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THE SONIC IMPERATIVE

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SOUND IN THE AGE OF SCREENS

Gary C. Woodward

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For Adeline,
Garrison,
Henry,
and Miles

CONTENTS

PREFACE

Because life tends to send us in circles rather than straight lines, we can sometimes catch glimpses of our earlier selves in loops of familiar experience we revisit. Look hard enough, and we see at least some recognizable landmarks that we remember passing before. It is those kinds of moments that can make it seem like it is actually a subject that picks its author. That is a feeling that grew throughout this project. When it comes to the life of the ear, we all have our stories.

In my case a pattern emerges early and turns into a persistent curiosity, a magnetic north, always steering my interest to some new auditory experience. A passion for sound began as another 1950s adolescent boy who built radio crystal sets and worked to get a scouting patch for knowing Morris Code. It was clear even then that radio rivaled food and water as one of the essentials for life. That first “cat’s whisker” receiver was one of many breadcrumbs dropped over time, creating a meandering trail that rarely strayed from the geography of sound. When I did take a wrong turn, as with a hand-me-down movie projector that rewarded my tinkering with random electrocutions, the message to stick to the auditory world was clearly received.

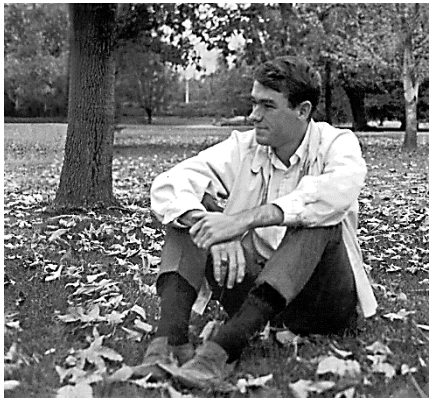
People and objects that delivered sound in one form or another always seemed to hold the most fascination, like weekend nights listening to KOA radio’s live bands from Denver’s old Elitch Gardens. It had to be KOA, the 50,000-watt giant standing alone out on the prairie. At night and under a cloudless sky, it was an Art Deco apparition glowing in the dark beyond the city’s lights. Fact was then stranger than fiction to know that the

high voltage transmitters inside came into their own at dusk, sending a powerful clear-channel signal deep into six other states.

If it wasn't radio as a subject, it was a one-tube electronics kit purposefully miswired to become a nuisance transmitter sending the sounds of my 45s and a crackle of interference to the rest the neighborhood; or a series of shortwave sets attached to a hundred feet of naked copper wire surreptitiously attached to a utility pole in the alley behind our house. New long-playing records joined the singles on a two-tone "suitcase" phonograph. Ravel's tonal fireworks and the Eastman School's Frederick Fennell were favorites purloined from our modest household collection, when a family friend roused an interest in becoming the next Sonny Payne or Buddy Rich. Drum lessons began and an assortment of teen bands followed, producing a musician good enough to play in a statewide ensemble, but who also made more of an impression falling off a stage mid-performance than mastering the forty rudiments of percussion.

I was also in the distracted post-war generation that had been captured by the world's rapidly expanding trove of recordings that promised nirvana and sometimes delivered. Bargain label reissues of classical and jazz albums from Sam Goody and Tower Records began to accumulate, as did recordings of European organs that mystified friends looking through my stash for the latest from The Doors. Instead, they found Bach and Buxtehude hanging out on the shelf with Basie and Brubeck.

Childhood obsessions may eventually extinguish themselves, but attraction to the aural continued at a campus radio station that was a nighttime refuge from sweltering summer



days at a steel plant in California's Central Valley. There were also rare weekend escapes with parents to nearby casinos in the Sierras. They gave an underage stowaway the chance to hear flawless musicians playing over the din of the slot machines. The cooler fall would bring a new semester and a course in the Psychology of Art that fed this sound-centric student's interest in writing a paper on Beethoven's deafness. The research led to an abundance of sophomore empathy for the stricken composer, as well as an art history professor annoyed at the escapee who went over the walls of his well-ordered discipline. But "speech" was my college major, later deepening into graduate work in one of the oldest of the auditory arts, classical rhetoric. Orality and fluency mattered to the Greeks. A person's mark as a leader rested on their skills to face an audience and win them over with the power of vocalized appeals. It was all to play out in the circularity of returning to where the journey had begun a few years earlier, but now in the person of an academic who taught courses as utterly different as rhetorical theory *and* radio production. It was a better fit than it seemed, and reason enough to prod young and more hip film colleagues with the dusty old canard that radio is like video, "except the pictures are better."

Back then, audiology and the mechanics of hearing seemed like a required curricular sideshow in widening discipline. But as these pages reflect, it was impossible to miss the passion of

instructors who insisted that aural media represented an essential gateway to language. They knew that the extraordinary processes that support listening represent a huge part of the human experience. I should have paid more attention. For them and for other reasons to be explored, this book is meant to celebrate debts to the sonic world that we too often take for granted.

A Word on Method

The capacity to hear requires a broader range of reference points than with other kinds of projects. Sound is a sensation but leaves no visible trace. Our perceptions about its effects are individual and unique. Like taste preferences or reactions to colors, sound processed through the mind is a set of impressions. Even while we have acquired metrics that identify many of its physical properties. The sensory side must be explored with the kinds of “deep descriptions” familiar to the phenomenologist or a systematic critic. The methods and theories of the social and biological sciences are not enough. Countless academics also theorize about sound, but to little practical effect. And we surely need the precision of acousticians, engineers and others who measure and document the patterns and boundaries of auditory content. We have the tools and electronic instruments to make sound discussable. And in musical notation we also have an awkward but functional way to visually capture the ephemeral artifacts of organized sound. But music on the page is not music that has passed through the ear. If we want to say much more about that process, we all function like phenomenologists,

applying a range of descriptive forms: self-reports, the descriptions of others and the judgments of those who have devoted their lives to appreciating the aesthetics of the sonic arts. In the pages that follow, therefore, some insights are drawn from empirical measures, others are more personal and impressionistic. A well-rounded view of sensate experience demands such an inclusive approach.

Finally, the scope of this study necessarily touches on a wide span of areas: the psychology of listening, the physiology of hearing, timelines of language acquisition, architectural acoustics, sound recording, martial uses of audible deterrence, sound-based therapies, and the use of music and voice to entertain. It goes without saying that taking on an inclusive approach suggests a degree of hubris while putting a great deal in the lap of a reader. There is arguably more than any one person can absorb or illuminate. But that is as it should be for a vital human capacity.

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Chapter 1

INTRODUCTION

> *Sound is one of our greatest opening voids, one of the richest and most perishable of all things. . .*[1]
>
> —John Durham Peters

Cultural fashion favors the idea that humans are visual learners and visual thinkers. We tend to give sound the second position in the hierarchy of the five senses. But the central argument of this book is that the capacity to hear and interpret sound remains the most consequential anchor of human experience. We may see lightning first. But only with its roar has the drama begun. While it may seem unusual to insist on our capacity to hear, the age of screens makes it easy to underestimate what we owe to the auditory pathways that sustain our attachments to places and people. We usually think we control its many forms, but in surprising ways the auditory universe also has its way with us.

The ability to hear casts a very wide net. It is not only the basis of verbal literacy, but of consciousness itself. We think in language. Learned labels trigger experiences that we “know” because they can be named. And while speech is the driver of all communication, it is only the first among many kinds of auditory cues that provide essential portals into the culture. We recognize

places by their sounds, just as we know individuals from the unique tonalities of their voices. Auditory signatures are crucial waypoints in navigating through the clamor of everyday life.

Sound is also ubiquitous; it is present even in conditions of apparent silence, and to the very last moments of death.[2] And because we are captives to its mnemonic triggers, we are easily motivated to dwell on its varied incarnations. We socialize ourselves through auditory channels, fulfilling our birthright—in Aristotle's words—as "the animal that talks." After all, speech is the generative source of language. The encoding of sound into words remains the key transactional tool of our species. We begin our lives as efficient and thirsty learners, absorbing spoken language and gaining a sense of self from its labels. The verbal capacities we acquire in the explosion of learning that happens in the first two years of life propels us into the culture. The resulting mastery that links the ear to the voice is both natural and essential. It sustains us first as strangers, then allows connections to expand and deepen over time. As ships need depth 'soundings' to find safe water, so we need aural cues and spoken language to navigate our way through the world.

Remarkably, auditory content as it typically comes to us is a relatively new phenomenon. Only in the very recent past have we been able to capture and recreate sound with any degree of accuracy. Painting, sculpture and other visual forms are ancient by comparison. Working near Florence, Giotto's vividly detailed paintings date from the early 1300s. By contrast, it's a stunning reminder that we only learned to accurately reproduce and store aural content just 100 years ago: first with radio in the 1920s, and later, with the widespread adoption of the German invention of magnetic tape recording. Prior generations living in proximity to composers we now revere were still likely to hear more street noise than music. The idea of a genuine concert for the public

dates back only to the seventeenth century.[3] Composers like Joseph Haydn survived largely because of their private patrons or the still powerful church. Remarkably, the recency of our modern immersion in sound explains why so many of the world's ancient philosophers and thinkers had so little to say about it.[4] Most lived without experiencing the sensate richness made possible by the broadcast and recording revolutions of the twentieth century.

Others have detailed the structural and instinctual reasons language and oral discourse evolved within humans.[5] Our goal is different and focused on how aural forms function in everyday life. To be sure, human activity now orbits around our thrall with screens. But human expressiveness comes alive in what we hear. We need a wide perspective like that of the musician and naturalist Bernie Krause, "Without sound," he noted, "there would be no music, no legend, no voice to stir the soul, evoke the memory, or transport the spirit."[6] Speech and music are just the most recognizable sound structures that leave their impressions, but many others remain to be explored—giving us good reasons to apply fresh ears to the familiar world around us.

Three Venues in Philadelphia

Consider a preliminary map of three representative cases of sound design scaled down to just one section of a single American city. A varied sampling of how we deal with speech, music and noise can be found in several locations along a four-mile length of Philadelphia's Broad Street, a wide boulevard originally laid out by the enterprising William Penn in 1682.

Near the modern city center is a block-long structure designed by the modern architect Rafael Viñoly. The defining feature of the Kimmel Center is an enormous arched glass ceiling

rising to eight stories. Built in 2001, it became the new home of the Philadelphia Orchestra, with the principal advantage of being one block further away from the rumbling subway that ran under the orchestra's old venue, the Academy of Music. Within the Kimmel Center's glass-dome expanse are foyers, restaurants and several theaters with their own enclosed spaces. The largest was built specifically to amplify the rich string sound of the orchestra made famous in films and a huge catalogue of Columbia and RCA recordings.

Architects like to describe this theater's design as an "egg in a box," an arrangement of double walls used in most modern concert spaces. The idea is to nest musical groups inside *two* containers that eliminate street noise, making it possible for a lone flute player on stage to be heard even in the back of the 2500-seat space. All three levels of what is officially known as Verizon Hall are curved in the shape of a cello, with undulating walls that are meant to reflect sound back to the audience. The varied angles are a defense against the tendency of any one pitch to dominate, a problem we will consider later. The interior walls of mahogany—a favorite of guitar makers—works to soften harsh reflections and add warmth to the overall sound. Together, these surfaces and their separation from the street means that a composer, the musicians on stage and the audience will have the aural environment to themselves. In specific terms, middle C played on a piano from the stage (261 Hz, or cycles per second) should sound just as robust as the lowest note on its keyboard (a very low-sounding A at about 27 Hz.). Even the very unusual case of composer John Cage's completely *silent* "composition"—his infamous "4'33"—can be "heard" more or less as intended, meaning that everyone including the orchestra will sit for almost five minutes in a sonic state of Zen, without any note played. Of course, Cage's musical riddle will not exist in perfect quiet. Even

in Philadelphia this strange piece of nothing must yield to the city's audiences of reflexive coughers, who are inadvertently assisted by the resonant acoustics of the hall.

The control of sound is very different at another landmark at the south end of Broad Street. The Philadelphia Phillies ballpark is one of many newer baseball stadiums that were built in revived downtowns at the start of the new century. Its field is basically an eight-sided box filled with seven tiers of seats, and a portion of the center outfield side left open for views of the city beyond. There is no roof, and the four packed levels are pushed up tight against the green edges of the field. When visiting the park for the first time, fans remarked on how much closer they were to the action than when the team played in a football stadium. One result is that the short distance between the left and right field seats helps reflect the crowd's roars in a full aural backwash: an important feature for an eighteenth-century game in need of more drama for its twenty-first century fans.[7] Nearly 1400 loudspeakers also help to keep the energy level high. It doesn't hurt that the space is also fed by a continuous low frequency rumble produced by traffic on nearby Interstates 95 and 76, as well as commercial aircraft landing on airport runways 27R and 27L, just beyond center field. A sports stadium is meant to exist in a continuous growl of anticipation, a need supplied by the rumble of all those distant engines carried into the stadium. As one local reporter noted, "from the minute you walk through the gate until the final out, your ears are bombarded by rock music, promotions, public address announcements, silly theme songs for batters and relief pitchers, goofball between-inning promotions and contests, PA announcements urging fans to 'Make some noise!' and whatever other ear-piercing innovation the club conjures up."[8] It turns out that the deafening roars are as carefully considered as the stillness designed into the Kimmel Center three miles north.

A third completely different space sits on the corner of Broad and Cherry Street on the other side of center city. As a venue for visual arts, this landmark was not only designed for the eye, but also to purposefully *limit* what a visitor's ears might detect. Built in the 1870s, The Pennsylvania Academy of Fine Arts remains a cherished Victorian pile of stone and red brick with an historic art

Figure 1.1:
Main Hall at the Philadelphia Academy of Fine Arts.
Library of Congress Prints and Photographs Collection

school and sumptuous galleries with walls of red damask. This Gilded-Age institution is a bulwark that is famous for its connections to important realist painters like Thomas Eakins and Thomas Cole. Eakins favored portraits of city leaders and doctors, a favor repaid with his name added to local landmarks. As for Cole, he spearheaded a rich legacy of American impressionism represented in sumptuous landscapes of the Catskills and New York's Hudson Valley. A walk through the grand front hall of polished wood and brass reminds a visitor that this is a place where it would have been possible to cross paths with the kind of elegant women found in an Edith Wharton novel.

As befits an art museum, the galleries were meant to be shelters from the cacophony of the industrial city at its doorstep. That included the smoke and tumult of the sprawling Baldwin Steam Locomotive Works just a few hundred yards north. Public art galleries like Philadelphia's have always been built to be library-quiet. The idea was that a visitor should allow their eyes to dominate.

In this goal of emphasizing the visual there is a subtle but significant cultural pattern that is relevant to this study. The rapid proliferation of art museums and municipal galleries in nineteenth century America reflected the nation's aspiration to emulate the towns of Europe, where generous patronage had long made the fine arts a source of pride and identity. In many ways these institutions did their part to prepare Americans to inherit these values. Thomas Jefferson was not the only new world leader enamored with the visual delights on display in continental Europe. His home and the campus for the University of Virginia were designed to be curated as well as inhabited.

In the broadest of historical strokes, Jefferson's eye for beautiful objects was predictive. It's possible to imagine an alternate path to American cultural uniqueness that might have

grown from the deep-rooted loquaciousness of the colonists and framers of the Constitution. Burgeoning sects of Puritans, Transcendentalists and other religious and sectarian groups made the angry rhetorical jeremiad their special trope. In more recent times our civil rights rhetoric has followed this American tradition of dramatic oral discourse: a legacy that might have made the nation an Athens of ideas predicated on the spoken word.[9] Yet a more durable legacy would eclipse it, represented in the ways American innovation was harnessed to support the mass distribution of ideas that could support the mass distribution of goods. This path can be traced in the nation's transference of its love for everything from the humble art canvas to the rapture for early photography in the mid-nineteenth century. It was only a matter of decades until the upsurge in popular entertainment and innovative electrical innovations would eventually lead us to the allure of even more stage and film spectacles. It is no accident that for a number of years vaudeville and film shared the same audiences and many of the same theaters.[10]

This American thrall of all things visual is well-represented in the inventions of Bell Labs, RCA's Sarnoff Labs, Xerox and Apple Computer. All and more combined to reorder the balance of our senses: a process that was complete with the rise of the graphical interface for computers in the early 1980s. Apple's Steve Jobs demanded screens that would be filled with icons and colors, a mode of thinking soon picked up by Microsoft and delivered in the software we still know as "Windows." All promised to offer much more than text and numbers to an increasingly ocularcentric world.[11]

But if our eyes let us see space, our ears tell us what that space holds. Notwithstanding the rise of visual media, our three sample institutions on Broad Street are useful reminders that we still organize our lives to hear what matters, even when one

intended outcome is near-perfect silence. The fragile sense organs embedded in the skull make the most of the binaural hearing that we share with most of the animal kingdom. The “acoustic shadow” created by the distance between our two ears allows us to sense depth, direction and the size of spaces. We can hear what is beyond our sight. But the additional capacity for languages seems to be ours alone.

Of course, we don’t spend most of our time in concert halls, ballparks or museums. A typical middle-class American family of four shares a suburban home of nearly 3000 square feet. There may be as many as 10 screens including televisions, phones and computers that are spread throughout that space. A surprising number of families leave a television on most of their waking hours. Even children under nine will spend several hours a day staring at one of them.[12] Other devices will also add to the hum and noise of daily life. A quiet house may register a comfortable 43 decibels (dB) of sound. But force of habit, and because some members may have impaired hearing, means that many are significantly louder.

The Rudiments of Sound

We have introduced two common terms of sound measurement represented by Hertz (Hz), or cycles per second, and decibels (dB). It is not possible to explore the audible world without a basic understanding of what numbers attached to them mean. Both represent core properties of acoustic energy we cannot see, but readily perceive as pitch and loudness. To be sure, sound has its own complex physics, which can easily ascend toward the mathematical stratosphere of acoustic

measurement. But it is sufficient here to begin by understanding these two metrics for measuring sound, even if we will use them more for comparative purposes than as precise measures.

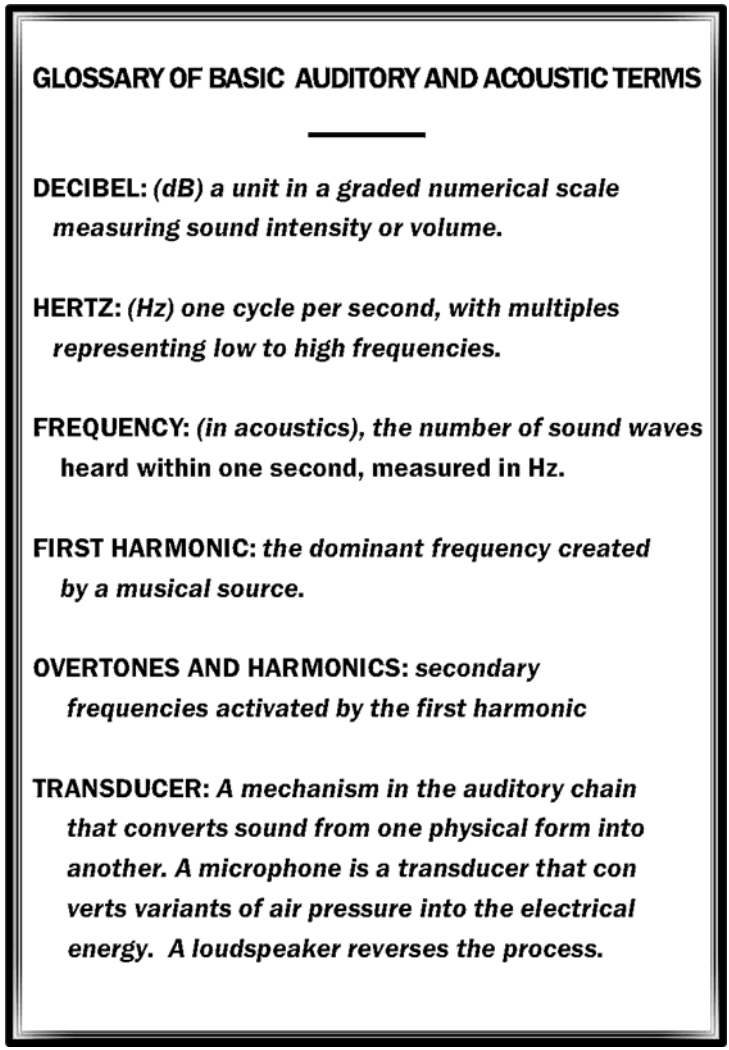

Figure 1.3
Glossary of basic auditory and acoustic terms.

Sound as a pitch comes to us as variations in air pressure at energy levels far smaller than might be assumed from the usual analogy of waves created on the surface of water. Our ears perceive subtle air pressure waves that radiate and decay like a pond's ripples that fade as they move outward. The regularity of these waves within a certain range is interpreted as a *frequency*, giving us our first measure in cycles per second or *Hertz.* A rate of 60-wave cycles per second produces the low frequency designated as 60 Hertz (*Hz*), near the note of B1, the 15th key on a piano. The unit is named after Heinrich Hertz, a German scientist who explored magnetism and sound in the nineteenth century. Perfect hearing may go as high as 18,000 Hertz, usually designated as18 kilohertz (kHz). As we've noted, middle C on a piano is 261 Hz. A violin has a range that goes from a low of about 190 Hz to highs of about 2650 Hz. A trumpet's narrower range goes from a low of 164 Hz up to 940 Hz. These figures represent the number of vibrations and their waves of air pressure measured in one location in one second.

As with most instruments and the human voice, there are also overtones of fainter, but complementary frequencies produced as secondary vibrations to the primary pitch known as the "fundamental." For example, 261 Hz of middle C on a piano will produce overtones or harmonics that usually double or halve the fundamental. They naturally set up "harmonics" that add more tonal color to their sounds.

Listen closely to a single note struck on a full-sized piano and you can easily hear the harmonics. The sound is more "musical" than the one-pitch tone an audiologist might use to test your hearing. Normally a younger person has the best hearing that can detect the fainter harmonics or overtones of an instrument that can go well beyond 10 KHz.

We hear primarily through *air conduction*: via pressure waves that reach the thin tympanic membrane we know as the ear drum. We also hear our voice and low frequency sounds through *bone conduction*. Bone is a good conductor of sound. For some people with hearing loss a specially designed headphone placed *behind* the ear is the better option, with sound bypassing the ear drum and carried through bone directly to the inner ear. Bone conduction accounts for why our voice always sounds “off” when we hear a recording of it. We hear our own voice partly through our skull, making it sound deeper and fuller than how it sounds to others receiving it only through air conduction. That sound can travel through bone is a reminder of the obvious point that it can travel through many solids. As an apartment resident can attest, walls are not necessarily acoustical barriers and, as is the case

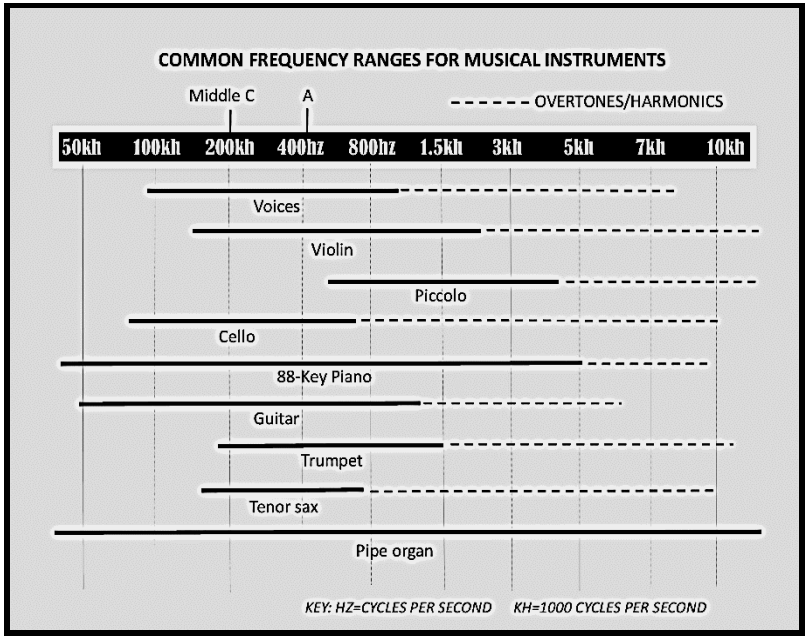

Figure 1.3:
Musical instruments cover the entire range of human hearing.

with low frequencies, they can become resonators and actually increase the loudness of a sound.

As to our second basic measure of sound as loudness, drop a heavy boulder in the water and the splash not only produce wave frequencies, but higher waves of that are easy to notice. Wave intensity is a valuable metric, calculated on the decibel (dB) scale. This numerical measure will also be with us throughout the book. Though it has many definitions and different applications, it is enough here to use it as a proximate indication of how much sound perceived volume is produced in a given space.[13] In slightly different language, it is the numerical calculation of the force of sound entering the ear. The more that sound waves intrude on our hearing, the higher the number on a scale that typically ranges from near zero to dangerous loudness measured as 100 dB or more.

While we will generally be more interested in listening *effects* than metrics, this central but slippery measure is a vital marker for all kinds of acoustic information: everything from the simple act of breathing (about 20 dB) to the headache-inducing noise of a chainsaw (120 dB). And, of course, what a microphone detects through a calibrated decibel meter is not necessarily the same volume an individual will hear. The scale applied to human hearing is only proximate because perceived loudness is subjective and unique to each individual. For example, it is common for older Americans to experience hearing loss measured in low decibel numbers within certain frequency ranges. A drop of even a few decibels in the range of 85 to 500 Hz will make it harder to hear the voices of others, especially male voices. A decline in this range is called “reverse-slope” hearing loss because it is typical for an older person to show a gradual decline in their abilities to hear *higher* frequencies.[14]

Variations in individual sensitivities to sound mean that some will notice this loss more than others.

The decibel scale is also *logarithmic* rather than linear. For example, an increase from 70 dB to 80 dB means the second sound is ten times louder. Again, individual perceptions of loudness will vary. But as generally used, a 30 dB level of a quiet room is typically easy on the ears, with the region north of 85 dB rapidly progressing into levels that may begin to be uncomfortable. A home with an operating washing machine or moderately loud television turned to higher levels may cross the 85 dB threshold, which is sufficiently loud to cause a degree of hearing fatigue. The sound pressure of 120 dB heard near the end of an airport's active runway is more catastrophic. It can lead to permanent inner-ear damage and hearing loss. Similarly, a listener's earbuds attached to a digital device may be pumping 100 dB into both ears: a level of acoustical energy also considered unsafe for any extended period. These instances make it easy to understand why our capacity for hearing can be easily overwhelmed, and why rates of American hearing loss are increasing.[15] Encountering high decibel levels can be the sensory equivalent of looking directly at the sun.

Consider another simple comparison with our vision. On a relatively clear day it may be possible to see the spine of the Rockies on the western horizon from a distance of about 80 miles. But sound as heard by humans usually has no such range. Generally, low frequency energy will travel a bit further than the kinds of sounds we make with instruments or voices. A rumble of thunder will easily carry for several miles. Higher frequencies will dissipate over the same distance. Audibility is better measured in feet rather than miles.

At one extreme, the vacuum of space precludes the direct transmission of any sound. Even though astronauts on a

spacewalk may see each other, they cannot be heard except via intercoms or radios. The 60-mile thick atmosphere at the earth's surface is mostly composed of molecules of nitrogen and oxygen. They are the carriers of sound waves that are not only generated by nature or the vocal folds inside the throat, but by every imaginable form of human invention: some that are "musical" because they produce coherent waves of sound pressure, and some where noise is an incidental byproduct. Toasters and electric motors hum (frequently at 60 Hz), loudspeakers speak, jet and automobile engines produce violent yet controlled explosions of fuel and sound, and the typical family kitchen erupts with noise from everything ranging from fans to microwave ovens.

Moreover, as we will explore later, every interior surface that makes up our surroundings significantly alters sounds. The materials of any enclosed space reflect, absorb or resonate in response to a sound source. Hard surfaces will reflect nearly all the acoustic energy that comes to them. Glass adds harshness to sound. Wood reflects but also amplifies and "warms" certain frequencies. Soft materials such as drapes and padded surfaces will absorb sound at some frequencies more than others. One practical effect of these features means that a buyer of a new piano will have no clear understanding of how its tonal qualities will sound until it is in their home. Similarly, a performer visiting a theater before a performance will often follow a ritual of going to the center of the stage and clap loudly just once. It's one kind of "sound check" of the space that tells them how long it takes for their voice to bounce off the back wall and return.

Even traveling at a little over eleven hundred feet a second, it's easy to detect the microsecond delay created by a large "live" room: a potential problem for a speaker but often a bonus for a musician. The author once temporarily taught a class in the reverberation nightmare of a college racquetball court, where the

hard walls unhelpfully offered at least *four* fractionally delayed "repeats" of everything that was said.

The Wide Universe of the Auditory World

Pianos, theaters, sports arenas, singers, children mimicking the words they hear: these are among the subjects that our journey into the sensory world of sound will consider. But a random glance at a map of potential routes for exploring sound can be full of surprises. Consider a sampling of representative cases that suggest the breadth of the journey offered in this study.

- Forty years ago, NBC experimented with the presentation of an NFL football game by dispensing with the commentary of the play-by-play and 'color' announcers that are usually a given in broadcast sports. Instead, the network simply offered audio of the stadium noise as the game unfolded. By all accounts it was not a success. With admirable understatement announcer Dick Enberg later observed that "something was missing."[16] Actually, quite a lot. Because there are generally less than twenty minutes of actual play in what can be a nearly three-hour broadcast the time gap is mostly filled with a continuous narration of stories about the players, the team, and all the vagaries of life that make professional sports a microcosm of the human experience. An overlay of constant talk from the broadcast booth is a reminder that even team sports that seem to be all about "action" owe a great deal to the ancient tradition of oral storytelling.

- During the Covid-19 pandemic of 2020, when Americans were asked to isolate themselves from crowds, the television

networks decided to add fake audience noises to events like tennis and baseball held in stadiums without spectators.[17] The decision continued another long tradition of “sweetening” the audio tracks of game shows, situation comedies and various live events. Augmented audio is the latest form of what persuasion specialists would call “shilling.” A shill is a plant placed within an audience to generate excitement or enthusiasm where too little exists.

- Most of the 420,000 complaints to New York City’s non-emergency hotline in 2016 were about noise.[18] The story is similar in Tokyo, where complaints have increased 30 percent in one year,[19] often because of children playing in the streets. There appears to be no shortage of ways we can generate aural mayhem to bother those who live nearby. Few things are as intrusive as sounds forced on us by what is usually someone else’s mechanical equipment. Leaf blowers, lawn mowers, motorcycles, car alarms, trash trucks and sirens from emergency equipment are common culprits. In New York the list grows much longer to include nearby neighbors, restaurant fans and multi-year construction projects. Residents or contractors can be fined $500 for second offense violations if they are making noise at 85 dB within 200 feet of a building.

- Since language is largely acquired by listening to speech, early deafness poses significant challenges to a child. As reported by the National Institutes of Health, children who cannot hear “fall behind their peers in language, cognitive, and social skills. They are also limited in their academic performance and long-term job opportunities.”[20] Research at Gallaudet University and elsewhere shows consistently low reading scores for those with all levels of hearing impairment. On average, an impaired

student who is seventeen years old will read at about the fourth-grade level, with somewhat better results in standardized mathematical skills tests.[21] The importance of the early auditory window has spurred research into ingenious workarounds. As we shall see in later chapters, better digital devices in the ear are one option. But the most promising is the growing use of cochlear implants, which provide an electronic bypass directly to the auditory nerve in the skull.

- A laboratory near Minneapolis has its own anechoic chamber, a small room designed to absorb virtually any sound made within it. The room is to sound what a cave is to natural light. The walls and ceiling are lined with soft spikes of absorbent material that consume any pressure wave that reaches them. The floor is made with a sturdy mesh to walk on, with the same absorption panels visible underneath. Orfield Laboratories' claims their anechoic chamber is one of the quietest spots on earth, measuring near zero on the decibel scale. The space reached through a thick door is used to test sound levels produced by various pieces of equipment. Places like these can also help accustom astronauts to the aural emptiness of space. Even so, a few minutes of quiet is enough for most people.[22] In fact, the room is *so* silent that it tends to disorient anyone who is left alone for more than a few minutes. The problem is not that they miss the company of others; the effects are considerably more basic. Individuals seem to grow uncomfortable hearing the surprisingly robust sounds of their own body. Even more unusual, most occupants begin to lose their balance: the result of not having aural information from their feet to help orient them to where their legs are. It turns out that most of us need to hear contact with a surface in order to stay upright. Visitors to the room are warned in advance to sit down or risk falling over.

▪ It has long been thought that a normal part of aging is a degree of difficulty understanding others. As we have noted, older Americans lose their perception of the highest frequencies. But the ability to detect all frequencies can decline. And new research points out that there are significant costs for those who have lost even a fraction of their listening acuity. With hearing loss, clinical dementia increases by 50 percent and depression by 40 percent.[23] Overall, study participants report increased feelings of isolation and disconnectedness,[24] as documented by a reporter recounting the story of one 68-year-old woman.

> [H]er world began to shrivel. She stopped going to church, since she could no longer hear the sermons. She abandoned the lectures that she used to frequent, as well as the political rallies that she had always loved. Communicating with her adult sons became an ordeal, filled with endless requests that they repeat themselves. Now considered as hazardous as smoking 15 cigarettes a day, loneliness vastly raises the risks of depression, dementia and early death.[25]

The clear implication is that hearing loss is life threatening because it represents an isolating separation from the world.

▪ There are acoustical reasons we can be annoyed by one loud guy sitting at a bar. Most Americans have been in a restaurant where it is quickly apparent that its mostly just *one* person's voice that seems to pierce the din like a siren. Why him and not the person he is with? Why not someone in the middle of

the room? Aside from the obvious fact that drinkers are generally less inhibited, it's likely that the physics of this man's lower vocal range *in this place* has worked in his favor. Another factor may be the mirror along the back wall of the bar. Sound reflected off glass is an acoustical nightmare. The super-smooth surface gives even a pleasant tone a harsh edge. An additional problem is one we will come back to several times: the racket he has created is likely the result of a voice pitch that matches the "natural resonance" of the room. Sometimes we want this effect, as when a low E string on an acoustic guitar is plucked and 'blossoms' into a rich sound. But the guy at the bar happens to have a voice-range that this particular room probably *wants* to hear. His voice matches the room's natural resonance. Like it or not, everyone sharing space in this six-sided box has become captive to his thunderous presence.

- A durable film genre is the space adventure. The vastness and unforgiving nature of interplanetary travel can be a feast for the eyes. But beyond earth's atmosphere the raw fact is that it will starve the ear. As we have noted, space is a vacuum; there is no medium of molecules of air to be set in motion as pressure waves. Luckily, that is no deterrence for Hollywood, where space film is awash in music and sound effects. And never more so than in Stanley Kubrick's iconic *2001: A Space Odyssey* (1968). In one of the classic pieces of lore about filmmaking, Kubrick abandoned the completed musical cues already prepared by the seasoned composer Alex North.[26] Instead, he kept the music temporarily inserted while he was editing the film. It included Johann Strauss Jr's "On the Beautiful Blue Danube" (1867) to accompany his long unbroken shots of elaborately detailed space vehicles gliding through the blackness. Kubrick liked how it looked and sounded, inadvertently made the Waltz King cool again. The choice of

romantic music from the salons of Vienna became one of the signature elements of the film. His love of the classics was further signaled in the story's first minutes, which famously used the opening "Sunrise" fanfare from Richard Strauss's *Also sprach Zarathustra* (1896), anchored at end by a floor-shaking organ pedal note of C. It turns out that organ pipes in lengths of 16 or even 32 feet have often been played as 16 Hz stand-ins for the primeval power of nature.

- For decades some Japanese have engaged in a practice called "forest bathing," and Swedes have a similar practice "*friluftsliv*," or "living outdoors," even in colder months. These are not necessarily proscribed forms of exercise, but simpler acts of pausing or moving through the serenity of a wooded location.[27] The transpiration-infused air of a forest is said to have its own restorative attributes. But sound also plays an important role. The woods are not silent. Wind, birdsong, the flutter of leaves or moving water all seem to be calming. Even Americans loaded with various armaments for fishing, hunting and camping may be inadvertently coaxing themselves to the less insistent murmurs of nature. "I went to the woods because I wished to live deliberately," Henry David Thoreau famously observed.[28] For him the company of others was too much of a distraction, as were the new products of the information age delivered by the rapidly expanding telegraph. He acted on a desire that many of us still know: We retreat into the woods for a chance to rebalance, to reawaken selves diminished by the clutter of noise and messages that ceaselessly intrude.

- Sometimes the obvious needs to be said, and we will say it many different ways here: nearly *everyone* loves music. The accomplished architect Daniel Libeskind notes that "Music is

really the center of life. . .. It puts everything in perspective."[29] Composer Claude Debussy saw it as a tantalizing but ambiguous place: an "imaginary country" known to us all but "one that can't be found on the map."[30] According to Nielsen, a company that keeps track of such things, the average American listens to music at least 25 hours a week, spending *more* time with it than with videos and television.[31] We crave the creativity and predictability possible in the 12-note structure of the western tonal system, with preferences that are predictably broad and nuanced. Rhythm is a major part of the appeal, as are the characteristics of pitch, timbre, and a nearly infinite range of chord structures. Toddlers swaying to a favorite family song are a reminder of our early attraction to the regularities of a beat and the earworms of melody. It's all evidence of what neurologist Oliver Sacks called "musicophilia:"[32] our natural affinities for this strange and wonderful idiom of feeling. Because the appeal of music is nearly universal, its presence in our lives is a reasonable benchmark of our perceived wellbeing. A world without music is unimaginable, making it easier than ever to understand Beethoven's despair and misplaced shame over his growing deafness. "How could I proclaim the deficiency of a sense which ought to have been more perfect with me than in others?" he lamented.[33] Fortunately for him and us, sound lives in the mind as well as the ear. His powers of musical invention resided in the auditory cortex of the brain, outlasting his ability to hear well through air conduction.

Most of us are more fortunate than Beethoven. The grand lifecycle that begins when a young pair of ears reaches to the horizons of language will continue through our lives. It's the first act in a multi-staged existence where neurons firing in the brain will give meaning to much of what we experience.

The writer and musician Robin Maconie ranks the ability to hear as "the second sense," ceding the top spot to vision.[34] Yet

the modern preference for content that comes via screens often deceives us into missing our profound debt to the aural. Of course, our lives are sustained best by cultivating all the senses. And it is undoubtedly true that different people and cultures prioritize sense ratios in different ways. But Maconie's ranking underestimates the enchantments of the ear.

Because sound is the gateway for communication, it's the ultimate pivot point of what it means to be engaged in the life of the species. We may shut our eyes and comfortably lapse into darkness, but our ears are reliable sentries and gateways to sensory immersion. More than any other sense, the capacity to hear frees us to explore perceptions not activated any other way.

Chapter 1 Notes

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PART I

Human Equipment

Chapter 2

HEARING AND THE MOTIVATION TO LISTEN

> *A man can see how this world goes with no eyes. Look with thine ears.*
>
> —William Shakespeare[1]

The human equipment for listening is one of the marvels of the natural world. Other creatures match or surpass human hearing in their range of the audible, or in sensitivities to sound that are even greater. But a human is a symbol-using animal, passing other organisms in the capacity to use spoken language to express an active consciousness of feelings, ideas, values, and so much more. As we note in more detail in Chapter 4, we live first through learned oral language, an inheritance that grows over an individual's life cycle. But our concern here is primarily with the physical processes and adaptations of hearing.

The first part of this chapter offers an overview of how the organs of the ear convert sound waves into nerve impulses that yield meaningful experiences. The remainder offers several probes on hearing and perception. We start with essential background about the ear and structures, but end on the more speculative claim that many among us are *sound-centric*, meaning that listening has become the primary source of pleasure in their lives.

The Auditory Pathway to the Ears and Beyond

Individuals who want to take a tour of their own auditory organs located above the jaw will be in for a surprise. The sometimes gaudy audio paraphernalia found in a typical electronics boutique hardly prepares a person for the diminutive mechanisms of bone, tissue and nerve that make up the ear. The capability of nature to capture and amplify infinitesimal winds of air disturbance is breathtaking in an organ so small. With the exception of the outer ear, or *pinna,* the rest of our hearing apparatus could fit into a bottle cap. No one can gaze at this miniature labyrinth of channels, levers and tiny drumheads without concluding that nature has both a sense of humor as well as a knack for merging mechanical structures with barely visible electro-chemical “switches.”

