4
Time and Transience

On August 20, 1969, the four members of The Beatles sat together in a recording studio for what would turn out to be the last time. They were doing some final overdubs, mixing, and editing for the song "I Want You (She's So Heavy)," which appeared on the *Abbey Road* album, released in December of that year.[1] The song's form is relatively straightforward, alternating between two simple, repetitive parts: a jazzy, laid back, and heavily syncopated verse in 4/4 time, and a harder rocking refrain, centered around an arpeggiated guitar phrase and an ostinato bassline in 6/8. The second half of the song (from 4:37 onward) consists solely of this refrain. Repeating fourteen times, it steadily intensifies toward the end. This intensity is only increased by a layer of semi-white noise that John Lennon created during the penultimate recording session, using a Moog synthesizer's white noise-generator. Kicking in as a low rumble in the distance during the fourth cycle, it gradually builds into a more audible hiss, which sounds rather like the wind of a rising thunderstorm, until finally the whirling noise threatens to overtake the other instruments entirely.

The song's ending, though, is especially famous, as it also closed side A of the original vinyl record. The original master, which was created by editing three takes together and adding overdubs, lasted eight minutes and four seconds. The obvious choice would have been to slowly fade out the repetitive ending, but Lennon decided otherwise. While listening to the final bars, the story goes, he told recording engineer Geoff Emerick to "cut it right there," creating an abrupt and rhythmically unpredictable ending at the second eighth note of the fourteenth cycle and bringing the song to a close at 7:44.[2]

This anecdote relates to the argument in this book at several levels. First, it speaks to the contrast between musical repetition and the white noise. Indeed, casting beyond the terms of this particular song, we might say it relates to the contrast between periodicity and noise as such. Whereas those final fourteen bars are so obsessively repetitive, reiterating the same motif over and

[1] "I Want You (She's So Heavy)," track 6 on The Beatles, *Abbey Road*, Apple Record/Parlophone, 2009, compact disc.

[2] Alan W. Pollack, "Notes on 'I Want You (She's So Heavy)' Notes on . . . Series no. 182," *Soundscapes: Journal on Media Culture*, 1999, accessed February 15, 2019, http://www.icce.rug.nl/~soundscapes/DATABASES/AWP/iwyssh.shtml.

The Logic of Filtering. Melle Jan Kromhout, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780190070137.003.0005

over again with little variation, the white noise introduces an element of endless variability—the absolute opposite of repetition. As a counterpoint to the cyclical movement of the instrumental backing, which essentially keeps the music and its listeners in the same place, the steadily growing and continuously changing noise produces an increasingly dense sonic texture. Pushing the song forward, it adds more and more information, slowly overloading the listener. Second, there is Lennon's deliberate, yet arbitrary, cut. The abrupt ending and silence that follows thematize the principle of the *cut* with an almost didactic explicitness.

This gesture of the cut, I argued in the previous chapter, is a quintessential aspect of technological sound reproduction. Whereas the myth of perfect fidelity rests upon the *clean cut*—which, having been made by an ideal filter, would leave no trace whatsoever—technical media can only make physical cuts, which affect the spectral and temporal contours of the signal in one way or another. When Lennon ordered Emerick to "cut it right there," there would have been a slight delay between his decision. . . his utterance of this decision. . . and Emerick's response. . . before the reel of tape was finally halted and cut in two. Despite the sharp suddenness of Lennon's instruction, these delays arbitrarily determined the cut's exact location. As the mind fills in the missing beats following the precipitate ending, the abrupt silence produces something like a sonic afterimage. Somewhat paradoxically, the impression created is that the song could have gone on, indeed *might* have gone on forever: endlessly repeating the cyclical phrase and growing noise, until there is nothing else . . .

In this way, the ending of "I Want You (She's So Heavy)" illustrates the basic principle of the physical cut that defines all technologically processed sound. The instrumental repetitions exemplify the plane of the ideal filter, in which infinite sine waves oscillate unchanged for all eternity. The Moog synthesizer's whirling white noise, in contrast, represents the domain of technical filters, in which technical media, channels, and filtering operations always affect their output in ways that cannot be fully controlled or predicted. What is more, the stark final cut illustrates how technologically (re)produced music is based on a negotiation between the two domains—a balance struck between the two opposite poles of the uncertainty principle. Thus, recorded music represents to the listener both the dreamed infinity of the domain of the ideal filter (an endless repetition of perfect reproduction) and the radical finitude of the domain of technical filters (signified by randomness, transience, and singularity). This chapter explores this conflicted temporality of sound reproduction in depth, showing how the duality of pastness and presence, finitude and infinity, defines the noise resonance of sound reproduction.

The Parasitic Channel

Whether they were recorded years, decades, or over a century ago, sounds that are stored on material hardware must be transduced back into physical sound waves if they are to return in the here and now as sound. Before the moment of playback, signals that are preserved on some acoustic, electromagnetic, or digital storage medium are nothing but analog representations of sound waves—grooves in vinyl, magnetized particles on tape, or pits in a plastic surface. Sound is never stored as sound, in other words, only as something else. In purely physical terms, this means that the vibrations that appear upon playback only exist in the present.[3] On this basis, Wolfgang Ernst argues that sound reproduction effectively cancels "the distinction between past and present."[4] He points out, however, that although all media technological processes are executed "in the present," their "material implementation" as medium also inscribes a "historical index" onto the recording.[5] In other words, as the channel inscribes itself onto the signal, these material traces of the medium signify that some technical process took place in the past. Acoustically, then, the sound may be entirely a thing of the present. The historical index of sonic artifacts added to the signal by its material carriers (gramophone scratches, magnetic tape hiss, or quantization errors), however, signifies that sounds played in the present in fact reproduce acoustic events that took place in the past.

This historicity of scratches, hiss, or digital errors, Ernst argues, is not an inherent property of these sounds. Physically, the scratches, hisses, and errors are as fully present in the present as the reproduced signal. Artifacts of the reproduction process, then, are not intrinsically "historical." What is more, their perceived historicity (the reason that people think of a scratchy record as being "old") results from a purely discursive, symbolic association between such sounds and the supposed "pastness" of recordings.[6] Given this conflation of perceived physical presence and symbolically signified pastness, Ernst writes, sound reproduction confuses or complicates more quotidian human experiences of time.[7] He also argues, however, that

[3] As Heidegger writes, "Everything that is encountered in the world is encountered by Dasein as residing in the now." Martin Heidegger, *The Concept of Time*, trans. William McNeill (Oxford: Blackwell Publishers, 1992), 16E.
[4] Ernst, *Gleichursprünglichkeit*, 22.
[5] Ernst, *Gleichursprünglichkeit*, 51.
[6] Ernst, *Gleichursprünglichkeit*, 398.
[7] Ernst, *Gleichursprünglichkeit*, 45.

