. He cannot hear the 'distant sound' – figured as a metaphor for divine artistic inspiration – and is driven from his young love, Grete, in search of this. In the opera, we recall, the sought-after sound is associated in the first instance with the Aeolian harp. As Example 6.2 shows, Fritz's first explanation of 'the puzzling other-worldly sound' (*der rätselhaft weltferne Klang*) couldn't be clearer:

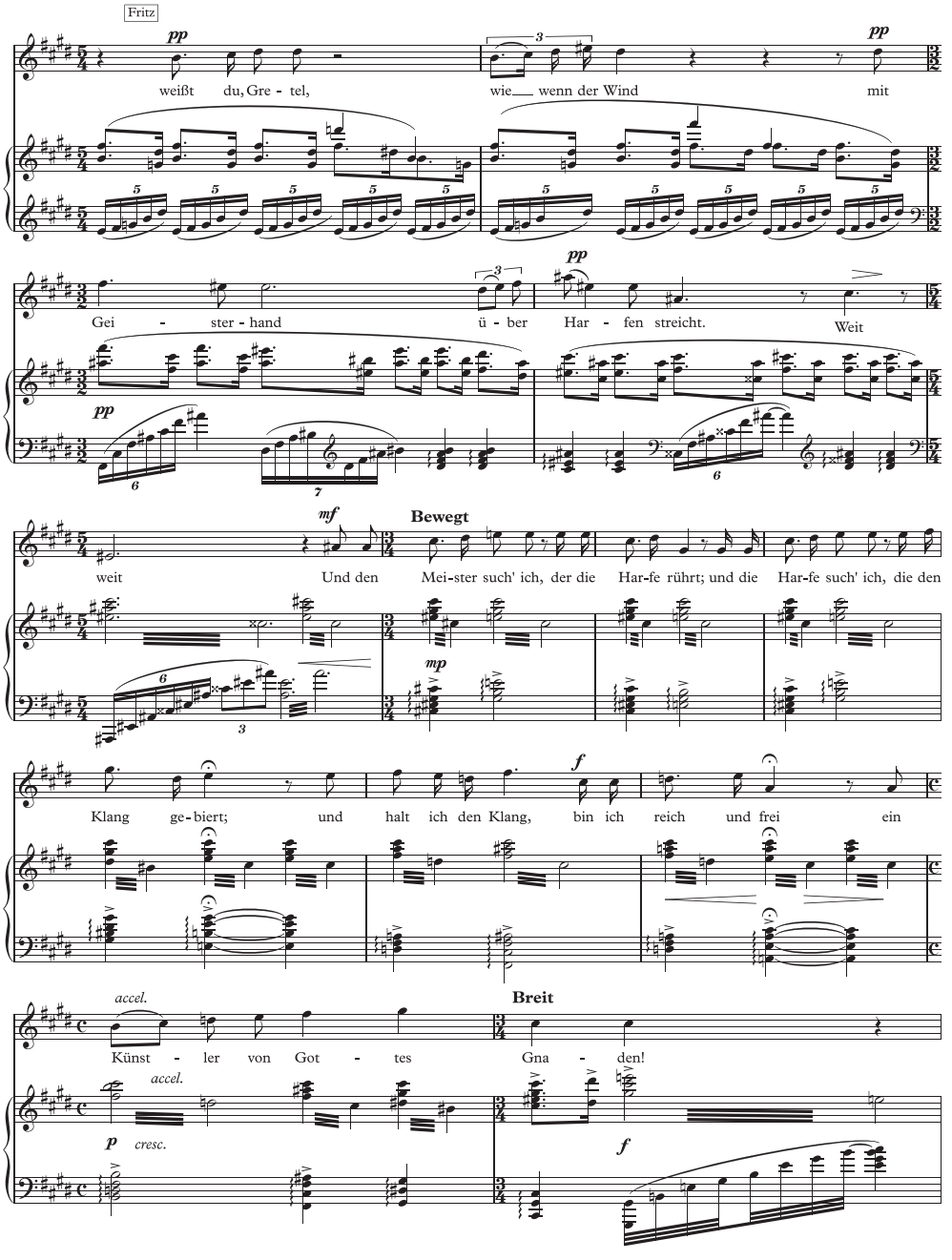
> Do you know, Grete, how when the wind wafts over the harp with a ghostly hand– afar, afar. And I seek the master who stirs the harp. And I seek the harp that brings forth the sound. And when I possess the sound I shall be rich and free – an artist by the grace of God.[52]

The harp, in this reading of the work, becomes not the voice of nature, but a mode of listening to nature, which is to say a mode of being receptive to nature, to what Wordsworth called 'mild creative breez[es]'. Such a literal reading of Fritz's ears brings together Schreker's neo-romantic imagery with the scientific discourse of his age. It seems he did not know of Kapp's writing, nor did he make statements to the effect of the prevalent analogies between the harp and the ear, but these were voiced by scientists whose discourse forms a sedimented layer in the cultural reception of the opera.

And at the end of the work, it is hard to read Fritz's words as other than a confession over auditory technology, that is, his harp-like apparatus has

[52] 'weisst du, Gretel, wie wenn der Wind mit Geisterhand ueber Harfen streicht. Weit, weit. Und die Meister such' ich, der die Harfe ruehrt; und die Harfe such' ich, die den Klang gebiert; und halt ich den Klang, bin ich reich und frei ein Kuenstler von Gottes Gnaden!' *Der ferne Klang*, Act I scene 1.