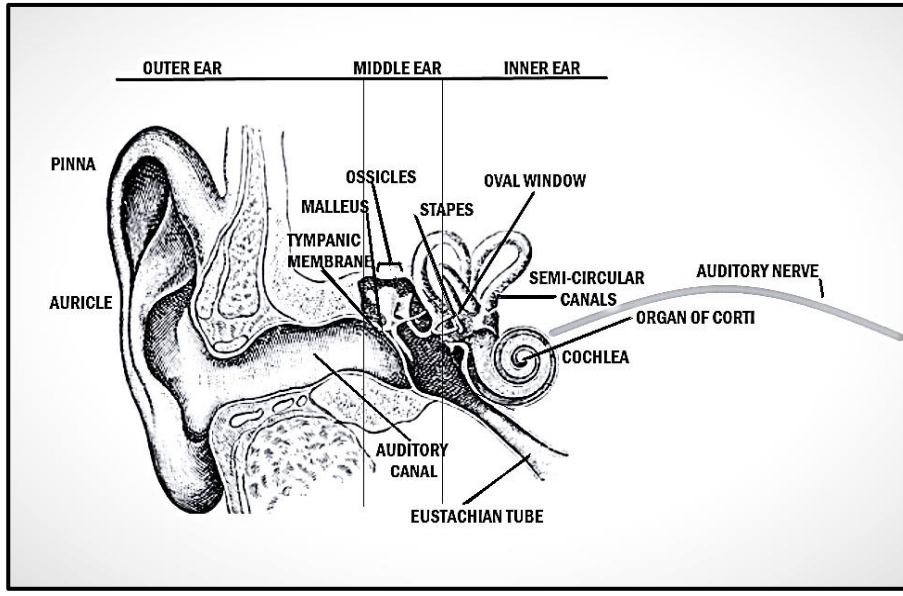

Figure 2.1
Anatomy of hearing.

Enlarging the mechanisms of hearing so they can be seen, one is left with the impression that this critical sense literally hangs on the smallest threads of functionality. We can only give thanks that these twin organs have been packed for life in the thick temporal bones of the skull. Rarely have the triggers of so much experience been so implausibly hidden. Behind the tympanic membrane or eardrum of the outer ear are the bones of the middle ear and, even deeper, the tiny sensory hair-cell receptors in the cochlea of the inner ear. It is these cells that function as transducers, converting slight variations in air pressure into nerve impulses that our brain registers as sound. It seems like it could not work as evolution intended, but it mostly does.

Working from the outside in, the outer or external ear collects and funnels sound to the *auditory canal*. The pinna and the smaller recess inside it, the *auricle*, helps focus sound into the channel. The pinna's shape is irregular, varying from individual to individual. But its front is nearly flush with the face, with the back-fold protruding from the skull by less than an inch. This angle and its asymmetric shape makes perfect sense, because it collects sound much as if a person cupped their hands to hear something in front of them. Forward facing eyes and ears are essential tools of navigation and safety. We need to be able to collect accurate sense data in areas that we can see. In addition, the pinna has natural and individually variable ridges of skin that diffuse sound in ways that make it easily possible to detect a source even when it is out of our range of vision.

The smaller auricle in the pinna also varies from person to person, altering at least slightly the way anyone will hear. The uniqueness of the ear's shape and internal equipment means that each individual hears sound reflected into the auditory channel just a little bit differently. We obviously can't easily "try on"

someone else's hearing, but perhaps the rough equivalent is wearing different sets of earphones. Each will have different sonic properties.

The auditory canal ends at the eardrum, or *tympanic membrane,* which is recessed just enough to protect its fragility, but not so deep as to dissipate sound that must travel about 25 millimeters to reach it. It is thin, small and flexible, just a few millimeters in diameter.[2] And it represents the first transition point at which air pressure variations will be converted to mechanical energy by the small bones of the middle ear. These *ossicles* sit in the middle ear's *tympanic cavity*, past the doorstep of the *outer ear* and separated from the biological microprocessors of the inner ear. Inside the air-filled space these pin-sized bones flexibly relay sound from the eardrum to a second membrane and final transition point, the *oval window,* which lies at the front of the spiral-shaped *cochlea* of the *inner ear*.

The first two bones that make up the ossicles are the *malleus* and the *incus*, held in place at odd angles to each other by thread-sized *tensor tympani muscles* measured in equally short lengths. They also connect to a third bone, the *stapes*, which pushes the oval window in and out, setting in motion the viscus fluid inside the cochlea. The stapes passes vibrations on through the oval window to the even tinier *hair cells* in the pea-sized cochlea that convert sound vibrations into nerve impulses.[3]

The middle ear's function at first seems to be a bit of a puzzle. Why isn't the eardrum simply connected directly to the cochlea? To put the issue another way, why is there an awkward and indirect mechanical linkage of tiny bones placed between the eardrum and the oval window in a separate chamber?

Nature clearly had reasons. The tensor tympani muscles are not passive. They can help the small bones of the ossicles fold back on themselves slightly, like the flexible couplings that adjust

at the joints of railroad cars. When too much sound threatens the ear, the slack they can provide protects inner ear hair cells, becoming less efficient at relaying what is verging into very loud noise. Sometimes they will also lengthen slightly to help us hear faint sound. But it's the first response that matters; a form of retrenchment that is the body's protective response as it tries to save the crucial smaller cells inside the cochlea—clusters of *stereocilia* on top of a tiny patch of hair cell tissue called the *organ of Corti*. These stereocilia are actually the mechanical-to-electrical transducers that will send sound to the brain. Distinct stereocilia along the length of the cochlea detect different sound frequencies, releasing just enough electrical ionization to feed the *auditory nerve* that connects to the *auditory cortex* of the brain.[4]

Hair cells and their stereocilia can be easily overwhelmed. We have only about 40,000 hair cells per ear, a tiny fraction compared to the millions of neurons in the brain.[5] Destroyed hair cells ruin stereocilia as well. As seen through a powerful microscope, one researcher described the damage as resembling trees thrown around by a tornado.[6]

But there is even more to note about the functions and sometimes dysfunctions of the middle ear. It must also deal with air pressure differences that result from the collection of fluids that can block the *eustachian tube*. In theory, the pressure in this middle section is equalized via this narrow channel that has an opening in the back of the throat near the nasal cavity. But if there was ever a recall of this equipment, it might be because of what seems like a design flaw in the eustachian tube; it's relatively small size makes it not all that efficient at equalizing air pressure.[7] Most of us strain to keep the air pressure in the middle ear in sync with both our body, especially when we hurl ourselves into the thinner air that comes with modern air travel. Ear pain and frantic gum chewing are familiar to flyers who try to cope with

changes in cabin air pressure. It's all more than many congested ears can handle.

Hearing may have evolved from what we now consider the second function of the inner ear, to provide us with balance and a sense of what is up and down.[8] The top of the cochlea has a set of *semi-circular canals* known as the *vestibular system,* with its own nerves connected to the brain. The canals are sometimes compared to miniature versions of cup handles, with an asymmetric circularity that is a cue to their navigational function. As fluid-filled vessels, they serve as sensory monitors of a person's relative position, the human equivalent of the self-balancing devices used in electric scooters and Steadicams.

If we spin ourselves heedlessly like a two-year-old, we can feel the effects of dizzy disorientation when the fluid is displaced too quickly and unable to provide a stable sense of balance. Our eyes and ears are temporarily out of sync, creating the unpleasant experience of motion sickness. Interestingly, there are real concerns that the coming of self-driving cars are going to create a new wave of this problem as drivers become riders.[9] For most of us, driving with eyes firmly on the road and horizon is enough to suppress this kind of disconnect that causes motion sickness.

A final aspect of the ear is often overlooked, but essential for understanding how we receive sound. Anyone who has had a hearing test knows that they will get an assessment which not only considers their ability to hear through the air, but also through the substantial bones in the skull. Sometimes a dense mass like bone is a better conductor of sound for an individual than the fragile equipment of the ear. A person who has rested their chin on an appliance, piano or any other carrier of sound is hearing via *bone conduction*, which can be a partial remedy for individuals with a weakened tympanic membrane, or ossicles that

cannot freely vibrate to transfer sound to the oval window. Beethoven improved what he could hear by placing a large open-ended horn over the top of his piano. It produced enough resonance to allow him to feel sound vibrations through his body and feet.[10] Bone conduction is a consideration for singers, explaining why their and our voices always sound different to others. Instrumentalists may have another variation on this problem. For some, like violinists, resting their instrument on structures of the head can yield more volume or a different timbre than they want a listener to hear.[11]

When Hearing Functions Differently

The World Health Organization estimates that approximately one third of adults over sixty-five years of age have a “disabling” hearing loss.[12] Only recently have the social isolation effects been fully appreciated, especially in older adults. A recent study indicates that treating impaired hearing with hearing aids and other methods could reduce the instance of dementia in older Americans by nine percent.[13]

In general terms, hearing loss has many causes: toxic drugs, the effects of an illness or the accumulated consequences of aging in a noisy world. “Mild hearing loss” might range from a drop of 26 to 40 dB in a dynamic range that extends to 100 dB.[14] But that scale is of limited use because the degree of loss can vary just in certain frequency ranges. For example, a dip in sensitivity in the range of 100 to 400 Hz would make it difficult to easily hear voices.

Rates of hearing loss in children are lower. One estimate is that up to 20 percent of children can also have some level of hearing difficulty.[15] Genetic issues make up about 50 percent of

hearing problems, with infections of various kinds another key risk factor.[16] For example, many people carry the cytomegalovirus (CMV) virus, which is otherwise not toxic to them. But children born with congenital CMV can develop hearing loss in their first few years.[17]

Almost all children are born with their hearing intact. Indeed, they seem to hear even in the womb. At birth they are routinely screened with a simple in-ear “otoacoustic test” that can read emissions detected from the tiny hairs activated deep in the cochlea.[18] Certain “emission” signatures from the test ensure that the ears are working. Parents who notice an active startle reflex created by a loud sound also view the result as reassuring. Problems need to be diagnosed early since hearing is an important marker for the development of language and social skills. As is explored in Chapter 4, the first 18 months are a fertile period for the acquisition of the basic phonemes contained in everyday speech.

Diagnoses of subnormal hearing in both adults and children are broadly classified as either *sensorineural* or *conductive.* The first is the most common type, and usually occurs because the cochlea or the nerves that relay sound to the auditory cortex are not responding at expected rates of sensitivity. The loss may be in one ear or both, and frequently shows up as a decline along certain portions of the audible frequency range. Problems in the lower-range of the human voice are of greatest concern in a newborn because of the early need to absorb the elements of speech. Otherwise, hearing researchers cite many causes, including: illnesses, drugs that are toxic to hearing, aging, the way the inner ear is formed, or repeated exposure to loud noises.[19] The latter cause shows up repeatedly and should be a red flag for anyone who wants to age with a reasonable degree of hearing intact.

Conductive hearing loss results when sound is blocked because of a problem along the pathway of the outer and middle ears. The eardrum may be pierced or compromised by an illness. Sometimes a hearing problem can also be caused by rigid or disconnected ossicles of the middle ear. As challenging as it seems, given their location in facial bones, surgery can sometimes repair the ossicles or replace them with artificial bones made in a 3D printer.[20] More often than not, partial hearing loss is often treated in the young and old with a digital hearing aid, which can be made to adapt to the shape of the ear canal or the specific "drop-offs" of frequencies that need an electronic boost. Some units have a behind-the-ear battery and amplifier that feeds an earpiece in the ear canal. More (and often quite) expensive units fit inside the ear canal. Some can also be controlled from a user's smart phone. Having dinner with a colleague a few years ago, I noticed that he made a point of reaching for his smartphone to "tune" his digital aid to the location we were in. The aid could accept a command to adjust its output to block loud background noise that can make hearing a challenge.

A restaurant setting is also a reminder that some adults who have partial hearing loss—usually in upper frequencies—have compensated by becoming adequate lipreaders or, more accurately, speech-readers. Obviously, a speech reader needs to be facing the person they are listening to. People who can pick up the ideas of another from facial cues are said to only get about 40 percent of the words another has spoken: a rate high enough to capture most of what has been said.[21]

Alternately, some hearing aids and over-the-counter headsets work through bone conduction, using small devices that usually rest against the temporal bones behind both ears. In either case the cochlea needs to be capable of receiving some of the amplified sound.

One solution to deafness or severe hearing loss shows the ingenuity of resources now available to bring individuals into the noisy but productive world of sound. In both children and adults with significant sensorineural loss, a *cochlear implant* often provides an auditory workaround that allows them to join or stay in the hearing community. An implant does not remove the cochlea. Instead, surgery implants an internal receiver in the skull, producing an approximation of sound directly to the cochlea or auditory nerve.[22] This procedure is usually done on one side, with the implanted receiver receiving a signal from a transmitter held in place on the surface of the scalp near an ear. Implanting tiny electrodes in the two- and three-quarter turns of the cochlea is a delicate but relatively safe operation that works best on children. As is explored in more detail in Chapter 4, they may still not experience “normal” hearing, but many get more than enough sound to be able to function and keep up with their peers. To be sure, they are still deaf when the external transmitter on the outside is turned off or removed. Yet many children with implants can have amazingly normal speech. While somewhat less effective with adults, the aural assistance it provides will usually facilitate recognizing words and full sentences.[23]

As of 2017 nearly 100,000 Americans had received implants, with follow-up training to learn how to make the most of the partial auditory information that implants can deliver.[24] But the artificial signals are usually strong enough to avoid what awaits some deaf or hard of hearing young adults who may only reach a fourth-grade level of reading proficiency.[25] An implant holds out the prospect that their hearing will improve well enough to be kept in their own schools and functioning and expected grade levels.

Implants are not without controversy.[26] The Deaf community has long taken pride in a small but active culture that includes the expressiveness of American Sign Language (ASL). Many see

their condition as a difference more than a deficit, and can rightly point to the richness of ASL and the bonds it has created with others. In addition to signing, many who are deaf are master interpreters of the facial cues in others. Deaf parents are also justifiably torn between wanting to keep their deaf children within the community or using advances that will mainstream a child into the hearing world. With some justification parents fear that their children with implants will be less interested in learning ASL.[27]

A more mysterious but usually less severe hearing challenge that effects about 10 percent of all adults is *tinnitus*, a condition characterized by a ringing in the ears. The source is not from the environment, but errant neurons firing somewhere in our own unique neurological universe. With about 100 billion neurons in the brain, it's easy to imagine a stray neural pathway that activates more or less on its own, producing the resulting internal buzz that we "hear." It's the same kind of a problem that the player of a large pipe organ has, often in the middle of a concert. Any of the 5000 or so pipes in a big organ may start "ciphering," meaning it stays on whether the organist wants it to or not.

It's not so easy with humans. The author is at an age where nearly all of his contemporaries have a degree of tinnitus, which can range from a barely "audible" 3000 Hz pitch resembling a gentle "ping" on a triangle, to something that is subjectively much louder and an impediment to living an ordinary life. No two complaints seem quite the same. And, of course there is no easy external measure to pull the plug on this kind of phantom noise. As with all conditions where discomfort is subjective, some adapt easily to tinnitus, and others seek assistance to reduce it through various therapies or medications.[28] Sometimes tinnitus is a symptom of acoustic neuroma, a serious medical condition. Or the problem may be corrected by cleaning the accumulated "wax" out of the ears. Digital hearing aids can help mask the sound.

And the brain itself is often effective at ignoring sounds we do not want to hear. But severe tinnitus can leave a sufferer exhausted and left to fantasize about what it would be like to again have the pristine ears of a child.

What do We Hear?

Many of the features of hearing can be diagramed and set out as particular mechanical and physical manifestations. But the process of hearing has only started when the ears send impulses to the brain's temporal lobes. The deeper mystery is how an impulse that travels down the auditory nerve is converted by an individual mind into sensations, memories, and the recognized patterns of music that can become so addictive. This is the realm of psychoacoustics. Explorations of this inner space are promising, but have barely reached beyond preliminary maps of brain regions and functions.[29]

As we have seen, frequency and relative loudness have well-defined metrics for measuring sound. An audiologist's audiogram can provide a reasonably good picture of how well our ears handle these variations. But it also makes sense to think of hearing as similar to other senses that yield responses that are more individual than uniform, more phenomenological than measurable. That is, many forms of sense data taken in by an individual are processed and understood in terms of prior experience, and how willful a person is in giving an experience the direct attention of conscious thought. Other senses illustrate the broad subjectivity of our responses. When is sour better than sweet? Why do some notice the high humidity in the outside air? What accounts for why so many like to bake in the sun under a cloudless sky, while others run for the shade? Individuals have different preferences that are tied to the interplay between their

sensory *and* perceptual capabilities. Auditory perception is no different. And in some cases, one sense can 'hand off' information to another. For example, the two senses of touch and sound have a transfer point at about 20 Hz. At that subsonic frequency we begin to *feel* sound more than we hear it. And the effects may be far-ranging and sometimes detrimental to human and animal health.[30]

With this perspective of legitimate subjectivity, we can claim that sound resides in the receiver as well as the source.[31] We assume a person in the path of sound (air) pressure wave is a pivotal reference point. There is the old aphorism about a tree falling in the forest. Does it make a sound if no one hears it? Of course, because the energy is still released partly as waves of air pressure if not received by anyone. But this not-so-profound conundrum raises a bigger related issue. With so active a brain capable of thinking in words and other forms of symbolic expression, it is also possible that we may conceive of what we have not strictly heard. We can conjure another's voice, a passage in a piece of music, or an entire imaginary world. *Intra*personal communications with the self certainly include imagined but not externalized auditory elements. So, while we lament Beethoven's deafness as a cruel irony, it's also entirely reasonable that he was not without perceptions of sound. With cognitive powers intact, and a fruitful life that had long been immersed in the textures and elements of sound, he surely "heard" the sonatas and symphonies composed late in life, even if they were more easily committed to a page of staves than to his own ears.[32]

Increased acuity to some frequencies is apt to make some of us more sensitive to certain kinds of stimuli, like the sibilant sounds produced by the way a person speaks, or what seems like a "nasal" sound of an oboe. Both may be annoying. And

nearly all people can identify sounds that they find irritating. Some of us have patterns of hearing that allow us to focus on one set of sounds in an otherwise cluttered soundscape. This may be a function of mind as much as ear. Others might not notice a composer's unusual choice of an accordion or banjo in a traditional symphony orchestra concert. For the right listener however, the unique layers of sound produced by these instruments could be the memorable elements that stood out. And still others might notice sound loops that occur with some regularity: motors cycling on and off, a pebble in a tire that regularly smacks the pavement, or noise coming from the repetitive motions of a neighboring office worker. In such cases it seems clear the ear has made the sound available. The focusing and attention that occurs seems to be a function of a consciousness that has been tuned by memory or experience to respond. In other words, sound *reception* is the work of the ear, but sound *perception* happens deeper in the skull and, like tinnitus, can include a kind of "hearing" that never passed the ear. Phenomenologically speaking, we hear what we *think* we hear.

The Sound-Centric Individual

One way to grasp the increased importance of auditory content in the lives of Americans is to appreciate the huge numbers who could be fairly called *sound centric.* This inexact but suggestive characterization represents a mixture of individuals who are consistently driven to find fulfillment in the creation or consumption of auditory media: mostly music, but not exclusively so.

We all reach our point of sensory buoyancy: where we are most comfortable with various kinds of experiences. They may

seem unusual, as when a person's taste for a certain kind of experience becomes an organizing principle. Screen addiction is one common form. Or a person may develop an intense distaste for certain sounds, creating a music or noise sensitivity that becomes clinicalized as "misophonia," [33] intense dislike of a sound discussed more fully in Chapter 9. But it is enough here to appreciate a predisposition or sensitivity that consumes the interest and energy of a person.

Again, there may be advantages here in thinking in phenomenological terms. In describing the sound-centric individual I mean someone with a preference altogether more basic and elemental: the pleasure we sense in another person caught in the raptures of music or the sounds of the human voice. For example, if you find yourself usually waking up in the morning with a first consciousness that includes an "ear worm" of a song heard the previous day, you may share this trait. Involuntarily repeating a song fragment is not uncommon and considered acceptable by about half of the population.[34] These would include individuals drawn from a broad cross section of any culture: sound archivists like Tony Schwartz, who reveled in the recorded voices of his family and the myriad noises of the city he compulsively documented in the last half of the previous century. The tape machine was Schwartz' talisman. When it first came along, he notes, recorded "sound made me feel much closer" to his family than any photograph.[35] His 30,000 recordings of moments from everyday life are now housed in the Library of Congress.

And there are so many connected to the web of music in varied ways: musicians like Vince Giordano, a New York City fixture, with his 30s-era band known from film soundtracks and nightly concerts in various clubs. Giordano has filled his small Brooklyn house with over 60,000 original "stock arrangements"

for his group. He comes alive on stage leading and singing, “happy to be working” with the other ten members of the Nighthawks. In one venue alone his group performed over 500 shows.[36]

Sound-centrics like Giordano are easy to recognize. I have known others who regularly perform on a given evening, then re-gather the same night to play again for hours. And there are many more: audio enthusiasts for whom state of the art recordings and audio equipment represent a never-ending quest; followers of specific musical groups who organize their lives around concert schedules of one band or many; podcast listeners who use their travel and leisure hours to follow offerings originating from public radio; music teachers and academicians spread far and wide; acoustical consultants and engineers who design interiors for recording, listening or performance; the audio book industry and their expanding clientele; and sound and studio professionals employed to provide film, game and video tracks.

To these many individuals we can add uncountable millions for whom the daily absorption of music is its own source of psychic regeneration. For example, a cultural marker in the United Kingdom is a weekly BBC show on Radio 4 featuring a celebrity who chooses a selection of Desert Island Disks.[37] Since 1942, the “stowaways” (mostly celebrities from Britain and the United States) have mused on the “disks” they would want to have with them if left isolated at one location.

Neuroscientist Daniel Levitan rightly notes that music is a prime “human obsession.”[38] And recordings are frequently the logical focus of these sound-centrics. They are perhaps most clearly identified as individuals who seem to naturally understand the need to commit to what ethnomusicologist Greg Downey describes as “an apprenticeship in hearing”[39] that helps focus their interests on particular streams of experience: certainly

listening to the material that connects with them, but also making an effort to understand its social origins, various ways of interpreting it, and customary ways for producing the sounds that are so enticing. For example, the *BBC Music Magazine* always includes a feature asking musicians, readers, the editorial staff or music critics what they are currently listening to. A common response is more than the name of an individual piece, but also a little elevator speech on what one particular recording means to them even after constant replays.[40] More than a few describe this kind of serial-listening (i.e., listening to any piece—even a long one—back to back): one manifestation of the kind of "apprenticing" Downey suggests.

Sound-centrics surely existed even before modern recording. Philosopher Susanne Langer notes that, for many musicians, music is "the prime source of their mental life and the medium of their clearest insight into humanity."[41] Antonio Vivaldi, Peter Tchaikovsky and Charles Ives were inevitably pulled toward composing from the more routine vocations their parents urged. They were forerunners of others who came later and given their life's mission in the form of a portable tape recorder, among them folklorists Chris Strachwitz, Allen Lomax and Moses Asch. All used their resources to document indigenous folk and roots music mostly beyond the interest of bigger record labels. Asch's Folkways Records with thousands of recordings eventually became its own Smithsonian library.[42]

The affinities for recorded sound among folklorists are not so different from the DJ and writer Jonathan Schwartz, who remembers his earlier years assessing every moment through music, including future partners. He played his records and they listened. "I was wooing, working, waiting. I was presenting myself in the music. That is who I am. I am those songs, those string quartets, I am Nelson Riddle's muted trumpet."[43] Schwartz's

passion was a kindred form of the music obsessives represented by the erstwhile record store employees in Nick Hornby's popular novel, *High Fidelity*.[44] As one critic observed, this crew of list-makers of top ten songs "assumed that what you like is more important than what you are like."[45]

Most musicians can offer elaborate reasons for building their own audio shrines around the work of Bela Bartok, Lester Young or George Harrison. Conductor Erich Leinsdorf named an influential study of his own musical life "The Composer's Advocate," hinting at the privileges and obligations that come with the intent of producing another's sonic ideas.[46] Indeed, most conductors seem to approach friends and audiences as if they were potential heirs to the sonic traditions staked out by their favorite composers.[47] They are perhaps less exotic versions of the opera-lover in *Fitzcarraldo* (1982), but no less enthusiastic. Werner Herzog's epic film tells a partly true and partly fictional story of a plantation owner intent on building an opera house in the Peruvian jungle, dragging a steamship over a mountain as part of the plan. Actor Klaus Kinski's co-star is a Victrola scratching its way through a stack of Caruso recordings: a case of common sense overtaken by inexorable passion.

According to the market-analysis firm Nielsen, in 2017 Americans in the aggregate listened to just music over 32 hours a week, with more each year curating their own playlists of favorites.[48] The trade publication *Billboard* estimates that 125 million are paying for at least one music streaming service that can be customized to a person's preferences.[49] To be sure, not everyone represented in these large numbers is sound-centric. But the enthusiasm represented by the term is one that most Americans can recognize.

Chapter 2 Notes

1. William Shakespeare, *King Lear*, Scene IV.

2. A good overview of the component parts of human hearing is available in "What Do I Need To Know About The Anatomy And Physiology Of The Ear?" in "Occupational Noise," The Occupational Safety and Health Administration, accessed February 4, 2020, https://www.osha.gov/SLTC/noisehearingconservation/anatomy.html.

3. "What Do I Need to Know?

4. D. Purves, G.J. Augustine, "Hair Cells and the Mechanoelectrical Transduction of Sound Waves, Neuroscience. 2nd edition," (Sunderland MA: Sinauer Associates; 2001), reprint of the National Center for Biotechnology Information, https://www.ncbi.nlm.nih.gov/books/NBK10867/.

5. David Owen, *Volume Control: Hearing in a Deafening World* (New York: Riverhead Books, 2019), 45.

6. Owen, *Volume Control*, 45.

7. There is a serious point here. According to the National Institutes of Health, instances of middle ear infections (otitis media) happen frequently. They are the most common reason children visit a doctor: five out of six before their first birthday. See "Ear Infections in Children," National Institutes of Health/National Institute on Deafness and Other Communication Disorders, accessed January 23, 2020, https://www.nidcd.nih.gov/health/ear-infections-children.

8. Owen, *Volume Control,* 38.

9. Bradley Berman, "Avoiding Carsickness When the Cars Drive Themselves," *New York Times,* January 17, 2020, https://www.nytimes.com/2020/01/17/business/motion-sickness-self-driving-cars.html?searchResultPosition=2.

10. Robin Wallace, "Good Vibrations," *BBC Music Magazine*, September 2018, 42-44.

11. See Robert Albrecht, Jussi Jaatinen, and Tapio Lokki, "Electronic Hearing Protection for Musicians," Proceedings of the 14th Sound and Music Computing Conference, Espoo, Finland, July 5-8, 2017, http://smc2017.aalto.fi/media/materials/proceedings/SMC17_p306.pdf.

12. "Deafness and Hearing Loss: Key Facts," World Health Organization, March 20, 2019, https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss.

13. Jane Brody, "For Brain Health, Correct Mild Hearing Loss," *New York Times*, December 31, 2019, D5.

14. “Type, Degree and Configuration of Hearing Loss,” American Speech-Language-Hearing Association, accessed February 4, 2020, https://www.asha.org/uploadedFiles/AIS-Hearing-Loss-Types-Degree-Configuration.pdf.

15. Jane E. Carreiro, “Auditory Perceptual Development” in Auditory Perception: An Overview, ScienceDirect, accessed March 28, 2020, https://www.sciencedirect.com/topics/neuroscience/auditory-perception.

16. “Data and Statistics About Hearing Loss in Children,” Centers for Disease Control and Prevention, March 21, 2019, https://www.cdc.gov/ncbddd/hearingloss/data.html.

17. “About Cytomegalovirus (CMV),”, Centers for Disease Control and Prevention, June 17, 2019, https://www.cdc.gov/cmv/overview.html.

18. “Otoacoustic Emissions (OAEs),” American Speech Language Hearing Association, accessed February 5, 2020, https://www.asha.org/public/hearing/Otoacoustic-Emissions/.

19. “Sensorineural Hearing Loss,” American Speech-Language-Hearing Association, accessed June 23, 2020, https://www.asha.org/public/hearing/Sensorineural-Hearing-Loss/.

20. Jeffrey D. Hirsch, Richard L. Vincent, and David J. Eisenman, “Surgical Reconstruction of The Ossicular Chain with Custom 3D Printed Ossicular Prosthesis,” US National Library of Medicine, National Institutes of Health, March, 2017, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5954796/.

21. See Jake Nevins, “Lip Reading,” *New York Times Magazine*, February 2, 2020, 16-17.

22. “Cochlear Implants,” American Speech-Language and Hearing Association, accessed January 5, 2020, https://www.asha.org/public/hearing/Cochlear-Implant/.

23. G. Raman, et al, “Executive Summary, Effectiveness of Cochlear Implants in Adults with Sensorineural Hearing Loss,” Agency for Healthcare Research and Quality (US); June 17, 2011, https://www.ncbi.nlm.nih.gov/books/NBK285763/.

24. “Cochlear Implants.”

25. Sen Qi and Ross Mitchell, “Large-Scale Academic Achievement Testing of Deaf and Hard of Hearing Students: Past, Present and Future,” *Journal of Deaf Studies and Deaf Education*, June, 2011, https://academic.oup.com/jdsde/article-abstract/17/1/1/359085.

26. A recent film, *Sound of Metal* (2019), tells the story of a rock musician who has lost most of his hearing and decided to have a double implant. The most interesting feature of the film is director Darius Marder’s efforts to build the film’s sound design around what drummer Rubin Stone is hearing and

not hearing. In this story, Stone's implants deliver something far less accurate than he hoped.

27. For an excellent if somewhat dated documentary case study, see, *Sound and Fury*, Unapix Entertainment Productions, 2001. It recounts the battles within her own extended family—some hearing, some deaf— about whether a young Heather Artinian should receive a cochlear implant. Heather more recently describes the battle, and the ways she made peace with both the deaf and hearing world. See "Deaf Student with Cochlear Implant Argues for Bridging Two Worlds," *Georgetown University News*, January 6, 2014, https://www.georgetown.edu/news/deaf-student-with-cochlear-implant-argues-for-bridging-two-worlds/.

28. "Tinnitus," National Institutes of Health, March 6, 2017, https://www.nidcd.nih.gov/health/tinnitus.

29. See, for example, Daniel Levitin, *This is Your Brain on Music* (New York: Plume, 2007), 83-94. Levitin does note that pitch specifically seems to be the one musical element that is directly observable in a brain mapping in the auditory cortex. Neurons will fire at the same frequency of a pure tone that the ear is hearing (29).

30. For interesting speculation on subsonic or infrasound see Steve Goodman, *Sonic Warfare* (Cambridge: MIT Press, 2010), 63-67.

31. Explorations of this and other distinctions are well explored in "Auditory Perception," *Stanford Encyclopedia of Philosophy,* May 14, 2009, revised April 24, 2011, https://plato.stanford.edu/entries/perception-auditory/#Distal.

32. Wallace, "Good Vibrations," 44.

33. Joyce Cohen, "When a Chomp or a Slurp Is a Trigger for Outrage," *New York Times*, Sept. 5, 2011, https://www.nytimes.com/2011/09/06/health/06annoy.html?_r=3. See also "Do You Hear What I Hear?" *Oprah Magazine*, August, 2019, 61-63.

34. Harriet Brown, "How Do You Solve a Problem Like an Earworm?, *Scientific American Mind*, November 1, 2015, https://www.scientificamerican.com/article/how-do-you-solve-a-problem-like-an-earworm/.

35. Tony Schwartz, "The Power of Audio with Tony Schwartz," Tape of Harvard video lecture, YouTube, November 29, 2005, https://www.youtube.com/watch?v=o_HGBsinKdY.

36. *Vince Giordano: There's a Future in the Past*, Video documentary, First Run Features, 2017.

37. The popular BBC Radio 4 program has been asking celebrities their choices since it began in 1942. Over 3000 programs have been aired.

38. Levitin, *This is Your Brain on Music*. The phrase is used in the subtitle of his book.

39. Greg Downey, “Listening to Capoeira: Phenomenology, Embodiment, and the Materiality of Music,” *Ethnomusicology*, Fall, 2002, 489-490.

40. See, for example, “Music to My Ears,” *BBC Music Magazine,* January 2019, 24-25.

41. Susanne Langer, *Philosophy in a New Key, Third Edition,* (Cambridge, MA.: Harvard University Press, 1971), 101.

42. For a profile of Asch, see Jac Holzman and Gavin Daws, *Follow the Music* (Santa Monica, CA.: First Media, 1998), 45-46.

43. Jonathan Schwartz, *All in Good Time* (New York: Random House, 2004), 156.

44. Nick Hornby, *High Fidelity* (London, Penguin, 1995).

45. Margaret Lyons, “Actually, It’s Kind of a Lo-Fi Update,” *New York Times*, February 14, 2020, C10.

46. Erich Leinsdorf, *The Composer’s Advocate: A Radical Orthodoxy for Musicians* (New Haven: Yale University Press, 1981).

47. Conductors often register their value in terms of particular composers or conductors they came to understand. See, for example, Haruki Murakami, *Absolutely on Music: Conversations with Seiji Ozawa* (New York: Vintage, 2016).

48. *“*Time with Tunes: How Technology Is Driving Music Consumption*,”* Insights Nielsen.com, November 2, 2017, https://www.nielsen.com/us/en/insights/article/2017/time-with-tunes-how-technology-is-driving-music-consumption/.

49. Colin Stutz, *“*More Than Three-Fourths of US Internet Users Are Now Streaming Music, Says Study,” *Billboard.com*, September 25, 2019, https://www.billboard.com/articles/business/8530989/us-internet-users-77-percent-streaming-music.

Chapter 3

THE WILDCARD OF ACOUSTIC SPACE

> *"It's the most famous instrument in the world. It was absolutely stunning, gorgeous—we don't have any words to describe it, it was a wonderful experience every time. It was such a privilege to work and to play in this wonderful place."*[1]
>
> —Johann Vexo

Yip Harburg's classic song *April in Paris* (1932) was meant as a love poem to the City of Light, with "holiday tables" everywhere and "blossoms" shaking off the winter chill. But a tranquil day in April 2017 would end on a different note of horror. The Saturday started with a shower, but a blue sky broke over the city in the afternoon. In the center of Paris and surrounded by the gardens along the Seine, the acoustic masterpiece of Notre Dame Cathedral opened for visitors and worshipers gathering for the early evening mass. A few minutes after six, organist Johann Vexo slid onto the bench of the smaller of the two organs located in the choir section between the transept and high altar. He would accompany the nightly service that began as tourists paused and lingered near the portico of the cathedral's famous West Front. This has always been the most impressive view of the structure,

its two great bell towers rising over two hundred feet above the massive doors memorialized in Victor Hugo's tale of medieval cruelty.

At the same time another of the cathedral's organists, Olivier Latry, departed on a two-hour flight to Vienna to give a long-scheduled recital. Latry was known worldwide as the unassuming musician who played the larger Grand Organ at the back of the nave that had been expanded and refined in the nineteenth century by Aristide Cavaillé-Col. The huge instrument doubled the importance of the iconic building, representing the high mark of one of the most admired organ-builders in the world. The massive towering oak case that houses his creation is in the back of the nave, fifty feet above the floor and just below a huge rose window between the West Façade's towers. From this vantage point the loft gives an organist a clear view to the far end of the cathedral four hundred and twenty feet away.

Cavaillé-Col's instrument in Notre Dame is a model for many other organs around the world and a sonic rocket when in full flight. It had been built and modified many times over, still retaining pipes made hundreds of years ago and brought to life by legends like composer/organist Louis Vierne. Every organ student knows at least one story about Vierne who, slumped over the huge console mid-recital in the same loft, perished while doing what he loved best. Vierne added to the lore of French organs and helped establish the Notre Dame organ as a benchmark.[2]

As the service began, the spell of Vexo's meditative music from the smaller Choir Organ was interrupted by a fire alarm. It was 6:20. The priest tried to continue for another minute before pausing, finally asking the small gathering to leave until the problem could be determined. Puzzled by the reason for the interruption, Vexo headed to the sacristy to check on the annunciator panel, not convinced there was an actual fire.[3] Still

not sensing a problem, he decided to leave until the alarm could be silenced. But within fifteen minutes white smoke was evident to patrons lingering in the cafes nearby. Valuable time was lost while a new security guard fumbled around trying to locate the origination point of the alarm. But by 7:15 it was clear to anyone standing outside that there were flames mingling with smoke along the roofline. Fire was in fact raging just out of sight in what Parisians knew as the “forest” of ancient oak timbers supporting the gable that ran the length of the building. This roof was an outer skin of lead shingles that sheltered the ornamented stone vaulting below it, more than 100 feet above the main floor.[4] The inferno was in the attic between the two, just above the mid-point transept and under the spire. Likely caused by a cigarette or overheated construction equipment, it quickly spread along the topmost spine of the cathedral and under a maze of temporary steel scaffolding, eventually toppling the 300-foot oak spire. Like a missile about to self-destruct, its blazing timbers of oak lattice rotated 180 degrees and penetrated the roof, coming to rest in front of the high alter in the transept below. Gasps of disbelief could be heard from crowds now gathered along the Île de la Cité, while millions of others watched on television in stunned silence. The old wood supports under the roof were burning their way from the center and toward the eastern end of Notre Dame, with its postcard view of flying buttresses parallel to the Seine. Then, and more ominously, the flames began to move west and toward the hidden wooden supports holding up the limestone towers of the West Front, and near the Cavaillé-Col organ filling the interior space between them.

Notre Dame looked like a stone fortress. But much of its weight was carried by ancient wood. Heroic fire crews rushed up narrow circular staircases to save the tower’s beams, which—if burned through—would have brought down most of the rest of the

building. A day later it would be clear that the handful of fire workers had only minutes to douse the oak supports that were beginning to burn. They not only held the towers in place, but also the heavy bells that had been Hugo's inspiration almost 200 years earlier.

Latry arrived at his Vienna hotel, only to be told that the building that was the center of his life was threatened with total collapse. In shock he headed home, and within weeks began an unplanned career as a recital organist in churches and concert halls around the world. His goal was to help raise money to restore the organ and the entire UNESCO Heritage site. A reporter recalls asking Latry when he played in the Cathedral for the last time. The day was Palm Sunday, six days earlier:

> It had been a beautiful service, he said, especially the moment when, according to tradition, a priest knocked on the cathedral's door with his processional cross and demanded to be let in. As the cathedral's doors opened, Mr. Latry recalled, he let the organ's full volume swell, sending its musical colors reverberating around the Gothic building. "It sounded like Christ was entering the cathedral," Mr. Latry said. "It was such a moving moment. I didn't know it would be my last time."[5]

But it will not be the last performance. The sonic embodiment of the organ's legacy remains present in many recordings. And there is hope for the instrument, which—unlike the smaller choir organ—was mostly protected by the stone roof directly overhead. "Two miracles happened that day," noted the composer, David Briggs. "Nobody was killed, and the great organ survived."[6] It has

been dismantled to be cleaned, repaired, and then reinstalled by 2024.

Key Principles of Applied Acoustics

Notre Dame Cathedral is a fitting case study for this chapter. Physical space always shapes the sound that comes from within it. Generally speaking, what we hear is a natural phenomenon altered by human-made constructions. To be sure, forests have natural acoustical elements, as do the vast spaces of a desert. In both it is frequently wind that is the initiating source of sound. Leaves and thin stalks of dry brush respond in whispers to mild zephyrs of air moving through them. But if we think about the sound at all, it has usually been changed by the interior spaces we build to contain it. A radio or recording studio may appear to be a more or less ordinary room. But a visitor may notice that their voice has been drained of the resonance normally heard in a seemingly bigger space. In an engineer's terms, it's "dead" and just what they want for voice or some music recording.

Every interior has a unique acoustic signature, with some friendlier than others to the noises or voices we want to hear. When we begin to think of it, we may realize that we often know the world by what spaces will allow us to experience. Some support the sound of a lifelike acoustic, meaning something approaching an ideal of clarity and a modest degree of resonance. In this kind of acoustic even a small source of sound can make a big impression, something that happens annually when a ten-year-old chorister begins to sing the traditional first solo lines of "Once in Royal David's City" in the Kings College *Festival of Nine Lessons and Carols* broadcast around the world.

The iconic Cambridge University chapel easily carries the modest size of his voice.

Others, such as the crew responsible for assembling live concert audio set-ups, make no pretense to a non-electronic ideal. This is an alternate model of sound changed and enhanced through a series of mostly electronic processors: devices considered more fully in Chapter 6. Either way, we listen. Arguably, a live concert in a venue built for basketball is going to deliver a performance transformed and perhaps degraded by the bad acoustics of the space and a tsunami of an over-amplified noise. A friend and professional musician who has traveled with a pop singer and his large musical entourage notes that he has often felt like a "puppet," with the efforts of his musicianship distorted by the clumsy manipulations of a concert technician.

A reader may object that my ideal of a "lifelike acoustic" is an illusion, since most of us receive content through elaborate electronic means. It's a legitimate point and often debated. The best counterargument is that a good recording, broadcast or electronically enhanced, still honors the open and natural sound of instruments—including the human voice.[7]

The ideal of natural sound is another clear reason to celebrate the rebuilding of Notre Dame. To have lost its ancient space would have not only been a significant historical and architectural blow; it would have also deprived the world of one the great locations to hear an instrument uniquely designed for it. Large churches benefit from the resonance that comes with massive interiors. But they can also lose the clarity of a melodic line in the process. The rate of reverberation produced by the Great Organ was about six seconds for mid-range frequencies, a level of sound persistence that added to its vivid sonic colors while retaining its nimble detail.