> in contrast to additional noises that are directly associated with musical live performance (such as the breath of singers and instrumentalists, or the gripping sound of the violinist), this distortion, this noise [the scratches and noises from sound carrier and reproduction device] is only arbitrarily connected to the sonic content.[8]

By drawing this distinction between "noises that are directly associated with musical live performance," and "arbitrary" noises produced by the medium itself, Ernst reinforces the idea that there is some "original" performance. In highlighting the latter noises' spurious relation to sonic "content" proper, he implies that this prior, prime sound event can (and should) be separated from the "arbitrary" noises added by the medium. As such, Ernst's take on the presence and pastness of reproduced sound relies, it would seem, on a supposedly clear separation of internal sound from external noise, and thus on the conceptual logic of noise reduction.

Yet this separation between "external" and "internal" sound is not sustainable. One could even argue that there is no such thing as "external" noise at all. In their book on aural architecture, Barry Blesser and Linda-Ruth Salter describe music "as a sonic energy package" (a number of compound sound waves) "that progressively passes through a series of passive acoustic objects" (instruments, walls, air, furniture, etc.), "each of which then radiates and couples energy to other acoustic objects, and eventually to listeners."[9] By this logic, by the time a technologically mediated sound reaches listeners' ears, the "sonic energy package" has not only traveled through (and refracted from) a series of passive acoustic objects, but also encountered a great many passive and active technological components. Each link in this chain of microphones and walls, amplifiers and furniture, cables and air, compressors and effect modules, loudspeakers and human beings "couples energy" to the signal, changing its frequency composition, altering the waveform, and shaping its sonic characteristics. Each link constitutes a passageway or gate that filters the signal in a specific way. What the receiver hears is not an original signal plus some "arbitrary noises" or random artifacts accumulated along this journey, but a signal that has been fundamentally formed by each of the filtering passageways along the transmission chain.

[8] Ernst, *Gleichursprünglichkeit*, 57.

[9] Barry Blesser and Linda-Ruth Salter, *Spaces Speak, Are You Listening? Experiencing Aural Architecture* (Cambridge, MA: MIT Press, 2007), 150. In *Earth Sounds*, Douglas Kahn also writes about the accumulation of such characteristics in every sound: "Sounds can be heard as having acquired their character through the course of their propagation, acoustically and electromagnetically. In this way, a sound is as much of the intervening space as it is from the source. I use the term *transperception* to denote the perception of those characteristics along with the source." Douglas Kahn, *Earth Sound Earth Signal: Energies and Earth Magnitude in the Arts* (Berkeley: University of California Press, 2013), 62, emphasis in original.

As sonic traces of the operations performed all along this chain, the many artifacts of signal transmission mark the route from the moment of recording to the moment of reproduction. Ernst assumes that all throughout this journey, the "original" sound somehow retains its independence, distinct essence, and unambiguously identifiable properties, all of which remain separate from the "arbitrary" and "external" artifacts added by recording and reproduction media. Ernst claims that these artifacts, despite being fully present at the moment of playback, are associated with a past moment of recording only at a discursive level. In contrast with this position, I argue that the sound that comes out of the speakers at the end of the chain is shaped as much by the specific conditions at the moment that the "original" first sounded, as by all of the filtering channels that subsequently shaped its sonic contours along the way. It is impossible to determine where the one's influence ends and the other's begins. As my analysis of technological noise reduction in chapter 2 has shown, the distinction between arbitrary and relevant noises is based on a symbolic, idealized separation of signal and noise, which was formalized by information theory. According to this conceptual logic of noise reduction, it is always possible to know where noise is located (that is, to say which sounds are "external") and how it can be reduced. This logic assumes the possibility of a Leibnizian "world without noise" (as Serres puts it), in which everything has its proper place and time.

Belief in the possibility of a "world without noise" also underpins positivist science and any project aiming to achieve absolute control over or unambiguous knowledge of the natural world. In the mid-1850s, Hermann von Helmholtz wanted to corroborate empirically Ohm's application of mathematical Fourier analysis to the study of sound and prove that sine waves are elemental or, as Helmholtz puts it, "simple" sounds. In attempting to do this, he inserted the narrow end of a spherical glass resonator, tuned to a single frequency, into one of his ears, before sealing the ear off with a piece of warm wax.[10] To shut out all acoustic disturbances, he also closed his other ear with wax. This experimental set-up echoes Odysseus's passage past the sirens: both Odysseus and Helmholtz plugged ears with wax so as to reduce noise and ensure a clear passage (first of a ship, then a signal) through a narrow channel. Like Odysseus's ruse, Helmholtz's efforts were entirely goal-oriented. In empirically approximating the clean cut of the ideal filter as closely as possible, he set out to hear only the signals he wanted to hear: those clear and loud sine waves, uncontaminated by noise.[11]

[10] Helmholtz, *Sensation*, 68–69.

[11] On Helmholtz's use of resonators to listen to the sounds of a mechanical siren, Kittler writes: "Odysseus' and Helmholtz's experimental set-up are the same. The Siren sings and people filter something out."

Still, no matter how finely tuned the resonators or how much wax one plugs in one's ears, the infinite purity of perfect sine waves cannot be realized in practice. The cuts applied by these technical filters introduce transient artifacts that shape signals' frequency spectra and temporal flow. Consider Orpheus's ruse of masking the Siren's noise with musical signals of his own—a decidedly less idealist noise reduction tactic than Odysseus's earplugs. Despite Orpheus's best efforts, something of the noise of the Sirens will always bleed through, meaning that the signal that arrives at the far side of the channel will be different to the signal that went in. In the light of both this scenario and Shannon's model of communication, signal, noise, and channel should be seen as constituting a single system. They are fundamentally inseparable. In contrast to this reality, rhetorics of "external noises" assume clear separations, demarcated categories, and concise models. The distance between Odysseus and Orpheus, and between Helmholtz and Shannon, then, resides in the difference between assuming the essential separateness of noise and signal, and observing that signals are always affected by the physical cuts made by technical filters.