Example 6.2 Franz Schreker, *Der ferne Klang*, Act I scene 1



been retuned, establishing a media link-up between his ear and the environment; he has learned to hear anew via a technology that consolidates his erstwhile loneliness:

> Do you hear the sound? How blessed – transfigured – no May wind and no summer storm. Just a shudder of air – a sensual trembling billows through the treetops and a thousand strings shiver with the divine breath of spring! Do you hear the sound? It no longer escapes me, I grasp it just as tightly as shall I never leave you. Birds are singing, bells are ringing – gloriously they burst forth with the mightiest splendour. That is not spring – earlier summer delivers a festive arrival. Harps resound to me as powerfully and sonorously as the sounds of the spheres.[53]

Comparable confessions are scattered throughout nineteenth-century European literature (e.g. Gustave Flaubert's *Novembre*), and Schreker, who famously wrote his own libretto, assigns the harp arpeggios a range of chromatic sevenths during this final passage.[54] Such diegesis predictably drew the ire of commentators like Walter Niemann who regarded the literal depictions of nature's breezes as 'a spiritual fallacy' (*seelischer Fehlschluß*), i.e. augmentations of the artificiality of the instrument. 'If we elevate these elements themselves to the impetus for creation,' he continued, 'we rob music of its highest value and of that which sets it apart from nature: its soul, its inner experience.'[55] Niemann's scepticism at musical mimesis, at the profane afflatus of implicitly representing nature's breezes as man-made, only underscores the modernity of Schreker's work in seeming to place the science of 'psychic automatism' at the centre of the inner ear.

The opera has, of course, inspired a number of different readings that hear in Schreker's music the staging of its own epoch: from the critique of marginalised female voices and anticipation of Hollywood underscoring, to the creation of psychological perspectivism and the Freudian id through sound.[56] In this tradition, Ulrike Kienzle sought to deepen the semiotic role

[53] 'Hörst du den Ton? / Wie selig verklärt / kein Maienwind und kein Sommersturm / ein Beben der Luft nur ein lustvolles Zittern geht durch die Wipfel und tausend Saiten erschauern unter des Frühlings göttlichem Hauch! / Hörst du den Ton?! Der schwindet mir nimmer, den halt' ich so fest, wie ich dich nicht mehr lasse. Es singen Vögel, es läuten Glokken glutvoll erbraust es in hehrster Pracht. Das ist nicht Frühling / ein früher Sommer hält festlichen Einzug / die Harfe erklingt mir, als klängen die Sphären machtvoll und rauschend.' *Der ferne Klang*, Act III scene 14.

[54] 'I tried to discover, in the rumour of forests and waves, words that other men could not hear, and I pricked up my ears to listen to the revelation of their harmony.' Flaubert 2005, 15.

[55] 'Erheben wir diese aber selbst zur bewegenden Ursache des Schaffens, so rauben wir der Musik das Höchste, was sie von der Natur auszeichnet: die Seele, das innere Erleben.' Niemann 1913, 216.

[56] See particularly Peter Franklin's (1991, 2013) interpretative readings.

of the Aeolian harp by figuring it as an emblem that explains Schreker's irregular phrase structures and unpredictable harmonic progressions through the perceived irregularity of the billowing wind.[57] Perhaps this analogy-based connecting process is what Roland Barthes had in mind when he defined the picture or image as 'the organisation of the various readings that can be made of it: a picture is never anything but its own plural description.'[58] We might conclude that the emblem of the harp itself must remain multivalent, pivoting between the impetus for analytical interpretation, narrative rereading, and scientific instrument.

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In the end, the fragile notion of automatic listening under scrutiny is consistently undermined by the discourses of psychophysics and empirical psychology from the 1860s onward. Helmholtz himself was irretrievably caught between these two discursive fields.[59] 'You might almost think Nature has intentionally fallen into the keenest contradictions here, by resolutely wishing to destroy any dream of a pre-existing harmony between the outer and the inner world', the scientist observed in 1868.[60] To recall my earlier claim, a theory of the ear as wind harp is based on mechanical principles of causality voided of cognitive agency. It forms a subspecies of what William James called the 'conscious automaton-theory', which maintains that in everything outward we are purely automatic mechanisms.[61] Feeling is a mere collateral product of our nervous processes, unable to react upon them any more than a shadow reacts on the steps of the traveller whom it accompanies. James, for one, passionately refuted such materialism. Common sense, he asserts, shows that even a live frog with an intact brain will not respond in predictable ways to stimuli: 'the signal may be given, but ideas, emotions or caprices will be aroused instead of the fatal motor reply'.[62] An ear's thinking mind is no different.

That a theory of auditory automatism could arise in the context of nineteenth-century materialism speaks to the attitude of scientists hearing musical sounds, and the authority of the contemporary model of listener as pure recipient of musical works. While opera's connection to theories of automatic listening must remain tentative, such theories serve to enmesh a

[57] Kienzle 1998, 79. [58] Barthes 1988, 150.

[59] See Steege's concept of the 'third ear' within Helmholtz's acoustic epistemology (2012, 43ff.).

[60] 'Fast könnte man glauben, die Natur habe sich hier absichtlich in den kühnsten Widersprüchen gefallen, sie habe mit Entscheidenheit jeden Traum von einer prästabilirten Harmonie der äusseren und inneren Welt zerstören wollen.' Helmholtz [1868] 1884, 1: 294.

[61] W. James [1890] 2007, 133ff. [62] W. James 1879, 4.

hermeneutics of opera within contemporary discourses of aurality. And here, the capacity for operatic narrative to brush against that which is anathema to its means of expression – i.e. directed listening, whether as an event (*Lohengrin*) or a theme (*Der ferne Klang*) – speaks to the flexibility of the medium during the nineteenth century and its ongoing dance with technological inflection.