The decay rate of any interior space is a function of its acoustics: the length of time it takes a sound from a single location to reflect off the surfaces and distant corners of a building. Natural reverberation is possible in large spaces and affected by the materials used in the interiors. As acoustics scholar and Notre Dame researcher Brian Katz has noted, "Acoustics is an effect of the choices of all the other disciplines . . . the structural engineers and the stonemasons and the architectural finishes."[8] In 2013 he and researchers from Paris's Sorbonne University took detailed measurements of how sound moved through the maze of galleries and open spaces in the 800-year old building. Even with the reverberance, the building still supported an unusual degree of clarity for quieter reeds and flutes within the Grand Organ.[9]

Sound is almost always a mix of blended effects created by the space that it is in. But it is useful to consider each acoustic element separately. Five crucial but overlapping variables shape how a given space responds to a source. They include *direct sound, reflected or diffused sound,* and *sound that is absorbed by non-reflective surfaces.* Two additional and important variables include *the specific dimensions and volume of a space, and resonance specific to a given room.* Any place can be assessed using the same five variables. It might be the family living room, a concert hall, or a space as massive as Notre Dame. Each of these factors will meld to produce an acoustic signature.

Direct sound is that portion of a pressure wave that arrives to a listener without being reflected off another surface. A person seated in the nave of the cathedral is going to hear direct sound coming from the pipes directly behind their ears.[10] As we noted in the first chapter, sound travels at about 1100 feet a second, much slower than the speed of light or a charged flow of electrons. Even so, the effect of a direct wave originating from perhaps 30

feet away seems instantaneous. This relative synchronicity is different from the phenomenon of direct waves created in the atmosphere by lightning, where the delay measured in seconds is a rough indicator of our distance from the source. Some consider a five second delay between the first flash and the following thunder as a measure of safety. Five times 1100 feet adds up to a bit more than a mile.

Even if we rarely think about it, we usually prefer the clarity of direct sound, routinely placing public speakers, performers, or loudspeakers in front of other obstacles. A large exception, of course, is liturgical music, which seems to have added grandeur because of the reflection-generating reverberations long associated with where it is typically heard.

In comparison to direct waves, *reflected sound* offers a field day of effects, some of which may be solved by an architectural acoustician or a novice who tries to fill the role. In all but the smallest of spaces, our ears will usually hear a mix that includes the factor of reflected sound. This more potent sonic cocktail can still come from a single source, but after bouncing off nearby surfaces and arriving at the listener with at least a microsecond of delay. Refection is one reason we can be reminded of how loud a source may be. A standard gas lawnmower is noisy enough on a lawn. At my home it is about 84 dB outside, on grass and measured 10 feet away. If it must be run in a closed garage—not advisable for its acoustic and toxic fumes—the engine noise is reflected off the concrete floor and walls, then back to a listener at a sound level of 95 dB, roughly twice as loud.

We can’t see the arrows of reflection, but they are there. Imagine the visual equivalents of a racquet ball court designed to test a player’s ability to deal with an opponent’s return shots of a hard rubber ball. The ball must be played off any of the six hard surfaces in the 40-foot long and 20-foot high room, but it can only

hit the floor once. Dealing with odd angles of deflection but still making returns is the point of the game. As every player learns, the shots that are hit by an opponent will often be aimed at a side wall, creating a delayed “return” and an odd angle that make the ball difficult to reach. The surfaces are hard plaster, which increases the reflectivity and the fast pace of the game. The point here is that, like the trajectory of a racquetball, reflected energy gets interesting and complicated very fast. Learning how to accommodate direct and reflected pressure waves of sound is a functional necessity for those seriously interested in creating a comfortable living or working environment, as well as maximizing the clarity of a musical performance.

Diffusion is the formal term for adjusting sound reflections to even out frequencies and volume levels in a given space. Diffusion can be accidental, as when a building partly blocks the sound of a police siren or car alarm. Where reflection can be a city’s worst form of sonic assault—as when a pedestrian is caught between a building’s glass wall and the siren of an emergency responder—diffusion can be purposeful, often spreading out energy coming from a sound source.

Large performance venues will often be built or modified to include “cloud” diffusers—slightly curved side or ceiling panels—that help evenly scatter mid to high frequencies. London’s busy Royal Albert Hall uses 85 “mushroom” diffusers hanging well below the ceiling, with their surfaces facing down and over the center of the round theater. Their convex shapes shorten an unwanted time delay created by the original high ceiling.[11]

In recording studios, orchestra pits and some concert halls clear plexiglas diffusers perform a somewhat different function by blocking the sounds of high-volume brass positioned directly behind the ears of other orchestra players. The hope is that these will help save the hearing of musicians subjected to the high

dynamic levels of instruments that are routinely used by composers to “punch through” the dense timbres of other players in front of them. The goal is the attenuation or reduction of high-volume peaks.[12]

Sound is easily reflected when a wave encounters hard and smooth surfaces. These materials typically include glass, masonry, plaster, stone, dense metals, and polished wood. Wood that reflects and also resonates is a wild card we will consider later. But all are nearly guaranteed to be reflectors and represented in the many oddly angled surface spaces within Notre Dame.

The porous limestone of its walls will absorb some sound. But the polishing that is common to dressed stone makes it more reflective. The floor, numerous side columns, windows, stone and stone vaulting all reflect and diffuse in a complex geometry of different angles. Energy that travels down the nave and parallel to its wall will travel the 420-foot distance of the church, back wall to front, in under a half second. This narrow portion of the sound wave traveling in a direct path encounters no diffusion. But *reflected* sound is by far the larger force, taking a longer route that comes in contact with the curved surfaces as well its long multi-level side arcades running the full distance of the central nave. Over eighty rounded stone piers hold all these separate side spaces, each with their own arched vaulting. Statues, stone mullions around the huge stained-glass windows, seating, the signature chandeliers between each of the columns along the arcades, and many other artifacts are all reflectors. The effect is a forest of hard surfaces that will send reflected sound to other surfaces to be reflected again, with the longest routes returning a diminished sound to a listener in about seven seconds. In such large and complex spaces sound can degenerate into auditory mush. That is a common impression of the organ sound that gets

lost in the recesses and dome of the otherwise beautiful Saint Paul's in central London.[13] But the effects of music and voice in Notre Dame can be spellbinding. In a real sense, it was the whole original space, not just the organ, that created the music for which it is known. Just as a loudspeaker depends on its enclosure, or the larynx in the throat depends on the sinus cavities and skeleton of its owner, so too, Aristide Cavaillé-Col depended on the building to complete what the organ would initiate.

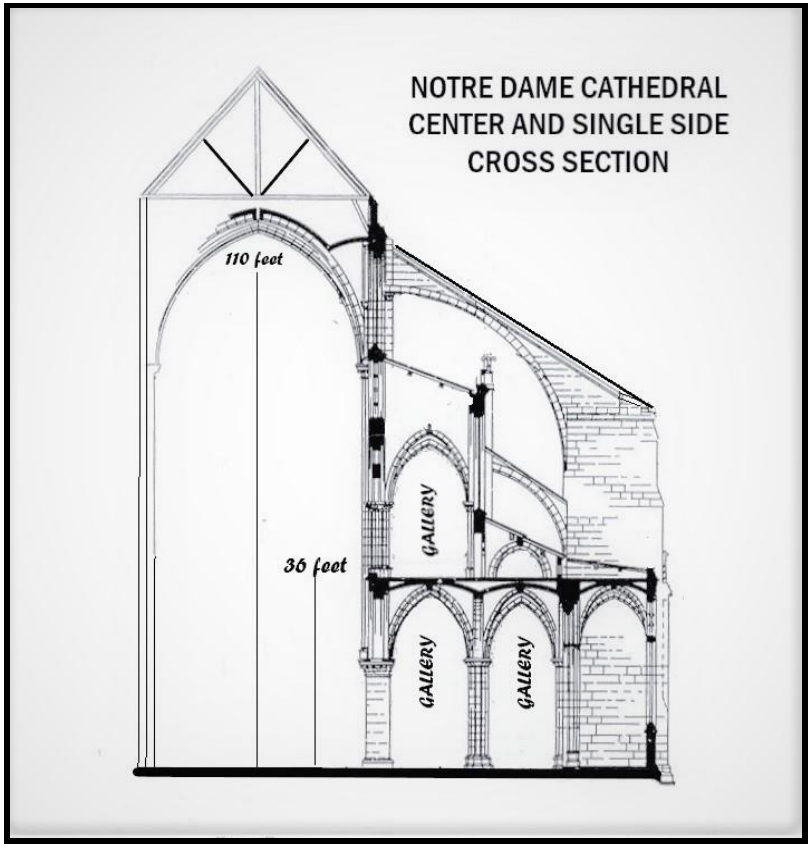

Figure 3.1

A cross section of one side of Notre Dame Cathedral in Paris.

Reflected sound can make music in a cathedral “bloom,” but it is often far less desirable in smaller spaces. Home theaters, movie theaters, radio and recording studios and some restaurants are normally designed to minimize reflective surfaces that can add to the din and make it hard for users to hear each other. In a bar, for example, large glass windows are going to send the voices of a loud group of drinkers to nearby windows with little attenuation. The tiny added delay for the short round trip across the room and back to other patrons can also add to the feeling that they have their heads in a barrel.

An additional acoustic phenomenon is also at work here. In limited space, hearing both a source’s direct and reflected sound can produce an “out of phase” auditory artifact—one label for the problem of competing pressure waves that are out of synchronization. Think of two waves of water coming from different directions and breaking against each other, producing a third ripple that looks completely different. The effect resembles the instability of air flow that creates the uncomfortable auditory “thumping” experienced in a moving car with windows halfway down. The resulting distortion can be unpleasant.

Phase problems are common when sound is delayed in a pocket of space, or when the electronics of music recording produce a delay called a “latency effect.” For example, amplifiers in a sound chain may slightly delay the response of one of the microphones used in a recording. Another form of “out of phase” sound happens easily when two or more speakers or two pickups on an electric guitar are wired to produce energy exerted in opposite directions, producing sounds that are often characterized as “thin, hollow and weak.”[14] The same dynamic is used to advantage in noise cancelling earphones, which “phase invert” low frequency sound heard from their small internal

microphones, essentially counteracting and neutralizing some unwanted external noise.

Solutions to bothersome reflected sound lie in the use of materials that will absorb unwanted or excess sound energy. *Sound absorption* is our fourth category. Though reflected sound in Notre Dame is mostly a plus, it is reduced when the church is full of worshipers. Human bodies are better as absorbers than reflectors. Designers of the many new concert venues around the world usually factor in higher levels of absorption created by a full house. For this reason, many of these spaces work better as recording venues when they are empty because they add a degree of desired reverberance.

If managing a space to support high-accuracy sound is a trial in large spaces, it is even more difficult in smaller ones. As the studio designer and acoustician Dennis Foley notes, the character of sound in a given space is governed as much or more by room characteristics than by the audio equipment being used in it.[15] Because they involve long wave lengths, low frequencies are especially tricky to contain without triggering unwanted side effects. Ironically, audiophiles often show off their expensive equipment in their living rooms by frequently turning up the volume to impress a listener. But more volume simply compounds the problem of low frequency distortion. It may be counterintuitive, but in a smaller space, reproduced music usually sounds better at more modest listening levels (i.e., 65 dB).

Why is there a diminution of sound quality at higher decibels? The problem is that low frequency sound waves literally won't fit into a confined space. And that creates distortion in the form of a "muddy low end," as audio engineers might say it.[16] The pressure wave will not reach the listener as originally produced. It will instead bounce back on itself and produce a blurred facsimile of the pitch rather than the accurate pitch itself. A physical

counterpart might be a set of swings that cannot extend to the natural arc determined by their length, perhaps hitting a tree that is in the way. For example, a piano can produce a fundamental of 40 Hz, which generates a wave that is about 28 feet long. A low human voice or a bass note on a guitar can produce a pitch of 80 Hz at around 14 feet. There is a great deal of auditory content producing these pressure waves, and many Americans use expensive audio equipment to capture them in their home theaters or living rooms. But there's an inherent problem with what nearby walls and low ceilings will do to this high energy bass sound. The phrase used before in these pages is "one note bass," which is not very musical. This is usually what we hear in the stereotypical "boom box."

Acoustic "traps" are treatments that usually look like flat, rectangular boxes that dampen long waves enough to allow a pleasing level of clarity. These low frequency traps are placed away from a ceiling or wall, and filled with a material like carbon that can soak up a great deal of sound energy. They are used in smaller studios or homes where expense and the space they occupy is not a deterrent. In addition, a number of more incidental materials can act as traps for low frequency sound, including upholstered furniture, pillows, carpet and sometimes bookshelves.

In Notre Dame a 28-foot-long wave is obviously not a problem. It can easily travel its length without being blocked. Most pipe organs can create pedal notes down to at least 40 Hz. And even if that low pedal note is recorded with high accuracy, the playback is not going to work easily in a smaller 14-by16-foot space. Acousticians charting the output of such a system will expect to find a "peak," where the low frequencies "bunch" and lose their original character. Home listeners may be content with a fog of low bass, but most recording engineers will try to set up

spaces that can deal with uncontrolled low frequency energy. The solution for “mastering engineers”—individuals that do the crucial work of mixing a final recording before it is released—is to build longer work spaces that provide enough room to allow their monitoring speakers to function well. They may also try to use bass traps to absorb some of the distortion-inducing reflections that can make listening for accuracy difficult.[17]

Absorption of higher frequencies is easier. A 1000-Hz tone easily heard in the higher range of a soprano or trumpet is roughly three octaves above middle C, and can create its own challenge of seeming loud or too shrill. But its length is a bit less than a foot, and usually distorted only by reflection rather than from a wave form that is too long. Sound in this range can be softened or damped with simpler acoustical treatments such as foam board, curtains and other softer surfaces that may reduce unwanted reflections.

Resonance is the fifth and final acoustic feature that can create both pleasure and annoyance, depending on where it shows up. As defined by Andrew Pyzdek, “Resonance occurs when a system preferentially vibrates at a certain frequency.” [18] This is called the “resonant frequency” that an instrument or space “wants” to support.

Most musical instruments are constructed to enhance sound through resonance over a range of frequencies. A given string on a piano has a specific resonance created by its length, the tension placed on it, and its position within the instrument’s cast iron frame and nearby sound board. A single kettledrum with a certain degree of tension on its skin also has a tuned resonant frequency. And a single organ pipe is tuned to a specific length and width. An eight-foot pipe can resonate and produce a low C at 64 Hz. By contrast, a one-inch-long pipe can resonate at 16,000 Hz at the upper margins of human hearing.

As we noted earlier, wood is sometimes used as a reflective surface. But it also tends to add warmth to a sound. It may also be prized for its resonance properties when it is turned into tubes, open shells or thin membranes that can freely vibrate. Stringed instruments are often constructed from rosewood, mahogany, maple, okavango, walnut, myrtlewood, and spruce. Stradivari violins were made mostly of thin maple, with their cherished tonal color added by a combination of the low moisture and layers of lacquers and minerals that are wedded to the surface.[19] Martin Guitars use various eastern spruce woods on the top of the instrument, providing what the makers see as an "ideal diaphragm" for the transmission of sound.[20]

By contrast, rooms and other spaces are usually not tuned to amplify a particular frequency. But most enclosed spaces with rigid surfaces have a natural point of resonance: a "mode"—a frequency of high resonance—it naturally wants to amplify, much like what an A string can produce on an acoustic guitar. This means there is usually at least one pitch range that is bolstered by the space, often at the expense of higher and lower frequencies. Anyone strolling through an empty house or apartment will hear noticeable resonance in specific locations. In the same vein, refrigerator compressors running a bit slow or fast due to changes in line voltage will sometimes vibrate and trigger a mode favored by the refrigerator's interior space. The noise can sometimes be intrusive. Without some sort of damping, what is known as a "high Q" factor of uncontrolled resonance will often surprise us with its persistence.[21]

Calculations of the modes or "standing waves" in each space are based on the room's dimensions and the speed of sound. Most commonly they are noticeable at lower frequencies. This is because, as we have noted, long sound pressure waves are reflected back into a space and invisible meeting points within it,

creating a strident or muddy sound, or—depending on where a person is sitting—almost nothing at all.[22] Someone designing a room specifically for music listening, for example, will try to absorb frequency ranges that produce the “standing wave” modes that create this excessive resonance. Loud and undefined low frequencies in music are one effect to be treated, but not the only one. A loss of overall musical detail is another. Equally noticeable a person may hear the annoying presence of a hum that produces its own standing wave and hangs around like a visitor who will not leave. The source may be running electric motors in air handling systems, compressors in refrigerators, elevator motors, or vent fans. I have a low voltage transformer in an electrical closet likes to hum at 120 Hz, reflecting the 120 volt power it is receiving.

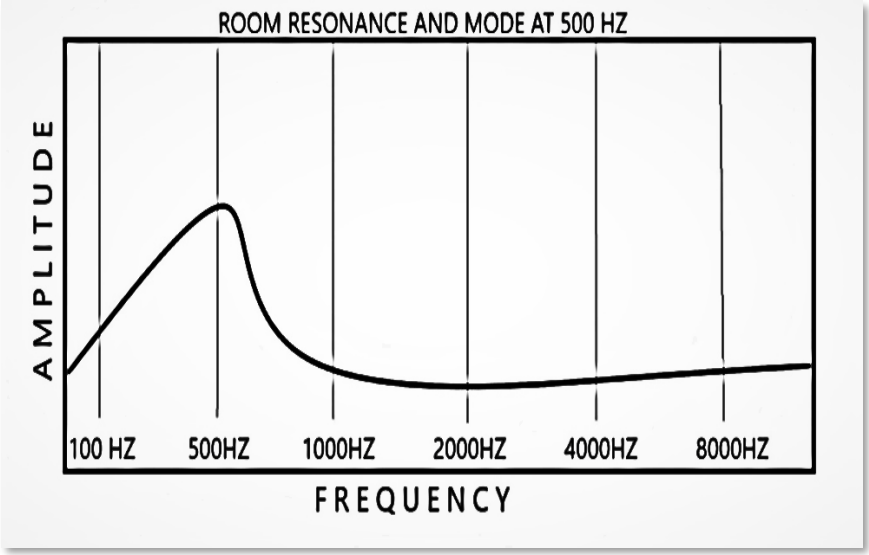

Figure 3.2
Room resonance and mode at 500 Hz

Consider a specific case involving standing waves that feed a loud resonant frequency. A restaurant near the writer's home is an eighteenth-century coach inn with low ceilings and many small and cut-up spaces. Only candlelight is used inside, giving the space an aura of intimacy. But the soft lighting does not carry over into soft sound. One of its spaces is a small enclosed porch about eight feet wide, with windows on three sides. Within this partial space are usually two "four tops" accommodating eight diners. As we have noted, window glass is stridently reflective. With eight souls crammed into this narrow space, and containing the talk of alcohol-fueled voices, the low frequency modes can rise to the heights of Mount Everest, falling in the neighborhood of 350 Hz and set off by male voices that fall within this range. The space may look like upscale dining, but acoustically it is more like joining a kitchen packed with children celebrating a birthday.

Of course, most people living busy lives are not going to pay attention to these effects in their relatively small living areas. Indeed, we routinely move through unpleasantly resonant locations all the time: hallways, subway stations, high-walled city streets and restaurants with too many diners packed into a tight space. Even live concerts in arenas are no guarantee of clean sound. Audio technicians at many rock and jazz venues have developed boombox ears, using rock music's defining legacy of extreme volume that can dwarf the musicality that might have existed on stage, but has been lost in the indistinct roar of over-amplification. Rare is the artist playing arena concerts who wants a natural acoustic to be a part of their performance.

For all of these reasons it can sometimes be revelatory to attend a live concert in a space for music and without extensive electronic processing. Consider the long pandemic "lockdown" that began in March of 2020. Many Americans heard their favorite musicians playing via home-produced performances presented in

television or video segments. And most were probably hearing a performer for the first time without all the electronic assists of the studio. One such event was produced under the banner of Global Citizen, with unadorned home-based songs from Lady Gaga, John Legend, Elton John, Chris Martin and others.[23] All were singing to acoustic or electric pianos in their homes, usually demonstrating a kind of direct musicality hardly known in a studio-produced album. The effect can be like hearing a grand piano in person after a long hiatus of listening to only recorded music. A live piano is surprisingly loud and covers the full sound spectrum. It is also one of the most difficult instruments to capture, even using multiple microphones. Featured alone, it clearly reveals its fundamentals and harmonics more fully than might be heard in a recording session. After a person has sampled the real thing there may be no going back.

This tangible example of performers reduced to the basics of their art is a useful reminder that, for many solid musicians, acoustic instruments remain essential. Despite all the stadium concerts the Beatles gave over the years, Beatle Paul McCartney still regards pianos or the humble ukulele as instruments that matter.[24] Both instruments retain the features of strings set in motion within physical but not electrical soundboards. Arguably, there is a vital dimension of musicianship that benefits from reference to unprocessed sound.

“Bad” and “Ideal” Acoustics

Our senses usually let us know when a given location makes us vaguely uncomfortable or unable to connect with others. In 1894 these were the problems lecturer Charles Elliot Norton detected from the first moments of his opening remarks in a 400-

seat lecture hall in Harvard's Fogg Art Museum. His students could barely hear him, and he struggled to understand any question coming from the outer edge of the semi-circular theater. Like many buildings, the Fogg Museum was designed to look the part, with a degree of Italian renaissance ornamentation. But it was not always kind to those who used the building for teaching. The problem was not fully solved until 1973, when a significant part of it was torn down.[25]

The experience at Harvard's museum is considered one important reason for giving more attention to room acoustics. Before its destruction, the lecture hall was one of the first renovation projects undertaken by the physicist Wallace Clement Sabine, who became the founding force in the new study of architectural acoustics. If he was not fully successful with an attempted renovation of the lecture hall, he at least asked the right questions and applied established principles related to the basic physics of sound. With his work, the idea of building with more consideration for the ear was born.[26]

Two traditional "shoebox" concert halls in Boston and New York reveal very different narratives for maximizing the listening experience, even though the second box was deliberately designed to resemble the first. Boston's rectangular Symphony Hall opened in 1900 and was acoustically designed by Sabine, who was hired by the architectural firm of McKim, Mead and White.[27] The simple auditorium is modeled on several European halls built as ornate boxes with the performance space at one end. It is one large room. The best-sounding halls broke with the old tradition of the opera house with its distinct stage, a narrow proscenium arch, and a stagehouse above the performance space where scenery is kept. These performance spaces were essentially two rooms, and often lost the direct sound from the stage that disappeared into the upper stories of the stagehouse

above it. By contrast, Symphony Hall is only adorned with statues and shallow setbacks along its plaster side walls. It also has a full width organ case above and behind the orchestra with curved pipes that spread out the sound. Organ pipes often function as sound diffusers to scatter the reflected sound of an orchestra immediately in front. With its shallow balconies and reverberation time of about 2 seconds, it was and remains well suited to the European classical and romantic repertoire the Boston Symphony once favored.

It was therefore logical that when Lincoln Center and its concert hall were first envisioned, a one-room shoebox shape like Boston's was one of the models. And what opened as Avery Fisher Hall in 1962 was nearly identical in shape and size to Boston's admired old space.[28] But even after repeated and extensive renovations in 1972, the newer hall still retained acoustics that were far from ideal.[29] For what is now called Geffen Hall, criticisms came from members of the New York Philharmonic, who complained that they could not hear each other on stage. In addition, audience members seated far from the stage often objected to the common psychoacoustic effect of sound that seemed too "distant."[30] Most classical musicians performing in New York favored the warmer acoustic quality of Carnegie Hall, which was nearly torn down before Lincoln Center's problems began to surface. Visiting orchestras preferred the older hall, with its shallow auditorium and arched plaster shell that throws all the firepower of an orchestra deep into every corner of the room. In fact, most of the city's theaters share Carnegie Hall's pattern of a relatively short distance between the stage and the last seats in the back: a function of the short-width of city blocks running from east to west. Their relatively narrow two hundred and sixty-five-foot breadth barely accommodates two buildings backed up to each other on adjacent on streets.

Newer halls built in big and even moderate-sized cities have emphasized the kind of proximity of players and audiences experienced at Carnegie Hall, but with an added twist: placing the performers in the middle of the room rather than the older architectural preference of placing them at one end. The newer pattern began with the building of the Berlin Philharmonie, opened in 1963. Seats surround the orchestra, in contrast to the "shoebox" approach with performers at one end. Direct sound from the players to the nearby ears of audience members is undiminished. But the hall is big enough to retain a modest degree of reverberation favored by orchestras. Over time most cities have adopted this approach, with leading examples in Denver's Boettcher Concert Hall, Los Angeles' Walt Disney Hall and Hamburg's more recently completed Elbe Philharmonic Hall. It is likely that when it eventually opens, the new Geffen Hall will also seat attendees behind the orchestra and in a reduced space that is more intimate.[31]

Finally, all is not lost if a studio or concert hall sounds less than ideal. A room with problematic acoustics can still yield decent sound, especially if helped by microphones that are carefully chosen. An expert sound engineer can pick devices that emphasize what a room otherwise lacks. They can also choose from omni, cardioid, bidirectional or unidirectional microphones. Other types exist in different gradients, but these three forms are the most useful to know. Omni-directional mics accept sound from any direction, and are not usually a good source except deep within a large ensemble. A cardioid pattern broadens to include the front and sides, but not the back of the mic. And as the names suggest, a bi-directional mic picks up sound along a single axis, and a unidirectional mic is meant to pick up sound in front of it. This last type is most useful where there is a lot of reflected or ambient sound: It will accept only what it "hears"

directly in front. A singer facing a unidirectional microphone can easily make their voice carry over a loud backing band, making lyrics that are clear despite competing reverberation or other sonic distractions. In a typical theater, for example, we want to hear the action that is onstage. We're less interested in crowd noise, coughs and other distractions from the audience.

A long tradition of "close-miking" singers began when Bing Crosby found that he could add greater interpretation to a song if he used less breath and more varied intonation. It allowed recordings of his voice that were bigger, more dominant, but also intimate.[32] The old-style vaudeville "belter" who could be heard in the last rows of a theatre began to lose ground to younger vocalists like Crosby who built careers from ballads crooned into a microphone. Singers today are still usually separated from a mic by just a few inches, with a "pop screen" in between. The screen prevents a rush of breath created by plosives (p sounds, for example) from overwhelming the fragile elements within mics. Crosby also had a voice that worked well with the mellow-sounding ribbon microphones of the day.

Because record deals are out of reach for more musicians, many are recording home or in smaller studios and emphasizing direct sound and minimizing reflections and other chances for a room's natural acoustics to be a part of the recording. This to some extent compensates for shortfalls common to spaces not intended to be studios. But it takes planning and a good ear to make a domestic environment friendly to the possibility of accurately conveying auditory content. This is a subject we will revisit in detail in Chapter 6.

As we have seen, sound is not just a product of a given source. Rather, it is usually a mixture of effects modified by the space it is in. Considerations of the effects of such acoustical environments is thus vital to understanding how we hear. We

started by looking and “listening” to the great spaces of Notre Dame in Paris. It is a long way from the much more intimate locations now used to enhance or sometimes sabotage the fractional whispers of air pressure that we still want to hear.

Chapter 3 Notes

1. Johann Vexo, quoted in “Notre-Dame fire: Treasures that make it so special,” *BBC News*, April 16, 2019, https://www.bbc.com/news/world-europe-47937775.

2. For a brief history of the organs at Notre Dame Cathedral see A. De Laleu, “A History of the Organs of the Notre-Dame Cathedral in Paris,” *France Musique*, April 16, 2019, https://www.francemusique.fr/en/history-organs-notre-dame-cathedral-paris-21640.

3. Saphora Smith and Jack Losh, “Notre Dame Organist Playing When the Fire Broke Out Calls the Devastation 'Unbearable'” *NBCnews.com,* April 16, 2019, https://www.nbcnews.com/news/world/notre-dame-organist-playing-when-fire-broke-out-calls-devastation-n995236.

4. For a timeline of the fire see, John Henley, “Notre Dame Cathedral Fire – A Visual Guide and Timeline,” *The Guardian*, April 16, 2019, https://www.theguardian.com/world/2019/apr/16/notre-dame-cathedral-fire-a-visual-guide-and-timeline.

5. Alex Marshall, “Notre-Dame Musicians Rejoice That Cathedral’s Organ Was Spared,” *New York Times,* April 24, 2019, https://www.nytimes.com/2019/04/24/arts/music/notre-dame-organ-fire.html.

6. David Briggs quoted in Luna Shyr, “Understanding the Majesty and Complexity ofGreat Organs,” *Atlas Obscura*, September 3, 2020, https://www.atlasobscura.com/articles/great-organ-notre-dame.

7. For a useful discussion of what “lifelike” sound might be, as well as one history of the search of it, see Greg Milner, *Perfecting Sound Forever* (New York: Faber and Faber, 2009), 185-236.

8. Emma Jacobs, “How Researchers Hope to Restore the Unique Sound Of Notre Dame,” The World, *Public Radio International*, April 15, 2020, https://www.pri.org/stories/2020-04-15/how-researchers-hope-restore-unique-sound-notre-dame.

9. “Reconstructing the Acoustics of Notre Dame,” *Acoustical Society of America*, May 3, 2019, https://acousticalsociety.org/reconstructing-the-acoustics-of-notre-dame/.

10. A reader may wonder if the sound is different if the source is directly behind a person who is facing the other way, as is the usual layout in Notre Dame. The best answer is perhaps only a little. Forward facing ears come into their own when sounds are faint. But one possible effect of facing forward is perhaps a slight increase in the sensitivity of a listener to the reflected sound coming back to the listener from the distant end of the church and the structures in between. This factor may be a part of what made the church sound qualitatively better to some listeners.

11. “Mushrooms (acoustic diffusers),” Royal Albert Hall.com, accessed April 6, 2020, https://www.royalalberthall.com/about-the-hall/our-history/explore-our-history/building/acoustic-diffusers-mushrooms/.

12. A useful overview is the BBC’s “Musicians’ Guide to Noise And Hearing, Part II: Toolkit For Managers,” BBC (UK), 2012, http://downloads.bbc.co.uk/safety/documents/safety-guides/audio-and-music/Safety-Musician_noise_guide_Part_II.pdf.

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Chapter 4

ORALITY: BREAKING THE CODES OF CULTURE

Blindness cuts us off from things,
but deafness cuts us off from people.[1]
—Helen Keller

The videos are everywhere on news and social media sites. In a small office a toddler born with severe hearing loss is outfitted with digital hearing aids, or has recovered from surgery that left a cochlear implant in place. And now professionals and parents are ready to begin a test. All hover nearby to witness a trial run of a device that is intended to bring the child into the hearing world. At this point the external portions of these devices are also attached to a computer that will eventually be replaced later by a tiny receiver worn by the child. They will use the computer to fine tune the frequency and volume levels, since every individual is different. In the case of a full implant, introducing a flow of electrons to a brain is never a small matter. Even so, the clinicians know that a barrier is probably about to come down. But

they are careful to act like the gradual introduction of sound to the child is routine—a low-key demeanor that is a counterweight to anxious family members nearby.

The results will typically melt the coldest heart. The kids range from a few months to a few years old: Kai, Amy, Rowan, Danielle and many others. The audiologist turns on the device, asking others in the room to talk in a normal voice. And then they look for signs of recognition. The switch from silence to sound sometimes creates a startle reaction, often followed by widening eyes, hopeful smiles from nearby parents, and even squeals as the tiny patient begins to crawl out of the silence. The hope is that we are witnessing the beginning of a permanent fix that will give a child the expressive power that they will never want to relinquish.

Teens and young adults receiving implants follow the same procedure. An audiologist looks on, her computer screen showing controls that will slowly increase a new implant's audio output. With the addition of sound into what has been a mostly dormant nerve, some are taken by surprise to hear their own voices. Perhaps the implant has provided new sonic power that digital aids could not match. Soon the shock of more noise and maybe garbled voices is followed by smiles and bewilderment. Something fundamental has changed. There is the voice of a parent, a brother or a partner heard for the first time or in a new way.

Typically, digital aids for children just a few months old are large, temporary, and usually need to be fitted at the beginning of every day. They are used until better long-term solutions for staying in the hearing world are explored. In one case, a Twitter video posted by her dad shows four-month old Georgina go from wide-eyed patience to joyously giggling as the aids are turned on. Her daily transition from deafness into the world of sound never

seems less than a new moment of excitement. As her father noted, it is “like she’s having the lights switched on.”[2]

Digital aids are basically amplifiers that add volume to prod the hairs in the cochlea’s organ of Corti to respond. (See Chapter 2.) The signal they deliver is an acoustic analogue, producing something like the sound of a radio station on an ordinary earpiece. They are often used to deal with “conductive” hearing loss, where a blockage has reduced the amount of sound. But implants work differently and have starkly distinct properties. They may be an option for individuals with severe to profound “sensorineural” hearing loss, meaning the fine bones or tissues of the middle or inner ear are not functioning.[3] Implants feed electronic signals to the auditory nerve, passing significantly altered versions of sound to the brain.[4] Because it usually circumvents the Corti hairs that are the transducers nature intended, implants involve a conversion process that is more likely to strip sound of at least some of its natural characteristics. Implant recipients who once had a degree of hearing note that it delivers something other than what unaffected listeners receive. To be sure, they stimulate neurons to mimic auditory content, but these facsimiles are not quite the acoustic sounds that usually pass through the middle and inner ear.

Children between a year and eighteen months usually take well to what a hearing person might describe as an auditory shadow of the real thing.[5] With therapy, children who have the advantage of a brain thirsty to learn will usually make it work. It is tougher for teens or adults whose brains have become slightly less adaptive. Morgan Leahy offers a reminder that a cochlear implant is delivering something very different:

> I had my hearing for 20 years before going fully deaf, meaning that my brain did not need to rewire as much when I chose to get a cochlear implant. But even though I

> was the most prepared patient at my hospital, I could not understand a single thing that was said to me for two months after my activation. Yes, I could hear sound, but it was extremely difficult to comprehend. The artificial sound a cochlear implant provides is not the same as the sound hearing people experience. It takes practice and hard work in order to obtain something close to audibility. Using a cochlear implant can be quite demanding, even for the most promising candidates. So when a person without this knowledge watches the activation video they are led to think that the Deaf person can fully hear everything, which is not the case.[6]

Her point is an important one because it is a reminder that external fixes to the tiny organs of hearing are sometimes partial rather than restorative.[7] As she notes, "sound is strenuous at first and it is a struggle to even keep the implant on for the first few weeks."[8] Leahy's experience is also useful as a way to begin our look at the sound pathways to language acquisition. With up to twenty percent of children facing some sort of hearing loss in at least one ear, [9] various and sometimes ingenious "workarounds" are a reminder of what is at stake when the capacity to hear falls short of its potential.

Language and most abstract forms of communication are born in speech. Our ascent into the heights of language is acquired by the very young through a natural process of listening and imitating others. To be sure, orality that grows into full-blown literacy is a lifelong process. But it must start with the capacity to learn, which comes with the natural plasticity of the youthful brain.[10] Young minds are able to fast-track processes of memory retention and language acquisition. They also need the help of eager talkers ready to model sounds that can be grouped into

expanding combinations of phonemes. These aural triggers make ever-wider circles of meaning possible.

There is no human capacity that is more worth celebrating. Animals use signs to communicate to each other, using gestures that indicate anger, submission and so on. By their nature, signs are reliable indicators for what they stand for. Handlers of horses, dogs or other species can usually "read" their levels of comfort or stress by certain cues.[11] Humans offer their own signs as well, as any student of non-verbal communication will affirm. But humans add to the arsenal of body language an even more expressive ability to associate combinations of sounds with specific places, things, feelings and ideas. As the critic Kenneth Burke famously noted, humans "are the symbol using animals."[12] Language is itself a product of abstraction where the world is remade by perception, experience and memory. Language is its own arbitrator of reality. It gives us the capacity to imagine the future and narrate the past. It lets us understand ideas that have meaning but no material presence: values, "truths," and the contents of our consciousness. We think in language. We imagine what-ifs and what could bes. Awareness triggered by the master-tool of language even forces us to ponder the existential fact of our own mortality. If animals mostly live in the moment, language gives us the power to ruminate in a continuum of time. And it starts with sounds coming from others, eventually extending to every corner of our lives.

In the pages that follow we cast our net broadly to explore how communication becomes the primary asset in our social natures, from childhood to adulthood. This capacity for living in communities builds out from communication-based competencies, starting with the acquisition of the elements of language in the first years, followed by the growth of a social self that allows a shift from an "I" point of view toward

acknowledgement of others. These are all consequential processes that also represent lifelong challenges of negotiating meanings with others. The chapter closes by considering how this hard-won fluency can be a positive force in the transformation of others.

The Primary Language Window: The First 1800 Days

A child is usually born with their hearing intact. Indeed, their ears are functional in the womb, but can't blossom to their potential until they can use their vocal folds to join the sonic fray. As William James famously noted, a baby is "assailed by eyes, ears, nose, skin, and entrails at once," perhaps experiencing a life that has just begun "as one great blooming, buzzing confusion."[13] The water world of the womb gives way to the external din that comes with joining a family and a community.

At birth, the capacity to hear surpasses the capacity to see. Children are born nearsighted, with distant objects out of focus. But from the start, their capacity to hear upper frequencies is intact, as are the mechanisms for pushing air past very young vocal folds. Phonemes and words will come later. But infants are almost immediately aware of the touch and sounds of their caregivers. As we would expect, the first stages of life involve more hearing than expressing. Ears are open to parents and others. And soon cooing and random sounds act to further stimulate others who are eager to begin "conversations" with a newborn. At under a year we tend to notice on familiar benchmarks: laughing, babbling, early use of consonants, control of the head to see the face of a talker and—near the end of the first year—vocalized proximations of words for a parent or relative. Often overlooked in this process is the vital role that

caregivers play in providing chatter that stimulates a child. The conditioning process is mutual; the most casual babbling brings responses of delight from attentive caregivers, making many toddlers even more loquacious.

Animal babies are usually born with more survival skills. A newborn horse can walk and even gallop in just one day. But humans have a deeper dependency on their caregivers. Their relative frailty needs the compensation of bonding vocalizations. Early on, babbling and the repetition of sounds act as proxies for the communication skills they will acquire. Infants can often vocally hint at an object they want before they can reach it. Within the second year most toddlers are on their way to imitating words and making crucial associations. They are fascinated with the sounds they hear and the ones they can make. “Children who hear acquire language without any particular effort,” noted Helen Keller. Having been deprived of sound and sight at an early age, she grew to understand the early development that her deafness at nineteen months blocked. More than most, Keller came to notice that “the words that fall from other’s lips” are what children so easily “catch on the wing.”[14]

Early shrieks that suggest a self that can assert as well as receive begin to place a child in the flow of interacting with others. The process of learning the language and its many characteristics—meaning, syntax, intonation—start to take shape. And what a learning curve it will be: to basic literacy and often far beyond. Think of a child’s brain as like a heavy vehicle about to take on the fuel it needs to accelerate. Its first few moments are tentative and slow. The inertia of a cold start from zero must be overcome. But soon, new humans are running Daytonas of perceptual learning even while they are still tripping over their own feet. The rapid creation of neurons makes precipitous

acceleration possible. Within the first years more than one million new neural links are created every second.[15]

In terms of cognitive capacity, a child in the first decade is a learning machine. A fast- expanding cortex processes sounds to construct answers to the puzzles of the world. Ask a four-year-old to tell you about a butterfly that you both see. At this point enough language has been heard to relish the chance to mold words into ideas. There may be ruminations about other bugs, colors, families they came from, and imaginative explanations for how they like to spend their time. The word-salad will typically extend to the very edges of their quickly expanding vocabulary. In a narrow sense, the explanation is self-initiated. But step back and consider what you have heard: a narrative taken from the material world that has come from an accelerated cycle of observing, listening, imitating and speaking. Even a disjointed narrative masks the speed of a child's cognitive growth. Language transforms their brain into a developing mind and, with it, a distinctly personal rhetoric that will allow them to flaunt their individuality.

Helen Keller probably lost her hearing to scarlet fever a few months before her second birthday.[16] But that brief window allowed her enough time to allow her to understand the experience of language.[17] Teacher and companion Ann Sullivan clearly brought Keller out of the catastrophe of also losing her sight, but those early months when her senses were intact surely gave her a consciousness of the possibilities of language. She understood its function and importance. As Keller noted years later,

> The problems of deafness are deeper and more complex, if more important, than those of blindness. Deafness is a much worse misfortune. For it means the loss of the most vital stimulus—the sound of the voice that brings

> language, sets thoughts astir and keeps us in the intellectual company of man.[18]

By age nine or ten, the front-loaded race for language acquisition begins to slow a bit. The cognitive work that has occupied the developing brain is beginning to knit together a functional set of communication elements. As Jan Carreiro notes, “seeing a word, hearing a word, thinking of a word and speaking a word all involved different areas of the brain.”[19] All have been engaged hearing the speech of others.

The babbling of the first year soon begins to yield to a “first word” stage (one to one and a half years), then “first word combinations” (around two years) and “simple and complex sentences” (three years).[20] In the first 1800 days or five years, a child takes in the world, but not like a mechanical recorder. Children have sticky memories for sounds, word-associations, and the vocal intonations that are beginning to be understood for the feelings behind them. Their learning is anchored in their unique circumstances.