In this sense, such physical cuts are exemplary of what Serres calls a "parasite": a "third" element or "middle term" that is positioned "in between" other elements in a system.[12] In relation to the parasite, the position and role of those elements are defined and redefined. In the language of communication engineering, the parasite is the channel: it is only because there is a channel that the difference between input and output, or original and copy, becomes apparent. In occupying the space "in-between" the two sets of categories, the channel exemplifies their separation in time and space. This means that noise, as the sonic manifestation of the channel's influence, is a parasite too.[13] It constitutes the necessary background for communication, but also denies the signal absolute symbolic purity. Any signal transmission requires a channel, and any material channel introduces noise. To ensure a signal's safe passage through the channel, successful signal transmission requires the suppression of this noise. This can be done by installing a noise gate, which reduces the width of the channel. However, the noise gate itself constitutes still another channel. The influence of one parasite (the background noise), then, can be reduced only by introducing another. Parasites (channels, noise)

Friedrich Kittler, "Echoes; ein Prolog," in *Hörstürze: Akustik und Gewalt im 20. Jahrhundert*, eds. Nicola Gess and Florian Schreiner (Würzburg: Königshausen & Neumann, 2005), 22–23.

[12] Serres, *Parasite*, 19, 65.

[13] The French word "parasite" means both "parasitic organism" (as in English) and interference, static, or unwanted noise (*bruit parasite*).

therefore both facilitate and impede the transmission. In the process, they define relations among the different elements in a sound reproduction system: it is parasites that produce the difference between information and noise, signals and channels. Hence, every parasite—each channel, each filter, each noise—simultaneously introduces a new order and enacts a cut or disruption.

Hence, a chain of transmission channels could be called a parasitic chain. Each channel that links sender and receiver, that lies between those who record and those who listen, constitutes a filter that makes a physical cut. If a signal is to get through unaffected, then ideally each filter (or rather, parasite) must be repressed. It is simultaneously true, however, that these parasites are indispensable for the transmission to succeed at all—as in the case of the noise gate. Each parasite cuts the sound and each cut changes the signal in specific ways. These parasitic cuts, therefore, turn the general and nonspecific (for instance, a frequency spectrum composed of highly predictable, semi-periodic sine waves) into the particular and specific (a more irregular, less predictable, nonperiodic signal). With every cut made by every parasitic filter, the system is organized and reorganized, ordered and reordered, shaped and reshaped. In other words, the parasitic chain produces the unique spectral character of the signal that comes out of the speakers.[14]

This sonic specificity, which arises courtesy of parasitic filtering channels, fundamentally negates positivist assumptions that filters make clean, ideal cuts. Physically existing signals take a certain amount of time, which is neither infinitesimally short nor infinitely long. And because they do, they must begin and end, introducing physical cuts that produce transient elements and a level of randomness that make each signal uniquely identifiable. These elements should not be interpreted as external disruptions or additions to an "originally" pure signal. Indeed, that purity exists only in the realm of symbolic idealizations. Instead, it is exactly this randomness that separates the timeless purity of the plane of the ideal filter from real, physical signals in the domain of technical filters, which not only exist in the frequency domain but irreversibly develop over time as well. Hence, all of the cuts that shape the signal at each link in a parasitic chain contribute to the perceived temporality of technologically reproduced sound. On the one hand, the noises of sound reproduction signify the inherent pastness of reproduced sound, in that they emphasize the impossibility of a clean cut that would capture the signal in all its temporal-spatial complexity. On the other, these same transient elements reinforce the physical presence of technologically (re)produced sounds, as they continuously unfold and develop in the here and now.

[14] Serres, *Parasite*, 230.

The Pastness of Sound

During the discussion following a lecture in Cologne, eight months before his death in October 2011, Kittler characterized the operations of Fourier analysis in the following way:

> God is the big Fourier-analyst and I have always said that in the time domain, we are mortal and in the frequency domain, in the Fourier domain, we are immortal. . . . It is the essence of the sine and cosine that they do not have a beginning or an end and are therefore immortal.[15]

Here Kittler espies a connection between the symbolic power of mathematical analysis and a sense of the divine. In connecting Fourier analysis with the Leibnizian omniscient God, he forges conceptual links among the operations of mathematical analysis, the development of technical media, and the wish to attain full analytical grip on reality.[16] In using an existentialist idiom of mortality and immortality to describe a strictly mathematical phenomenon, Kittler offers a highly distinct perspective on the infinity posited by sine waves. Conceptually, his use of "immortality" instead of the more mathematically correct "infinite" points in two directions. Although at first these directions might seem contradictory or even mutually exclusive, on closer examination it turns out that they are wholly complementary. On the one hand, the rhetorical pairing of the all-too-human dream of immortality and idealizations used in mathematically analyzing physical sounds suggests a connection between the symbolical purity of sine waves and spiritual motifs of heavenly purity, infinite bliss, and eternal life. On the other hand, this presumed "immortality" in the domain of ideal filters also accentuates the fundamental impossibility and absence of such idealizations in physical reality.

With the application of trigonometric functions to the analysis of periodic phenomena, Fourier analysis creates a symbolic domain that transcends our everyday experience of space and time. Measuring frequency spectra entails symbolically suspending temporality through the introduction of an infinite timeframe. Reading this infinity as "immortality" links mathematical

[15] Friedrich Kittler, *Und der Sinus Wird Weiter Schwingen: Über Musik und Mathematik* (Köln: Verlag der Kunsthochschule für Medien Köln, 2012), 48.

[16] Regarding the connection between technical media and the divine in Kittler's thinking, see, for instance, Friedrich Kittler, "The God of Ears," trans. Anthony Moore and Paul Feigelfeld, in *Kittler Now: Current Perspectives in Kittler Studies*, eds. Stephen Sale and Laura Salisbury (Cambridge: Polity Press, 2015), 3–21 (discussed in more detail in chapter 5); Kittler, "Lightning" (discussed in chapter 3); and Friedrich Kittler, "Preparing the Arrival of the Gods," in *Kittler Now: Current Perspectives in Kittler Studies*, eds. Stephen Sale and Laura Salisbury (Cambridge: Polity Press, 2015): 95–112.