Language specialists—myself included—sometimes have what amounts to a “trained incapacity” [21] to formalize the natural phenomenon in language, masking the wide variability and fluid timelines for any single individual. Conventionally, the language learned at this time includes its “phonology;” the sounds of word fragments; “syntax;” the structures of units of language; a “grammar” that includes a culture’s norms of language use; and “semantics,” or how words have meaning. But at close range language is made up of a rapidly expanding set of auditory cues and associations that can be missed in formal labels.

The heuristics of language learning are useful, but are only after-the-fact descriptions to individualistic ways a person makes sense of the world. Consider some of the more practical cues

evident in a story told by Damien, age 5, a child in an American Head Start program:

> Me and Spiderman and Batman went to the movies. Then we played together. Then we do flip flops together. Then Batman flied up to his car. Then I sprayed my webs up there. Then we all drive the car. A real car. Then we beat up the bad guys. Then Batman flied away and I swung away with my webs. Then we sat together. Then we saved the world. Then we got in the house and we watched scary movies. We watched "Scream." Then we heard the bad guys. we saw the bad guys movie and how they beat the world up. Then we saved the world. Then a dinosaur hurt the world and we had to flip the dinosaur over to his country. Then we played the guitar. Then we made an iced tea stand. Then we were in the woods. Then we broke our toy. When we heard the bad guys say, "let's take over the world," we saved the world once again. Then we saw them doing karate. That's the end.[22]

Damien's tale illustrates some revealing ways a child his age has come to understand his world. The story is told in the first person. Damien is taking a scary ride with a couple of well-known superheroes that have already shown up in the media seen in his household. Moreover, experiences are turned into tales with the teller at the center. The shift from self-reference to more interest in "the other" will come later. His story is also about things more than feelings or attitudes. It is typically loaded with nouns—dinosaurs, guitars, toys, houses—perhaps the simplest words to acquire in the first few years of life. The plot is told in action verbs: watching, saving, driving, playing, and so on. And its narrative frame already mimics a paradigm story structure: a problem followed by a solution; a villain is vanquished by heroes. Already Damien is seeing his world partly through the lens of

popular narratives. But he is some years away from acquiring the kind of social intelligence that would allow him to explain the motives or feelings of the outsiders he describes. They will come, supported by a vast lexicon of terms that allow us to name intentions and feelings, and find ways to express empathy.

The story is also a reminder of how much culture *is* language. Damien's perceptual world lies at a busy crossroads of word acquisition and story frameworks that have general visibility in a community. His easy shift into a fantasy builds on a common ground of myths and suppositions that are constructed from everyday perceptions. The narratives for adults may be more complex, but they still retain leaps from known experiences to fantasy chains that are already seen in Damien's world.[23]

What is next in the listening and learning cycle that gives a child the rhetorical keys to the culture? Speech and language experts expect that children Damien's age will add more pronouns and modifiers, more references to the past and future, and will begin to understand how to conceptualize categories. Children now deeply into the maw of the culture will also accept the challenge of words that are hard to say, and begin to welcome the chance to have a conversation with another person.[24]

In some senses, the cycle of language expansion and growth never ends. Child development experts will debate whether the first three, five or nine are the "golden years" of language acquisition.[25] 1800 days is roughly five years. What is clear is that the early window for learning language and the culture it supports will partly close by the end of the first period of life. Oral literacy is a lifelong process that eludes total mastery. The early facility to acquire and use language heard from auditory cues will broaden and include the challenges of reading language on the page. But

children with all of these preliminary skills have made it to the base camp for ascending the mountain of language.

Shifting to "the Other:" From I to We

The dominant thread running through this chapter is that oral language is the primary portal into a culture. The early years of life are often consumed with mastering some of its rudiments. But full interaction with others requires additional learned understandings.

It's a truism of child development that the youngest are likely to be referencing the world largely from their own point of view. "I" and "we" may not come until after a child's first word, but the impulse to base actions and reactions from the perspective of the self shows up early. Put simply, and as every parent knows, self-reference has a lock on the limited perceptions of a child. A key threshold is crossed when a young human can begin to see that it limits the development of full relationships with others. Parents usually work at teaching a child to be "considerate of others," or to "think about the feelings of others." But these are lessons that are hard for a child to internalize. The learning curve usually begins with stories that model empathy. Yet lessons to be more other-centered may often fall short. Most of us carry the bruises of a lifetime of contact with some stunted adults who still cannot see the world from another's point of view.

A number of important scholars have grappled with the dynamics of making the consequential change from "I" to "we." Sociologist's Charles Cooley and George Herbert Mead were early leaders in describing the process of gaining awareness about "the other" by cultivating a simultaneous awareness of how others react in our presence. Cooley's idea of the "looking glass

self" speaks to the core of our social nature.[26] We understand who we are by the accumulated impressions we receive from others who have engaged with us. This comprehension of "otherness" then makes it possible to extend our sensitivities beyond personal needs or wants. In other words, interaction processes serve as the raw materials for fashioning a self-image. This is the first step of two, when this "mirroring" in which we "become objects to ourselves," paves the way to "become not only conscious, but self-conscious and thus human . . ." These are Hugh Duncan's words, by way of a key example:

> As the child strikes a pose or the adult "takes an attitude" they are like actors on a stage playing before an audience. Actors do not know how a gesture will "go over" before they strike it. They learn from the responses of other actors and the audience the meaning of what they have just done.[27]

Construction of a sense of self is a necessary developmental achievement that precedes a second step, the acquisition of a degree of social intelligence that makes us capable of "being in the other." As "I" makes room for "we" a lifelong awareness has started where a person must begin to negotiate their own place in the community by also being responsive to the needs of those around them.[28] In other words, mastery of communication will eventually depend on the cultivation of the capacity to show and act on the sensitivities of others. This is empathy, the real but conditional capacity leading to a deeper level of co-existence with people who are different.[29]

Language as a Portal for Consciousness

Our point about language as an essential cognitive map merits its own brief discussion. For most people, language

communicates experience, with the event or thought coming in front of the search for a label. As a result, words often seem like mostly inadequate snapshots of a far more vivid reality. We may hastily put the words together, but the reality is always there. Or so we think. But what if the reverse was true? What if language is in fact the primary window for perceiving, and not having a vocabulary for experience means that we don't have the experience? What if the power to name is the power to see? From this view it becomes more obvious that the language window of early childhood is even more vital.

The idea that to name is to perceive is the essence of the hypothesis proposed years ago by two linguists, Edward Sapir and Benjamin Whorf.[30] Some of Whorf's original research, for example, focused on the structure and vocabulary of the Hopi tribe in America's Southwest. Among his findings was the observation that some colors familiar to English speakers were not named by the Hopi, and easily overlooked. In addition, Hopi did not usually specify past and future tenses, as many other languages do. Not having these "semantic domains" usually means not organizing our thoughts in these temporal categories. We could flip this over as well. There are no doubt many sensibilities supported by the languages of indigenous people that speakers of English are likely to miss because they have no linguistic support.

Since a lot of higher order cognition depends upon language, we don't easily focus on what we cannot name. Consciousness itself is structured around labels we have acquired, with larger portions of the cerebral cortex devoted to language.[31] Hence, we get to the startling and counter-intuitive conclusion that language guides thought. Language is the great engine of consciousness. For example, English exists within a grammar of binaries. We think of something that "is" or "isn't," or "true" versus "false:"

sometimes very different from more nuanced Asian languages that more easily accommodate the idea that something can have two seemingly contradictory traits at the same time.[32] As one of my colleagues who grew up near Shanghai noted, "'To be or not to be'" is not a phrase that comes easily to the Chinese. Broadly speaking, Mandarin helps the Chinese mind entertain more nuanced possibilities. Views put on offer are expressed as more contingent: better understood as joined rather than isolated.

At some levels what is sometimes called "linguistic relativity" is obvious. English includes a wealth of clinical terms that created new perceptions because they were named. "Attention deficit/hyperactivity disorder," "post-traumatic stress disorder" and "autism" are just a few terms that evolved in the last 100 years that have allowed us to notice what had always been present. The Centers for Disease Control now estimates that 1 in 54 American children have this last condition.[33] Similarly, we also know that children usually acquire the impulse for racist actions often from the language of peers or parents, not through their own interactions.[34] The language unfortunately seeds the experience. And more hopefully, we delight when a child acquires a name for an activity and expands her world into it. Indeed, we organize our educational system mostly around the idea of literacy. As Helen Keller noted earlier, reading and writing are justifiably considered the gateways to a richer intellectual life. There's good reason to worry if a child has hearing issues and is not acquiring the kind of expanded vocabulary we expect through each stage of the graded school system.

Consider a final example. Most of us at a gathering may simply see a room full of people. But a person who has spent a life providing mental health diagnoses is probably going to notice more: perhaps the "bi-polar" behavior of the guy in the corner, the clinical "depression" evident in the young woman who went on at

length about her family, and the apparent “paranoia” of the couple who spent the evening talking about their fears. The principle here is crucial: we tend to notice what we can name. We routinely underestimate the auditory roots of most of our perceptions: constructions that only come to life because we have acquired the perceptual equipment to understand.

Negotiating Meaning and Living with Ambiguity

In theory, the acquisition of language looks so straightforward. Once we have acquired a sufficient working vocabulary, we expect that we can pass unambiguous meanings on to others. After all, most words have been around for a while, enough to be catalogued in dictionaries. We act on the assumption that language is a kind of community property. While we may struggle to learn how to share thoughts with others, an individual may still have confidence that certain terms and ideas will register in predictable ways.

But it is not so easy. The initial oralism that turned a child into a language user is a necessary condition for fluency, but it is not sufficient. Shared meaning as a requisite for clear understanding is harder to achieve than we imagine. It turns out that we aren’t very good at transferring even simple information or individual preferences to others. It’s one thing to label a certain toy a “car.” But simple nouns quickly give way to unexpected complexity. Consider a simple case. A *Huffington Post* reporter noted that a Spanish language version of President Barack Obama’s 2015 State of the Union Address missed a lot. In one case, where Obama used the phrase “I couldn’t be prouder of them” to refer to Americans fighting Ebola in Africa, the Spanish translation was “I couldn’t feel masses proud of it.”[35] The bungled

translation was a simple mistake, but anyone converting one language to another knows that perfect equivalency is illusive. All communication is translation. Even when words appear to retain their meanings, there is always an interpretive function which requires that they pass through the filter of our experiences.

This doesn't mean that we are always in a solipsistic fog. Some statements are relatively obvious and can produce a quick consensus. "Turn right" is not a vague command, but it can be ambiguous if the sender and receiver are facing each other. Similarly, statements like "He failed algebra in high school" or "She dislikes liver and onions" are mostly concrete and stipulative: two features shared with most kinds of mathematical statements. In math, common agreement about basic terms leaves little room for confusion. Yet, even moving to the slightly more complex task of naming simple objects can be problematic, as when one person's idea of a "camera" is one that uses film, and another's is the digital device in their phone.

The uniformity of meaning is somewhat different in youth culture. Teens and young adults are attracted to music and speech that signals their separation from older people or institutions. Broadly speaking, teen language is often driven by wordplay that intentionally distorts standard usage patterns, frequently building alternate lexicons—often within music—that herald alternate identities or different narratives.[36] Most youth lexicons come alive in how they sound. They are mostly heard on the street or in recordings rather than frozen on the page.

This challenge of tracking shifting meanings can be scaled up to assessments of the value of complex cultural products like speeches, songs or movies. At these levels, the hope for uniformity of understanding pretty much goes out the window. For example, ask an adult what songs are on their music player, and you will get a list of favorites that are likely to be more personal

than communal. Finding widespread agreement on the significance of films is even harder. What means so much to one enthusiast is often unlistenable to another. Even as we rhapsodize about a performance, watching another's face curl up in growing bafflement can make the idea of "shared meaning" seem like an unachievable aspiration. This is where the quest to master the heights of communication can require patience and perseverance. It's a challenge that will last a lifetime.

There are at least two villains at work here. One is the basic energy required for accurate listening. The second is the tricky business of producing concurrent meaning.[37]

Accurate and thoughtful listening is demanding. A child generally listens haphazardly. Sound is a stimulus. But sound coded as language requires a cultivated capacity for attention. The body levels an energy surcharge for being intensely engaged with the feelings and ideas of others. This is a prime form of mental work, a kind of exertion many of the young or old are reluctant to undertake. And yet it is a necessary part of the communication terrain, and frequently taught especially to bilingual children in the earliest grades.[38] Anyone learning a second language must become an attentive listener.

Listening also suffers from doing a variety of actions that can be performed without becoming cognitively engaged. Everyone engaged in repetitive and boring tasks knows that the kind of active listening required of a doctor or teacher requires a high degree of mental focus. Hearing others well enough to successfully deal with their problems must begin when a child crosses the threshold from the simple expression of personal needs to the kind of conscious absorption of ideas evident in a substantive conversation.[39]

There is also an additional reason for why an exchange with another can easily reach an impasse. We often say that the other

has “misunderstood” us. But building a life on the uses and understandings of a language should also include coming to terms with what a child senses all too well: ambiguity is built into the system. The same word or a similar word mistaken for its twin can mean many things. Stipulating meanings, as happens in mathematics and computer codes, does not solve the problem of “negotiating meaning.” In the recent past, the promise of mathematical precision was the model solution to solve the problem of frequent conversational impasses. At least that was the hope of some linguists and semanticists.[40] But while we can wring the ambiguity out of most calculations, ordinary language allows no such escape. Maturing fluency requires coming to terms and sometimes celebrating the designs and accidents that produce ambiguity. We know this only too well when apparent certainties give way to the vicissitudes of real life. “I think she is coming,” “It’s not too spicy,” and “The computer glitch is fixed” are all statements from a very deep well of expressions that should come with a permanent asterisk signaling uncertainty. What we hear and what has been affirmed may not be the same thing.

And yet, slippery meanings have many functions. A certain vagueness can trigger new insights. Breakthroughs in thinking sometimes happen by accident, or the near-accidents triggered using analogies, metaphors, and on-the-fly comparisons. These sideways glances into a problem can yield surprising new understandings.

The history of the sciences is full of cases of insights made by letting meaning and comparisons drift far beyond the literal. Astrobiologist Caleb A. Scharf notes that

> The simple truth is that scientists themselves constantly make use of analogies, metaphorical devices, and similes. Sometimes it’s the only way to build an intuition for a problem, by relating it to something else. Richard

> Feynman was perhaps one of the greatest players of this game, turning spinning plates into cutting-edge quantum physics and Nobel prizes.[41]

Notably, all of these rhetorical forms are significantly ambiguous. Children learn this function of language early. If they don't yet know that ambiguity is the engine of new insights, they love wordplay that lets different ideas bump up against each other. Teddy bears who aren't hungry because they are "stuffed" or smart fish who live in "schools," or the very idea of "jumbo shrimp" will often delight children with their verbal slipperiness.

The poet John Keats said he admired Shakespeare for his "negative capability," meaning that The Bard was "capable of being in uncertainties, mysteries, doubts without any irritable reaching after fact and reason."[42] Even an undisputed master of the language did not want to force it into one-to-one linkages with its referents. Ambiguity preserves options. We depend on a certain degree of verbal skill to protect ourselves and allow for generous reinterpretation. The calculated spaciousness of a statement can gives us room to adjust to what a situation requires. It is an old joke that a politician's favorite color is plaid. But we often exercise the same kind of linguistic sleight of hand as a kind of accommodation with others.

There is even pleasure in the malapropisms that spring to mind when one's mind gets a little ahead of their vocabulary. A friend recently emailed a couple who had sold a property they owned in Florida after many attempts, noting that they must be glad to finally "be rid of their condom." I'm sure they figured out what she meant. If all else fails, blame the autocorrect function on the computer. I similarly recall an errant explanation to students describing the risks to American troops stationed in Afghanistan and Iraq. I noted that soldiers were constant targets for "exploding IUDs." These examples are potholes on the road to fluency.

Notice a final feature of verbal ambiguity. As its own kind of unstructured meaning, ambiguity is like a bridge halfway between the verbal and the musical. Music easily carries the possibilities of multiple meanings. As we note in later chapters, music is expression without stipulation. It can be partly understood in terms of the mathematics of tonality. But its open-ended and expressive range also puts it in a very different category far removed from more discursive forms of communication. It offers a panorama of welcome ambiguities. What did Dmitri Shostakovich mean by the crude and blunt marches embedded in the First Movement of his Fifth Symphony? Just a modernist impulse? A taunt to authorities who wanted a more "Soviet" style from him? A garish state of his own bouts of despair? Who knows? Or try to identify the emotional thread in *A Chorus Line'*s big anthem, "What I Did for Love." Is the Hamlisch/Kleban song a simple expression of commitment to the precarious life of a Broadway dancer? A "no regrets" act of defiance over a committed relationship that failed? Or a defiant affirmation of same-sex love when it carried a heavier social stigma? We hear what we need to hear.

Advocacy and Language in Change Agents

We began this chapter considering the moments that produce a new individual and the voice they have acquired. It is a magical process. Language acquisition is the core act of creating an identity that will be constructed and refined over a lifetime. As we have noted, it is first fashioned in the vacuum of self-reference. But with time it is also represented to others in the unique signature of our personal rhetoric. Mastery over the self begins to yield to interest in mastery of a subject, and command

of language to be a useful advocate for a cause. Influence over a community is perhaps the final reward for the lifelong quest to be heard.

Thought leaders in ancient Greece were among the first in the west to equate social progress to the power of eloquence. Plato's wide-ranging *Phaedrus* and Aristotle's *Rhetoric* are but two examples of a powerful teacher and his student working out the ethical boundaries for exerting rhetorical power.[43] The tradition continues with our own modern institutions—universities, shared governance models, organizations intent on reform—that prepare individuals to be change agents in the larger world. It would be too facile to argue that all human progress stems from traditional verbal fluency. The literary critic George Steiner was one of many thinkers to concede that complex innovations sometimes require the understanding of new and mostly technical languages.[44] But it is clearly the case that human histories focused on social justice and individual freedom are honored with the hope that they will bend the line of human progress forward.[45] This has been the United States' most hopeful legacy.[46] We mark the American revolution, for example, more in the words of the nation's founders than in the varied military skirmishes within the colonies. Less than 4500 are estimated to have died in the fifteen-year struggle for American freedom.[47] But the revolution lives on as a benchmark in the idea of self-governance and its natural corollary of broad public engagement.[48] As Robert Bellah and his colleagues wrote in *Habits of the Heart*, it "is a peculiarly American notion of the relation between self and society" to be engaged with others in a community. "Individuals are expected to get involved—to choose for themselves to join social groups."[49] While there are plenty of counterarguments that the broad middle of American life was not holding well even before the disruptive Trump interregnum,[50] the promise of a citizenry able to shape its

collective future remains. This exceptionalist view of the American enterprise is still written in hopeful terms in editorial pages and online opinion pieces in our national media.

We can also pick realms of cultural upheaval and progress in terms of the change agents who led the way forward. For example, American slavery had its opponents in a host of pre-civil war advocates in Frederick Douglas, William Lloyd Garrison, Harriet Beecher Stowe, Harriet Tubman, Sojourner Truth, among many others. Women's rights advocates similarly span hundreds of years: from Susan B. Anthony to Betty Friedan, to thousands of advocates in virtually every corner of American life. Charlotte Perkins Gilman, for example, combined an early respect for the power of a woman's voice with a deep distrust of the Gilded Age consumerism that ignited in the 1920s. Her utopian novels idealized women's values and gender equality.[51]

American progress can be understood as an extended cultural conversation on the fate and future of citizens living within its borders. Most of its moments of change are reflected in the names of their movements: Black Power, Black Lives Matter, LGBTQ civil rights, the farm worker movement, immigrant rights, the "Me Too" movement, Occupy Wall Street, and scores of causes concerned with conservation, climate change, indigenous rights, animal rights, slavery reparations, the proliferation of guns and educational reform. It is easy to see these labels as markers of cultural flashpoints. But they can also be understood as the products of a culture that has a relentless interest in change through advocacy.

This view of the uses of language in the culture offers a clear preference for individuals who place themselves in experiences that are more immediate than simulated, more first-hand than second-hand. In specific terms, it means a life spent less in the insulating bubbles of social media or commercial entertainment,

and more energy with seekers and stakeholders in a college, town, church, or civic group.[52]

From the very first words spoken at the beginning of life, language is never done with us. Our words confirm our membership within a unique species; they also have the potential to make us influential with additional members in it. Acquired by hearing the speech of others early in life, the tools of communication open wide to include the possibilities of social progress.

Chapter 4 Notes

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PART II

Natural, Organized and Disorganized Sound

Chapter 5

FUNCTIONAL AMBIANCE AND THE CLUTTER OF NOISE

> And amidst the clashing noise and din
> Of the ever beating loom,
> Stood a fair young girl with throbbing brow,
> Working her way to the tomb.[1]
>
> —Unknown New England loom worker

An item published by United Press International in 2012 under the heading of “Odd News” described a Tennessee man charged with assaulting a woman with his leaf blower. She complained that the man pointed the running blower at her “in an offensive and provocative manner,” throwing grass clippings in her face and on her car.[2] Presumably she recovered, but probably could have complained about a triple assault. The clippings were perhaps bad enough, as are the fumes common to dirty two-cycle engines. Officials in California estimate that the contamination from one top-selling leaf blower running for just one hour matches

the emissions from driving a 2016 Toyota Camry for 1,100 miles.[3] But we especially want to notice that anyone who lives or works in a leafy environment is familiar with the auditory battering that leaf blowers inflict. The sound of most that are gas-powered averages around 90 dB, which can cause permanent hearing damage over as little as two hours.[4] And blowers spew fragments of mechanical noise within the same range of the human voice, roughly 150 to 500 Hz. They make communication with others nearly impossible. Used on grassy areas around homes, offices and schools, they represent what has become an extended season of air and noise pollution. It's little wonder that more cities are imposing controls against the use of these devices that promise spotless grass carpets.[5]

The racket of a leaf blower is a good representation of what "noise" most commonly represents—a sonic intrusion that is unpleasant to hear, a distracting nuisance, or a kind of sensory roadblock that robs us of comfort in a space. Perhaps nothing in the history of human communities is as annoying as blasts of extraneous sound forced on to others. Any list of modern offenders is arbitrary, but also familiar. The two hair dryers in my family run at 80 and 94 dB. The first was advertised as "quiet;" the second, when held a few inches from a person's ear, is dangerously loud. And then there is a long list that suggests how unsettling the aural space we inhabit can be: snow blowers, tree cutters, aircraft overhead, heaters, refrigerators, microwave ovens, copying machines, food mixers, clothes and dish washers, lawn mowers, radios and televisions running all day, auto and motorcycle mufflers "tuned" to be loud, car alarms, emergency vehicles, nearby construction, exhaust fans, truck "engine braking," cooling fans, video games, noisy restaurant patrons, live concerts and sports, elevator machinery, subway and train traffic, the impossible-to-block energy from a boom box, portable

generators, barking dogs, cooling systems, power tools and vacuums. Our ordinary vacuum creates a deafening 94 dB at 6 feet, requiring ear protection.

To be sure, various degrees of ambient and more intrusive sound are accepted as the price to be paid for alerts we feel we need to hear. Newer refrigerators now buzz a warning if someone spends too long in front of open doors grazing for something inside. Sirens have long been accepted as necessary on emergency vehicles. Almost as loud are fire, smoke, and carbon monoxide alarms in buildings. The latter form of alarm is indeed important since it signals the presence of a deadly gas that the body cannot otherwise detect. But while we can shut our eyes or look away, we can't turn off our hearing. The accumulation of necessary and often unnecessary auditory commotion simply piles up. As one researcher put it, "if we could see the sound we generate it would look like litter."[6] It's the garbage of life we are immersed in but sometimes fail to notice.

One goal of this chapter is to look at noise as a both a health risk and a degrading form of human experience. Few Americans take active steps to limit their exposure to auditory intrusions. An additional goal is the more pleasant task of looking at quieter and more common sounds around us that generally pose no risks, representing sonic refuges that anchor us to environments in productive ways.

Levels of Unwelcome Sound Intrusion

Setting aside the unfortunate few with musical anhedonia—the dislike of all music—the sections that follow define noise in at least three ways, each representing an escalation from comfortable to increasingly unpleasant. The first level includes

the sonic microenvironment that we have grown used to and can easily accept. Most hotel guests tolerate the sounds of a ventilation fan which have the incidental function of masking noise from the hallway or next door. Others prefer the looped sounds of a waterfall from a sound machine. Recurring ambient noise is a reminder that our world is functioning as expected. In our rural home I listen for the muted hum of a water pump that comes on when it periodically recharges our domestic water supply. If the hum doesn't stop within a minute, I go into action looking for a water leak. When it does stop, all seems—pardon the pun—well. If it is possible to imagine, the pump's auditory signature is reassuring. A second order of sound calls attention to itself, either because it represents a warning or sound that is more annoying than loud. One often quoted study cites a Newcastle University survey that included what their subjects classified as "unpleasant" to hear, for example: a fork on a glass, fingernails on a blackboard, or a disk grinder.[7] Individuals can easily generate their own lists of irritants that tend to derail their concentration. Apartment dwellers are especially likely to have long lists, often with construction work and a neighbor's video and audio equipment near the top.[8] In a different realm, the leading nuisance for a performer in a theater or concert hall is a cell phone that was never properly silenced. Some performers suffer in silence. Others have gleefully shamed the offender by grabbing the phone or stopping the performance.[9]

A third level of noise is that which is destructive to the organs of hearing, potentially inflicting permanent damage on the tiny and delicate hair cells in the organ of Corti embedded in the inner ear's cochlea. This category is made worse by the fact that Americans are generally lax in acting on noise that is unsafe. We often accept the aural assaults, failing as even elemental stewards of our own hearing. Construction workers without ear

protection are easy to find everywhere, and the problem extends to other trades. It seems to be a sign of masculine toughness to accept environmental forces that will eventually lead to significant hearing loss.

Occasionally aural chaos will come to us faster than we can respond. City pedestrians cannot always predict the passing of an emergency responder or a nearby motorcycle modified to demand notice. Or a source of an auditory onslaught can be accidental. I recently passed by a commercial power mower near a sidewalk I was traversing. Just as I moved within a few feet of the mower's huge blade, it slammed into a metal pole at full speed that had been hidden in the grass. The metal-on-metal encounter stopped the machine in an instant, apparently only a minor problem for the operator. But it left me reeling with the sledgehammer shock wave it produced.

Each of these levels of sound intrusion, need a closer look. Embedded in each are some simple annoyances as well as surprising life savers.

Non-Invasive Ambient Sound

Ambient sound is the aural backdrop that is present when we are usually in the midst of focusing on other things. It is only a subdued din coming from the nearby world that we usually accept as normal and even pleasant. It is the birds heard in the distance rather than the conversation that consumes your attention. It is the sound of a stream that you may be hiking past. It is also the distant freeway traffic heard in a neighborhood, or the heater fan that may be running when the family is watching television. We mean it here as generally lower frequency sound that may impinge on primary sources, but not drown them out.

Other kinds of ambient sound signals have aesthetic or practical functions. The chimes in London's "Big Ben" at the north end of the Palace of Westminster are known around the world and even written into the music of composers who have lived in or visited the capital.[10] Workers in central London report that something is missing when the giant clock is out of service for repairs or restoration. Several additional examples indicate the importance of aural cues we might otherwise not think about. The players of various winter sports depend on hearing how their equipment sounds on the ice and snow to make necessary adjustments. Worn skate blades that have lost their edge have their own aural signatures.[11] And even relatively quiet ambient noise can create problems. Audio engineers doing film work are alert to extraneous noise that ruins the illusions they are trying to create. Airplanes overhead have spoiled the on-location audio of many exterior shots. And there is the case of one sound designer who fretted over floors in studio sets for the *Star Trek* film series. Their surfaces were space-age smooth, but concealed an underlayment of thin plywood. Not surprisingly, they audibly creaked when Captain Kirk and other masters of the galaxy walked on them, ruining the location sound.[12] The sleek Enterprise moving through hyperspace is apparently not supposed to make the sounds of a weather-beaten front porch.

If some ambient noise can be a nuisance, its opposite of complete silence is usually not a realistic goal. As a rule, we need a degree of ambient sound to feel comfortable in most environments. As tool users and makers, we are a noisy species. We equate sound with activity, and activity with productivity. To try to get at what undoing this chain would be like, acoustician Trevor Cox traveled to the Kelso Dunes in the Mojave National Preserve in South Central California. It's a hot and barren landscape of sand and limited vegetation. He found virtually no

planes overhead and almost no noise, especially at dusk. He recalls nearby coyotes that “howled like ghostly babies:” something less than the nirvana some might imagine.[13] He missed some of the sonic anchors of everyday life.

The same could be said for the sudden stillness that came over the nation by the afternoon of September 11, 2001. The devastating capture of airliners that were then used as weapons against Americans and foreign residents in New York City, Washington D.C. and Pennsylvania forced the grounding of all 4000 commercial aircraft that were in American airspace at the time (a number that has more than doubled in recent years). That awful day turned uncharacteristically quiet. Freed from the air traffic that normally hums overhead near most large cities, it was as if a machine never known to fail suddenly stopped working. For many inhabitants in the west living near large cities, air traffic is frequently the most pervasive and often loudest source of sound.[14] Normally the absence of the planes that had been grounded would have offered a kind of respite. But sound is always connected to the fabric of whatever else is going on in the culture. And on this day the stillness understandably added to feelings of fear and isolation.

Sound writer David Owen prefers the nighttime songs of “spring peepers,” small frogs common to wet areas in the eastern states. At dusk and into evening they offer a virtual symphony of chirps.[15] For many, crickets and peepers may make sleeping easier. Based on all the internet chatter, it appears as if a lot of Americans also sleep with a radio on. The sedative effects of a space with a soothing sound represents a ready market for makers of “sleep machines” that mask or flatten background noise that might disrupt what is now the common problem of interrupted rest. All of the machines include the option of “white noise,” which is a steady but subdued “woosh” of middle range

frequencies, creating what resembles the aural signature of an air-handling system in a modern office.

Interestingly, if we are watching a film that features a scene with someone going to bed and turning out the lights, we expect a quick cut to the next scene. If the camera dwells on the stillness with no musical or ambient cues of normality, we will begin to worry for the character. A sound sensitive director knows that no sound in a scene also devoid of most light will make an audience anticipate that something is about to go wrong.

Ambient sound is part of what we expect in any new space. We listen for aural evidence of human activity. It is our nature to welcome connection as much or more than privacy. Almost any aural evidence of human industriousness is its own kind of reassurance. A silent space is likely to leave us with the visual equivalent of entering a dense fog. In fact, the construction of artificial ambiance that seems 'natural' has become an important part of the performing arts, and a topic we will take up in a later chapter. It's enough to note here that film composers and Foley artists who add incidental sound to films are extremely busy. Composers also write short "cues" that toy with our expectations of aural reassurance. For example, there is the famous anticipatory effect created by composer John Williams for the film *Jaws*. The alternating low notes of E and F in the first part of his shark motif have become a kind of national auditory shrine. Throbbing basses creating sound like an accelerating heart rate are a familiar trope in film music.

In a different vein, ambient and sometimes untuned sound can even give music a spark of spontaneity that can play off the more formal abstractness of a song. In Joni Mitchell's popular "Night Ride Home" (1991) we can hear the chirps of an uncredited but rhythmical cricket contributing to the song's depiction of a perfect summer evening. In a similar way the first

introductory chords of a familiar song can establish a sense of occasion by producing an appreciative roar of affirmation from a crowd, as happened in London as keyboardist Roy Bittan began his signature synthesizer introduction ahead of the first lines of Bruce Springsteen's familiar anthem, "I'm on Fire" (2009).[16]

Creating quieter environmental sound is now its own specialty. Stéphane Pigeon, a research engineer & sound designer, runs a website filled with ambient sounds. He offers samples of perhaps eighty different mechanical, environmental and musical sources of background material: a Japanese garden, a café, gentle waves breaking on a beach, a forest, riverbank and rain on a tin roof among them.[17]

Language is its own elaborate and natural signaling system. Perhaps no other animal can top humans as a chattering species. In addition to our speech which communicates feelings and ideas, we signal to others a great deal: through applause, catcalls, laughter, shouts, referee whistles, collective roars and—of course—silence in the place of an expected comment.

The Importance of Incidental Auditory Cues

Sound can provide an important signaling function that helps keep us safe: what we've described as a kind of second level. When blindfolded we are usually able to locate the environment—if not the precise location—we have been transported to. Cities, forests, small indoor rooms, large indoor spaces, lakesides and seasides all have auditory signatures. Our binaural hearing takes this skill one step further by making it possible to sense our location in three-dimensional space. A hiker walking along the edge of a curving road will usually sense an oncoming car that is still unseen. This is something I do nearly every day, with a route

that includes a narrow lane with two bends. A rock wall comes down to the road on one edge. The other edge has a width of space that borders a creek. Cars that are out of sight can be heard ahead of the two blind curves, sometimes requiring the need a step off the road on the creek side even before they can be seen. In similar ways an inside structure usually will provide a small aural cue that tells them that someone is walking on another floor or even standing on the other side of a closed door. These simple and anodyne cases are reminders of the forms of aural vigilance we take for granted.

Under certain circumstances, we even mandate a degree of noise. For example, European and American regulators have required that electric cars be loud enough to warn pedestrians and others of their approach. BMW has even hired Hollywood film composer Hans Zimmer to create a suitable sonic signature for its expensive all-electric cars, presumably something less than an amplified exhaust; he promises a sound that is “less chaotic and more beautiful.”[18] These cars join a range of other equipment on the streets that use audibility to signal their presence, even though street noise ranks high on the list of objectionable city noises.[19]

Or consider an example where a barely audible cue tamed some youthful but dangerous hubris. The author remembers an adolescence often spent in nearby mountains, on one occasion exploring an abandoned silver mine from the 1860s with his brother and sister. Back then, the hillsides on the eastern slopes of the Rockies were still filled with open tunnels, their dark recesses held in place by aging timbers. Something beyond the narrow sunlit entrance of one mine above Georgetown, Colorado was a magnet for heedless exploration. The void ahead sent auditory cues suggesting a larger space deeper into the darkness. Colorado silver mines could be unpredictable:

abandoned after just a few feet or tapped out only after long tunnels had been dug deep into a mountain. At the entrance we were feeling cooler air from an internal cavity that seemed much larger than the narrow space of the entryway. Before we moved inside my smarter brother picked up a heavy stone and threw it forward into the dark as far as he could. Then we waited for a sound to return. It eventually came as a muffled clatter fading as it descended to the bottom of a long *vertical* shaft. Our ears had performed their function of signaling a danger we could not see, and we retreated in a flash.

And then there is the new twist in a long baseball saga of trying to figure out the pitching signs of an opposing team. The Houston Astros were heavily fined in 2019 and their leadership fired for using elaborate auditory cues to relay what a center field television camera revealed about the catcher's hand signals to the pitcher. The hand gesture is meant to be a secret way to call for certain types of pitches. The Astros studied tapes of the hand signs while a game was in progress, decoding some of the cues. Then a team member whistled out a kind of Morse code to their batter. In other cases they used another bat to pound out a code on a dugout waste receptacle: "no bang on the trash can: a fast ball; bang on the trashcan: some sort of off speed pitch."[20] This daisy chain of signals was camouflaged by the ruckus of the stadium's crowd but audible to a batter listening for cues. The ruse eventually resulted in widespread condemnation of the team, and at least an unofficial asterisk added next to the team's record by people who track such things.

Industrial Noise

Pre-industrial space in the United States and elsewhere must have been altogether more tranquil before the wide use of

mechanical power and steam engines in the early part of the nineteenth century. We can surely over-romanticize the quiet of a farm or village: for example, the stillness of a tree-lined wheat field with only the faint murmur of a distant horse-pulled reaper at the far end. Helped by that century's landscape painters like George Inness, we imagine these scenes as tranquil and free of noise. And they often were. But we have also mostly forgotten the activities of voracious wood cutters, quarrymen splitting stone and loading it on to wagons, the clatter of horse hooves and metal-rimed wheels on cobblestone pavement, or blacksmithing and iron fabrication that kept nearby farms functional.

The iron horse began to cut through villages and fields as early as the 1830s. It's noise was one of the first products produced in abundance during the industrial revolution, joined by the chatter of New England textile looms, the grain mills of the upper midwest, the roaring iron furnaces in various pockets of the northeast, and mechanized cotton mills across the south. Eventually industrial activity droned with machine noise that bled into the corners of small towns as well as big cities. My own small village in Western New Jersey now only produces crops of tourists amidst second-growth forests bordering the Delaware River. But two and even three centuries ago the town of perhaps one thousand was the site of large stone quarries, wagon wheel makers, and at least one foundry making heavy iron stoves.[21]

Then, the idea of "noise abatement" was little more than a theory fussed over by German industrialists or Marxist writers.[22] Even so, in the mid- to late 1800s cultural observers like Charles Dickens, Thomas Carlyle and Marcel Proust worried about nervous breakdowns caused by noisy cities: "neurasthenia," they called it. Proust went to the trouble of building a fully cork-lined room to escape the din of Boulevard Haussmann outside his

Paris apartment.[23] More recently, Brooklyn resident George Prochnik revisited the same problem.

> If we acquired our extraordinary auditory sensitivity—a sensitivity so pronounced that it can detect energy levels one hundred times lower than the energy emitted by a solitary photon in the green wavelength—because the world was striving to be as quiet as possible, what happens now when almost every day we're exposed to sounds that treat our eardrums like bass drums? Is it possible that the sublime sensitivity of human hearing has become just a point of vulnerability?[24]

If urban residents ranging from Proust and Prochnik have been driven to distraction by the activities of their neighbors, even as late as the 1960s there was little will to seriously control industrial noise. In the United States the Occupational Safety and Health Act of 1970 was the first significant step in setting standards for the workplace, a fact that slowly fueled interest from unions and workers.[25] The Occupational and Safety and Health Administration (OSHA) was set up under the United States Department of Labor, publishing standards observed and sometimes ignored at many workplaces. Prior to 1970 the author worked for a summer in a steel galvanizing plant in California, where the importance of eyewear was mentioned by the company. OSHA standards would come soon. In the meantime, a deep vat of 700-degree molten zinc "exploded" every time a large but cool piece of metal was dipped in it. At those moments we would hide behind metal shields to keep the liquid metal off our skin. Even so, no one thought about ear protection. That has since changed for most American factory workers, but not for many who work outside the gates of a manufacturing plant.

Consider a modern and very different example that exerts itself far from the industrial site. For several years residents of

suburbs in parts of the Southwest have complained about low-frequency sounds that never cease. Most seem to be hearing a low-level drone—a kind of pervasive hum—coming from huge collections of cooling equipment built at “server farms” nearby. These warehouse-sized buildings hold data for large internet providers and their millions of users. In spite of its name, “cloud” computing is firmly on the ground in these facilities holding up to 80,000 servers.[26] Each individual unit is about the size of a PC and generates heat that must be removed from the building all day, every day. The large motors for the air handling systems that cool these large warehouse spaces hum and create what engineers call “infrasound,” very low frequencies that can be felt as well as heard. The noise is pervasive because these units are generally outside of the vast rooms holding the servers.[27]

Scores of industries around the world generate noise thresholds within their facilities that exceed a loud 85 dB, with levels that can go significantly higher. This is clearly third-level noise that is a threat to any hearer. These industries include manufacturing of food, textiles, wood products, paper, furniture, chemicals, metal products and machinery.[28] One early estimate from the Environmental Protection Agency in the United States indicated that about 30 million workers were regularly exposed to occupational noise above the 85 dB mark.[29] Some industries are proactive in guarding the hearing of their employees, frequently with mandated hearing protection. Automation also helps by putting the workers that remain on the job further away from noise sources. For example, steel and automobile fabrication can now often be done by robots, keeping workers that remain at least partly isolated from the roar of the factory floor.[30]

But problems remain. Aircraft engine noise is deafening and pervasive in the United States. The 140 dB registered near some jet engines not only seeps into planes and structures at airports,

but into the ears of ground workers and neighborhoods nearby. Portions of larger American cities are also located under the final approaches of heavily used runways.[31] Other industries such as construction have the same problem in less exotic ways. At large work sites OSHA standards may be observed. But individual contractors often follow more ad hoc practices. In early 2020, in a pattern that is all-too common, workers breaking up concrete near the author's office routinely used jackhammers without wearing any ear protection.

Samples of Sonic Stress

Exhibit A for sound at the third level we identified at the beginning of this chapter may be a New York City subway car. It's not surprising that it runs under one of the densest urban areas in the United States, the midtown blocks in Manhattan that run south from the bottom of Central Park at 59th Street down to 34th Street.[32] If the surface noise in this part of the city is loud, it's even more of a heavy metal festival underneath. Indeed, the subway is a certifiable health risk throughout the system of 472 stations spread throughout four of the five boroughs of New York City.