"infinity" to theological "eternity." In this way, the Fourier domain's mathematically abstract atemporality is transformed into an eternity—the traditional temporality of the gods. Indeed, it was only after Ohm and Helmholtz transformed the symbolic mathematical object of the sine function into one of the cornerstones of the analytical representation of sound that technical sound media caused "speech," as an early reviewer of the phonograph famously noted, to "become, as it were, immortal."[17] Over the course of their development, it seems, technical media have striven for the infinite clarity of the Fourier domain, whose perfect, infinite repetition of pure sine waves would ultimately enable entirely seamless sound reproduction. In other words, when one presupposes the possibility of a clean cut and achieving transcendental clarity, media technologies do indeed seem to hold out the promise of immortality: "as long as a turntable is spinning or a CD is running," Kittler imagines, "an old magic emerges despite the fading of years, hair and strength. Time stops, what more do hearts want?"[18]

Nonetheless, time does not stop. In the end, that which looks or sounds like magic when one is under the spell of the myth of perfect fidelity is always revealed as mere illusionism, simple trickery, or clever ruse. This is why Kittler's rethinking of the infinite sine wave in terms of immortality also points in the opposite direction. The word "immortality"—which is much more emphatic than "infinity"—implicitly connects the atemporal purity of the Fourier domain to its conceptual opposite. Indeed, it suggests that the concept of the ideal sine wave also carries with it a sense of the physical world's temporal finitude. For as Kittler said in Cologne, in the face of his own imminent demise, it is in this fallen temporal world that "we are mortal." This sense of finitude, as I now argue, is just as important for our understanding of the noise resonance of technological sound reproduction as the ideals of infinity and immortality.

Following the uncertainty principle described in the previous chapter, pure frequency analysis grasps the properties of a signal in the "eternal" mathematical domain at the expense of obscuring its properties in the temporal realm. Because of this, wrote physicist Dennis Gábor, the fact that "sound has a time pattern as well as a frequency pattern finds no expression either in the description of sound as a signal $s(t)$ in function of time, or in its representation by Fourier components $S(f)$."[19] In other words, spectral analysis based on the Fourier transform only provides half of the information. A more

[17] Cited in Kittler, "Preparing the Arrival," 105. Kittler and many others attribute these words to Edison himself, but, as Jonathan Sterne notes, they actually appeared in 1877 in an editorial comment of *The Scientific American* on Edison's invention. Sterne, *Audible Past*, 298.

[18] Kittler, "Lightning," 68.

[19] Dennis Gábor, "Acoustical Quanta and the Theory of Hearing," *Nature* 159, no. 4044 (1947): 591.

complete representation would also include information about temporal specifics: when a signal occurred and how long it lasted. Gábor suggests a solution to this problem: first one chops a signal into very small bits of time called "windows," each of which contains information about the frequency spectrum of the signal at that specific instant. Then one can plot these windows (and their accompanying frequency information) on a temporal axis, lining them up one after the other so as to represent or reconstruct changes to the frequency spectrum as it develops over time.

Even this windowed approach, however, is limited by the uncertainty relation between time and spectrum. Gábor's approach too is a compromise between representing infinitely complete spectra and identifying infinitesimally exact durations. The uncertainty principle limits the possibility of completely representing or reproducing signals as they occur in the flow of time. As the most extreme limit cases of this attempt at achieving absolute accuracy (sine waves and Dirac impulses) reveal, the operations of modern mathematical analysis always produce their own negation. Despite their analytical clarity, these idealizations find their mathematical origin in Leibniz's concept of infinity. As such, they are constituted by their own physical impossibility: they can only exist in the symbolic domain, by virtue of their very impossibility in physical reality. Mathematical models show that physical signals endlessly tend toward (asymptotically approximate) the perfect clarity of analytical representations. Precisely the impossibility that signals will ever coincide with such idealizations, however, confirms their physical existence in space and time. Idealized infinity, then, always contains traces of—indeed even gestures toward—physical finitude. On these grounds, the "immortality" that Kittler imputes to sine waves also brings to mind its opposite: mortality.

This reciprocal implication of conceptual opposites—infinity/finitude, immortality/mortality—can be explained in more detail by way of a short excursus on philosopher Paul Ricœur's take on St. Augustine's account of the problem of divine eternity. For Augustine, divine eternity is a "limiting idea": the absence of eternity in our daily lives, Ricœur writes, "is not simply a limit that is thought, but a lack that is felt at the heart of temporal experience."[20] Much like the representational limit cases of sine wave or Dirac impulse, the "limiting idea" of eternity is not just some ideal to strive toward or some concept in a thought experiment. Instead, as something that can be thought but not realized, the limit signifies a lack, an absence that "becomes the sorrow proper to the negative."[21] On account of this absence, our everyday

[20] Paul Ricœur, *Time and Narrative*, trans. Kathleen McLaughlin and David Pellauer, Volume 1 (Chicago: University of Chicago Press, 1984), 26.
[21] Ricœur, *Time and Narrative*, 26.

experience of temporality is "permeated through and through with negativity."[22] For Augustine, then, the fact that eternity is conceivable yet absent is fundamental to our lived experience of time as fundamentally limited and finite.

By analogy, the supposed "immortality" of the sine wave is also a limiting idea that becomes meaningful only beyond the purely symbolic domain of ideal filters. Even in presenting an infinity of perfect repetition, the sine wave points back toward the mortality that characterizes everything in the temporal domain. Although Fourier analysis seemingly approximates the omniscience of Leibniz's God, when it comes to analyzing full frequency spectra, the gates to heavenly eternity remained resolutely locked. Instead, the introduction of transient events negates the possibility of ideally pure signals. Physical (approximate) sine waves are not immortal; their timeframe is not infinite. Eternity remains forever out of reach. In the physical world, signals decay and die out, and time flows irreversibly in one direction. Despite the infinity of the ideal sine wave, the traces of its impossibility—the impossibility of a clean cut—haunt the specific character of each reproduced sound. Confirming the irreversible flow of physical time and fundamental inaccessibility of eternity, these traces of material production and transmission attest to the fact that a signal at some point began and will eventually end. Sonically, they negate rhetorics of eternity, immortality, or infinity.

In the final analysis, this implicates our own finitude too. When judged at the requisite timescale, everything is transient. Measured against geological timescales of tens or hundreds of millions of years, each human life is a mere flash, impulse, or burst of random noise. The transience of signals, then, resonates with the transience of human existence. If the infinity of ideal sine waves promises immortality, the ever-present element of noise brings us firmly back to earth. The advent of technical media has only heightened this contrast between the idealized domain of symbolic representations and the physical domain in which "all things must pass," to quote the late George Harrison.[23] Despite the unmistakable physical presence of sounds flowing from loudspeakers, the subtle, nonperiodic traces of events that have changed the signal during its transmission serve as sonic reminders of finitude and facticity. They bespeak the complexity of a world in continuous flux, the unidirectional flow of time, and the transience of all things.