To its credit and prior to the 2020 pandemic, it was carrying 5.6 million riders daily—an astounding feat. But at certain points a single train can generate an ear-splitting 92 to 102 dB as it pulls into an individual underground station.[33] Nearly everything about the design of the 75-foot cars and their stations is certain to subject those waiting on platforms to sound levels that could only be equaled on the tarmac at any of the city's airports. The car itself is a complex system with parts designed to roll or scrape with other parts: wheels on tracks, abrasive brake pads made to

rub against hardened wheel surfaces, chains and couplers that have enough “play” to push and pull against each other, traction and compressor motors attached to the steel frames of the cars, and metal “shoes” that drag along the “third rail” that provides power to a train. All of these contribute noise that frequently visits narrow platforms finished with concrete floors and glazed wall tiles that reflect noise back on to waiting passengers. Rubber tires and wooden brake shoes are only some of the innovations that make the subways of other cities less of an auditory assault.[34] But New York stoics seem hardened against the daily clamor, even while the faces of visitors indicate surprise at what local residents will tolerate. According to the director of subway safety of the local Transport Workers Union, many employees retire from the system “legally deaf."[35]

On the noise spectrum there is no doubt where New York City’s antiquated system belongs. Harder to explain are motor vehicles explicitly designed to create air and noise pollution. Most drivers have encountered other drivers who have decided their personal form of self-expression will be to drive a modified vehicle that is dangerously loud. These groups sometimes meet up in wet rural bogs or swamps around the country for “mud rallies,” or simply gather in an industrial area in a city to test out the noises they can make with altered mufflers or mufflers removed. In New York City these mostly younger drivers connect through social media to meet up in the Bronx or Queens, creating sound well above what the city ostensibly allows. The point seems to be to create a car engine that is “throaty” and noticeable as possible.[36]

Those within earshot of these modified cars, trucks and motorcycles are only slightly better off than people standing near various, recreational, military or police weapons systems. Guns in particular effect a variety of Americans, ranging from military service personnel to hunters. No one knows for sure, but some

hearing experts believe that about 80 percent of all hunters have some deafness related to their gun use.[37] Although there is better awareness in military and law enforcement that guns cause hearing damage, the risks continue because ear protection is more variable. Almost all firearms create a sonic shock of 140 dB or greater. At that astoundingly high level on what we can't forget is a logarithmic scale it may take only a single shot to create permanent hearing loss. The size of a gun and its caliber hardly makes much difference. A small Glock 22 handgun is only slightly quieter than a much larger 12-gauge shotgun.[38]

At least since the American revolutionary war, soldiers returning from combat have been subjected to the same high impulse sounds, sometimes for hours or even days at a time. Personal firearms, traditional naval and army canons, rocket launchers, grenades, land mines and improvised explosive devices destroy hearing just as predictably as when they rip through human flesh. Indeed, the percentages of hearing loss may be higher than in various industries where government data suggests the worst outcomes: mining and petroleum extraction (27%), construction (23%), and manufacturing (20%).[39]

Music Contrasted with Noise

We have mentioned fragments of what might be considered noise that were also functional parts of the performances of singers Bruce Springsteen and Joni Mitchell. But where is the line that separates music from noise? Even though we certainly know it when we hear it, is there a reliable indicator of the difference between the two? One key point of separation is that noise is usually *sonically incoherent*, meaning that it does not produce a single smooth wave form from one or a group of tones. Again, we

can hear this. But we can also demonstrate it by doing something as simple as plucking a guitar string and then noticing how its vibration is a smooth oscillation at a certain frequency. The vibration is visible because it is regular. A microphone attached to an oscilloscope or spectrometer will display the same more or less stable “standing wave.” Represented visually, music shows predictable peaks and valleys indicating complementary frequencies. It is nearly always made of sounds from tuned instruments producing evenly spaced and smooth wave forms, as we would hear at, say, 260 Hz, which is middle C on a piano. By contrast noise produces irregular and ragged waveforms.

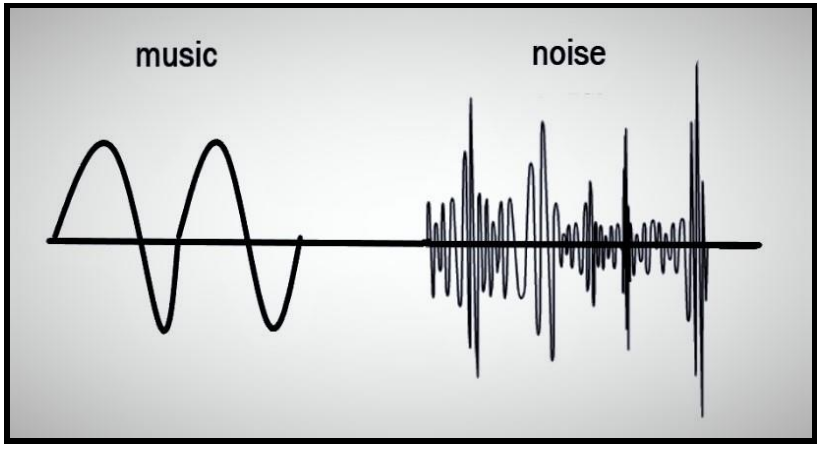

Figure 5.1
A coherent sound wave and a noise sample.

Musical intervals for more complex music are built from notes “stacked” in thirds, fifths, and so on. For example, keys representing C, E and G on a piano sound “right” and ordinary. We can imagine any number of songs starting with this root C and its triad chord. Played together, they represent the generally pleasing sounds we expect. They have coherence. The visual representation of a chord would show a more complex wave, but

it would be constant and audibly coherent within the 12-note musical system. By contrast, noise usually produces sound prints on a scope that are jagged rather than smooth. There may be a pitch or “keynote sound” embedded within the noise coming from a vacuum cleaner, an automobile, or nearly any other device. But when sound is incidental to the functions of a piece of equipment, we think of it as characteristically producing noise. What we hear is a byproduct of the mechanical or electrical energy that is required to complete a task.

For most of us, noise is just a nuisance, a backdrop of aural wallpaper that exists against the foreground activities of a busy life. But it is worth remembering what the modern auditory soundscape may be doing to the delicate and tiny organs of hearing. A person without significant ear damage can hear a pin bounce against a hard surface, a single drop of water that falls to a sink, or a single leaf pushed by breeze across a sidewalk. I have one grandchild that is sure that our home has a bird in the heating system. We don’t; but we do have a small damper in our system that produces a tiny squeak when it adjusts to air passing through it. His acuity is a reminder that still undamaged ears can discern the faintest eddies of air pressure at the very edges of audibility. A necessity of modern life is to preserve this asset by more aggressively blocking noise and demanding that their sources be subdued.

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Chapter 6

CAPTURING AND STORING SOUND

> *Songs mark a secret calendar. Their structures already save a place for what happens before it happens.*[1]
>
> —Geoffrey O'Brien

An audible flaw in a classic recording reveals the limitations and possibilities of the medium. The year was 1961, and the problem was a relatively simple one: a single snare drum in Mort Lindsay's backing band for Judy Garland was too loud. The drummer's heavy hand came down harshly on the second and fourth beats of a tune she had sung for years. Drums are generally untuned timekeepers in otherwise tuned ensembles. But they still need to blend, especially when accompanying a singer. Yet there would be no easy fix for *Judy at Carnegie Hall*, considered one of the great live recordings of American popular music. Back from bouts of drugs and depression, Garland sang this one performance to Manhattan's elite gathered in the famous auditorium. There was no way to "comp" the song by assembling different takes to create a clean version. Even so, the album topped the *Billboard* charts for an impressive 73 weeks, flaws and all.

Garland had a history with "Zing! Went the Strings of My Heart." As a 16-year-old she sang it in the film *Listen Darling* (1938). A year later she would be on her way to superstardom in *The Wizard of Oz,* made on the MGM lot where she grew up. Frank Baum's story of a young innocent carried on the wind still plays in theaters and on television. Even in 1939 it was clear that Garland had the phrasing and vocal control of a master musician who could find her way to a song's emotional center.

The album is a useful talisman for the problems and opportunities created with recorded sound. An audio engineer who re-mastered an updated version recalls that Capitol Records used a three-track Ampex tape machine, probably fed by five or six microphones: some on the left side of the band, a few for the right, and a microphone that Garland carried as she moved around the stage.[2] In one of the few available photos its clear the drummer is also sitting *in front* of the band. That's a problem because percussion instruments in performance are naturally loud. They are usually tamed by arranging them behind other musicians who act as involuntary but necessary human baffles. Yet, with only three tracks to work with, and with dead thuds embedded on the same piece of tape with the contributions of other band members, there was no way to correct the heavy artillery in the final mix.[3]

Live recording now means more elaborate *multitracking*, where most musicians have separate microphones that can be adjusted to balance their work with others in their group. No change so clearly separates Edison's first recording device from our modern counterparts than the development of synchronous tracks that make it possible to separate nearly every sound source in a recording. It's now common practice to delete or add other players as a performance is built up, sometimes by

"thickening" a piece with more musicians than those who first recorded it.

But we are getting ahead of ourselves. An overview of the evolution of multitrack recording is a key part of the narrative in this chapter. But a related and equally important side story is how recordings entice us to linger over audio artifacts packaged as performances. *Judy at Carnegie Hall* is but one example of a sonic event that still remains fully accessible: an obvious feature of recorded music that encourages at least an elemental form of connoisseurship. Almost everyone curates their own music library or pays a service that will use algorithms to do it for them. With such handy access, it is easy to understand how two hours of imperfect sound captured sixty years ago still can matter to a loyal coterie who keeps the singer's work alive. Among other reasons, the Judy Garland concert became its own marker for many trying to navigate their own cultural place. Most of us use music made by others as proxies for our personal stories. For years members of the gay community have seen Garland's struggles against professional and personal demons as the personification of defiant survival.[4] Captured sound can create that kind of intense feeling. A single song can create a personal arcadia that we happily come back to again and again.

The Reinvention of the Auditory Sense

The advent of recording is the key landmark in the transition to our age of auditory immersion. It was the beginning of what listening as its own rich experience could mean for non-musicians. No single innovation is created by one individual in a cultural vacuum. Several French thinkers and inventors predate Thomas Edison in conceiving of recording as a mechanical

possibility.[5] But it was the Wizard of Menlo Park who put it all together. His device changed everything.

The year was 1877. It marks the moment when the capture of sound was a breathtaking and audacious act of defiance against what seemed like the natural order. At the close of the century Americans were open to the idea that there might be ingenious ways to converse with the dead. Some fantasists were certain that the "ether" of our mostly invisible atmosphere contained the echoes of lost souls that could be heard again.[6] It's doubtful that Edison had any such illusions.[7] But he gave the mystics of his day reasons to believe. Recorded sound was indeed a kind of repudiation of death. The deceased lived on through their words and music: refutations of the idea that legacies die with their makers. The printing press 400 years earlier had made it possible to carry the disembodied thoughts of writers over time and distance. But it was quite another matter to make a record of another's "live" voice. The very breath of a person was now audible. What did immortality mean if it was possible to witness the life force of a figure long gone? Was this new world of recorded sound a part of the promise of the "renewal" of mortals, the chance to "live again" described in the Old Testament?

In a different way the coming of the phonograph was also another kind of Gutenberg moment. The relatively simple mechanics of the phonograph make it easy to miss the cultural shift it set in motion. Sound in the pre-industrial past was a second-tier sense associated with mundane speech or, more than anything else, the noise associated with living in the world's dense cities. But it was now on a trajectory to become an instrument of emotional fulfillment. The rapid growth of relatively inexpensive recording devices meant that performances once lost to their environments could now be replicated, stored and

replayed at will. To be sure, Edison well understood the more utilitarian functions of an audio recording. Dictation was an obvious application. It is less apparent he fully appreciated that his efforts had triggered an untapped source of rapture. What was obscure then is obvious now: we expect sound to be easily accessible, portable, and rendered in near-perfect accuracy. We know it is available when we need it. Edison's cylinder was the first step in making the world fall in love with music they had never heard.

Music is our most satisfying form of mental incitement, even while it defies easy understanding. In William James' apt phrase, it somehow "enters the mind by the back stairs," delivering diverse effects that add up to much more than its notes and structures would suggest.[8] Whatever its form, the new capability wallpapers our lives with sonic documents that the auditory cortex is anxious to hear. Conventional musical invention might be beyond the abilities of most to master. But this part of the brain easily connects us to the organized sound that we relish.

Early Recording

Edison's first recording device was demonstrated during a period in American life when chaotic industrial growth contributed to economic desperation, industrial strikes and social unrest. In the "green country" of Middlesex County, New Jersey his laboratory crew of several dozen took their lead from the dour inventor. Edison worked all the time, leaving employees and his own family to make the most of his limited attention and hair-trigger irritability.[9] The man also had little appetite for food or sleep. All the better to launch his favorite invention, the phonograph, as well as his most consequential: a practical way to produce reliable artificial light.

But the “talking machine” was to come first: an outgrowth of what Edison learned from other early experimenters, especially Alexander Graham Bell’s telephone. The key insight came from the use of a flexible diaphragm in the mouthpiece. It demonstrated how a thin membrane could flex in response to sound pressure. Edison’s contribution was to embed a stylus in its center that could create a physical imprint of sound. It was a crude but consequential transducer, which is any organ or device that converts sound from one form of energy into another: in this case, acoustic energy into the movement of the stylus.

The first device was simplicity itself: a piece of foil wrapped around a heavy can-sized drum that rotated, coming in contact with a needle attached to the diaphragm near the mouthpiece. As the drum rotated at a steady speed, a worm-screw at its center slowly moved it under the stylus at a set horizontal rate. The single continuous spiral of the groove stored sound in hill-and-dale impressions in the foil. In language we still recognize, those etched impressions were “analogues”—physical facsimiles of the captured sound—and could be played back at will. “Mary Had a Little Lamb” was among the first human utterances frozen in their tracks.[10] The device was named a “phonograph,” a melding of two Greek terms meaning “sound writing.”

The French inventor Charles Cros submitted a similar idea to the Académie des Sciences in Paris at about the same time.[11] But Edison’s claim on creating the first functional device is real. It was built and worked as intended, even though it would fall to other innovators to make sound recordings that were inexpensive to manufacture. He called the phonograph his “baby,”[12] perhaps because it’s a nearly perfect example of simple physics applied to a quest that was thousands of years old. The diligent patent-seeker was certain he had found the kind of innovation that would make him financially independent for the rest of his life.

A demonstration of the invention in the New York offices of *Scientific American* had witnesses reaching for superlatives like "wonderful" and "astonishing."

> We have already pointed out the startling possibility of the voices of the dead being reheard through this device. . . . When it becomes possible as it doubtless will, to magnify the sound, the voices of such singers as Parepa and Titiens will not die with them, but will remain as long as the metal in which they may be embodied will last.[13]

The reference to now obscure Victorian singers by these early science writers made clear that they understood where the phonograph was heading.

Figure 6.1
Thomas Edison with an early model of the phonograph.
Library of Congress Prints and Photographs, Brady Collection.

The earliest records were made acoustically, without the use of any electrical assistance. The sound was often scratchy, and the hard wax cylinders were difficult to mass produce. While Edison lost interest for a time and turned to the bigger technical challenges of electric light, he later came back to his favorite invention, working on bigger “Amberola” cylinders and flat “Diamond disc” records with improved sound. The newer discs led to frequent “tone test performances” in front of audiences who were asked to compare live singers with their newly-minted records. The recorded sound was indeed better, but still short of achieving lifelike accuracy.[14]

The heirs to this monumental moment can still be seen in old Edison cylinders sitting around flea markets, or in their more distant cousins of newly pressed vinyl recordings manufactured for modern diehards who find more warmth in analog (versus digital) sound.

The wonder of it all impressed no one more than Edison. Not only was he astounded at how well his invention worked, but it obviously meant something special to extend a sensory capability he had partially lost. From early adulthood he was nearly deaf from either a childhood accident or physical abuse, none of his biographers seem sure. As a result, he would sometimes bite into the edge of a wooden phonograph base to ‘hear’ its music via bone conduction. Music still mattered, though his taste for simple ditties partly explains his strange dismissal of the Russian composer Sergei Rachmaninoff (“He thumps!”) as a potential Diamond Disc artist.[15]

Recording eventually achieved a firm foothold on the American imagination when it was re-imagined early in the new century by a German immigrant, Emile Berliner, working with a Camden, New Jersey machinist, Eldridge Johnson. They combined patents for a new type of flat disc and player that would

eventually spoil Edison's plans to fully monetize his invention. The seven-, ten-, and twelve-inch flat shellac *discs* of what would soon come from the Victor Talking Machine Company could be easily pressed by a single metal "master," making copies like a waffle iron. And where the Edison stylus etched sound undulations along the *bottom* of the groove, Victor discs had a different pattern that placed the physical analogues along the *side*. In a pattern repeated many times, the media products of one company would not play on a competing system.

Edison and Victor still shared similar recording practices that were dictated by an acoustic signal path. A musician or small group would cluster tightly around a large recording horn resembling a tapered stove pipe. What sound there was would be concentrated at the narrow end with a cutting stylus rigidly attached. It converted pressure waves amplified by the horn into corresponding indentations in a single continuous groove. Edison's better sounding "Diamond Discs" were slowly eclipsed by cheaper records of the savvier Victor, making their players initially called "gramophones" less expensive.[16] Victor was also better at producing a wide variety of records for its players, shrewdly licensing other companies in the U.S. and elsewhere to use its patents.

The company's headquarters could not make gramophones and records fast enough. Radio was still a few years in the future. But it was now possible to listen to sounds from performers all over the country who made their way to the Camden studios. Military bands, sentimental waltzes, "comic" monologues, Irish ballads, duets, dance bands, popular opera singers, lamentingly named "coon songs" and speeches by politicians were rushed into stores. All that was happening in vaudeville, musical theater or the flamboyant rhetorical arts was coaxed on to a disc in two-

or four-minute segments. What were once sounds that were mostly exclusive to the public auditorium or theater were beginning to pile up in the homes of families with cash to spare.

Victor also pulled off one of the first great examples of branding the commodity of recorded sound. Edison wisely kept his own signature script on his hardware, but not on the records of his National Phonograph Company. By contrast, Victor's famous trademark dog "Nipper" was everywhere. The small English fox terrier painted by Francis Barraud seemed like the perfect representation of a device that was as accessible as a toy and as far-reaching as a serious vocation. With his head cocked in front of a gramophone horn as he listened to "his masters voice," Nipper's presence on every Victor product made even the strangest bits of music seem to be a piece of the same fabric of connectedness.[17] To seal their dominance, Victor eventually merged in 1929 with the growing giant, the Radio Corporation of America. In current terms, RCA Victor became a vertically integrated company with plenty of audio software to go with its hardware and broadcast interests.[18]

Even before the merger, it would be hard to imagine another turn of the century invention that gave Americans more pleasure. As Evan Eisenberg observed in his book *The Recording Angel,* music had "become a thing,"[19] The most fleeting of sensory data could be owned and played at will. What once faded into nothing was now a playable artifact. [20] It's a cliché to say that pieces of the culture would live on: that a "performance" was not just an event in a theater. It was fast becoming an aural anchor, all the more attractive to be on call at the whim of the individual.

Figure 6.2
Francis Barraud's 1898 painting of "Nipper," that would become the logo of *Victor Records* and, later, *RCA Victor*, Britain's *EMI*, *HMV*, and Japan's *JVC*. *Library of Congress Prints and Photographs Division.*

Captured sound extended what it meant to be alive at the end of the nineteenth century. With the telegraph, the telephone, recordings and the coming radio, a listener could be transported away from the confines of hard times and small towns with visits to the larger creative sea of performers and Tin Pan Alley hustlers.

From Acoustical to Electrical Recording

Before the 1920s, the audio chain from source to record was short and limited by the fragile energy of sound pressure waves. Music passed from a musician to a stovepipe horn using only natural sound vibrations to move the recording stylus.

Predictably, coaxing sufficient volume out of acoustically recorded records was a challenge. Thicker playback needles and larger external horns helped. But the static of surface abrasion got magnified along with everything else. Even loud musicians could sometimes only make noises that suggested apparitions calling from another room.

The problem of the limited dynamics of early records would suddenly change for the better with the advent of microphones and simple amplifiers. Electric reproduction lengthened the signal path but also dramatically improved the quality of recordings. In the newer process, musicians played into the mechanical-to-electrical transducer of a microphone, which converted sound waves into minute voltage variations that could be amplified to power a robust stylus. This recording needle still made impressions on the groove walls of what were by now heat-softened lacquer discs. But the resulting electrical recordings were louder and able to reproduce more of the audible frequency range. Singers and bands no longer had to cluster around a horn. Records were still produced on just one recording track. But the timbre of voices and instruments could be captured with more microphones in larger spaces.

Improved “record players” of the day could easily handle both the older acoustic and newer electrically recorded records. Players advanced by replacing spring-wound motors with electric drives, which provided a constant speed of 78 revolutions per minute (rpm). Some still relied on sophisticated acoustic horns folded into a console cabinet.[21] But after 1925 newer loudspeakers functioned as microphones in reverse, converting electrical signals into acoustic energy. To the relief of style-conscious homeowners the concealed speakers began to replace the large “morning glory” horns that are still enshrined in miniature replicas given to Grammy award winners. What worked

for radio worked for record players as well. A tube amplifier could easily increase the low-voltage signal from a radio tuner as easily as from the small magnet-encased cartridge that generated a variable current when the needle of a phonograph vibrated. By 1929 it was common practice to place these two burgeoning audio forms in the same cabinet, transforming the American living room into an essential locale for the expanding entertainment marketplace.

From its earliest days at the beginning of the 20th century, Victor had a knack for lining up dealers and selling records and gramophones. And by 1925 their releases were mostly electrical, including jazz artists like Paul Whiteman, Duke Ellington, Ted Weems, the Original Dixieland "Jass" Band and others. Sales grew steadily, and popular radio stars helped feed the public appetite for recorded music. Work was also beginning on the miniaturization of the record groove and a slower speed that would allow extended playing times. In the early 30s Ted Wallerstein at the new RCA Victor would experiment with "long play" records. But a successful slow speed format would have to wait until Wallerstein moved to Columbia, which began producing 12 inch "LPs" in 1948.[22] RCA resisted, and settled on mostly pop 'singles' with a larger spindle hole playing at 45 revolutions per minute.[23] Older 12-inch 78 rpm discs might get 4 minutes of music on one side. Columbia's newer 12-inch "microgrove" vinyl disc with the same dimensions would play for over 20 minutes per side at 33 1/3 rpm. The long-playing record was more precisely mastered and able to cater to artists interested in organizing ten or eleven songs into a coherent package. The switch from shellac to smoother vinyl also made it easier to think about taking the next step of offering two audio channels on the same record—stereo—with a higher level of fidelity.[24]

Initially, many in the newer medium of radio thought it beneath them to play what band director John Philip Sousa called "canned music."[25] In its first growth phases radio was on its way to creating live music shows and dramas that would endure well into the age of television in the 1950s. Indeed, the history of television *is* the history of radio.[26] Television devoured radio's growing list of networks and shows of all types, leaving the medium without enough programs. And so stations began to find survival in playing the popular records they and Sousa had once scorned. [27]

Between 1920 and 1960 radio set up crucial cultural markers that defined much of what popular culture meant. It greatly expanded the idea of the American Songbook and it fed the growing celebrity machine represented by Bessie Smith, George Gershwin, Rudy Vallee, Billie Holliday, Bing Crosby, Frank Sinatra and, later, Elvis Pressley. The twin formats of recordings and radio were to become completely interdependent, creating a legacy of songs and performances that would take their place in the canon of American culture. Radio "airplay" practically guaranteed record sales.

Works represented by these artists and many others are now curated with the same care and interest for detail that is perhaps more familiar to the art world. For example, 1930s recordings of the Belgian guitarist Django Reinhardt and other early French "Hot Club" performers are still prized items, now transferred to compact discs and digital audio files. Unlike people acquiring the works of another 1930s artist—the painter and sculptor Joan Miró, to pick a random example—recordings could be lovingly assembled into collections by almost anyone with even a modest budget. Such is the significant advantage of recording that the perfected result of the artist's studio work was released in abundance, and at a tiny fraction of the price of an original piece

of art. The new medium was *not* devalued because it was a duplicate. In ordinary language, it was its own form of an original edition. This immediacy made recorded music an affordable way to possess pieces of the rapidly expanding entertainment complex of film and radio. More Americans curated their record collections with the feeling that they owned something that was worthy to be played and displayed.

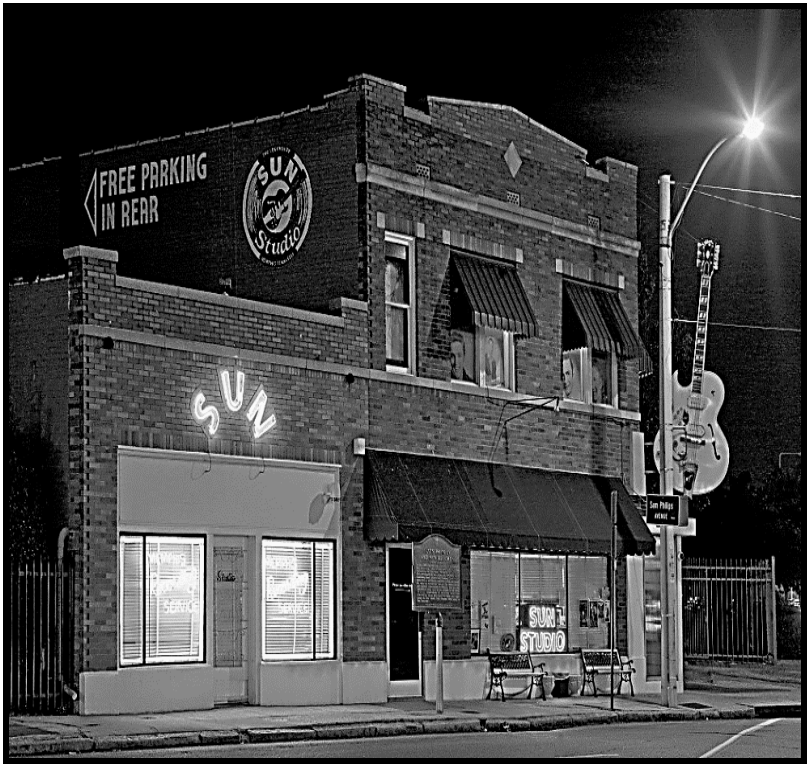

Figure 6
Sun Records in Memphis, where Elvis Pressley paid four dollars in 1953 to make two recordings of songs made popular by the rhythm and blues group, the Ink Spots. ***Source: Carol M. Highsmith's America, Library of Congress, Prints and Photographs Division.***

From One Track to Many

At nearly the same time in the middle of the century the signal path for recordings took a huge step toward higher accuracy reflecting what microphones were already capable of hearing. Magnetic tape-recording machines developed by German companies during World War II began to make their way into recording studios after the conflict ended. For the first time it was possible to escape the narrow option of direct recording to a single groove. Although there were varied precursors that included metal tape on reels weighing 40 pounds or more,[28] the practical PVC audio tape eventually developed by BASF quickly captured the attention of a growing population of audio and radio engineers. The tape was usually one-quarter or one-half inch wide and easily wound onto reels holding 1800 feet or more. It carried a thin layer of iron oxide on one side, allowing a continuous track to be recorded. When unspooled to run past the device's "recording head," small voltage fluctuations magnetized particles of the oxide in a width of one to two millimeters wide. Running the tape back through the machine at the same speed (often seven and a half inches a second) reproduced what seemed like near-perfect replicas of what the microphone heard. Quarter-inch tape could record up to four tracks. Wider tape widths soon appeared, allowing even eight tracks to run concurrently. Each could be used to capture different parts of a large ensemble, and then remixed or "mastered" if necessary. As well, some track space could be kept empty to use later if more instruments or voices were added. With the tape recorder, multi-channel recording and the modern music industry had the transformative tool it needed to produce lifelike or, alternately, a completely synthesized "studio" sound.

Recording was now becoming a craft requiring a knowledge of electronics, practical acoustics and a musical ear. It was beginning to benefit from good engineering talent to get the most from microphones, studio spaces, pre-amplifiers, audio mixers and tape machines. The very idea of musicianship began to include exploiting the unique possibilities of all these devices, creating effects that could only be achieved with equipment in a studio's control room. It is at this moment in the 1940s that sound was fully reborn to more closely resemble what the ear was capable of hearing. Less than a hundred years ago we gained the capacity of recreating lifelike sound.

Engineers could now listen to what they called the "soundstage" made by a recording, meaning the mental image of the relative placement of the musicians in the space where they recorded. The soundstage of a monophonic recording can create a sense of a room's depth relative to the musicians in it. With the advent of stereo—still experimental at this point—the soundstage could spread out along a horizontal axis and begin to replicate our natural binaural hearing, which gives us the ability to hear sound in three-dimensional space.

The still new recorders from the Ampex Corporation and others set the stage for a frenzy of innovation. Singer and radio star Bing Crosby saw their early potential, encouraged by a young guitarist and tinkerer named Les Paul. In 1949 Crosby bought several early-model units to streamline his own radio and recording efforts, giving some to Paul, who was intent on exploring ways to experiment with multi-track sound. [29]

These machines were configured to handle three tracks as easily as one, making it possible to record next to or over existing tracks. Paul soon realized that two heads placed in line and a few inches apart easily created a perfect split-second "overdub" delay during playback, making singers like his wife Mary Paul sound

like matched twins harmonizing in ways never heard before. The effect could be achieved on one track, two, or many, with the fractional delay as one of the first kinds of sound processing.[30] "Mastering"—the final mix of multiple tracks—also came into its own as a separate skill. Records are prepared for commercial release by focusing down many tracks into a one or two track final version. Mastering can also change many of the sonic characteristics of a recording by altering the characteristics of any single track.

Paul was also using his recently improved Gibson electric guitar: one of a new breed of solid-bodied instruments with two "pickups" that amplified the sound of the strings electronically rather than through the acoustic body.[31] Adding rhythm and bass tracks in a multitrack recording to his own previously recorded melody line turned him into a one-man band, with perhaps no set of innovations coming together so clearly than in "How High the Moon" released in 1951. Mary Ford's doubled and slightly delayed voice melded with Paul's multi-tracked guitar to produce a pop hit that wore out jukeboxes from coast to coast. Listeners were stunned by the new and distinctly non-acoustic sound. As multi-Grammy-winning engineer Bruce Swedien recalled:

> Up to that point the goal of music recording had been to capture an unaltered acoustic event, reproducing the music of big bands as if you were in the best seat in the house. It left no room for imagination, but when I heard "How High the Moon," which did not have one natural sound in it, I thought, "Damn, there's hope!"[32]

Les Paul's insistent experimentation represented an emerging pattern in the production of popular music. Musicians exploring the new option of accompanying themselves created a hybrid kind of performance that could only be realized in a studio. The idea that a public concert was the zenith of success would be

challenged more and more. It's increasingly rare to encounter any kind of music that seeks to duplicate the auditory soundstage represented by a listener sitting in the fifth-row seat of a performance space. Radio did its part. Its natural intimacy was exploited by radio legends like Crosby and Bob Hope, favoring their apparent spontaneity in front of the microphone. But musicians caught the same impulse, represented by Paul's excitement at having the chance to create records in a mostly built up—if artificial—soundstage.

The Recording Studio

The most powerful figures in every category of music began to make alliances with producers and record labels who would help to achieve the processed sound more performers wanted. A recording studio always had the capability to add tracks and use edits that could save or "sweeten" a ragged performance. While some resisted the elevation of producers and engineers to part of the musical team, others welcomed their collaboration. More in the record business were beginning to see the studio and the mastering suite has their natural home. Live performances generated interest, but often sacrificed an emerging studio sound quality that put instruments and voices forward. Classical pianists Glenn Gould and Vladimir Horowitz favored the studio, as did more recent performers like Barbra Streisand, Billy Joel and Adele. Stage fright was one reason.[33] Another was that live audiences got in the way of the task of making the best possible music. With hands in fingerless gloves, Gould warmed to the idea of a second chance to do 're-takes' of passages that still displeased him.[34]

At the same time, the idea of recording a band or group in a natural acoustic in real time began to wither. Frank Sinatra may have wanted to be in Capitol Record's Studio A in Hollywood with Nelson Riddle and his band, but those making records for teens often worked with more anonymous studio musicians in sometimes smaller spaces.[35] For example, a young guitarist named Glen Campbell essentially became one of the Beach Boys *only* in the recording studio, well before he went on to a successful solo and television career.[36] Savvy producers would assemble these freelance men and women who could bolster the final sound of a recording. Motown, for example, became legendary for the ability of owner/producer Barry Gordy Jr. to identify young local singers burning with talent, including Diana Ross, the Jackson 5, Stevie Wonder, Marvin Gaye, Smokey Robinson and many more. He would then multi-track their efforts with string and brass players from the Detroit Symphony. With a reliable writing team that included Brian Holland and Lamont Dozier, Gordy also had access to good local jazz musicians he crammed into the small 16 x 26-foot studio on West Grand Avenue in Detroit. Motown's version of rhythm and blues emphasized a brash high-end sheen that redefined pop music.

A useful case study of Motown's 1960s recording style took place with the help of Will Kurk and Joe Shadid, for the video service Reverb. Using professional musicians and singers, they replicated the original studio and all of the audio add-ins that Motown used to create popular hits like "My Girl" and "Ain't No Mountain High Enough." The add-ons included low pass filters to suppress lower frequencies and filters favoring the upper mid-range, giving the tambourine, snare drum, strings, and voices the ability to cut through any acoustic fog. Pushing all of the sound into distortion was not uncommon and considered part of what gave the "hit factory" its listenability on the radios of the day.[37]

Gordy was among a group of pop auteurs that sought to build a music and publishing monolith from the lucrative teen market. If other producers had musical accuracy as a goal, he and others like Phil Spector knew how to create sounds better suited to a young listener's car radio than the all-purpose "radio/phono" consoles used by their parents.[38] It was perhaps inevitable that audio engineering was on its way to becoming a recognized specialty in music schools that wanted to broaden their curriculum to include popular music.

Studios and The Nullification of Ambience

One important effect of the move to multi-tracking was to build more studios with modest dimensions and heavy acoustical treatment to eliminate reflected sound. Relatively "dead" acoustics neutralize reflection effects that were often welcomed in bigger venues like the studio scoring stages in Hollywood. But reflected sound on multiple tracks can sometimes make a recording "muddy" and unmanageable. The solid acoustical principle that a room is always a presence with its own voice is mostly nullified by heavy baffles, sound absorbers and separately miked booths that essentially put singers or musicians like drummers in a closet. The logic of "no reflections" is even behind the recent efforts of one recording company that recently announced it was going to make a classical album with a group in an anechoic chamber with virtually no acoustic reflections. They noted that the sound of the room would be added later.[39] It is the same logic that made fake reverberation a common way to fudge sound to create the perception of a larger space.

The case of Judy Garland's concert at Carnegie Hall discussed at the beginning of this chapter included the appeal of

hearing the hall and the crowd. It's heard in every track. Similarly, Abby Road's impressive Studio 1 in London was made to make any sound seem bigger, including some of John William's *Star Wars* music that was recorded there. The 24-foot high and 95 x 52-foot room still retains a luster that most orchestra musicians love. Acoustic musicians tend to notice when a space gives "air" to their music. Their listening extends beyond other players to include how the space they are in will add depth and color. The open ambience of a great concert hall is still an ideal in classical music.[40] The effect can be somewhat similar to what the great trumpeter Miles Davis said when asked about the most important part of his solos: "It's the empty spaces between the notes."[41] But if performances once gave a listener cues to the place an artist was in, new studios give up very little.

The mostly inaudible acoustic of a "dead" space makes it possible to easily overdub or add backing tracks later, and possibly in a different studio. A vocal recorded in Los Angeles can be easily "sweetened" in New York. Dead spaces deny the effects of room acoustics. A vanilla background is primarily a convenience for the recording engineer, which may explain one reason live concerts of all types of music survive. The irony is that live performances usually give back some of the sonic information of a space that we were born to hear.

The decline of this kind of ambient sound in recordings was both an esthetic choice and the result of better equipment. With accurate microphones and recorders, an engineer can imagine the auditory equivalent of a white canvas. Sound is put into empty space essentially providing the visual equivalent of all foreground against no background. Then auditory color can be added with a variety of electronic effects.

This pattern of a blank canvas also got an assist from more sensitive microphones and performers that favored their extreme

“forward” perspective. Placing a musician or singer near the ear of the listener was a style favored radio crooners rather than theater-trained ‘belters.’ As we have noted, working with a microphone just inches away created an intimacy that enhanced the popular love songs of Bing Crosby and a host of pop singers that he influenced.[42] It also made listeners experts in the nuances of voicing of people and specific instruments. The movement of the keys of a tenor saxophone or the breath of a flautist became part of the recorded experience.

One landmark recording that avoided close miking and the nullification of ambience was the legendary *Buena Vista Social Club,* a 1996 album of mostly retired Cuban musicians playing in the Afro-Cuban style popular when Havana was a prime destination. Musician and producer Ry Cooder recorded the reunited group over a week in the old EGREM studios once owned by RCA, using equipment not much changed from the late 50s.

The small record label World Circuit Records was hardly prepared for sales of over a million copies. Ten older musicians anchored by pianist Rubén González sounded like a band captured just in time, with the studio’s acoustics placing the ten musicians in the three-dimensional space of an “open” and generous-sized room. There were some re-takes of songs, but most were recorded in real time in the same room. “This is what I think is one of the great things about this record,” Cooder later noted. “You put in on and you feel that you can see it. You can imagine the space, you can feel the interaction. That's not easy to do either. Two mics do it and then a couple of close mics for the voice and that's it.”[43]

Stereo

Cooder's comment illustrates the successful use of ambience to create a three-dimensional stereo "soundstage." Stereo recording became practical with multitrack tape machines and popular with record buyers in the early 1960s. At the end of the 1950s, most recordings were still monophonic, meaning that all of the musical information was encoded and then reduced to only one channel. A phonograph sold in the 1950s typically had a single speaker. However, the logistics of putting two tracks in the groove of the new format of the LP record—the accepted medium of the time—would take some elegant experimentation.

Because of the relatively slow speed of sound (around 760 miles per hour through the air), an individual's brain is capable of sorting the fractional time lag as sound passes from one side of the face to the other. This "interaural time difference" helps us know the location of a sound source. It was understandable that engineers wanted to replicate a full "soundstage" and record executives wanted the attribute of more realism to pitch to buyers. In addition, by the mid-1960s, most recordings were already mastered to tape in stereo from multi-track recordings that had been in the vaults for years. The final hurdle was to develop a system of etching two channels in a single groove of a vinyl record. How could one groove hold two tracks of sound? And how could one stylus capture both?

A solution finally emerged using some ingenious engineering from interested parties, including New Jersey's Bell Labs, EMI Records, Audio Fidelity Recordings, audio engineers at Westrex (a division of Western Electric), and several leading record companies.[44] The solution was to embed each channel along separate walls of the groove at a 45-degree angle, while also varying the depth of the groove. As the stylus negotiated this

miniature geography, it would understand some groove variations as right channel information and others on the opposite wall as left channel information. Each would be sent to their own amplifier sections and speakers.

While early use of stereo was sometimes gimmicky, the results could be impressive in allowing a listener to gain what audiologists call “binaural fusion.”[45] Well placed speakers could locate the source of a sound anywhere along the distance between them. Stereo spreading out on a horizontal axis “opens up” the soundstage, creating a convincing impression of being “in” the midst of a performance: something earphone listeners consistently experience. Interestingly, newer audio formats like Sony DTS, and Dolby ATMOS have more than two channels, but they are ultimately processed by our binaural hearing, which builds on the interaural time difference the brain detects as micro-second differences in the arrival of a sounds to an individual’s left and right side.

The Signal Path: Audio Processing

Listeners to radio and recorded material can be forgiven for having the impression that what they are hearing is precisely what was recorded in a single complete performance. But recordings of most current music other than classical or jazz are better understood as assembled over time, often in different studios, and usually with some alterations done after a first track has been “laid down.” The complex sound of a record or music file has usually gone through an elaborate process that has changed the sonic character of what audio engineers call an unaltered and original “dry” recording. Using massive audio “desks” or computer equivalents known as digital audio

workstations, engineers see their work as enhancing what is first offered in the studio, usually with the input of a producer and the lead artist. Their yardstick is the simple one of making the results "better," an effect that happens when the audio equivalent of a Photoshop makeover yields an "enhanced" or "wet" version. The results may be clearer and even more musical. At other times the end product is what some ambience -sensitive listeners might consider "overproduced," a judgment suggesting that the natural talent of the performers has been lost to audio gimmicks that were added to make the sound more "commercial."[46] Audiophiles and those with a preference for acoustic instruments tend to prefer less processing, but most pop music has been altered in a post-production process. For example, to many listeners, the recordings of the iconic folk-duo Simon and Garfunkel were their best with minimal studio-produced effects. For good or ill, their producer-engineers Tom Wilson and (later) Roy Halee favored a range of after-the-fact add-ons for some recordings, everything from guitars and harpsicords to trumpets overdubbed at different times.[47]

A well-known complaint against overuse of audio effects comes from another folk-rock legend, Neil Young, who sees music distorted by electronic compression that limits dynamics (loud and soft passages) and some musical content. "What he is after," notes music writer David Samuels, "is not some ideal sound but the sound of what happened. The missed notes and off-kilter sounds are part of his art, which is the promise of the real, but also, even mainly, of imperfection."[48] This is a minority point of view, especially among younger performers who have grown up listening to more electronic devices and instruments. In fact, there may be a genuine movement to get back to the idea of live recording with minimal audio tampering,[49] but it represents a small segment of the recording industry today.

It says the obvious that most recording engineers are now major forces in the music business.[50] If earlier recording was intended to capture a performance in real time, as in the opening example of *Judy at Carnegie Hall*, it is undeniable that producers and/or recording engineers have taken on the role of an additional musician and sometimes the de-facto leader of a recording session. He or she is essentially using instruments in service of some aesthetic: the same motivation of a performer in front of a microphone. To be sure, classical music recording studio engineers routinely follow the conductor's score, making adjustments in line with what the composer originally intended or what the conductor wants, and calling for retakes if a particular entrance by a player was late or rough. In popular music or jazz there is more variability in what an engineer knows, and whether their sense of what is "musical" conforms to what an accomplished performer might desire. In some cases, the engineer functions as the technical expert who will help achieve what a performer envisions. In other instances, engineers may verge into producing by attempting fixes for problems only they hear. Most are especially interested in audio effects that "thicken" or add emphasis to a sound. Music made for radio airplay or a bid to make the *Billboard Top 100* charts is generally altered to shrink the natural dynamics of the original recording and to add more aural color to what was first heard in the studio. The result is a "signal path" that is elongated and altered beyond what the microphones in the studio originally heard.

While microphones have their own cherished or problematic characteristics—ranging from "warm" but fragile ribbon mics to sonically more accurate condenser mics—most of the signal path will be altered by various black box devices used later in the mixing and mastering process. The more common audio add-ons

that are routinely applied during and sometimes after a recording session include the following:

> ***Compression*** *— the reduction of the dynamic range of electronically processed sound.* Compression exists in almost every form of audio processing. A signal is processed to mostly reduce extreme softness or loudness of sounds, often to remain within the limits of a medium's bandwidth, as when the dynamic range of a recording is greater than what the overall recording chain can handle. Loud cymbals or a full *forte* from an orchestra can send equipment into audible distortion. Careful listeners can usually hear the compression that pulls back the audio "peaks" of a radio or television signal. Compression is also used as well in popular music to maintain what can be perceived as a more dominant audio presence. For example, in the 1950s and 60s jazz giant Count Basie liked to play soft one-note-at-a-time piano parts in deliberate contrast to the punchy loud horns that were characteristic of his band. Left uncompressed, it can be hard for listeners to tolerate that very wide loudness range. If he were recorded today those single notes would likely be "spotlighted" with a separate mic and likely made more prominent than what might have been heard by one person in location in the studio. Similarly, a singer's dynamic may trail off because of their own particular interpretation, or because of insufficient breath to sustain a note. As we have noted, singers and engineers like these solos to be clearly 'in front' of other elements in a recording. Compressing the performer's dynamic range helps achieve this effect.

Delay *— a fractionally late duplicate of an original sound.* As noted earlier, Les Paul discovered that he could produce the apparent sound of two voices from one by using a short delay. The effect is two singers almost singing in tandem. It was especially common for female pop singers recorded between 1950 and well into the 90s (i.e., Mary Ford, Anne Murray, Karen Carpenter, Alison Krause). Longer delays can also create a not-very-convincing simulation of reverberation that a listener would expect to hear in a large hall.

Slap-back Delay **—** Most pop recordings use this effect to thicken the voice of a lead singer. The sound of a voice is effectively doubled and enhanced with a fractional reverberation (40-120 milliseconds). This recording add-on was used frequently by producer Sam Phillips recording Elvis Presley in the 1950s. It can be heard in Presley's iconic "That's Alright Mama" (1954).[51] The effect is also evident in John Lennon's classic "A Day in the Life" (1967).

Reverberatio*n — a series of fading sounds that can add layers of "space" to a recording that has little acoustical information of its own.* Applied lightly, it adds weight to a weaker voice or a sparse arrangement for few musicians. For years this was a Motown special, produced with an actual echo chamber (a long space in the attic with a speaker at one end and a microphone picking up the delayed sound at the other end) built into the attic of one

of their original studios on West Grand Avenue. Reverberation today is mostly created electronically. Singers accept it because a slight “blur” of a sound adds a degree of sonic color thought to be missing in a “dry” recording. At least a small amount of added reverberation exists in the recordings of nearly all modern singers.

Auto-Tune — an electronic computer application that brings performers with a wandering pitch back into tune. While it can help a singer who is off-pitch—and there are many— most performers would prefer that this effect would go unnoticed. If used extensively, a singer’s voice begins to sound mechanical and robotic, which seemed to be the point in Chris Brown’s 2009 hit “Forever.”

Distortion — While most classical and jazz record engineers do everything to minimize various forms of distortion, heavier rock and pop music features sound where deliberate distortion is added. Typically, the effect happens when a signal overtaxes the circuits of a piece of audio equipment, resulting in what some might characterize as a “ragged” “roughed up” timbre. Rock musicians claim that various forms of distortion add a sense of drama to music that was not intended to be “pretty” or melodic. The effect of this kind of “nasty” sonic color that has an “edge” is clearly a matter of taste.[52] To some ears, including the author’s, the effect seems more like an assault than a musical achievement.

Equalization *— segments of the audible sound spectrum that are emphasized or de-emphasized.* Equalizers are more sophisticated versions of the tone controls that exist in many home audio devices. Images of studios with vast “desks” of knobs spread over a number of feet owe this apparent complexity to the hundreds of “EQ" knobs that can boost or cut a set frequency range for each separate channel. For example, a slight boost of volume in the 200 to 500 Hz range can add “warmth” to a track that is full of higher frequencies. Additionally, a singer with a lot of sibilance with their "s" or "sh" sounds may have the effect reduced by filtering the frequencies where they occur (usually around 3000 Hz). Engineers also use equalizers to take away some of the frequencies that overlap in two prominent sources performing at the same time. One element in a recording should not mask the presence of another. For example, the lower sounds of a cello can overwhelm the signature timbre of a male singer. Putting a “low pass” filter on the cello may solve the problem. At the other extreme, a cymbal can produce very high overtones that can seem harsh or too dominant. This problem can be tamed by a “high-pass” filter. Likewise, a closely miked guitarist can sometimes create unwanted squeaks caused by the player’s fingers moving up and down the fretboard. Equalization in the form of a “notch filter” may delete most of the narrow range of frequencies where this sound is concentrated.

Pan *— placing an individual channel’s output along the horizontal axis of the stereo “soundstage.”* Done well, the effect adds to the three-dimensional feel of a recording.

> An orchestra has a conventional layout that engineers mostly duplicate: violins to the listener's left, and violas, cellos and basses to the right. But where to put the brass players along the left-right axis is more of a judgment call. A typical band of singers, guitars, drums and bass guitar is also open to a wide range of decisions. As a rule, engineers go for a blend, but will sometimes highlight a performer by moving their placement on the soundstage slightly to the side opposite most of the other musicians.

There is no more consequential add-on in audio processing than the first on the list: compression. In some ways it is the hardest to detect, since it mostly affects the dynamics or loudness of a given piece of audio. Compression is an old process that allowed more recording time on a record, better sound from the comparatively lower fidelity medium of AM radio, and the opportunity to put more content into a smaller digital file, such as those produced in the familiar MP3 format. In short, compression allows more music to be put into a smaller space, often by narrowing the distance between loud and soft passages. But the result for the listener can be sonic fatigue: a subtle outcome that can hollow-out the richness of an actual performance. Uncompressed music sometimes called "lossless recording" usually sounds more natural and uses the ear's capabilities to detect sound behind sound. Even so, as recording engineer Bob Ludwig notes, compression is "still a motivation for some producers:"

> If their record jumps out of your iPod compared with the song that preceded it, then they've accomplished their goal. . . People talk about downloads hurting record sales. I and some other people would submit that another thing that is hurting record sales these days is the fact that they

> are so compressed that the ear just gets tired of it. When you're through listening to a whole album of this highly compressed music, your ear is fatigued. You may have enjoyed the music, but you don't really feel like going back and listening to it again.[53]

Another use of compression is to make sound louder on the assumption that it will command more attention. Americans have complained generally about the perceived loudness of television commercials, provoking legislation in 2012 prohibiting broadcasters the kind of “dynamic range compression” that keeps every sound in a spot louder than would be the case in the original “dry” form.[54] The logic used by the advertiser is that quiet in an ad represents precious lost seconds to make a favorable impression. The same logic applies to film trailers, which are notorious for assaulting multiplex audiences at volume levels approaching the risk threshold of 85 dB.[55]

The Signal Path: Musicians in a Box

Music produced electronically rather than acoustically has proliferated since the development of the electric guitar in the 1930s and the electronic synthesizer in the mid-1960s. Guitars are now usually amplified and with their own built-in effects. A synthesizer works differently, producing stored audio samples or electronically generated sounds amplified separately or fed directly to an audio control board. Most have individual keys modeled on those of the conventional piano, but with the addition of a range of settings to imitate or generate different audio forms. Modern synthesizers can play individual pure tones, but usually combine various chords and timbres and all sorts of musical effects. Some more or less imitate acoustic instruments like a

traditional piano, strings in an orchestra, or the important Hammond B3 organ used extensively in jazz and gospel music. Others include entire rhythm sections or various “band” or “orchestra” combinations.

A musician using the popular Roland VR-700 keyboard, for example, can more or less duplicate the output of a reed, percussion or wind instrument. Others can make string sounds and what the maker describes as a “synth engine loaded with tons of ready-to-play synths, from vintage to modern.” Virtually every pop record will include keyboards like the Roland. Newer instruments can be combined with large software collections of “sampled” sounds like the Vienna Instrument Collection or the BBC’s Spitfire Audio. These include sonic samples of every instrument in an orchestra, with the ability to affect how a single note from a violin or cello or another instrument is attacked or sustained. Most synthesizers also store what has been played on them, and some can copy their output using traditional musical notation. The prolific writer of film scores, Hans Zimmer, composes music using a synthesizer, often integrating sampled sounds into individual film cues, while still using actual musicians playing acoustic instruments.[56]

Even so, experienced listeners may still notice efforts to pull back from traditional acoustic sources of music in favor of synthesizers. For example, 24 musicians played the original version of Leonard Bernstein’s musical theater score *Our Town* back in 1953. But the touring company of the show many years later was down to 12 musicians and one synthesizer player working from a standard PC computer. On that occasion, noted a critic of the *New York Times*, the “synthesized trumpets sounded like oboes and oboes like burglar alarms.”[57] The glories of a full Broadway pit orchestra are now heard mostly on recordings.

The Decline of the Giants

After 1920 and the advent of the microphone and amplifier, decent-sounding records were everywhere. Early microphones had surprisingly good fidelity across most of the audio spectrum. Amplifiers quickly improved as transistors replaced failure-prone vacuum tubes, gaining the ability to power loudspeakers that could fill a room or even a theater with music.

By mid-century recorded music was not only a popular American product, it had also turned into an obsession. Even television frequently used pop music to prime-time attract viewers, with recording artists hosting scores of their own hour-long variety shows, sometimes for decades, among them, Dean Martin, Perry Como, Andy Williams, Nat King Cole and Glen Campbell.[58] Their recordings sold in sufficient number for major record labels to justify taking risks on more distinctive but less mainstream talents like Carmen McRae (Columbia) and Nina Simone (RCA). Thousands of record and music stores were spread across cities and shopping malls, fed by radio airplay of popular 45 rpm singles. Listening to records and comparing albums was a favored ritual for listeners representing every kind of taste. Many Americans spent more time browsing in record stores than attending church. And there could be a great deal to take in. One of the Virgin Records “megastores” in Los Angeles carried 100,000 titles (mostly CDs) spread over 30,000 square feet.[59] Record retailers like Virgin, or its even larger competitor, Tower Records, were havens for youthful browsers and their friends who pondered the fateful decision of whether they could afford the $9.95 price for a best-selling album. Smaller towns had their own retailers, sometimes drug or department stores who

used “rack jobbers” who kept high-turnover albums on hand in a corner of the store.

Then the bottom fell out. With little public notice young tech-savvy listeners began to copy digital music using computer software that was widely available. Sales of records plummeted after 1999, hindered by the higher cost of CDs and a growing interest in converting albums into digital files that were easily shared. The same year Napster began hosting a web site and software that allowed the circulation of music files via peer to peer networks. In the process, and even though Napster was eventually forced out of business, file-sharing suddenly froze the music business out of a primary revenue stream.[60] They were only partly rescued two years later when iTunes began selling streamed music online and sharing royalties. But the rush toward downloading as the preferred way to acquire music would stick. It matters less to modern listeners that they have a hard copy of an album; it matters more that they can access it at will via a music service. In the process, music became just another form of a digital file and somewhat devalued. It was now among many other content platforms (i.e., computers and phones) favoring graphical interfaces, making them sometimes more interesting visually than aurally.

In a collapse of sales almost unprecedented in American retailing, by 2007 most of the huge brick and mortar stores were shuttered. Music sharing (copying) itself was a problem. And fee-based streaming services put performers at the end of a meager financial food chain that was mostly tapped-out before they were paid.[61] In 2019 the Canadian cellist Zoe Keating noted that her royalty for each stream of her music played by Spotify was $0.0054.[62]

The Signal Path: Digital Media

At one time the future of music seemed solidly tied to the digital storage medium of the 5-inch compact disc (CD), a format that was developed by Philips and Sony in 1982. Representing a broader trend of data storage used in the computer industry, a CD converted sound into discrete bytes stored in binary code. It could hold about 90 minutes of material (ostensibly to accommodate Beethoven's sprawling 9th Symphony.) Then, the slim silver platter had the advantage of being a product rather than a less material file. But their manufacturing facilities and processes were initially expensive. And because the discs were digital, it was possible to make perfect copies, which is not quite the case if a person wants to make an analogue duplicate of a recording. Even so, audio enthusiasts wondered if the "Red Book" standard of "quantization" rates for converting sound into strings of 0s and 1s had been set high enough. Would the music please listeners who had grown to expect what many remembered as the warmer sounds of analog music on vinyl records? Some of the debates on this point included doubtful assertions. But the medium initially thrived without the noise and distortion problems common to the old record groove. Even so, there is little question that the greater ease of copying digital files shortened the commercial prospects of CDs. One original could spawn many homemade duplicates. The format remains alive, but digital streaming music via the internet is now far more common.[63]

Does it matter that our current methods for retrieving sound from supposedly "lossless" audio files is based on sampling? As a way to encode data, sampling represents how many times over a given period (usually measured as one second) a medium will "read" an audio source, encoding its fragments into a binary set of numbers. A groove in a record made on analog equipment

"reads" the signal continuously. In contrast, a digital sample "quantizes" content as *separate* samples, with each moment of sound given a numerical form.

Think of the analogy of motion picture film as doing the same. In playback we usually see 24 frames a second, which are blended by the eye and brain for the perception of a continuous moving image. On a typical compact disc or better streaming services, the Red Book sampling rate is much higher for audio content: usually 44,100 times a second. In a standard 16-bit recording the sampling process can adjust the amplitude or loudness of music in 65,000 steps. Higher sampling rates supposedly offer a more accurate "resolution" of whatever has been recorded.[64] But the difference may be more theoretical than practical.

Common complaints about the harshness of early CDs may seem unjustified, because these sampling rates would seem to be fast enough to be undetectable: a point of view that does not convince many who claim the analog signal is less strident. But consider a second visual comparison. Consider a light analogy. A traditional fluorescent light flickers slightly at 120 times a second, twice the speed of American alternating current at 60 Hz. It is clearly true that the slower and mostly unseen flicker rate does leave some persons with an unpleasant sense of visual fatigue.[65] The flicker can be annoying even if we don't easily see it. But, again, the signal path for *audio* samples sound at a considerably higher rate. And so we again enter the realm of psycho-acoustics. Can the ear notice the discrete moments of sampling that our consciousness might miss? There is no definitive answer. The debate continues, with many audiophiles opting for "smooth sounding" analogue recordings, which—as we have noted—follows a continuous track (a groove or tape track) rather than a data stream of distinct samples.

Whether the original standard for CDs is adequate, there is little doubt that it takes a significant amount of bandwidth to download or stream content at those rates.[66] For obvious reasons, video files of music are even larger and consume more storage space. The solution to making all digital files smaller has been to use sampling tricks that omit some material that might not be noticed. This is the principle behind the common MP3 format and its newer equivalents. MP3 audio files remove some ostensibly hidden musical content to compress music files so that more can fit into the memory of a computer or smartphone. Bluetooth as a transmission tool similarly degrades a digital source. But many listeners seem to have trained their ears to not care about less-than-optimal sound.

The Decline of Collecting

There is no shortage of literature on the American canon of popular recorded music.[67] It makes sense to continually reconsider how Americans find and access the music they are passionate about. Owning a physical copy of the work of a writer or performer was, until recently, a sometimes-obsessive pursuit. For many born in the last century, displays of neatly organized books and records were a badge of honor, perhaps suggesting membership in a kindred tribe of appreciators.

This chapter is written in a room cluttered with stuffed bookcases. It's the same in other parts of the house, where CD cases sit on tabletops and stand upright on shelves. These are clearly vestiges of the Edison past when the nation collectively swooned at the chance to own the riveting performance of another. Scratchy one-track cylinders and flat discs soon became their own fetishized possessions. Every middle-class parlor had a

record player and a growing collection of relatively expensive records. Jump ahead several generations well into the 1990s and teens especially were still heirs to this passion of record collecting. The local record store was their domain. The young and more than a scattering of adults made weekly pilgrimages to Tower Records, HMV, Sam Goody's or a city's Virgin "megastore." They paid homage in knowing details about groups that signaled their coolness. Many were voracious readers of album notes, shaping what they would want to display with pride and what to hide. Smaller innovative companies specialized in areas beyond pop music: a fact that appealed to young listeners eager to stand apart from the pop radio hits of their younger siblings. Their names were repeated like the original sources of a sacred canon: Mercury, Vanguard, Nonesuch, Concord, GRP, Blue Note, Atlantic, Verve, Telarc and many more. Ownership with all its constituent parts—the exotic record labels, album covers, *Rolling Stone, Spin,* posters and music magazines—were their own reward, or perhaps the last vestiges of a traditionalist approach to curating.[68]

The collecting tide has clearly receded. To more younger consumers around the world—with the notable exception of those in Japan—CDs and other formats are anachronisms: echos of thrift-shop collectors still looking for old player-piano rolls like those hidden in a corner of my grandmother's lace-curtained living room. Digital "natives" are just as happy essentially leasing access to commercial libraries, such as those offered by Amazon, Spotify, Pandora, Apple and others. They curate their collections now through initial choices that set up libraries "in the cloud." It does not seem to matter that the streamed equivalent of a hard copy is never quite the owners in the ways that a vinyl or CD version is. It can't be easily loaned or resold because its storage is usually in a proprietary server. Diehard accumulators used to

owning works are not quite convinced having access to a work is the same. The fetish effect of ownership of a specific record is its own reward. As music critic Alex Ross notes, now “consumers show more fealty to apps and media conglomerates than to labels and artists.”[69]

At present the two most important sources of music for teens as this is written is Spotify, Pandora radio (streamed and over the air), with YouTube a distant third.[70] Like all preferences related to media use, a common pattern is the melding of old and new. Radio continues to be a habit especially with older listeners, but newer listeners are increasingly attracted to radio-on-demand in the form of podcasts. As to streaming, by 2019 Spotify had become the dominant form of music delivery.[71] The business estimates that they now receive an unimaginable 40,000 new songs a day.[72]

YouTube is representative of a longer and obvious trend to include a video dimension to music. For many teens, interest in finding new acts leads them to sources that are running their videos. The economics of the music industry also dictates a related need for musical groups to be prepared to perform live concerts. Concert revenue has partly replaced the devastating crash of record sales.[73] But videos and touring put new and mostly unknown groups at an obvious disadvantage. Video production is more expensive than straight audio recording. And YouTube royalties are considered to be too small.[74] In addition, some musicians lack the desire and resources to make their creative efforts an exciting visual experience. Visual performance standards can pull many some distance away from where their talents and enthusiasms lie.

And what of owning as opposed to streaming a performance? Communication scholar Joshua Meyrowitz offers the term “association factor,” which helps explain what has

changed when ownership is replaced by purchased access. When we own a hard copy of another's work—when it is in our physical possession—we more readily identify ourselves with it. It's an artifact tied to our identity, an outward representation of our place on the human map.[75] An album of music sitting in someone's room means they are probably prepared to defend its presence. The visible product is something they have "associated" themselves with. By contrast, a person may feel no responsibility to defend a song that presents itself on a streaming service.

Even so, consumers of these digital services seem just as passionate in their own ways about "their" music as were earlier generations. Growth in the music industry has mostly recovered from the slump that occurred more than a decade ago. Revenues from streaming have again made publishers powerful, to the tune of nearly 10 billion dollars annually.[76] Musicians don't always get much of the share of the revenue, as high rates of mental health data from working and underemployed musicians would seem to indicate.[77] Surviving in the music business is rarely easy, and never tougher than through the 2020 world Covid-19 pandemic. And yet the pleasure musicians give to consumers is clear. One recent industry study of international patterns of leisure reported that most people (54%) describe themselves as "loving" or being "fanatical" about music.[78] And access to sources online has the advantage of opening our ears to the world's vast libraries of recorded music: a capability that may only be circumscribed if a music career must include a video format. Even so, ownership of the thing itself—a fact that kept postwar teens in music stores for hours on end—seems to be a passing signifier of the avid appreciator.

Summing Up

Sound recording has evolved from the miraculous capture of a few words shouted into a horn to becoming its own cultural force. We record sound less to produce a document of a one-time live event, and more to display an artist's mastery a studio's technical prowess. The resulting sounds are constructed as much as performed and backed by a cadre of business and media professionals thirsty to find more ways to monetize the ongoing love affairs between musicians and audiences.

The Library of Congress has nearly 700,000 audio files available, with 21,000 online: everything from "Hunting Horn Calls" recorded in 1939 to "Omaha Indian Music" recorded in 2000.[79] As the library notes, the recordings are part of "the American memory." Every year they award the Gershwin Prize to a musician; in recent years recipients have included, Willy Nelson, Smokey Robertson, Tony Bennett, and Garth Brooks. One program embedded in the Library's vast American Folklife Center has also used its recordings to build its own national following. The weekly *StoryCorps* feature on National Public Radio that is archived at the Center draws on nearly 5,000 recorded conversations between friends or relatives who recount a special moment in their relations: perhaps a transgender child raised by a loving aunt, or a ten-year old explaining to his mother what happens in school during an "active shooter" drill. We live for these kinds of connections to the words and music of others. It seems right to end this discussion of captured sound with a reminder of how often we are easily coaxed into silence by the opportunity to hear others through the audio chain.

Chapter 6 Notes

1. Geoffrey O'Brien, *Sonata for Jukebox* (New York: Counterpoint, 2004), 271.

2. "Judy at Carnegie Hall," Steve Hoffman Music Forums, August 6, 2007, https://forums.stevehoffman.tv/threads/judy-at-carnegie-hall-in-2011-judy-garland.122460/

3. Recording engineers today could lessen the problem by putting in place a "notch" filter that would block just the frequencies created by the drum. But, of course, any instruments creating the same frequencies would also be affected.

4. Garland's legend was enhanced in the 1980s when her struggles and triumphs were taken up by segments of the gay community. See Curtis Wong, "Why Judy Garland Still Captivates Gay Fans 50 Years After Her Death," *Huffington Post*, June 10, 2019, https://www.huffpost.com/entry/judy-garland-gay-fans_n_5b30edb3e4b0321a01d3a9d7.

5. Greg Milner, *Perfecting Sound Forever,* (New York: Faber and Faber, 2009), 23-24.

6. John, *Speaking Into the Air* (Chicago: University of Chicago Press), 94-108.

7. Neil Baldwin, *Edison: Inventing the Century* (New York: Hyperion, 1995), 374-377.

8. William James, *The Principles of Psychology, Volume 2* (New York: Henry Holt, 1923), 627.

9. Baldwin, *Edison,* 85-88.

10. Roland Gelatt, *The Fabulous Phonograph, Second Edition 1877-1977* (New York: Macmillan, 1977), 21

11. Gelatt, *Fabulous Phonograph*, 23.

12. Baldwin, *Edison*, 90.

13. "The Talking Phonograph," *Scientific American*, December 22, 1877, Thomas Edison Papers Digital Edition, Rutgers University, https://edison.rutgers.edu/digital/document/PA084.

14. Milner, *Perfecting Sound Forever,* 40-45

15. Baldwin, *Edison,* 359.

16. Gelatt in *Fabulous Phonograph* offers a useful overview of this period, 58-99.

17. Arnold Schwartzman, *Phono-Graphics: The Visual Paraphernalia of the Talking Machine* (San Francisco: Chronicle Books, 1993), 25-37, 50, 54.

18. Milner, *Perfecting Sound Forever,* 58-59.

19. Evan Eisenberg, *The Recording Angel* (New York: McGraw Hill, 1987), 16.

20. In whatever form—phonograph, gramophone, or Victrola—the machines of the period were a glorious menagerie of mechanical designs interlaced with ornate or simple woodwork. No appreciation of the ingenuity of these devices is complete without a look at their varieties and functions. See, for example, Daniel Marty, *The Illustrated History of Phonographs* (New York: Vilo, 1979).

21. Gelatt, *Fabulous Phonograph*, 221-223.

22. Sean Wilentz, *360 Sound: The Columbia Records Story* (San Francisco: Chronicle Books, 2012), 127-129.

23. RCA hoped to set a new standard with the 45-rpm record, which won the support of younger listeners interested in buying hit singles. The format would eventually fade, however, because of its shorter playing time.

24. See Wilentz, *360 Sound*, 127-135.

25. Gelatt, *Fabulous Phonograph*, 146-147.

26. Erik Barnouw, *A Tower in Babel: A History of Broadcasting in the United States to 1933* (New York: Oxford, 1966), 191-192.

27. This gradual transition is documented in Erik Barnouw, *Tube of Plenty: The Evolution of American Television* (New York: Oxford, 1975) 25-83.

28. Milner, *Perfecting Sound Forever,* 110

29. “2: Sound on Sound,” The Les Paul Foundation, N.D., https://www.les-paul.com/timeline/sound-on-sound/, accessed October 14, 2020.

30. Richard Buskin, “Classic Tracks: Les Paul and Mary Ford ‘How High the Moon,’” *Sound on Sound*, January, 2007, https://www.soundonsound.com/people/classic-tracks-les-paul-mary-ford-how-high-moon.

31. See Dave Hunter, *The Gibson Les Paul: The Illustrated Story of the Guitar That Changed Rock* (Beverly MA.: Voyageur Press, 2014), 36-39.

32. Quoted in Buskin, *Classic Tracks.*

33. Many performers have battled with stage fright and the increased adrenaline that comes with it. See Bruce Britt, “Adele, Van Halen Among Musicians Who Battle Stage Fright,” Recording Academy Grammy Awards, May 15, 2017, https://www.grammy.com/grammys/news/adele-van-halen-among-musicians-who-battle-stage-fright.

34. Glenn Gould and Jonathan Cott, *Conversations with Glenn Gould* (Chicago: University of Chicago Press, 2005), 12

35. The 2015 video documentary *The Wrecking Crew* (Magnolia Pictures, 2015) is the best-known exploration of this world of Los Angeles–based virtuoso musicians.

36. Stephen Betts, "Jimmy Webb on Glen Campbell: 'The American Beatle Has Passed,'" *Rolling Stone,* August 9, 2017, https://www.rollingstone.com/music/music-country/jimmy-webb-on-glen-campbell-the-american-beatle-has-passed-127064/.

37. See "Can We Recreate the Motown Sound," YouTube, accessed Oct 3, 2019, https://www.youtube.com/watch?v=TysRGMSjtpQ.

38. Spector is especially recognized for his "Wall of Sound" approach to recording, loading a pop song with instruments, back-up vocals, and strident percussion that produced the overloaded production of indistinct but catchy elements. See, for example, Milner, *Perfecting Sound Forever,* 152-154, and Eisenberg, *The Recording Angel,* 126-127.

39. "Studio Secrets," *BBC Music Magazine*, October, 2019, 20.

40. A listener can hear this kind of spaciousness even in the 1953 cast recording of the film *Kiss Me Kate.* The MGM Culver City soundstage (now the Sony/Streisand Soundstage at Sony Pictures) was miked to clearly put the brass "in back," and let us hear the slight delay. Listen to the last half of *From This Moment On*, which is probably the work of master-orchestrator Conrad Salinger.

41. Daniel Levitin, *This is Your Brain on Music* (New York: Penguin, 2006), 18-19.

42. Gary Giddens, *Bing Crosby: A Pocket Full of Dreams: The Early Years* (New York: Little, Brown, 2001), 7-8.

43. Betto Arcos, "Interview with Ry Cooder," *The Global Village/Pacifica Public Radio*, December 15, 1997, https://www.pbs.org/buenavista/music/interview.html.

44. David Morton, *Sound Recording: the Life Story of a Technology* (Westport, Ct: Greenwood, 2004), 146-148.

45. "Notes on Binaural Hearing," American Academy of Audiology, April 29, 2014, https://www.audiology.org/news/notes-binaural-hearing.

46. For a sense of what this process was like on the iconic Michael Jackson album *Thriller*, see Quincy Jones, *Q: The Autobiography of Quincy Jones* (New York: Doubleday, 2001), 236-241.

47. Richard Buskin, "Classic Tracks: Paul Simon 'You Can Call Me Al,'" *Sound on Sound*, September, 2008, https://www.soundonsound.com/techniques/classic-tracks-paul-simon-you-can-call-me-al.

48. David Samuels, “Neil Young’s Lonely Quest to Save Music, *The New York Times Magazine*, August 20, 2019, https://www.nytimes.com/2019/08/20/magazine/neil-young-streaming-music.html.

49. See, for example, the popular YouTube channel, *Scott Bradlee’s Postmodern Jukebox,* with over 1 billion views. The music put together from a “cooperative” of younger musicians is produced live in one-take performances. On his website https://postmodernjukebox.com/home/ (accessed November 15, 2019) Bradlee notes that “The vocalists sing every note live, without any tuning help. The musicians make every sound you hear on stage and in my living room with the instruments you see them playing.”

50. Few women are encouraged to specialize in studio recording or producing. The Audio Engineering Society still puts the number well under 10%. See Lindsay Zoladz, “Revealing Herself, One Rock Song at a Time,” *New York Times*, August 19, 2020, C5.

51. Milner, *Perfecting Sound Forever,* 151-152.

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Chapter 7

MUSIC REFUGES AND RIGHTS

We are the music makers,
And we are the dreamers of dreams,
Wandering by lone sea-breakers,
And sitting by desolate streams; —
World-losers and world-forsakers,
On whom the pale moon gleams:
Yet we are the movers and shakers
Of the world for ever, it seems.[1]
—Arthur O'Shaughnessy

There's a heartbreaking image captured in an old sepia-toned World War I era postcard. Two soldiers are in a trench, managing a smile for the camera with a portable Victrola sitting unsteadily on the dirt mound between them. The year is probably 1917. They are listening to a record sent to the front from the safer confines of their native England, the lyrics of the old song sung by Florrie Ford stretches toward a lighter mood:

Take me back to dear old blighty,
put me on the train for London town.
Take me over there, drop me anywhere,
Birmingham, Leeds or Manchester—well I don't care. . .[2]

The top half of the image has two photo vignettes above the men representing their wives or girlfriends. Somehow it all seems more heart-rending than the designer of the postcard probably intended. Their extreme youth is jarring; many British soldiers were under 18. In addition, their smiles belie the fearsome odds they faced. Over 700,000 British men would die in the Great War, leaving those back home with little comfort beyond the stone monuments built in town centers to memorialize their names.

Was the photo posed in less dire circumstances? Probably. But that doesn't change the paradox the image represented. It was a common practice of sending record players to the front—among them, the Decca "trench model."[3] It's clear in an instant that music would have been an obvious link to a life these young men wanted to remember.

Music extends beyond what words can express. It's brilliance as a human artifact is realized in the impressions and associations it so effortlessly evokes. The Swiss philosopher Jean Jacques Rousseau described music paired with language as the twin organizing forces for building human communities.[4] Producer Quincy Jones similarly placed it at the center of the human orbit, noting that when everything else is gone, "water and music would be the last things to leave this planet."[5] In spite of a long tradition of suspicions spanning from Plato to intellectuals aligned with a narrow view of rationalism,[6] music matters and endures. That it does is reflected in the Arthur O'Shaughnessy poem opening this chapter, set to music in Edward Elgar's melancholy oratorio *The Music Makers* (1912).

This chapter reviews attributes of music that can so easily draw us in, frequently offering escapes we cannot resist. It's partly because of this capacity to satisfy a basic human thirst that it is not only a source of bliss, but a virulently contested kind of property as well. The last part of the chapter looks at how this

refuge is a vast terrain where claims of ownership are common. And so in music, as in life, the transcendent and the commercial coexist side by side.

Enduring Origin Theories

Most theories about the appeal of music are mimetic.[7] In various ways these origin ideas suggest that music imitates some natural sounds that are part of the human experience. In one view rhythm is a natural extension of a human heartbeat; its vital regularity within both the body and a written score is a reminder that we live by distinct measures of time. The inherent predictability of rhythm exists in defiance to the asynchronous happenstance of the natural world. Rhythm is one form of patterning we search for in our environment. Our brains are extraordinarily well-adapted to notice cyclical patterns in spoken language, the uniformity of simple activities like walking or swimming or the routines of work and play.[8] Igor Stravinsky's famous *Rite of Spring* (1913) splits the difference: its musical brutalism is a reminder that the natural world has its own chaotic time signatures. But like most music, its insistent use of evenly spaced but irregularly accented rhythmic lines reveal the human propensity for regularized markers.

Another common view of music is that we are hardwired to hear minor-key darkness that eventually settles in the comparative sunshine of a major key. Any number of symphonic works like Beethoven's Fifth Symphony do most of their agonizing and soul-searching in a darker mode (C minor, in this case), finding major-key optimism only in the final movement. As the composer noted about the work, "joy follows sorrow."[9] The great conductor Leonard Bernstein had a related belief in a person's

intuitive sense of what works harmonically, theorizing that some of the elements of generative linguistics may apply. This approach to grammatical forms argues that music builds on intuitive understandings: a view that was extended by Bernstein to natural sense-making for recurring patterns of rhythm and chromatic consonance.[10] Even the very young seem to intuit musical and unmusical intervals. Others aren't so sure, like the musician and neuroscientist Daniel Levitan, who notes that we probably learn the grammar of chord structures and cadences by absorbing them early in life.[11]

The absorption theory gets some anecdotal support from a well-known moment captured on film when a conductor did not get what he wanted from a particular performance. The Spanish tenor José Carreras struggled in one 1984 session to please the same Leonard Bernstein. The scene of the impasse was an RCA studio in mid-town Manhattan. A select group of musicians had gathered to make a new recording of *West Side Story* (1957), Bernstein's most admired piece of musical theater about two gangs struggling to thrive in Manhattan's Hell's Kitchen. At the same time it's also Arthur Laurents' unusual re-imagining of Shakespeare's *Romeo and Juliet*.

The record label that would release the album thought that it would be useful to make a promotional documentary about the session, especially since the composer was on the podium.[12] But they had not counted on the slow humiliation of the Spanish tenor, José Carreras, as he tried to perform the tricky rhythms in "Something's Coming," a touching bit of dramatic foretelling from the teenage Tony, who is about to meet his Juliet. Carreras struggled to match the jazz vernacular that is woven throughout the score and that was second nature to Bernstein. But each "take" was rhythmically botched in some new way. Bernstein's face was always a reliable register of his feelings, and it reflected

his growing pain. Not only was Carrera's diction alien and too formal for the character, but his reading of the eighth-note rhythms was blocky rather than "hip." Classical performers generally have a hard time using the looser and more improvisational sound of American pop and jazz. Most reviewing the clip will find a singer from a different cultural heritage who was never trained to hear the hesitations and anticipatory entrances that Bernstein wanted in the performance. The episode is a reminder that the absorption theory works broadly but does not necessarily transfer to different cultural traditions. Carreras would probably have been fine had he grown up in the United States listening to Sammy Davis Jr. or Mel Tormé.

However we acquire musical skill, the paths to musical insights are varied. While it is usually possible to translate sentences from one language into another, the submission of music to the stipulative meanings of any linguistic form is partly a denial of its very essence. Talk about music should always be suspect. It never fully works to take a sense form out of its natural home. This is a caveat to be taken seriously, even as we momentarily follow tradition and ignore it. Music minus lyrics is resolutely ambiguous. Even the overworked clichés frequently used in scoring mainstream films—for example, the mock military marches in composer John Williams' *Star Wars* scores—can still succumb to what linguists describe as polysemy: the fact that words, symbols and expressions can be understood in many different ways.[13]

For example, most listeners assume that Aaron Copland's popular *Appalachian Spring* was written with a specific program in mind. But the wonderful score now associated with the green hills of Appalachia carried the original title of "Ballet for Martha." It was not written with bucolic images in mind, though the Brooklyn resident did make use of the Shaker hymn "Simple Gifts." Only

later did dancer Martha Graham actually come up with the name.[14] Similarly, I can try to explain the feelings triggered when listening to Ralph Vaughn Williams' *A Sea Symphony* (1909), or the sense of witnessing sonic perfection in the chord progressions of pianist John Bunch's "You're Sensational" (1956), or the rightness of LaVance Colley's rhythm and blues version of Beyoncé's "Halo" (2008). But in every case our language is likely to falter. It's an implicit reminder of why we have music. It sets up another way of knowing that is beyond the verbal, creating a form of interiority that thrives without specified meanings. In short, music is its own set of subjects without predicates, a form of awareness mostly understood by the private self.

Fundamental Attributes

Music has several qualities that account for its status as a refuge, among them: the sonic richness found in the *timbres of instrumentation, phrasing and rhythm, the attractiveness of chromatic elements woven into melody, and the power of organized sound to convey feelings and moods.* These elements are noticeable even in a relatively short segment of a composition or song: often phrases of four or eight measures, legato passages that blend shorter phrases together in a wider sweep of expressiveness, or perhaps in segments anchored by an underlying drone with complementary melodies dancing on top.

It's useful to momentarily separate these four musical attributes that are obviously combined in any single instance. And the first is a special case that can often account for why we are so easily captured by a particular voice or combination of sounds.

Timbre refers to the character or tonal quality of a particular instrument or a voice: muted or edgy, brash or ethereal, piercing

or soothing. The closest visual equivalent is perhaps color. Tubas often carry the sound equivalent of a gray fog in a sonic trench of 40 or 50 Hz; but unmuted trumpets can be as bright as the midday sun. Air movement through these instruments contributes to their varied colors. Pipe organs, which a nameless wag once called a "big box of whistles,"[15] are fascinating sources of timbres, featuring wood "pipes," tubes with vibrating reeds at their bases, and long tin pipes of varied dimensions and lengths. Older organs often make an interesting "chuffing" sound produced in the first microseconds when a pipe starts to "speak." Age and fussy mechanical links mean that a pipe will grudgingly respond, but slow enough to leave a split second of leaking air with the unique timbre of a Peruvian pan pipe. The sound has since been mimicked by modern synthesizers in the fusion jazz of Don Crusin and others. The same quality of allowing more sound of flowing air permitted clarinetist Benny Goodman to produce a softer style in his signature recordings of "Moonglow" (1933), which are still staples on some American film soundtracks. By contrast, the famous musician needed a more "up front" timbre to perform the opening glissando at the beginning of George Gershwin's brash and jazz-infused "Rhapsody in Blue" (1924).

Perhaps the loudest musical sound with a defined timbre is also a drummer's biggest weapon: a "rim shot" that dramatically punctuates jazz and rock music. A drumstick is positioned to simultaneously strike its midpoint shaft on the rim of a snare drum *and* its tip on the drumhead. Both points struck at the same time can sound like a rifle shot: the ultimate way to accent a single beat. At the other extreme, a quiet but clear timbre comes from a triangle, a bent but open length of solid metal meant to deliver an untuned "ping" that can stand out against the heaviness of an orchestra.

Timbre is heard because of the cochlea's sophistication in sensing the unique tonal attributes of different instruments. When several instruments play the same note in the same octave, their evident differences in sound are partly attributable to their contrasting timbres. All produce unique sounds based on their materials, size and harmonics, giving each a "voice" that adds depth and variety to what could be read in musical notation as a plain line. We seem drawn to multi-hued timbres that entertain the ear with a certain freshness. Woodwinds and brass instruments impart different sounds caused by the interaction of a resonant air column with a particular mouthpiece, lip position and the dimensions of their plumbing. Alone, the mouthpieces of brass instruments have a rude nasal quality, not unlike the sounds coming from a group of ducks. We need the rest of their pipe-like tubing to achieve the fullness we expect to hear. The same would be true for the human vocal folds *out* of the larynx, creating what would amount to mere squeaks without the resonance added by the cavities and bones of the upper body. The final result heard through a complete instrument—human or mechanical—is "coherent" sound, with the kind of regular and repeated waveforms easily recognized by the ear or an oscilloscope.[16]

Double reeds like oboes and some organ pipes have different characteristics than single reed clarinets and saxophones. And instruments with strings are defined by the timbres created partly by their hollow and resonant wood structures, as well as how they are plucked or strummed. String instruments like a violin or viola produce tones by drawing a bow with rosin-coated horsehair across the strings. The resistance created by the horsehair and the sticky rosin against the strings produce a vast range of tonal colors: everything from a voice-like cello, to violins muted to produce a soft timbre that is a kind of auditory velvet.