[22] Ricœur, *Time and Narrative*, 26.

[23] "All Things Must Pass," track 2-5 on George Harrison, *All Things Must Pass*, Parlophone, 2009, compact disc.

These resonances of pastness and finitude invoked by sonic transience recall Heidegger's notion, elaborated in the first chapter of the second part of *Being and Time*, of "being-toward-death."[24] According to this idea, "death" participates in the Being of individuals and cultures from the very beginning.[25] It figures a potentiality to be fulfilled in the future. Although Heidegger acknowledges that very few people can be certain as to when and how they will die, it is nonetheless an "indefinite certainty" that there will come a time when they will no-longer-be.[26] Heidegger quotes a line from the fifteenth-century story of Death and the Ploughman: "As soon as man comes to life, he is at once old enough to die."[27] However: this indefinite certainty of finitude, the certainty that Dasein—a person's "Being-there"—will at some point not be, confirms its present existence. Indeed, being-toward-death affirms our "being-in-the-world." We know that we are alive not despite but because we grasp its finitude, because we sense that death is still outstanding. Following this line of reasoning, I argue that the transience of sounds not only resonates with the ephemerality of human existence and "pastness" of the reproduced signal. What is more, the presence of the transient signal—which includes the certainty that it will end—also highlights the "not-yet" of not-having-died-yet, the "not-yet" of continuing existence. The signal's transient presence and inherent finitude mirrors both the finitude and being-alive of human existence.

The ideas that immortality/infinity always already invokes mortality/finitude, and that finitude is inherent to our being-in-the-world and effectively live-affirming, have further implications. Stasis, clarity, and eternity on the plane of the ideal filter do not only refer to immortality, the complete absence of death. Quite the contrary, if everything were to remain the same forever (a sine wave oscillating infinitely), then nothing would ever die, nor would ever be truly alive. Heaven, as the Talking Heads have it, "is a place where nothing ever happens," and a place where nothing ever happens cannot support life.[28] Only not-living can achieve immortality, only death grants access to the infinite stasis of an otherworldly domain, whether it is called heaven or

[24] Martin Heidegger, *Being and Time*, trans. John Macquarric and Edward Robinson (Oxford: Blackwell Publishers, 1962), 279–311.

[25] In scholarship on Heidegger, a *being* (uncapitalized) indicates a particular existing thing—an ontic phenomenon—and *Being* (capitalized) signifies the quality of existence shared by such beings—an ontological disclosure. The Being of beings is the mode in which things are. See, for instance, George Steiner, *Martin Heidegger* (Glasgow: Fontana, 1978), 43–46, 79.

[26] Heidegger, *Being and Time*, 310.

[27] Heidegger, *Being and Time*, 289.

[28] "Heaven," track 8 on Talking Heads, *Fear of Music*, Sire 1984, compact disc. In the light of the infinite repetition of ideal sine waves and the "old magic" that Kittler espies in the technological repetition of music, it is worth mentioning that Byrne also sings: "The band in Heaven plays my favorite song. They play it once again. They play it all night long." This confirms that "heaven" is nothing but endless repetition—a single song played over and over again.

goes by another name. Contrary to a heavenly immortality defined by infinite periodicity and absolute control, randomness, transience, and noise manifest finitude and change. They constantly push time forward, creating a world in which time flows, matter changes, and nothing is without end. As the opposite of infinite repetition and eternal stasis, the randomness of noise signifies life. Still, in implying finitude and the impossibility of truly storing (let alone halting) time, noise always does so in the sense of being-toward-death. It signifies life because it admits the indefinite certainty of death.

The possibility of the event of death—which, like a lightning bolt, remains beyond representation—separates physical media operating in the domain of technical filters from the plane of the ideal filter that administers a clean cut. The symbolic immortality of sine waves in the Fourier domain represent the event's reverberations; as such, they offer clarity and insight into the being of Being. In doing so, however, they turn all transients into steady states, sacrificing the sheer singularity of the event for complete analytical repeatability. Transients that tend toward the Dirac impulse, in contrast, mark the singularity of the event itself, which, as Jacques Derrida writes, "implies surprise, exposure, the unanticipatable."[29] Representations produced by ideal filters suggest a completely static reality in which nothing ever happens—a heavenly world. Indeed, Derrida writes that written representation, which includes the representations of sound spectra produced by Fourier analysis, "always comes after the event." As such, they always miss its singularity. The operations of technical media, though, are able "to intervene, interpret, select, filter, and, consequently, to make the event happen."[30] Technical filters do not just represent; they (re)produce. They produce not representative signs, but physical signals themselves, which are complex, contingent, random, and transient. So, to fully account for this instantaneity of the event, let us take a closer look at the conceptual opposite of the sine wave's "immortality": the Dirac impulse.

The Presence of Sound

In 1996, Derrida wrote an essay to accompany a set of black-and-white photographs of Athens by Jean-François Bonhomme. In the essay, which has been translated into English under the title of *Athens, Still Remains*, Derrida

[29] Jacques Derrida, "A Certain Impossible Possibility of Saying the Event," *Critical Inquiry* 33, no. 2 (2007): 441.
[30] Derrida, "Impossible Possibility," 446–447.

turns a meditation on photography into a problematization of what he presents as the Western philosophical "tradition of being-for-death," running from Socrates to Heidegger.[31] This questioning takes the form of an extensive analysis of the brief "click" of the photographic shutter, which, for Derrida, encapsulates the multilayered temporality of photographs. The analysis centers on Derrida's thoughts regarding a short sentence that had suddenly revealed itself to him—or, better, struck him—on a bright and warm summer day in the vicinity of Athens:

> *Nous nous devons à la mort.*
> We owe ourselves to death.
> It was this past July 3, right around noon, close to Athens.
> It was then that this sentence took me by surprise, in the light—"we owe ourselves to death"—and the desire immediately overcame me to engrave it in stone, without delay: a snapshot [un instantané], I said to myself, without any further delay.[32]

With just a few strokes, these opening sentences lay out the main concerns explored in *Athens, Still Remains*: the semi-exact date, time, and place ("this past July 3, right around noon, close to Athens") signal both the accuracy and inaccuracy of the author's written representation of the event. The "surprise" emphasizes instantaneousness with which the sentence struck him (suddenly, as if he were hit by a lightning bolt) while the idea of the snapshot ("engraved in stone, without delay") expresses both the wish to capture the moment itself, exactly as it occurred on that hot summer day near Athens and the impossibility of doing so. What seems to be a passing observation regarding the light (which must have been the bright, torrid sunlight of a Greek summer afternoon) emphasizes the irreproducible experience of being here (or rather, from the reader's perspective, there), now (back then), in the present moment (at that time). It also represents the attempt to "engrave" it using the light-capturing medium of photography, which Derrida calls "the writing of light."[33] All of this spirals back to the event itself: the sudden arrival of a sentence, without explanation or context: "We owe ourselves to death."

In the rest of the essay, Derrida tries quite literally to make sense of this sentence. First, he focuses on the final word: death. Implicitly evoking Roland Barthes's concept of time as "punctum," Derrida initially approaches the way in which photography captures an event (freezing it in time and space) as an

[31] Jacques Derrida, *Athens, Still Remains: The Photographs of Jean-François Bonhomme*, trans. Pascale-Anne Brault and Michael Naas (New York: Fordham University Press, 2010), 59.
[32] Derrida, *Athens*, 1.
[33] Derrida, *Athens*, 19

act in which the photographer always arrives too late.[34] The picture is taken at the very instant that the shutter opens and closes—but the moment itself has already passed. In Heideggerian fashion, Derrida writes that the photograph is a testament to the attempt of capturing what is always already gone: it confronts its viewer with the fact that life is nothing but a "temporary reprieve" from the time when one is no-longer alive.[35] In producing images that depict things that have already happened, and are no longer happening, this "lateness" of photography embodies the transience of life. It forces on the viewer the fact that every living moment "suspends the coming due."[36] What the picture shows, will perish. Perhaps it already has. In this way, petrified photographic images of what has always already gone remind us of both the catastrophe of death and death's "not-yet" for us, as viewers.

The photograph thereby shows how we always exist in relationship to what Derrida calls this fundamental "delay," which stretches between the moment that something takes place and our (cognitively or technological) processing of it.[37] As soon as we grasp the presence of the present, it is already past. Unable to represent the here and now as it takes place, we can only process or represent what has already passed. The "click" of the camera—the short time between pressing the release and the shutter closing—represents the "cut" that defines this delay. This cut is not clean: although it tends toward the impossible instantaneity of a Dirac impulse—the ideal now—it will never fully converge with it. Derrida's ontological delay, then, is analogous to the response time and delay of any technical filtering operation, as defined by the uncertainty principle explained in the previous chapter. This uncertainty principle postulates that a physical filter's response time cannot be zero (nothing happens instantaneously), meaning that the delay can be expunged only from an imagined ideal Dirac impulse, in which the timeframe is infinitesimally small and the frequency range infinite. In real time, however, the now can only be stored as the no-longer-now—as the past. We are always already too late to grasp it fully. Once it is processed and defined, captured and reproduced, the event itself is gone. We are left with an impression that lingers in our memory or a representation inscribed on media hardware.[38]

[34] Derrida, *Athens*, 3; Roland Barthes, *Camera Lucida: Reflections on Photography* (New York: Hill and Wang, 1981), 27.
[35] Derrida, *Athens*, 29.
[36] Derrida, *Athens*, 27.
[37] Derrida, *Athens*, 17.
[38] As Kittler writes, "In order to know what something is, we need time to recognise it, thus we always miss when it happened; if, conversely, we want to know when something happens, there is no time left to say what it was." Kittler, "Lightning," 71.

Still, this relation with finitude and death notwithstanding, Derrida suggests that the click of the photographic shutter also allows for another perspective, premised on a radically different reading of "nous nous devons à la mort"—"we owe ourselves to death." Shifting focus away from the inherent lateness of the photographic image and impossibility of the clean cut, Derrida thematizes a different interleaving of past and present—of has been, being, and will no longer be. In exploring what he calls "the at-present of the now," he broaches the possibility of rethinking "instantaneity on the basis of the delay."[39] In other words, he means to rethink the unrepresentable experience of the transient presence of the present in relation to its pastness. Whereas Kittler is preoccupied with the atemporality of sine waves (which can only grasp the whatness of signals expressed as periodic frequencies), Derrida foregrounds the very short instant between the opening and closing of the shutter itself. Focusing entirely on the point-like moment of the cut, he considers a perspective that is diametrically opposed to notions of permanence and infinity. In this way, he develops a different analysis of signals' presence and development over time—of the continuous thatness of signals in the here and now, which tends toward the radically infinitesimal "now" of the Dirac impulse.

A pure Dirac impulse encapsulates the promise of an impossible moment of full, untrammeled presence—an ideal event. At such a moment, however unfathomably brief, the signal would be present in all its complexity before its inherent transience makes itself felt. Regarding this ideal event or pure "now," Derrida writes that by symbolically suspending the delay inherent to photographic image-making, and honing in as closely as possible on the moment of capture itself, we can begin to imagine what it would mean to "refuse [the] debt" of our being-toward-death.[40] We can imagine defaulting on the inevitable coming due and staying—if only for an infinitesimally brief instant—within the moment of the click, of capture, of the event itself. In tending toward the infinitesimally short timescale of the Dirac impulse, this moment represents the almost unimaginable nowness of the present.

At a specific, unrepeatable moment in time and space—somewhere close to Athens, for instance, right around noon on July 3 of a certain year in the late twentieth century—one can choose to ignore the debt, to withhold what we owe to death, if only in temporary and imperfect way. For an infinitesimally short moment, lasting no longer than the nonduration of an ideal Dirac impulse, the end is kept at bay. In such instants, Derrida writes, we are nothing but "an innocent living being who forever knows nothing of death."[41]

[39] Derrida, *Athens*, 17, emphasis in original.
[40] Derrida, *Athens*, 63.
[41] Derrida, *Athens*, 63.