It follows that a mastery of mixing timbres is at the heart of orchestration, the art of melding the “sweeter” sounds of some instruments next to the simpler edginess of others. Orchestrators do arrangements of their own music as well as the compositions of others. Once mostly anonymous, the growth of a more sound-centric population has brought new interest to many of these individuals.[17] The Beachboys’ Brian Wilson and Hollywood veteran Dave Crusin are cited for their skills at blending sound.[18] Among contemporary music videos, a productive Scott Bradlee uses singers and mostly acoustical instruments to create what he calls “successful mashups” of instruments and styles in his ongoing Postmodern Jukebox channel.[19]

Perhaps the ultimate immersion in the possibilities of timbre may be in the gamelan ensembles of Java and across Indonesia: players of what Westerners would recognize as bronze bells, small gongs, cymbals and bell-like xylophones. Their music bathes the listener in subtle and exotic timbres. Unlike our Western and Turkish equivalents, all seem to ‘bloom’ with unusual warmth and subtlety, creating waterfalls of seamlessly blended sound.[20]

An additional and essential attribute that feeds our thirst for music includes the ways it is patterned into units of *phrasing and rhythm*. Humans are fast learners in detecting distinct structures in the spacing of notes and phrases, which are distinct sections of a work. Each is different but related, and best understood as patterns and recurring forms that our species seems hardwired to notice.

Phrasing is an inexact musical term, but a useful one. It is any segment of music that is complete as a sonic idea, and will often be repeated. It may be four short measures of music, eight measures, or even sixteen. Conductors and musicians will often identify “tricky” phrasing that needs to be rehearsed, somewhat

like a line of poetry that begs for the right reading of particular words. The phrasing in pop songs conventionally gives us three chances to hear a melody: two back-to-back statements of a tune (sometimes two phrases put together), followed by a second and different transitional melody or "bridge." Then it may close with a final third statement of the original melody. This A-A-B-A structure has reliably worked for decades in generating hits, everything from Richard Rogers' "Blue Moon" (1934) to Paul McCartney's "Yesterday" (1965), to Burt Bacharach's and Hal David's "Raindrops Keep Fallin' on My Head" (1969). Indeed, for songwriters, it is often the clever modulations in the "bridge" or "release" that puts a song on a higher plateau of interest.[21] The totality of this four-part structure often adds up to a classic song made up of eight or sixteen phrases.

Understanding phrasing matters because we grasp them as ways to understand the pathways a song will follow. Like a walker in the woods, we look for familiar landmarks that remind that we've been to the same spot before. Think of some popular music you want to hear again and you can find yourself waiting to hear the great bridge (the B melody), which is revealingly called the "hook" by some songwriters.

In more traditional and usually longer pieces of classical music, variations or repetitions are built from a central theme or a music motif.[22] These may happen in a compressed form, such as Johann Sabastian Bach's well known *Toccata and Fugue in D Minor*, with a stormy prelude combined with a fugue, or a pair of competing phrases building off the same melody. It is an organ showpiece, and all over in under nine minutes. Conventional symphonies often use a broadly defined sonata form that is made up of three or four movements, sometimes running a quarter hour in length. Each movement uses a contrasting tempo, and usually involves the "building out" of a fragment or phrase from the first

movement. As the music appreciation guides often summarize the form, “exposition” is followed by “development” in a second movement and “recapitulation” in the third.[23] In practice, most pieces have their own logic, often following masters of the form like Joseph Haydn and Ludwig Beethoven. But all gain their appeal from the threads of a common key and the use of phrasing patterns that were heard before.

Usually a single movement can stand on its own, but astute listeners can hear compositional elements that unite the movements into a larger sonic universe. For the rest of us, the piece simply builds within a dominant key to a satisfying climax.

More “modern” composers like Gustav Mahler enlarged what an orchestra can say musically. Children’s songs, klezmer music and references to the noise of the streets are parts of the auditory universe his music enacts, shattering the formalist rules of the sonata form, as in his *Fifth Symphony*, creating a vast aural canvas suggesting life’s highs and lows.[24]

This macro-level of patterned organization also contains a *micro*-level of structured *rhythm*, usually designated as so many beats per measure. A measure is simply the notational and conceptual device for representing a recurring beat pattern, as with the two measures of eight beats below:

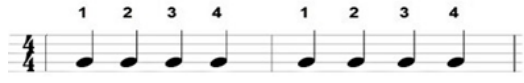

Figure 7.1
Two measures

We could be describing a Billie Eilish hit or a Beethoven symphony. Most Western music is understood and notated on the page in terms of a certain number of beats per minute or per individual measure. One common meter for music is $\frac{4}{4}$ time,

meaning there are 4 quarter notes (♩) or 8 eighth notes (♪) to a measure. This is all set in motion at a certain pace that a composer indicates at the top of the score. A song or longer work that is fully scored may suggest 83 beats a minute, notated as ♩=83, considered a moderate tempo. The reader may remember such metronome markings on music scores intended to help master the rudiments of playing an instrument.

Of course, any music can combine various rhythm combinations. But the ear will still clearly hear the regularity of the $\frac{4}{4}$ time-signature even when listening to eighth notes, whole notes, or combinations that split up a measure in other ways. Most pop music is also more easily recognized if the second and fourth beats are emphasized, sometimes one more than the other. Jazz also uses this common rhythm form, but with a distinct impulse to play certain notes slightly "behind" or sometimes ahead of the first or last beat. This flexibility is what gives jazz its reputation for on-the-spot invention, so evident in the piano playing of musicians such as Jon Batiste, McCoy Tyner, and many others. By "playing around the beat," jazz engages the ear's willingness to share in the sonic equivalent of painting "outside the box." As for the jazz drummers who are partly responsible for keeping a steady beat: their trance-like expressions may reflect the mental concentration it takes to maintain the forward movement of a piece that features other musicians surging ahead or deliberately falling slightly behind.[25]

Less intense, perhaps, but also important is the meter of a waltz, which is, by definition, music at *three* beats per measure. Waltzes usually proceed at a leisurely pace and with an emphasis on the first beat: everything from Johann Strauss' "Blue Danube" (1866) to Alison Kraus' "Dreaming My Dreams With You" (1999). Regardless of the meter, the underlying point remains the same:

most music hangs firmly on a framework of regularized rhythm made even more attractive by the decoration of a strong tune that seems like a perfect fit.

Indeed, recognizable *melody*, our next attribute, seems to lie at the heart of why music means so much. In whatever form and for almost all audiences, melody is clearly a driver of our musical interest. For the composer Aaron Copland, the baseline test for any "intelligent listener" rested on their ability to recognize melody.[26] Melodies are distinct repeating sets of phrases built from the Western 12-semitone chromatic scale.

The ingredients for a good song remain mostly a mystery, but as cultural historian Geoffrey O'Brien rightly notes, "haunting melodies take up residence" inside us and endure.[27] Writers have often attempted to dissect the sources of appeal and mastery of even the relatively simple popular song.[28] But looking for formulas for making hits is like trying to come up with a set of rules for writing memorable poetry. As Copeland noted, no one can say with any certainty what makes a good melody.[29] And most performers spend little time trying to explain how they create an original piece. In fact, many pop or jazz musicians create pieces without constructing highly detailed sheets of musical notation. Instead, they often depend on simpler "lead sheets" or just "head arrangements" of melody lines and key phrases that are embellished and recorded, then perhaps "sweetened" with added voices or instruments prior to producing the final master of a new release. As a rule, a spirit of experimentation and their enduring relationships with other musicians matter to song writers a great deal; technical knowledge: not so much.[30]

What turns a melody into an ear worm? As we have noted, we are wired with the capacity for perceiving and receiving pleasure from a rhythm sequence. And it is mostly the same for the tonal contours of a melody. From childhood we quickly absorb

the “what-goes-with-what” conventions common to the tropes of harmonic structuring.[31] It helps that sound frequencies spread over seven full tones *double* with each succeeding octave. For example, A4 on a piano carries a frequency of 440 Hz. One octave further up is the next A5 at 880 Hz, with an equalized frequency distribution between these seven notes. These steps make it perceptually possible to hear intervals of thirds or fifths that sound best between these whole steps.[32] Children easily pick up the *do-re-mi* scale, setting the stage for their appreciation for even intervals and interesting variations. The idea is that we already “know” a harmonic series like a triad of C, E, and G without having to do more than hear it a few times. Even without being able to name them, we hear and recognize the basic elements of home keys and spaced note intervals that almost intuitively sound right, picking up the emotional resonance of music that moves from, say, “perfect fourth” or “perfect fifth” note intervals, (as in “Mary Had a Little Lamb”). Moreover, with more listening we begin to hear the yearnings of blues or jazz that drift beyond the seven whole chromatic steps into the minor scale represented by the black keys on a piano.[33]

Chord structures are learned as well, with familiar intervals that make sense for a given key and the rest of its scale. From these elemental basics its just a short step to the pleasant surprise of a shift to a new key, or to slightly dissonant notes or chords. In the case of a simple melody, all of this happens in four minutes or less, as we begin to anticipate the pattern of given note sequences tied to a key, its scale, and a rhythm pattern. Again, it is this cognitive capacity for perceiving patterns that gives melody its familiarity even after a first pass.

Programmers of classical music for orchestras or various media often rely on this kind of pattern-making, choosing music that will contain a “big tune” that is a listener’s reward for sitting

through a long work.[34] And the rewards can be rich. Sergei Rachmaninoff's *Second Symphony* (1907) contains a third section with a melody that would melt the heart of the most hardened soul. Most people know this *Adagio* of this popular work, where the melody is passed from the violins to a clarinet, back to the French horns, and eventually back to the strings. It's probably the most breathtaking theme this Russian American master ever wrote. Music like the adagio is a pleasant sensation that takes up occupancy and endures. We savor the familiarity it triggers, which explains the hundreds of recordings of it that exist.

Another common view that accounts for what music can become is when it is seen as a unique form of *expression that creates feelings or moods.* Program notes written about most of the orchestra pieces that are passed out to concert goers lovingly dwell on the pieces they are about to hear. The thumbnail estimates of what was on the composer's mind are usually far too deterministic. But music is not exempt from our love of interesting backstories. The same holds true for singer/songwriters, who are often understood as revealing their inner struggles in their melodies and lyrics. There is no shortage of master story-telling in the songs of John Prine, Richard Shindell or Joni Mitchell.[35] Mitchell recalls a plea from fellow singer Kris Kristofferson to withhold some part of her private self from the public.[36] Her confessional "River" (1971) about a failed relationship and a child given up for adoption seems to have been what Kristofferson had in mind.[37] There is also evidence that the popular composer Ralph Vaughn Williams was expressing a deep empathy for his home city of London in his *Third Symphony* (1914), and a quiet despair over the human tragedy of World War I in his *Fourth Symphony* (1936). It is also surely the case that pop singer Taylor Swift's music video, "The Man" (2020), was intended as it plays:

as a rebuke against the men at her record label making decisions about her catalogue of recordings against her wishes.[38]

For many, music means even more when linked to biographical associations. But there's always room for doubt. For example, in an earlier chapter we wondered if Dimitri Shostakovich's *Fifth Symphony* (1937) was a taunt at Soviet leaders who often disapproved of his work.[39] It's possible to hear its clichéd triumphalism as mocking the formalism of his Soviet masters. Famous composers and musicians can't help but speak as surrogates for the rest of us. And so, their stories matter even while the original caveat still applies. In the end, words about a specific piece of music can force it to be more earthbound than it wants to be.

Alternatively, moods created by music may have what Aristotle described as a catharsis function, providing aural triggers to emotions, feelings and memories that we already know. From this point of view first mentioned by the philosopher in his *Politics*, music is a proxy for feelings that tend to outlive our interest in the particular experiences that might have triggered them.[40] If an experience remains as a benchmark—a memory that we have banked—then, perhaps, the memory function offers a reasonable explanation. Most people retain a mental playlist of songs and fragments. Such is the nature of adolescence that its experiences often carry accessible sound stamps representing moments of infatuation, self-realization, and social dislocations that often go with the period.

These associations often show up in modern "jukebox musicals," which seem to be another version of what the playwright Tennessee Williams would have described as "memory plays."[41] He meant that one of the characters ends up narrating the story: not so different from the idea that a music listener hears a sonic artifact that flares up in an otherwise

cooling memory of a distant period. Somehow, music allows us to revisit old feelings and sensations through a sonic lens. In an era of audio saturation, music puts back into play small fragments of memory that were otherwise on their way to extinction. In more basic terms, music can be a substitute experience that can take over when the verbal fails.

All of these rich forms of sonic triggers are a reminder that it can be a novice's film director's mistake when they treat aural elements as merely supportive of the story. To be sure, sound is more fragile and easily swamped by visual clutter. Yet, as we note in the next chapter, it can also be a stand-in for the story. To hear John William's main theme for *Schindler's List* (1993), for example, is to feel the weight of the movie's harrowing story all over again. Music clearly converts intensity of feeling into something that is both sensate and accessible.

Music and Memory

Watch a two-year-old child move to the beat of a song and we are reminded that the ear readily learns to love music's rhythm. Often minimized as a pleasant addendum to life—sensorially rich like "cheesecake," notes cognitive psychologist Stephen Pinker, but "biologically functionless,"[42]—in truth, music cannot be so easily dismissed. Not only do we live for its moments of connection in times of stress or joy, but its presence is a positive factor in the mental health of many. During the 2020 covid-19 pandemic and extended quarantine it became clear that, among other comforts, people turned to the respite of music: listening, curating and sometimes performing pieces from their own balconies and windows. As music journalist Ed Prideaux has noted, "From as early as ancient Egypt, Greece and the

Babylonians, music has been a reliable tool for spiritual healing and social bonding for thousands of years amid disease."[43] It is its own form of sustentation and personal reinvention: a balm for the soul and also a uniquely human answer to the furies of nature.

We can see this in another way in the Netflix release of Michael Rossato-Bennett's 2014 documentary, *Alive Inside*.[44] The filmmaker initially signed on for just one-day to film an effort by social worker Dan Cohen to reclaim an older American lost to the fogs of dementia. The experiment soon captivated the filmmaker and became a full-time project. Cohen discovered that many seniors were reanimated by their own seemingly lost memories when reintroduced to the music of their youth. For one older gentleman it was simply enough to hear the restless swing of Cab Calloway through an MP3 music player to lift clouds of withdrawal and confusion. He smiled and looked up, suddenly noticing his caregiver. The formerly unresponsive man began to engage as a conversational equal. The music brought him back to portions of his past, which included his memories as an accomplished dancer and self-confident musician. The idea of a wearer of a set of headphones experiencing private ecstasy is hardly new to us. But it means so much more when the person listening is thought to be lost in a cognitive fog. Musical memories are usually not lost in many who have dementia. The portion of the brain that is fed by the auditory nerve is relatively undamaged by the plaque that suffocates other neurons.[45]

In another scene from the documentary the same was true when the headphones were placed on Mary Lou Thompson, a younger woman perhaps in her early sixties with early-onset Alzheimer's disease. Even recognizing the purpose of an elevator button was difficult. Thompson's fit and alert husband could only marvel at the sight of his wife, earbuds in place, slowly unfolding

her tall frame to glory in an old Beach Boys song she obviously never forgot.[46] It was like watching a time-lapse image of a newly opened flower reaching for the sun. I've seen very few screen documentaries that so dramatically revealed the transformation of a person's mental life.

There is a useful symmetry to all of this. The first sense to come online in the womb is hearing. It also appears that meaningful responses to musical sounds may be the last form of cognition to be extinguished at the end of the life cycle.

There are reasons to lament the mobile phone and music player as devices that undercut the value of direct and immediate experience. But the portable music player has added to the reinvention of sound, which is one of the recurring themes of this book. A music library stored on a small electronic card fully delivers on the promise of making art portable to those who need it. Even the crusty Thomas Edison sensed the power of his first device to mesmerize. Listeners clamored to hear songs on his audio cylinders, often listening through rubber ear tubes that were the forerunners of earphones. He seemed to understand the regenerative possibilities aural media can bring to refreshing the human spirit.

Where Does Music Mean?

Even with its advantages, what was once the most 'social' of our activities—sharing music—can now be used to keep others at bay, a new kind of refuge from the outside world. Portable music has been with us at least since the Sony Walkman introduced in 1979. Forty years later we are accustomed to taking a preferred aural environment with us, mostly drowning out the one we are in. A glance at a busy sidewalk will show many people who have

substituted a private soundscape for their urban landscape. The lanyards hanging down from ears is the giveaway.

This kind of isolation seems like a peculiar violation of the social dimension that has always been a part of making and often listening to music: easily illustrated with the ordinary experience of awkward non-interaction in a supermarket. The challenge came from a tall man, perhaps in his 20s, his earphones leaking out sound like hundreds of little straight pins rolling around in a can. We both wanted to extend our reach to a high shelf blocked by the other. At the same time his eyes seemed to take a cue from his aural isolation; he looked down and away. This shopping trip was strictly a solo effort in his own private space. My friendly glance to him was ignored or not seen; his body and his head were in different places. And so I was both in the way and also not really there. We now routinely enter the personal space of strangers without ever acknowledging them.[47] There is nothing unusual about this in the twenty-first century. And yet there was this little insight: what is arguably the most 'social' of our media is now part of the apparatus we use to keep others at bay. Can a refuge also be a barrier?

The history of music-making has almost always had a social dimension. Of course the simple idea of "cooperation" does not begin to describe the intense listening and blending that musicians playing together must master. As for the rest of us, in most of the nineteenth century families with any disposable income had a piano, and usually enough kids to assure some duty-bound performances to visitors. Performances in private salons and concert halls came even earlier. In England the Hanover Square Rooms holding about 900 people were used in the late 1700s to hear composers such as Joseph Haydn and George Frederick Handel.[48] By the early 1800s halls were built and packed with listeners eager to hear small groups and even

full orchestras. To this day avid music fans thirst for “live” performances of a sort in both massive arenas and more intimate clubs.

All of this can make a person wonder if music belongs in the detergent isle at all. Is part of its essence violated by a cheap ear-sized speaker competing with the commotion of a supermarket? Is there a sense in which our love of the form has the effect of undermining its traditional powers to foster affiliation?

To be sure, isolated listening has increased the time we can spend with this precious form of sound. The mass production of phonographs at the end of the 1800s was only the first step in making music accessible. And who doesn’t cherish the ability to call up a great performance that can be rendered at will? Even so, communication “at a distance” always exacts a price. When performers and their audiences are separated, something is lost, just as clearly as when a listener is in a reverie that goes unshared.

The Strange Business of Organized Sound as Property

If music is a refuge and a balm for the soul, music as a *business* can be just the reverse: what musician and record-producer producer Quincy Jones has described as a “disaster.”[49] So we turn to an important exception to the pleasure principle that applies to casual listeners who are music *consumers,* but partly conceals some hard organizational truths a professional will likely encounter. It is not always easy for the thousands of singers, musicians and writers who want to live off the fruits of their work. And it can be costly to use the work of others. Rarely has an evanescent art form come with so complex a maze of legal structures to define authorship and monetize its value.

Avid listeners know of many singers and musicians. But behind most performers lies a much larger group of less visible organizations that have converted music-making into a lucrative business of rights and royalties. These include publishers, record labels and performance rights organizations (PROs) who apply formulas for royalties collected from users and paid to performers.

The broad principle behind these sets of obligations is straightforward. In the West and other parts of the world the creator of an original work can claim protection against its use by others. The principle of copyright is meant to prevent anyone from using or profiting from another's artistic or intellectual project. This right of ownership is especially clear with whole works, such as a novel, film or a particular image. But it applies to organized sound as well, with many complex permutations beyond what we have space to explore.[50]

To start with a straightforward case: a singer/songwriter like Taylor Swift gets about nine cents per copy of any recording made of one of her original songs. That would be true for most songwriters who are recorded by others. In addition, consumers buy or pay for the rights to stream those songs, usually at a modest flat monthly rate. It is also true that there are scores of businesses and groups that are billed for using copyrighted music. They include every kind of organization, ranging from a bar with a jukebox, to radio stations playing contemporary music, to high schools mounting performances of *Oklahoma!*

Generally, the law of copyright exists to protect music as "intellectual property," even though sound may seem less tangible than a book-length manuscript. A singer-songwriter has the same protections as a published author. In the case of music, a piece is "published" and protected if it is recorded or made available to the public in any form, including uploading a video or music file to a website.[51] Under American laws individuals who are protected

can include the songwriter or their publisher, in addition to a particular performance of a song. Individuals are legally liable when taking another person's creative output and using it for anything more than private consumption.

In publishing, a doctrine of "fair use" prevails, allowing one author to quote a brief passage from another without payment. But this leeway does not apply to music or lyrics. The only music that does not need to be "cleared" prior to use are pieces that have fallen into the category of "public domain," meaning they were written before 1925. Older works as varied as Mozart's or Brahms' great symphonies, or Irving Berlin's "Alexander's Ragtime Band" composed in 1911, are no longer restricted by American copyright law. However, if a music arranger comes up with a unique version of Berlin's classic, the use of that arrangement *is* covered by copyright.

Even with these legalisms, music is clearly an unusual case. After all, its creation is subject to the mathematical and aesthetic routines built out from a narrow twelve-tone scale. How many different ways can those twelve notes be assembled, triggering copyright protection? How original is any eight- or sixteen-measure "bridge" in a pop song? In the judgment of some experts, it's quite likely that larger melody overlaps will occur, making many copyright infringement cases "absurd."[52] Moreover, there is a long tradition of composers using themes and musical ideas from their predecessors. As one music critic notes, "It's just as well copyright law didn't exist in the eighteenth and nineteenth centuries, because composers often cannibalized each other's tunes. Without Mozart remodeling Handel, Brahms recomposing Bach and Schubert "rewriting" Berlioz, "classical music wouldn't be as fruitful."[53]

Consider "My Sweet Lord" (1970) by George Harrison of the Beatles, which was ruled an infringement on the copyright of

"He's So Fine" sung by the Chiffons in 1962. Even with so prestigious a defendant, a court decided that Harrison had at least "subconsciously plagiarized" the song owned by the Bright Tunes Music Corporation, and he was ordered to pay $587,000.[54] And then there is the notorious case of "Happy Birthday to You." Are families on the hook to pay a fee to Warner/Chappell Music for having sung the allegedly copyrighted song around the dining room table? Luckily, in this notorious case a judge spoke on the side of sanity, noting that it was inappropriate to ask anyone, including a documentary filmmaker, to pay $1,500 to use the ubiquitous tune. In a class action suit she sued Warner/Chappell over their claim of exclusive rights, with a decision that the song was rightfully in the public domain. As a result of the 2015 decision, Warner was required to pay a fourteen-million-dollar settlement to past filmmakers and others who had already paid fees to use the song.[55]

The trend with charges of infringement is for more courts to follow the lead of the Warner/Chappell case in dismissing suits brought by copyright holders. The pattern evident now is to err in favor of songwriters who have simply duplicated simple chord structures found in other songs. This approach is what is described by music insiders as a "thin" interpretation of copyright, meaning "a plaintiff must show that a work is 'virtually identical' to a defendant's."[56]

Even so, for a little over a hundred years the presence of recordings and live performances has produced increasingly strong organizations with the clout to require payment to artist-members for using their work. The oldest performance rights organization (PRO) is the American Society of Composers, Authors and Publishers (ASCAP), which came into being after a Supreme Court case *(Herbert v. Shanley Co., 1918*) ruling that Victor Herbert should be compensated by a New York restaurant

for using player piano rolls of his music.[57] Herbert and Irving Berlin were among its founders, determined to get paid for their compositions. ASCAP operates as a non-profit cooperative of musical professionals of various sorts, taking a small percentage of royalties on behalf of its members to do its work of identifying and billing music *users*. ASCAP licenses music and musical performances to television and cable networks, 11,000 cable systems, 11,500 local commercial radio stations, public radio and television, Pandora, Spotify, YouTube, Rhapsody, Netflix, Amazon, Apple Music and thousands of websites and mobile apps. Over 2,000 colleges and nearly 7,000 concert presenters and orchestras also pay yearly fees.[58] And, of course, it still means that a restaurant owner may receive a bill from ASCAP or another PRO for using licensed music.

In addition to ASCAP, musicians are represented by other licensing groups like BMI (Broadcast Music Incorporated) and SESAC, (Society of European Stage Authors and Composers). The latter represents Bob Dylan, Adele, and others. All collect user royalties on behalf of their members.

Those recouped royalties are sometimes paid to individual artists. But the modern mammoths of the music business are music publishers, who are more likely to be holding the copyrights. A songwriter or composer usually needs a music publisher and record label—often one and the same—to invest in and manage their creative efforts. Some publishers may also still live up to their namesake origins and produce sheet music. But their primary function is to secure copyright ownership of a singer or composer's "catalogue," in exchange for help in finding venues to perform portions of it. For this service they usually take 30 to 50 percent of the royalties due the original creator.[59]

In a basic sense, publishers *are* the music business. There are many, but a handful dominate publishing, with various parts

that extend from obscure private-equity investors to units managing companies with well-known record labels. The largest publisher, Universal Music Group, is the owner of Capitol Records, Motown, EMI, Decca, Island, A&M and many other labels. In turn, it is owned by the French parent company, Vivendi. The second largest is Japanese-held Sony/BMG Music Entertainment. In 1987 Sony purchased CBS Records, (including Columbia) from CBS: a dismembering of the once-storied American company,[60] but a shrewd software purchase by the Japanese manufacturer. The idea was that it would be able to sell its own music to play on its many ingenious devices (i.e., versions of the Walkman). A close third in size is the U.S.-based publisher, Warner/Chappell, also known as the Warner Music Group.[61]

Some musicians and semi-professionals try to avoid this "corporate" side of the "business," preferring to act as their own publishers and record producers, thereby retaining all rights to their music.[62] But it is still a noted mark of having "arrived" in the music business to be offered a recording contract, as well as the management services that come with having a music publisher.[63]

Since record deals usually carry a stipulation that the publishing rights are to be turned over to the publisher, tensions can suddenly become very public, especially if a mega-star with a huge following feels like they have been cheated. So, it was when Taylor Swift sought to fire her record label, Big Machine. The label had invested in her career early and owned the recording masters and copyrights of her first six albums, and she wanted to buy the rights back. The company and its largest investor, the Carlyle Group, sought to find another solution rather than lose their biggest artistic asset. But they had not counted on the battle going public, with Swift urging her fans to write to the managers of Big Machine and the heretofore very private

individuals in the Carlyle Group.[64] Her argument echoed other segments of the entertainment business. She noted that, as a woman, she wanted to have her “independence” and artistic decisions honored in a business dominated by male executives.[65] Most established artists lament that they “gave away” too much in their early careers, when getting a foothold in the business meant more than permanent copyright ownership of their work. In Swift’s case, her record label and publisher generated considerable revenue that was split between them and her. At the time this is written, her own answer to losing control of her catalogue was to re-record the same songs and re-release them on her own terms.[66]

In different circumstances where an artist wants to “cover” songs written and performed by another writer—possibly Swift, for example—a *mechanical license* is granted, requiring payment to the publisher and author of approximately nine cents per track per copy mentioned earlier. A release of 1,000 vinyl albums by a singer that uses one of Swift’s songs would yield roughly a $90 payment. A mechanical license royalty is also owed whenever a copy of the author’s song is reproduced for purchase in the form of a recording, a download, or if it is streamed.[67]

In the case of music used in other media such as movies or television, music licensing often involves two separate fees. A *synchronization fee* must be paid to the publisher/copyright owner by another creator who wants to use their own version of someone’s copyrighted music. The name simply implies that some version of the song will be used “in sync” with planned action within the film or program. Typically, a film producer or their music supervisor would hire a group to record it. But if a director specifies that they want to use an existing recording of a song—usually a version most people know—an additional fee must be paid. This is called a *master fee.* In a hypothetical case

this could occur if a director decided that they wanted a Frank Sinatra recording (an expensive choice) to play under a scene depicted in a film set in the 1960s. A common favorite is his version of the Richard Rogers/Lorenz Hart song, “Where or When” (1937), which was brilliantly recorded in full Sinatra swagger for a live 1966 album. In this specific case a synchronization fee would be paid to the publisher or copyright holder of the *song*: Warner/Chappell and the Williamson Music Company. In addition, a master fee would be paid to the owners of the version heard in the Las Vegas recording.[68] The fees to either one would still apply even if the music was used for just a few seconds.

And it can get even more complicated. Additional fees will usually be assessed for international rights, and for different forms of media that might carry altered versions of a song in a re-edit. Rights must also be paid again if the original holder of the rights sells the entire finished film to another company. Sometimes smaller fees may be negotiated for film students who only seek temporary music rights, or documentary filmmakers working with small budgets.[69] Licensing a cover version (a lesser-known recording) of a song is almost always cheaper, which explains why a song requested by title from a subscription streaming service may be by a lesser artist.

Obviously, licensing can be an expensive business for anyone who wants to use copyrighted music of masters that have remained popular and recognizable. Consider one insider account of fees paid by the producers of a late-night television show, where some very costly music choices were made by the host who knew he was about to be fired:

> Conan O’Brien wanted the last laugh when NBC replaced him on the “Tonight Show” with Jay Leno after only seven months on the job in February of 2010. He decided to use

> the Rolling Stones 1965 mega-hit “(I Can’t Get No) Satisfaction” when Adam Sandler was introduced as a guest. The move reportedly cost NBC $500,000 even though the song was played for only a few seconds. O’Brien also used the Beatles’ “Lovely Rita” earlier in the week to introduce Tom Hanks, costing NBC another $500,000.[70]

Another revealing case study of music licensing is the landmark film, *When Harry Met Sally*. When it was released in 1989 it offered what some critics saw as a new model for the standard genre of the romantic comedy.[71] The film recounts the long friendship of college acquaintances of Harry Burns and Sally Albright, who proceed to build their careers in New York City while trying to remain in a “just friends” relationship. The premise of the comedy is spoken early in the film by the cocky Harry. He is certain “that men and women can't be friends because the sex part always gets in the way.”[72] Written by dialogue-savvy Nora Ephron, the story captured their hopes and frustrations over a number of years, until their inevitable third act transformation into a true couple. Beyond Ephron’s observant one-liners delivered by actors Meg Ryan and Billy Crystal, director Rob Reiner’s film seemed to spare no expense to license a group of songs from top performers of American popular music. The soundtrack is a filmmaker’s dream-list of recognizable classics for a fantasy Manhattan romance. A traditional budget for a film usually sets aside about ten percent for music. But this production features songs by Sinatra, Bing Crosby, Harry Connick Jr., Ella Fitzgerald, Louis Armstrong, and Ray Charles, among others. At the time, the studio that produced it was tied to a series of deep-pocket investments by Columbia Pictures and Group W Productions. So the $16 million budget ($33 million in current dollars) apparently could handle the considerable fees that must have been paid to

secure the synchronization and master fees: by one ASCAP estimate, $30,000 to 60,000 per song.[73]

But there's an interesting twist. Viewers revisiting the film in recent years have noticed that some of the original songs are missing, replaced by musical cues called "extruded substitutes" given to an anonymous piano or saxophone soloist.[74] The changes are a reminder of why music clearances are so difficult. Anyone who purchases the rights to a film is then considered the new owner (i.e., of a DVD reissue). Those who are budget-minded do not want to pay for the original clearances, using instead the option of "extruded substitutes." In one of these versions, the final scene of Harry and Sally coming together on New Year's Eve is not underscored as it was in the original, with Sinatra's "It Had to be You" (1924). A cheaper instrumental version was used instead. All of this makes it clear why young filmmakers often settle on the music of up-and-coming film composers, whose hourly rates are likely to be well below the master fees for current pop hits. It's an old adage that film students would be wise to find a musician as a roommate.

As we have noted, words hardly do justice to the glories of musical invention. Yet it serves a purpose to celebrate this form of expression in the inadequate terms offered by another form. It is one more reminder that music in the aggregate is its own force for shaping and sometimes restoring our psychic equilibrium. Music has the power to buoy lives that may be floundering: a unique way to restore our creative resources, and to do it in ways that are more open-ended and inclusive than perhaps what any other art form allows. As the writer and critic Fran Lebowitz noted, at almost any kind of concert it is hard to not notice "how happy and grateful people are for music." It is "centrally important to people" for the pleasure it gives. "No one is loved like musicians."[75] Fortunately, we don't ask others to give up the

musical worlds they crave. For the sound-centrics, any attempt at this question would be impossible. Most would claim that music is not a negotiable presence.

Chapter 7 Notes

1. Arthur O'Shaughnessy, “Ode,” Poetry Foundation, accessed March 3, 2020, https://www.poetryfoundation.org/poems/54933/ode-.

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3. Don Tyler, *Music of the First World War (*Santa Barbara, CA.: Greenwood, 2016), 6.

4. John T. Scott, "Rousseau and the Melodious Language of Freedom." *The Journal of Politics* 59, (1997): 803-829.

5. “Quincy Jones Breaks It Down About the Music Biz,” *Hollywood TV*, March 5, 2009, YouTube, https://www.youtube.com/watch?v=1Vt0Fcbp6jA.

6. Susanne Langer, *Philosophy in a New Key, Third Edition* (Cambridge: Harvard University Press, 1971), 210-211.

7. Langer, *Philosophy*, 222.

8. Robert Jourdain, *Music, the Brain and Ecstasy* (New York: Avon Books, 1997), 58-90.

9. Timothy Rice, Dave Wilson, *Gateways to Understanding Music* (New York: Routledge, 2019), 211.

10. Leonard Bernstein, *The Unanswered Question: Six Talks at Harvard*. Cambridge MA: Harvard University Press, 1976), 53-65.

11. Daniel Levitan, *This is Your Brain on Music* (New York: Penquin/Plume, 2006), 37.

12. “The Making of West Side Story,” Deutsche Grammophon (DVD), 1985.

13. Geoffrey Nunberg, “Transfers of Meaning.” *Journal of Semantics*, December, 1995, 191-192.

14. "'Appalachian Spring' by Aaron Copland," *National Public Radio's Performance Today*, 1999, accessed June 29, 2020, https://www.npr.org/programs/specials/milestones/991027.motm.apspring.html.

15. “How a Pipe Organ Works,” Pipe Dreams online, *American Public Media*, https://pipedreams.publicradio.org/articles/how_a_pipe_organ_works/howapipeorganworks.shtml, accessed June 29,2020.

16. One simple definition of “coherent sound” as a defining feature of music is that the wave forms that make it up are “consistent and well ordered in both time and phase.” The sustaining of a single pitch or frequency is one example being “well-ordered.” “In phase” has many meanings, but can be taken here as meaning that the sound arrives to the ears at once, rather than a residue of it arriving a microsecond later. See John Strohbeen, “Coherence: What Is It? Is It Important In Music Reproduction?” Ohmspeaker.com, May 12, 2015, https://ohmspeaker.com/news/coherence-what-is-it-is-it-important-in-music-reproduction/.

17. See, for example, Susan Eliot, “Off the Stage, What's Behind the Music.” *New York Times*, August 13, 2008, https://www.nytimes.com/2008/08/17/theater/17elli.html.

18. Interview with Carol Kaye by Charles Chapman, *Interviews with the Jazz Greats* (Pacific, Mo.: Mel Bay Publications, 2001), 35.

19. Scott Bradlee, *Outside the Jukebox* (New York: Hachette, 2018), 226-227.

20. A useful introduction to this music is Anne Midgette's “Does Indonesia Matter To Western Music? Here's A 3-Hour Concert That Proves It Does,” *Washington Post*, January 24, 2019, https://www.washingtonpost.com/entertainment/music/does-indonesia-matter-to-western-music-heres-a-3-hour-concert-that-proves-it-does/2019/01/24/093de3a8-1fff-11e9-8b59-0a28f2191131_story.html.

21. Jimmy Webb, *Tunesmith: Inside the Art of Songwriting* (New York: Hachette Books, 2013), 122-125.

22. Aaron Copland, *What to Listen for in Music,* (New York: New American Library, 2009), 133.

23. Copland, *What to Listen for in Music,* 146-159.

24. See, for example, Stephen Johnson, “What Makes a Mahler Symphony?” *BBC Music Magazine*, May 2017, 32-36.

25. There is drama in jazz drumming as an essential kind of beat-keeping. See, for example, Damien Chazelle's popular feature film, *Whiplash*. Sony Pictures, 2014.

26. Copland, *What to Listen for in Music,* 4.

27. Geoffrey O'Brien, *Sonata for Jukebox,* (New York: Counterpoint, 2004), 139.

28. See, for example, Alec Wilder, *American Popular Song: The Great Innovators, 1900-1950* (New York: Oxford University Press, 1975.) For a simple list of characteristics see Jourdain, *Music, the Brain and Ecstasy,* 85-86.

29. Copland, *What to Listen for in Music,* 39.

30. For a representative example of this process, see Jac Holzman and Gavan Daws, *Follow the Music: the Life and Times of Electra Records in the Great Years of American Pop Culture* (Santa Monica, CA.: First Media, 1998), 341-344.

31. Jourdain, *Music, the Brain and Ecstasy,* 58-69.

32. To be sure, the mathematics behind equal distribution or "temperment" across the 12-note scale reveal their own complexities. In simple terms, evenly spaced intervals have to be slightly nudged away from the Pythagorean ideal to equalize across the musical scale: a challenge that plagued musicians for centuries. For a comprehensive and fascinating explanation see Stuart Isacoff, *Temperament: How Music Became a Battleground* (New York: Vintage, 2003), 9-42.

33. Levitan, *This is Your Brain on Music,* 36-38.

34. See Joseph Horowitz, *Classical Music in America: A History of its Rise and* Fall (New York: Norton, 2005), 506-508.

35. Shindell's *Wisteria* (2000) would rank near the top of any list of well-crafted story-songs. For an overview of John Prine's career see William Grimes, "John Prine, 73, Whose Songs Unmasked the Human Condition, Dies," *New York Times,* April 9, 2020, A25.

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37. J. Freedom du Lac, "'River,' The 'Thoroughly Depressing' Joni Mitchell Song That Somehow Became a Christmas Classic," *Washington Post*, December 5, 2017, https://www.washingtonpost.com/news/arts-and-entertainment/wp/2015/12/17/how-a-thoroughly-depressing-joni-mitchell-song-became-a-christmas-classic/.

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40. Aristotle, *Politics*, Bk 8, Ch. 7.

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42. Stephen Pinker, *How the Mind Works* (New York: Norton, 1997), 525.

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Chapter 8

HOLLYWOOD AND THE ART OF SOUND DESIGN

> *I've always been of the belief that our ears lead our eyes to where the story lives*.[1]
>
> —Steven Spielberg

One classic piece of Hollywood lore[2] is how the fabled sound designer Ben Burtt created the iconic effects of "lightsabers" slashing through the air. The distinctly electronic noise from the *Star Wars* series is now burned into our cinematic memories as much as Alfred Newman's *20th Century Fox Fanfare* (1933) or Jim Henson's voice for Kermit the Frog. Before he was known for his work on such innovative films as *WALL-E* (2008), *Indiana Jones and the Temple of Doom* (1984), *Raiders of the Lost Ark* (1981) and *American Graffiti* (1979), Burtt was a student at the University of Southern California and a new hire at Lucasfilm. The idea of the lightsaber was born when George Lucas first conceived of the *Star Wars* saga, partly a traditional space

fantasy and partly the result of his interest in hero-making myths. He was also one of a new group of directors who believed, as he once noted, that “sound is half the experience.”[3] The sword was to be a beam of light a bit longer than the medieval variety, but even more lethal. The sabers were the preferred weapons of the future, but also a throwback to the swashbuckler films of the 1930s and 40s. Every film needed a master dualist who could slice his way to dominance against villains who were as unlikable as Lord Vader. The first film in the series was actually *Episode IV: A New Hope,* released in 1977 to audiences who became instant fans. If you somehow missed being around bedazzled youth at the time, it is enough to know that the plots of the series regularly featured face-offs on the edge of space, where lightsabers were potential tools of instant death.