Radically unconnected with past and future, this is the perfect transient experience, the ideal event. It comes and goes as instantaneously as a flash of lightning. Like a Dirac impulse, it contains an infinite amount of information, too much to process or filter in any limited amount of time. Its pure transience can be neither captured nor reproduced, for it only exists—can only exist—in the radical present. The mathematical Dirac impulse, then, would be an unfathomably brief moment of full and saturated being; an impossible instant at which an infinite spectrum is nothing but present and the transience of existence is of no import. At this infinitesimally short moment, Derrida concludes poetically, we can imagine being "infinite": "We are infinite, and so let's be infinite, eternally."[42]

Following this conceptual move, our analysis of technological sound reproduction can also move away from the atemporality of sine waves and focus instead on the absolute presence and continuous temporal development of sound signals in the now. Looking beyond dreams of complete replication allows for a fuller recognition of the present, in its infinite complex and indivisibility. Derrida's analysis of transience and infinity offers a compelling counterpoint to Kittler's description of the stasis of the Fourier domain. Although the "we are infinite" of Derrida's instant might seem to echo the "we are immortal" of Kittler's eternity, in fact the two statements form complementary opposites. Derrida's analysis of the "click" of the shutter and call "to be infinite" reveal an aspect of the temporality of technological reproductions that goes overlooked in Kittler's emphasis on immortality and sine waves: the continuously renewed presence of the present that is exemplified by the infinitesimal Dirac impulse. On the one hand, the physical cuts made by technical filtering operations and unrealizable purity of ideal sine waves evoke pathos in the face of intractable transience of existence. On the other, the absolute randomness of nonperiodic transients also produces this experience of a continuously developing sonic present and promise of an infinite now. Together, the absolute transience of the moment of the cut and impossible ideal of immortal sine waves thereby produce the simultaneous awareness of each sound's radical presence in the here and now, and of its inherent pastness.

Listening to Passed and Passing Time

The uncertainty principle that balances time and spectrum physically necessitates a delay in the recording and storage of a sound event in its full

[42] Derrida, *Athens*, 63.

spatiotemporal presence. If we were able to wallow in the eternal presence of an infinitesimally short instant, we would never have time to grasp what was what—time to analyze, process, and define the event would be lacking. Conversely, if we were able to grasp every frequency in perfect clarity, time would never progress, because everything would stay the same for all eternity. The delayed response times of technical filters, therefore, is not just a physical or technical limitation of media, which might be overcome at some point. What is more, it postulates what John Durham Peters calls "an ontological point about the nature of things and an ethical point about the uniqueness of every act."[43] Given the absolute physical limit imposed by the uncertainty principle, Peters argues, "all empirical representation both depends on and crashes into the wall of finitude."[44]

Derrida imagines postponing this delay, entertaining a dream of immediate and complete capture in which all worldly things could be processed at the very moment they occur.[45] The appeal of the ideal filter, noise reduction, and positive science as such lies in this dream, which promises to expunge all fuzziness, uncertainty, lack of clarity, and randomness. In giving everything its proper time and place, this vision of instantaneous processing wards off the constant, "indefinite certainty" of death. Like Kittler's dream of immortality, as encapsulated in the infinite periodicity of the Fourier series, this dream of absolute presence, freed from the shadow of transience and delay, is physically impossible. Just like lightning and thunder, event and series, Dirac impulse and sine wave, Derrida's infinity and Kittler's immortality are symbolic idealizations at opposite extremes of an uncertainty principle. Although they might be striven after like the fountain of youth, they are only possible in theory—as mathematical formulas or philosophical stories.

Whereas a sine wave is a single frequency, filtered out from among an infinitely complex sound spectrum by an ideal spectral filter, a Dirac impulse turns time into discrete, infinitesimally short windows or grains of time through an ideal temporal filter. In this process of perfect temporal discretization, continuous time would be divided into a succession of these windows or grains, each representing a perfect infinitesimally short temporal sample, without any loss of information. This is a Dirac comb—also called "impulse train" or the "sampling function" (Figure 4.1). This procedure (a series of infinitesimally small bits of time, each containing an infinite amount of spectral information, lined up one after the other) figures an idealized version of both

[43] John Durham Peters, "Resemblance Made Absolutely Exact: Borges and Royce on Maps and Media," *Variaciones Borges* 25 (2008): 11.
[44] Peters, "Resemblance," 19.
[45] Derrida, *Athens*, 51.

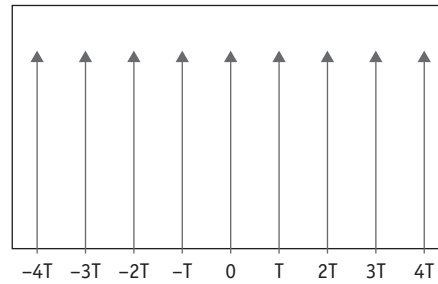

Figure 4.1 Dirac Comb. (Courtesy of Krishnavedala, "Dirac Comb.svg," *Wikimedia*, accessed October 23, 2015, https://commons.wikimedia.org/wiki/File:Dirac_comb.svg).

Gábor's "windowed" time-frequency analysis and digital sampling. Unlike these actually implemented procedures, however, every infinitesimally short impulse in an ideal Dirac comb is utterly unrelated to the next. Each window or pulse is a unique snapshot of a singular moment in time.

An ideal Dirac comb renews itself with each new infinitesimally short instant, pushing time forward irreversibly. Not coincidentally, this is also the definition of white noise: an endlessly varied, temporally uncorrelated signal with an infinite frequency range. Accordingly, ideal white noise is just as physically impossible as an ideal sine wave. Producing ideal white noise would require infinite time and an infinite number of frequencies, or an endless series of infinitesimally short Dirac impulses and infinite amount of energy.[46] On one extreme, then, white noise constitutes pure, unrepresentable randomness—like everything on the plane of the ideal filter, it can only be approximated, not fully realized. At another extreme, the sheer regularity of completely periodic signals tends toward, but never achieves, the absolute repeatability of ideal sine waves. These immortal sine waves would embody the purity of a perfectly periodic frequency spectrum—a purity that is every bit as elusive as that imagined in age-old Pythagorean fantasies of celestial harmony. The transient noise of sound, in contrast, tends toward the infinite spectral complexity of a Dirac comb. Since no physical signal is entirely periodic or entirely transient, physical sounds exist somewhere between the two. They resonate at a liminal position between sine waves and Dirac impulses, infinite time and infinite frequencies, absolute periodicity, and complete randomness.

When a sound arrives in human ears, it includes sonic traces of everything it has encountered between its first attack and ultimate decay. In its specific

[46] Kosko, *Noise*, 66–67.

waveform, we hear its journey over space and time. On the one hand, the accumulated noise produced by technical cuts underlines the impossibility of capturing the presence of the present exactly as it happens, at some specific moment and place. All of the transient elements that stick to the signal over the course of its transmission point to this impossibility of holding on to the now. They draw attention to the fact that, although the sound is unmistakably present in the here and now, it has traveled over time and through many different places. It was captured, cut off from its origin, and changed. On the other hand, the specific conditions of each transmission, from input to output, are irreducibly singular. The sound flowing from the speakers is inevitably affected by the materiality of each link in the parasitic chain of channels, and its transient singularities have an unmistakable sonic presence that resonates with the listener in the present. In this way, they confirm the radical presentness of all sound as it passes through the now.

Hence, the multilayered temporality that characterizes the noise resonance of sound media is double-sided. Noise, distortion, and randomness—the results of a long series of intermittent filters—mark both passed time and passing time. Passed time in the sense that they figure indexical traces of both temporal irreversibility and the finitude of all transient phenomena, including signals. Passing time in the sense that these traces of the materiality of communication media evoke continuously renewed sonic presence. As such, they recall time's constant flow through the present.

Periodic frequencies make it possible to identify a sound's whatness, including all of the historicity engrained in its spectrum as frequency alterations. The transient events that caused these alterations, however, cannot be described in terms of whatness. Rather than being stable properties belonging to the sonic object, they constitute the thatness of an event. Despite the fact that we are always already too late to process and capture the event as it occurs, in these traces' brief appearance and disappearance we hear both the passing of time and continuous presencing of the present. Although the moment of presencing is always already gone, it is constantly recalled by the transient traces it leaves behind.

The myth of perfect fidelity, in striving for clearly delineated spectra and infinitely oscillating sine waves, adheres to a rationalist ideal of a world in which every part of every sound has its proper, unchanging place. It presupposes the possibility of both a clean cut between signal and noise, and a perfect filtering operation. To account for the way in which channels shape sonic outputs, however, its supporting logic of noise reduction should be replaced by a conceptual logic of filtering. In doing so, I mean to conceptually replace the ideal filter with a technical filter, much as one might substitute a circuit

diagram for the actual circuit.[47] Whereas the logic of noise reduction symbolically suppresses the artifacts of signal processing, the logic of filtering acknowledges the importance and complexity of everything that happens in the middle. Understanding technological reproduced sound and music requires such a reorientation toward the mediatic conditions of everything that emerges between the two extremes of the uncertainty principle, of everything that causes the continuous interweaving of pastness and presence that characterizes the experience of listening to sound media.

Around 1857, at the outset of the emergence of these mediatic conditions, French inventor Édouard Léon Scott de Martinville developed the phonautograph: a machine that could trace aerial sound waves on paper. The visual representations produced by his device, he imagined, would enable users to learn to "read" the inscribed waveforms like conventional musical scores.[48] With the phonautograph, Scott wanted to create more direct representations of natural sounds, based on their immediate inscription on a physical surface. He hoped that this would allow better access to, and control over, the physical intricacies and complexities of sound. For most media historians, Scott's invention has been of interest as a predecessor of machines such as Edison's phonograph, which could not only inscribe and visually represent, but also play back the sound waves it recorded.[49] In that sense, the true power of Scott's device was only revealed when, about one-hundred-and-fifty years later, a team of scholars led by Patrick Feaster used digital scanning technology to reconstruct Scott's phonautograms and turn them back into sound. In this way, they uncovered, among other recordings, twenty seconds of what is presumed to be the inventor himself singing "Au Claire de la Lune."[50]

When one listens to this reconstructed recording, Scott's ghostly voice, although covered by layers of noise, is actually, unbelievably, physically present. Precisely because of their age, crudeness, and unlikely survival, these twenty seconds might be the most vivid example of the power and magic of sound reproduction, which can save a transient sound event and replay it over and

[47] As Wittje writes, "Circuit diagrams were not about the materiality of the circuit, but about its operations. In contrast to mechanical drawings, circuit diagrams were meant to show functional relations, not spatial arrangements." Wittje, *Age*, 19.

[48] Patrick Feaster, "Édouard-Léon Scott de Martinville: An Annotated Discography," *ARSC Journal* 41, no. 1 (spring 2010): 43.

[49] This fixation on the phonautogram's place in the history of sound recording, Feaster writes, "has distracted most critics from seeking to understand the phonautograms on their own terms, as visible, archivable documents implicated in motives and uses to which playback was irrelevant, and not a conscious or conspicuous omission." Patrick Feaster, "Enigmatic Proofs: The Archiving of Édouard-Léon Scott de Martinville's Phonautograms," *Technology and Culture* 60, no 2., supplement (April 2019): 15–16.

[50] Édouard Léon Scott de Martinville, vocalist, "Au Clair de la Lune—S'il Faut Qu'à Ce Rival—Vole, Petite Abeille," track 14 on Patrick Feaster, *Pictures of Sound: One Thousand Years of Educed Audio: 980–1980* (Atlanta, GA: Dust-to-Digital, 2012), compact disc.

over again. At the same time, though, those noisy traces of its ingenious but crude recording mechanism and belated (and unintended) digital reproduction also clearly signal that this voice is not actually present as it sounded about one hundred sixty years ago. Reproduction does not make passed sound transparent and accessible. This sound, much like any regular sound, remains opaque and transient. Besides proving that Scott did indeed record physical sound waves, then, the digital reconstruction emphasizes that his visual representations of sound revealed a complexity that cannot be "read" or "interpreted" in any conventional way, as one would read notes on paper. Although acousticians like Helmholtz would use the phonautograph, or modified versions of it, to analyze sound, the inscriptions are not necessarily legible if one does not already know the sound that has been recorded. Ultimately, a phonautogram of a complex sound wave only deepens the problem of grasping its physical nature, further highlighting the unrepresentability of its full spectro-temporal being.

Technological sound (re)production operates through series of physical filters that cut the flow of events. The sheer presence of a signal as it emanates from the speaker confirms that these filtering operations took place (if a sound can be heard, after all, then it has to have been produced). As soon as these workings can be pinpointed and analyzed, however, the moment of filtering itself has already vanished. Although the instant of filtering always eludes us, its audible traces—spectral and temporal changes and noisy additions—simultaneously confirm the finitude and pastness and radical presence of the (re)produced signal. In making each sound singularly different from the next, these traces gesture toward the fundamental fact that no technologically produced signal is truly a complete reproduction of a supposed "original." Ultimately, every sound is only fundamentally itself—a unique signal.