What makes a lightsaber so interesting? Without its auditory buzz it is a bright but not-very-intimidating flashlight. Its lethality was in how it sounded. Working out a way to give the beam a fearsome presence was the first challenge. Burtt came up with a blend that included sounds of an old movie projector motor at USC, in addition to a nasty interference hum he discovered when his microphone got too close to an old television set. Back then, a household filled with radios and televisions was an endless source of spurious electric interference that could rival Victor Frankenstein’s laboratory. That intrusive hum picked up by the microphone gave off a noise of bleeding electrons not so different from what someone might hear standing near a high-voltage substation. But a lightsaber was not fixed in place. Its sound needed to change when it sliced through the air. Burtt found that if he took what he recorded from his two sources and played them back, he could then wave another mic around and near the speaker, creating a Doppler effect where the pitch slightly raises and lowers as the mic moved by. It is the same auditory

sensation a person experiences when a train or plane travels past someone standing in one place.[4]

The saber was the first of a series of earworms that Burtt would invent which would enter the culture as benchmarks, including Darth Vader's labored breathing, Chewbacca's expressive howls, and the beeps and whirrs of the faithful droid, R2D2. This was five years before he gave E.T. its voice in the later Steven Spielberg film. Burtt picked up an Oscar for "special achievement" in *Star Wars*, which has since gained the status of one of the most influential films ever released, even receiving the rare honor of its own U.S. postal stamp in 2007.[5]

This study devoted to sound might seem to be at the margins by focusing on what is widely seen as a visual medium. But film is obviously pictorial *and* aural, even though it would be accurate to note that most film professionals are more preoccupied with light and images that appear on the screen. Sound sometimes still comes as an afterthought, a pattern evident to audio designers who are not brought into a project until after the pre-production phase of planning scenes and locations is complete.[6] For example, when interviewed for a 2012 video segment, members of the sound department for Martin Scorsese's impressive *Hugo* (2011) seemed a bit uncomfortable when a question was posed about "what the pre-production process was like." They awkwardly noted that they were not onboard at that point, apparently reflecting the professional tension in the filmmaking hierarchy that gives the people who will shoot the film far more access to the director.[7] While Hollywood has begun to pay more attention to movie sonics, it is still the case that the Academy of Motion Picture Arts and Sciences—the organization that gives out the Oscars—can't really settle on which professionals should receive awards for quality sound in an individual feature.[8]

Now, for many reasons, what is heard in a theater is coming into its own. This is partly because of increasingly sophisticated "immersive" theater systems from Dolby and Sony.[9] As this is written, Dolby Atmos seems to be the preferred format. Its many channels can fix a particular sound at almost any point on the six surfaces within a theater: a possibility that makes life more challenging for a film sound designer.

Immersive sound has also created the necessity to treat every audio element and music as signifiers that will be noticed. The difference is analogous to listening to music on a good set of studio earphones rather than a small speaker in a bedside radio. All of the processing tools discussed in Chapter 6 are available at dedicated units at Warner Brothers, Technicolor and Skywalker Sound, among others. The latter facility located in the hills of Marin County north of San Francisco was where *WALL-E's* 2,400 sound files were assembled.[10]

There has also been a dramatic rise of interest in live concerts devoted to film music.[11] And a number of cinema composers have taken their places next to the more familiar names whose music has been performed by the world's orchestras. Any short list is incomplete, but would include John Williams, Rachel Portman, Ennio Morricone, Nino Rota, Henry Mancini, Dave Crusin, John Barry, James Horner, Hans Zimmer, Danny Elfman, Michael Giacchino, Randy Newman, Howard Shore, and the Sherman Brothers at Disney. More Americans seem to be coming around to the view spoken early by Orson Welles, when asked about the success of *Citizen Kane* (1941). Half the credit, he noted, should go to the composer of the score, Bernard Herrmann.[12] In addition, cinema *music* has the more practical function of giving audiences a chance to take a breather from the bombardment of sometimes too many sound effects, a

source of listener fatigue that designers of immersive sound acknowledge.[13]

Creating an Inhabited World from Scratch

In film nothing is as it seems. Theater in all forms trades in illusions. But any illusion is never more complete than the one that allows us to watch a story unfold in what appears to be a natural order. Almost every image, color, character, and rustle of sound that seems right has been added or altered with the same care that a master modeler might employ to assemble a three-dimensional diorama of a city. It is also worth remembering that a professional film or video camera is used to capture only what is seen. The audio chain is generally separate and will be married with edited images during the post-production stage in advance of a film's release.

The manufactured magic of life unfolding spontaneously can be remarkable. It is especially a credit to sound designers that a business focused on riveting images can also get the sonic environment of a location so right, usually by building its elements up in separate tracks, then mixing them together for maximum effect.[14] The audio tricks for doing this are many. For example, extras in one scene may appear to be talking, but often they are not; they are pantomiming conversation so that the live audio being recorded won't be ruined by too many voices. Or consider actors dressed for a night on the town. Because the footsteps of shoes (especially high heels) are a constant auditory distraction, actors may need to be barefoot and photographed so their missing footwear is safely below the frame. Actors dressed in silk may cause other problems. The fabric is too noisy for body microphones, so cotton that can substitute for silk must do.[15]

And there are other unseen accommodations. Microphone booms and their operators need to be near the action. These awkward microphones on long poles remain a staple because they can capture better sound.[16] The boom is held overhead by the operator just outside of the camera frame, a fact actors new to film must learn to ignore.

Sound design works best when it unobtrusively strengthens a story, as in one revealing scene from James Brooks' *As Good As It Gets* (1997). The screenplay written with Mark Andrus follows a phobic writer in Manhattan as he interacts with neighbors who typically cringe when they see him coming. Jack Nicholson's Melvin is a recluse with a long list of compulsions, including the need to sit at the same spot during his daily visits to a busy Manhattan coffee shop. Without his medicine he has no ability to monitor what he says, loudly demanding in this scene that "the Jews" in his regular table move somewhere else. He also has rude comments for Helen Hunt's Carol, the only server in the busy restaurant who has the fortitude to tolerate his off-putting eccentricities. But this time he crosses a line, throwing out a thoughtless observation about her chronically ill son. The usually unflappable Carol is wounded by the comment, pausing for several beats before she turns on him ready to explode. At this point—and just before she unleashes her fury—the ambient bustle of the busy restaurant on the audio track subtly fades away. She delivers her own expletive-leaden rebuke against a hushed backdrop of total stillness. It is a wonderful effect. In closeup, Nicholson's Melvin looks trapped within himself, and maybe even ashamed. Life does not normally happen this way, but some among the thirty-seven people receiving sound credits for the film gave Hunt and Nicholson this powerful moment.[17]

Anchoring a Story in Auditory Information

Even with all of the recent refinements of recording, Ben Burtt sees the capture of live sound in relatively simple terms. He divides the development of film audio into three overlapping roles. Burtt sees the "production recordist" as the person who is on site in a studio or beyond to capture sound and dialogue. The first goal is to get a "clean dialogue" track that can be used in the final release. It is often harder than it would seem, given unanticipated problems like muffled voice quality from a body microphone, or perhaps an actor's habit of dropping the last syllables of a word.

A "sound editor" gathers additional auditory detail that will be added to the track, often from audio effects libraries, but also from Foley artists who specialize in recreating the exact sound a scene requires.[18] In film sound, any added audio element is a "cue." There are long-standing ways to produce cues from surprising sources: crinkled cellophane for fire, salt falling on paper for rain, a creek suggested by blowing on a straw in a glass of water.[19] But because of magnified theater sound, directors can be very specific about what they want the audience to hear. A given cue may need to be their specific conception of rain falling on the roof of a 1930s limousine, footsteps in icy snow, street noise in a Lebanese village, or a fist landing on another person's chest. These and many more are recorded in a separate Foley studio.

Finally a "sound mixer" or "rerecording mixer" blends all dialogue, music and other atmospheric effects that add realism and detail to a story.[20] The mix is complicated by multi-channel playback that spreads out the sound field to be considerably larger than the viewing screen. The right sound levels for every distinct element—perhaps multiple actors, sound effects and music—need to be established. In addition, the mixer will determine where individual sounds should come from. In the

newer theater systems with speakers nearly everywhere, a story's audio elements can come from any direction, making the older habit of stereo "panning" to the left or right of an image too limiting for what modern directors have in mind. The mechanics of binaural hearing contribute to making this even trickier, because we can perceive sound that seems to originate between two channels. With ten channels setting up an almost limitless placement of specific sound sources, the acoustics of theater sound are both very complex and unique to every listener. A mixer will have an almost endless array of choices to make about where to place a source's audio.

In Burtt's simple scheme it might appear that three people could get the job done. And that still could be the case on a low budget television series or film. But bigger releases will have more carrying out these core functions, and usually a separate staff that arranges for the musicians or pre-recorded music to use as part of the soundtrack. As we have noted, even a talky non-action film may have dozens of sound and music professionals. Many sound designers who have emerged as their own of Hollywood type of royalty have extended what is possible in adding detail, music and dialogue to a film. Gary Rydstrom, Pat Jackson and Walter Murch among others led a transition to elaborate sound design that began in the 1970s. They were on their way to making movie sound another reason to buy a ticket. Notably, Murch's work on soundscapes for *The Conversation (1974)* and *Apocalypse Now* (1979) are considered by his peers to be gateways to the idea that film can be an aural experience.

Newer sound designers also had help from an unlikely source. While working on her 1976 version of *A Star is Born* the actress and director Barbra Streisand insisted that the final release to theaters be in stereo. Her efforts would hasten a long-overdue abandonment of one-speaker monophonic playback

systems that were still in use: a changeover that had happened a number of years earlier in the record industry. [21]

Location Sound

A feature starts as a story with characters who will propel it mostly through dialogue. It's useful to consider how difficult it can be to capture words spoken on a set or in the field. Recording "clean" location sound is a goal for most live-action productions, with intelligibility at the top of the list. It is obviously a necessity that audiences can easily understand what the actors are saying. Most directors and producers involved with a feature would rather use authentic ambient sound and actual dialogue rather than recreated lines "looped" by the actors at some later date. This common practice of looping, also known as "Automated Dialogue Replacement" (ADR), is expensive and time consuming. With some exceptions, most working on a film consider it an obvious way to salvage a missed opportunity to record location sound. So, with the exception of the ADR staff and some actors, looping is more of a chore rather than another chance to make a performance shine.[22]

Film sound is often so good that we rarely ponder what is required to capture it. Imagine that you are assisting the sound recordist on a period story that takes place in colonial Philadelphia. The Old City section is filled with architecture and gardens that approximate what actually did exist during the American Revolution. Location scouting made it an easy first choice.[23] The scene to be shot outdoors is a "walk and talk" conversation between two actors as they proceed up Walnut Street, running through several pages of the script, with one closeup of a dialogue segment shot earlier at the same spot.

Visually, the shot heading west will frame the actors against the red brick colonial structures restored to look as they did when the Continental Congress met nearby. This is now the edge of Independence National Park, and the sequence will include passing a perfect three-quarter view of the Exchange Building, with its original crescent of Roman columns that must have dazzled residents in colonial times. Shooting between Second Street and Fourth Street will require the removal of street signs and one set of light signals. But everything else in the foreground is authentic to the period, right down to the stone curbs with elevated horse-mounting blocks. The director is excited; few actual street scenes are so evocative of their period. The sound recordist will use wireless mics usually hidden inside lapels to catch the dialogue: less ideal than a boom mic, but a necessity, given the camera's need to follow the action on tracks paralleling the street. There is not quite enough room for a boom operator. In addition, all are aware that sounds of horses and carriages passing by will be added later by the sound editor. Ambient sound from off-screen sources created for the period adds a level of realism to what we see.

Traffic is blocked for this early Sunday work. Production assistants and police are doing what they can to ask people nearby to be quiet. If the actors can avoid flubbing their lines, the whole sequence might be done quickly, allowing enough time to move "set ups" of lights, reflectors and camera equipment as the scene unfolds. The first call for action on the sidewalk near Old City Tavern happens at 10:00 and must move smoothly to avoid shadows across the street that will edge closer as time passes. As the actors begin their scene walking west and trying to keep their faces visible to the camera, a car alarm goes off in the next block. Old City has many residences, and it is a rude reminder of the present. The recordist has lost her first attempt for a "clean

track." The director stops the action, and everyone goes back to their first position. They go again, better this time, until an emergency vehicle on nearby Interstate 95 goes by, siren blasting. Cut again. The director asks if the intrusion can be "cleaned up" with some sort of audio "notch" filter in post-production? Not easily, in the judgment of the recordist. They need to start over before the looming shadow begins to eat into the sunny sidewalk. There's time for one more try and the actors are beginning to get impatient. But the third attempt is no better. After a minute of shooting, the mics on the actors start picking up what sounds like drums from a march moving along South Street, a few blocks away. And there's another problem. The male actor is wearing heavy riding boots with hard leather soles that—with his uneven gait—scrape hard against the brick sidewalk with every other step he takes. Cut again. Are fake period boots with rubber soles available in the costume truck? Can the scene be shot in barefoot? And then a decision is made by the director that almost no recordist wants to hear: "Keep going; we'll ADR it later." And, yet again, the rest of the crew may show annoyance that their project has been interrupted by the need for quiet. The decision to re-record later can be a problem when actors struggle to sync their words to the film image. Also, microphones in the ADR studio may sound different if not duplicated with what was used on location.

If the director has been lucky, the sound crew pre-recorded the ambiance of the street earlier in what is called a "wild" or "atmos" track. It can be a "bed" under the voices of the actors inserted later in ADR, providing a way to partly replicate the outdoor ambiance that was present at the original location. This kind of "wild track" is almost never the loudest element in a film. As creatures existing in an atmosphere of restless air we naturally expect to hear are the aural elements of a place: leaves rustling,

a breeze moving through trees or around buildings, the movement of water in a nearby stream or lake. A film without a bed of atmospheric cues rings false.

This simple example illustrates how difficult it can be to get good sound “in the field.” It also explains why we still have soundstages or makeshift warehouses available in different locales throughout the nation. Sometimes even a less authentic set or computer-generated matte backgrounds can contribute to clearly capturing voices. But even indoors, not all problems are solved for a recordist. A major challenge is that many studios or warehouses have distinctly audible air conditioning. We accept the movement of air through ducts as an acceptable trade off in modern life. But its white noise almost never sounds good on film. Actors indoors will often have to work with the HVAC system momentarily shut down.

Film Operas

Attendance in the nation’s opera houses may be thinning. But there can be no denying that Americans might be surprised to find themselves classified as devotees of opera. Functionally, films are often “music dramas,” though opera composer Richard Wagner’s term is usually not part of any film lexicon. Some directors may want to let the characters speak for themselves, but it is far more likely that a score will figure significantly in elaborate and expensive films. These features are almost always “musical” because producers usually want a film to have broad appeal.[24] And the net of music catches more of us than we might think. A personal story makes the point.

The author remembers being a new husband trying to come to terms with a generous but sometimes-overbearing father-in-

law. A well-intentioned man long retired from work as a policeman, he did not know quite what to make of a newly acquired relative who seemed more dismayed than charmed by his Vodka-fueled bellicosity. I remember disliking the time I was enlisted to help him in what amounted to illegal "drag-fishing" in the beautiful waters near northern California's Bodega Bay, a setting featured in Alfred Hitchcock's film, *The Birds* (1963). Unshaven and fueled for the trip, this old man of the sea and his nervous passenger ventured out into the bay with beer and buckets. The goal was to drag the bottom and snag halibut while not being seen by more law-abiding fisherman. These were indeed alien waters to a future humanities professor more used to the inside of a library than an under-sized fishing boat in the rugged Pacific. But there are musical ironies here. I can also remember his reverie during rides back to the beach house in his old truck. He loved listening to his eight-track recording of the music from Alan Jay Lerner and Frederick Loewe's *Paint Your Wagon* (1969). For many years "The West" for these Broadway composers probably did not extend much beyond their beloved Lambs Club on West 44th Street in New York. But it really should not be a surprise that the crusty former motorcycle patrolman had turned himself into a lover of a horse opera about the California gold rush.

There is also an interesting footnote to this film. In it Clint Eastwood has a significant part and delivers one of the musical's best songs, "I Talk to the Trees." Years later, when Warner Brothers decided to convert its ancient scoring stage into offices, the former tough-guy actor in Sergio Leone westerns intervened.[25] Eastwood was then also a producer and director, and clearly knew the importance of having a pristine recording space on this venerable Hollywood lot. Management yielded to his request to keep it intact. What is now known as the Eastwood

Scoring Stage takes its history clear back to early films by Judy Garland, including a key scene filmed on the same stage in *A Star is Born* (1954).[26]

Consider an additional case for seeing film as a kind of music theater: the final half-hour of Steven Spielberg's much-honored *E.T. The Extra-terrestrial* (1982). The last half is mostly given over to John William's rich score that soars as high as the kids fleeing on bicycles with federal agents in hot pursuit. The music leaves us in awe for the emotional turn of the story, not all that different from a third act conclusion of a Puccini opera. Williams voices most of the melodic highs with surging strings, keeping the traditional Hollywood trope of shimmering brass to puncture through toward the end. Its romantic musical palette is meant to sweep a viewer up into a wordless victory for childhood against the darker inclinations of adulthood. This final sequence entitled "Escape /Chase /Saying Goodbye" was actually scored before the scene was edited: a reversal of the usual process. Spielberg sensed that the nearly 15-minute climax should be driven by the music. To put it simply, *E.T.* is at times an opera on bikes, and we are the better for having it.[27]

The author was amazed recently to see a documentary on director Alfred Hitchcock, who carried on an extended discussion with French new wave director François Truffaut in the 1960s. A book based on the documentary was published as *Hitchcock/Truffaut* (1966) and later revised.[28] In their extended conversation the two auteurs talked at length about lighting, camera shots and set ups, mostly in reference to Hitchcock's landmark films. And yet, strangely, Hitchcock was usually mute on the subject of music, even in discussing what is often considered his best film, *Vertigo* (1958). The score is considered one of Bernard Herrmann's finest efforts: a presence that saves the enigmatic action that alone would not hold the film together.[29]

No one should fault a director for being a visual person. Even so, think of *Vertigo* as another piece of music theater created as much by Herrmann as by Hitchcock's relatively static shots. The film's dialogue is sparse and circular. So, it is little wonder that a full-scale screening of it now may well be in a concert hall, with an orchestra accompanying the projection of a pristine print. A total of the film's music cues adds up to about 75 minutes, well over half of the entire feature. The centerpiece is "Scene D'Amour," a five-minute cue featuring James Stewart wordlessly trying the fathom Kim Novak's enigmatic character. It has since reappeared as a kind of tribute in *The Artist*, (2010), the not-so-silent French film that won the Oscar for Best Picture in 2011.[30] The musical sequence in both films is one of those rare moments when a collaborative effort of a director and composer defies all of the reasons it could have failed. Music critic Alex Ross concluded that Herrmann wrote "the century's most piercingly effective dramatic music."[31] "Scene D'Amour's" few minutes of sonic ecstasy certainly makes his case.

A successful match of music and mood can also be made for the Griffith "Planetarium" dance sequence in the musical reboot, *La La Land* (2016). Former roommates while attending Harvard University, director Damien Chazelle and composer Justin Hurwitz intentionally followed old Hollywood conventions to make the conventional love story.[32] The film updates plot, color and musical tropes that can be traced to MGM musicals, an intention confirmed by Chazelle to me and other colleagues at a local reception before the film was released. This seemed rare for a man born in the 1980s. We hardly knew how serious Chazelle was until he mentioned a need to return to Los Angeles to oversee the recording of the score by an 80-piece orchestra.[33] Significantly, those sessions were recorded on the same M.G.M

scoring stage used by the pair's aspirational model, *Singing in the Rain* (1952).

Professionals in the recording, composing, and performing business may sometimes be praised for their "golden ears." It's a common and intriguing term that is widely used in the music business. A record executive may admire a producer for their abilities to know how to best present a songwriter or band. In popular music this kind of praise came early and often to gifted producers like Quincy Jones (for Michael Jackson), John Hammond (for Bob Dylan), or musical gadflies like T. Bone Burnett (a producer for the many acts featured in *O Brother, Where Art Thou*? [2000]). It is no accident that all have been musicians. To succeed at their levels, a person not only has to have an ear for melody, harmony and recording technology, but also an understanding of how instrumentation will help to give a performance a unique sound.

A classic example is the master-arranger Conrad Salinger. He reached an extraordinarily high level of skill at MGM, turning the work of composers into stunning jazz-band-in-an-orchestra arrangements that became the studio's signature sound.[34] The young British conductor John Wilson is among others who have worked to restore a sound put together by Salinger that was thought to be lost. As Wilson notes, the MGM orchestra for musicals

> was really a dance band line-up with a string section. Many of the musicians had been star players with such as Benny Goodman and Tommy Dorsey. . . They were augmented as required from film to film. Above all, though, the orchestra was noted for its warmth of the brass sound and the 'fat,' almost old-fashioned string sound. . . So the sound is rich and vibrant, full-bodied, at

> times almost flashy, with a strong vibrato, and relentlessly brilliant.[35]

Composers working today like Hans Zimmer and Justin Hurwitz often do their own arrangements because of the way the composing process has changed. But the results can be just as mesmerizing.

Most studio staffs working on film sound or music prefer a dry acoustic, assuming they can more easily manipulate the sounds made within them. Sometimes the mismatch is jarring, as with the audio track in the opening scene of the 1955 film *Oklahoma!* Gordon McRae's anthem "Oh, What a Beautiful Mornin" is sung astonishingly well, but the prerecorded song also gives away a dry studio space and a vocal timbre that is absent in the location sound. A careful listener can often hear a sometimes-jarring change of acoustic when live-action dialogue gives way to a song. Rather than the supposedly breezy cornfield McRae and his horse are passing through, there is the somewhat awkward sensation of his powerful voice that is closely miked, but in an acoustic black hole rather than an open field. Ambient sounds of the vast filming location in Arizona—including breezes clearly playing through the trees and a bit of distant traffic noise—only creep in when songs transition back to location-recorded dialogue. A finished film usually has most of its seams concealed. But even a slight change in the sound of one location can break the illusion of continuity.

Pre-recording songs that will be lip-synced when cameras are rolling is still common. Indeed, how would an orchestra sound on a prairie? Not good, even without dealing with the logistics of getting the musicians and all their equipment on location. Still, the gap from location to studio recording can be difficult to bridge. Among recent films, the most recent remake of *A Star is Born* (2018) and *La La Land* seem to be exceptions.[36] In the latter case

composer Hurwitz sometimes played a piano that was fed into an actor's unseen earpiece, so they could sing "live." And musicals that are based on material about performance can more easily include sequences in theaters, studios or clubs that can more naturally segue into dialogue.

Diegetic and Non-Diegetic Music

The most elemental distinction that can be made about film music is whether it is *outside* of what the characters in their own world can hear, or whether it is part of the audible environment of a scene. "Non-diegetic" music is the first form *heard by an audience but not a film's characters*. Music that punctuates action wallpapers most films in the form of cues that call for underscoring a sequence. Director Sidney Lumet called the common use of a music cue to heighten what is happening on the screen "Micky Mousing," using obvious cues that simply telegraph to an audience what they are witnessing and how they are supposed to feel. As his term suggests, his preference was for a "score that will say something nothing else in the picture is saying."[37]

Underscoring using non-diegetic music is common and easier to manage since the live action does not have to sync precisely with onscreen singing. This often means that composers working on non-diegetic music will usually see a film only after a rough cut or unfinished assemblage has been made. Then, in a "spotting session" the director and the composer will decide where they want to add music. That is an older pattern that still exists, even while younger directors interested in the possibilities of music will bring in a proven composer sooner. The work of John Williams, Hans Zimmer and others has made it

more likely that a director may know that a proven composer can reinforce light or dark moments unfolding in a story.

Broadly speaking, minor key scoring often suggests risk or regret. Music in a major key usually represents a more positive attitude that a story is meant to convey. This predictability is how most of composer John Williams popular scores work. *Schindler's List* (1983) has an especially poignant score in A minor. The slow lamentation is a memorable fit for its story of a German businessman who managed to save some concentration camp prisoners by employing them in his businesses. The music in Steven Spielberg's masterpiece forces us to care about every desperate soul whose fate lies in the hands of Oskar Schindler. In contrast, Williams starts the first *Star Wars* film with an opening theme that begins in in a more upbeat key of G major, reflecting the film's debt to the old cinematic binary of good winning out over evil.

That first *Star Wars* also includes a well-known piece of diegetic music: a cue also heard by the characters within a scene. The familiar cantina sequence may now look a little old-fashioned, but it introduces Luke and the audience to the very different life forms that seem to co-exist on Mos Eisley. As Luke and Jedi master Obi-Wan Kenobi enter the tacky roadhouse, the "band" is playing ersatz dance music that suggests a 1930s speakeasy. What kind of pop music does one write for creatures that look as much like a zoo menagerie as the inhabitants of a corner bar? As a former jazz pianist, Williams seemed to have no trouble supplying an answer.

Arguably, the most honored piece of diegetic music is probably the song, "As Time Goes By" (1931), sung by Dooley Wilson in *Casablanca* (1942). The sentimental ballad is what the stressed owner of the Moroccan city's Café Américain wants to hear, even if Wilson's character is reluctant to play it. A common

view was that Humphrey Bogart's "Rick" was a stand-in for the American public's conflicted view of engaging in a second European war. The song clearly enhances the performances of Bogart and Ingrid Bergman, whose characters must deal with their own dashed hopes of together escaping their own circumstances. The thick angst of the film is reflected in the horseshoe arches of the Moorish bar that throw dark shadows in its many corners. Rarely has the filming location of Burbank, California or a song written in Montclair, New Jersey seemed so exotic.[38]

Some film enthusiasts might argue that a thick carpet of non-diegetic music is a vote of no confidence in the audience, since music often functions to tell them how they are supposed to feel, for example: the anxiousness of witnessing the shower scene in *Psycho* (1960), or perhaps a sense of reassurance if strings and cameras soar high above lovers embracing. It is an old test of the power of film music to watch the shower scene in *Psycho* without music. Early on we know that it is not going to end well for Marion, the secretary who fled with stolen money to the shelter of the creepy Bates Motel. But the terror of the sequence is less shocking without Herrmann's muted and screeching strings. In its day, few film moments carried as much power or raised questions about what might be too much to put in front of audiences.

On a happier note, a musician friend notes that a well-worn musical cliché for film sex has often been the ubiquitous "bedroom sax," referring to non-diegetic underscoring of scenes featuring languorous alto or tenor saxophones. This has been such a familiar cue that it still survives. A prime example is how composer Dave Crusin set up the opening credits for *The Fabulous Baker Boys* (1989). "Jack's Theme" remains an ideal sonic trope.

The simple binary of diegetic and non-diegetic music is useful, but also misses some subtleties of how a story is understood. By their nature, musicals are fantasies. We might worry if we actually saw a person walking down a city sidewalk singing in the rain. But in what many judge a perfect sequence, we expect that Gene Kelly's Don Lockwood in *Singing in the Rain* is just living out a more accessible form of his private consciousness. In the title song he is happy, in love, and just solved Hollywood's problem of what to do about the coming of movie sound. A literal rendering of these ideas would be obvious and tedious. In many musicals the assumption is that we are hearing the interiority of a character: just a more artful rendering of what they are feeling. This is a form of "the willing suspension of disbelief" that comes easier to some viewers than others. Even so, as *Black Panther* (2018) director Ryan Coogler noted, "a song can do in three minutes what a great movie needs hours to do."[39]

Film music is a potent form of enchantment. It's easy to understand why so many cinematic storytellers find stunningly detailed sound irresistible. Perhaps one reason director Stephen Spielberg has many commercial and critical successes is that he loves music. As one of his biographers noted, if he were not a director, he probably would have been a composer:

> Perhaps the most joyous scene in all of Spielberg's movies is the ending in *Close Encounters of the Third Kind*, in which scientists finally devise a way of communicating with the alien mother ship by using their computers to play synthesized music together. The musical exchange between the humans and their extraterrestrial visitors starts as a few tentative notes and quickly becomes a rapturous duet of spiritual celebration.[40]

Chapter 8 Notes

1. Stephen Spielberg quoted in *Making Waves: The Art of Cinematic Sound*, DVD, Gravitas Ventures, 2019.

2. We use the conventional reference to “Hollywood” as a stand-in for filmmaking in the west, even though expensive features are often assembled from elements produced around the world. In the case of the first *Star Wars* film, locations listed on the Internet Movie Database include the U.K, Tunisia, Mexico, Arizona and Guatemala.

3. Larry Blake, “George Lucas: Technology and the Art of Film Making,” Mixonline, November 1, 2004, https://www.mixonline.com/recording/george-lucas-365460.

4. “Ben Burtt - Sound Designer of Star Wars,” FilmSound.org, N.D., http://filmsound.org/starwars/burtt-interview.htm, accessed July 30, 2020.

5. United States Postal Service, “Two Legendary Forces Unite to Honor 30th Anniversary of Star Wars,” Stamp News Release, March 28, 2007, https://web.archive.org/web/20070329033048/http://www.usps.com/communications/newsroom/2007/sr07_012.htm

6. Christian Bell, “6 Ways Directors Screw Sound Editors,” August 30, 2012, Raindance.org, https://www.raindance.org/6-ways-directors-screw-sound-editors/.

7. See the interview, “The Sound of Hugo,” at audiospotlight.com, July 6, 2012, https://theaudiospotlight.com/the-sound-of-hugo/. The film won the Oscar for best sound editing and sound mixing in 2012.

8. Jazz Tangcay and Tim Gray, “Sound Mixers and Editors Express Conflicted Feelings on Oscars Merging Sound Categories,” *Variety*, Apr 28, 2020, https://variety.com/2020/artisans/news/sound-mixing-oscars-categories-sound-editing-1234592204/.

9. For an explanation see “Dolby Atmos for Cinema Playback,” Dolby Laboratories, 2020, https://professional.dolby.com/cinema/dolby-atmos, accessed July 31, 2020.

10. Annemarie Moody, “How Did They Make That Sound on WALL-E?” Animation World Network.com, November 13, 2008, http://www/awm/cp,/print/news/how-did-they-make-sound-*WALL-E*.

11. Jon Burlingame, “Score One for Movie Maestros: Audiences Grow for Film-Music Concerts,” *Variety*, November 4, 2013, https://variety.com/2013/biz/news/score-one-for-movie-maestros-audiences-grow-for-film-music-concerts-1200827772/.

12. Wells quoted in Alex Ross, *The Rest is Noise: Listening to the 20th Century* (New York: Farrar, Straus and Giroux, 2007), 293.

13. Michael Semanick, a sound editor and mixer for Pixar/Disney, noted that too much sound can “wear an audience out.” Quoted in “The Sound of Toy Story Three,” SoundWorks Collection, June 9, 2016, https://www.youtube.com/watch?v=Wr1XbXSoP0g&t=206s.

14. A dated but useful overview of recording sound for film was nicely summarized by Director Sidney Lumet in *Making Movies*, (New York: Vintage, 1996), 170-192.

15. These are some problems cited by John Coffey in, “An Open Letter From Your Sound Department,” FilmSound.org, N.D., http://filmsound.org/production-sound/openletter.htm, accessed July 27, 2020,

16. Ric Viers, *The Location Sound Bible* (Studio City CA: Michael Wiese Productions, 2012), 24-30.

17. “’*As Good as it Gets*,’ Full Cast and Crew,” *Internet Movie Database,* https://www.imdb.com/title/tt0119822/fullcredits/?ref_=tt_ov_st_sm, accessed August 2, 2020.

18. “Foley” is the name for the process of recording everyday sounds separately to be integrated into a particular scene. The term comes from the name of the first innovator in cinema effects, Jack Foley at Universal Pictures. His career expanded to including sound effects in the 1920s when films began to contain an audio track. See Laura Almo, “Why Is It Called ‘Foley’ Anyway?” *Cinemontage*, May 24, 2018, http://cinemontage.org/2016/02/called-foley-anyway/.

19. David Sonnenschein, *Sound Design,* (Studio City, CA: Michael Wiese Productions, 2001), 58.

20. Burtt, “Sound Designer of Star Wars.”

21. *Making Waves* makes a compelling case for this transformation, aided by Streisand’s insistence to abandon monophonic playback systems in theaters.

22. Edited excerpts from Randy Thom, *Cinema & the Sound of Music,* reprinted in “ADR,” FilmSound.org, N.D., http://filmsound.org/terminology/adr.htm, accessed August 3, 2020.

23. This fictional narrative includes typical problems of recording on-location sound, reflecting some of the frustrations that sound designers, mixers and recordists experience with less than engaged film directors. See Coffey, “An Open Letter from your Sound Department,” and Robert Clark, “Five handy location sound tips from pro recordist, Chris Frith,” AudioTechnology, July 4, 2014, https://www.audiotechnology.com/tutorials/5-tips-on-recording-location-sound-for-film.

24. Lumet, *Making Movies*, 178.

25. “Warner Bros. Names Sound Stage for Eastwood,” *Los Angeles Times,* April 20,1999, https://www.latimes.com/archives/la-xpm-1999-apr-20-me-29314-story.html.

26. Ronald Haver, *A Star Is Born* (New York: Knopf, 1988), 146.

27. Other scores that beg the reassessment of film music as generative of powerful feelings can be found in Matt Lawson and Laurence MacDonald, *100 Greatest Film Scores* (Lanham Md: Rowman & Littlefield, 2018), 90-92.

28. François Truffaut and Helen G. Scott, *Hitchcock, Revised Edition* (New York: Simon & Schuster, 1985).

29. Lawson and MacDonald, *100 Greatest Film Scores,* 289-291.

30. *The Artist,* DVD, The Weinstein Company, 2011.

31. Ross, *The Rest Is Noise,* 293.

32. *La La Land*, DVD, Lionsgate, 2017.

33. Conversation and panel discussion with Damien Chazelle, The College of New Jersey, March 28, 2016.

34. One excellent example of Salinger’s art is his arrangement of the Harry Warren song, “This Heart of Mine,” for the film *Ziegfield Follies* (1945). The simple tune is passed from Fred Astaire to the orchestra in an extended dance sequence, giving Salinger the freedom to explore it using many styles and colors. See Christopher Palmer liner notes for *A Musical Spectacular, Songs and Production Numbers from the Classic MGM Musicals,* https://www.chandos.net/chanimages/Booklets/CH8781.pdf, accessed August 10, 2020.

35. John Wilson quoted in Richard Hindley, “Conrad Salinger,” The Robert Farnon Society, June 2003, https://www.robertfarnonsociety.org.uk/index.php/legends/conrad-salinger, accessed October 16, 2020.

36. Calum March, “Lady Gaga, Bradley Cooper Pulled Off a Near-Impossible Feat During ‘A Star Is Born’” *Variety*, October 3, 2018, https://variety.com/2018/artisans/production/bradley-cooper-lady-gaga-a-star-is-born-2-1202966079/.

37. Lumet, *Making Movies*, 170-174.

38. Aljean Harmetz, *The Making of Casablanca* (New York: Hyperion Books, 2002), 255-256.

39. Quoted in *Making Waves*.

40. Joseph McBride, *Stephen Spielberg, A Biography, Second Edition* (Jackson: University Press of Mississippi, 2010), 34.

PART III

The Modern Assault on Hearing

Chapter 9

WEAPONIZING SOUND

Horrible, nauseating pain hit my body, and then I realized it was sound.[1]

—Cory Choy

The intrusive noises started in 2016. American diplomats living in one of the old-wealth homes of Havana near the U.S. Embassy heard a loud, high and continuous sound flooding the house from the direction of the back garden. Crickets or cicadas, some assumed. These summer creatures are notoriously loud. But the continuous high whining began to ruin evenings when the garden was a respite from the heat of the day. One diplomat recalled that the patio was otherwise perfect "to consume all things Cuban." The temperature would fall to the 70s, and "the music, the rum and the people" left him "thrilled to be there."[2]

This was at a time when the new Obama administration was signaling a softening of the hard line taken by the United States toward Cuba and the aging Fidel Castro. For many State Department officials, the island nation was a client state of

Russia, a condition inadvertently aided by crippling American boycotts. The effect of this tension was that embassies in both Havana and Washington had been downgraded to the level of less prominent consuls, though within the same buildings. But there was also new optimism fueled by a visit by President Obama in March in March of 2016. He was clearly trying to move beyond the old cold war obsessions that consumed prior administrations and the politically active exile community in Florida.

More parties brought more people to the Spanish-styled house used by the diplomats, adding new questions about the insistent ringing that seemed to spread to other residences and offices. “Those are not cicadas,” a neighbor insisted. “Cicadas don’t sound like that. It’s too mechanical-sounding.”[3] Soon thereafter, three American intelligence agents became ill.

Flights back to Miami began to include both American and Canadian embassy workers seeking medical advice for a wide but vague range of symptoms. In the words of clinicians, they often included “a general feeling of impaired well-being (sleep disturbance, fatigue, headache and irritability), poor cognition (concentration and memory), visual disturbance (blurred vision and sensitivity to light) and audio-vestibular symptoms (tinnitus, sensitivity to sound and dizziness).”[4] According to a University of Pennsylvania Medical School analysis, a number of diplomats seemed to have what was a paradoxical diagnosis. They “appeared to have sustained injury to widespread brain networks without an associated history of head trauma.”[5]

Were there “sonic cannons” embedded in buildings nearby? Had devices been planted to emit sound at higher frequencies than other “cannons” used by authorities around the world to disperse crowds? Police now have what are euphemistically described as tools of “area denial” that amount to machines

delivering overwhelming beams of focused noise.[6] Deafening sound radiators called LRADs (Long Range Acoustic Devices) were employed first by the military near the Gulf of Suez, and later by American police departments in cities that included New York and Pittsburgh. LRADs do not have the usual cloth or paper cones that mellow out the sounds heard in regular loudspeakers. The police equipment can be made of metal piezo electric drivers that create near-lethal amounts of noise, about 125 dB at 3000 Hz, far in excess of what can cause hearing loss.[7] But these crude devices don't work through the kind of stealth evident in Havana.

There are also deterrents that are more annoying than dangerous. For example, there is the widely reported story of a convenience store in Sydney, Australia, where the operators wanted to rid the front entrance of teens and vagrants. Their solution involved blasting the music of Barry Manilow through speakers placed just beyond the front door.[8] For modern teens, at least, Manilow was not cool; the implied association factor of hanging around could be hard on a youngster's reputation. Retailers have since taken up their own forms of music that encourages lingerers to relocate, ranging from Beethoven at bus stops to baroque music in transit centers.[9]

Sound as a deterrent or as a different form of physical assault is the mostly disturbing subject of this chapter. Sonic cannons, LRAD devices, flash bombs, annoying vocal habits or deliberately inappropriate music are just a few of the forms of sound that strike out at others. They deserve a place in this study that is both compact and cautionary. Our goal in this book is to mostly celebrate our auditory prowess. But as we have pointed out elsewhere, our two organs for hearing are fragile. Ears were meant to recognize otherwise unnoticeable shifts in air pressure. It is hardly surprising that they would be easy candidates for

abuse with the objective of submission or torture. Purposefully disrupting the emotional or physical equilibrium of others is a dark intention, which brings us back to the strange events in Cuba.

The Havana Legacy

The American embassy staff based on the island was initially hopeful about repairing relations between the two nations, but also had reasons for concern. To be sure, there was satisfaction that a diplomatic rapprochement might thaw the cold war chill, but there was also continued stress associated with serving in the capital of a nation where leaders vilified your country. And now offices and even hotels in the area seemed to be targets of an invisible intruder. By March of 2017, concerns had grown sufficiently for Ambassador Jeffrey DeLaurentis to hold a classified briefing raising the possibility that American staffers were being targeted by a sonic device perhaps mounted on a vehicle. Soon after, he took the precaution of asking them to sleep in the middle of their rooms and away from windows. Six months later he would order the evacuation of non-emergency staff and families.[10]

Tear gas, rubber bullets and stun guns all leave marks of their effects on flesh or the psyche. But deafened or traumatized individuals who have been exposed to ultra-high frequency sound will exhibit less external evidence that they have been attacked. Even so, it seems plausible that exposure to such energy could inhibit a person's robust intellectual skills.[11] Most disturbing of all, the research done on a selection of Americans and Canadians confirmed at least some damage to the bones of the middle ear, and to the inner-ear canals that help an individual keep their balance. Michael Hoffer, an otolaryngologist at the University of

Miami found these nearly immobilizing effects in some of the fifty embassy staffers, again suggesting the potential for near total incapacitation.[12]

Skeptics who have since studied the Havana Embassy episode argue that there are reasons for doubt about claims of a sonic attack. Their most convincing argument is that ultra-high frequency waves do not easily penetrate buildings or dense materials. It might be possible to drive a person to a state of disorientation with noises in their back garden. But known forms of sound cannons need a line-of-sight path to the ears of their potential victims. A masonry house in Havana should easily block most forms of high-frequency energy.

And then there is the persistence of Jamaican field crickets, which Cubans know to be very loud. One embassy housekeeper who grew up on a nearby farm observed that “they drive people crazy.”[13] Different species flourish worldwide, notably in eastern portions of the United States and throughout the Caribbean. On my own property in western New Jersey the sounds of crickets begin to fill the air in late July. They produce a persistent and distinctly clear peak in the sound spectrum at a little over 6000 Hz, unnervingly uncomfortable to listen to as a pure tone.[14] But cicadas also produce a somewhat lower frequency at a peak loudness level of about 60 dB, not dangerously high. Even so, at close range in Cuba, many concentrated in one neighborhood could make a phenomenal racket.

Dr. Mitchell Joseph Valdés Sosa, a Cuban neurologist asked the Trump administration to stop blaming his government. “We believe that everyone who complained of feeling sick was sick,” he said. “But that doesn’t mean they were brain-damaged or attacked by a mysterious weapon.”[15] Privately, some American intelligence experts agreed.[16] But a report released in December of 2020 by the U.S. National Academies of Sciences,

Engineering, and Medicine put the blame squarely on exposure to pulsed radio frequency energy.[17]

Two additional theories also emerged. One accepted by many American clinicians and their Cuban counterparts is the idea of contagious “mass hysteria,” a term that sounds more alarming than the common condition it describes. As the small cadré of Americans and Canadians met and discussed their symptoms, it was perhaps enough to trigger a group response, where a common set of symptoms is attributed to the same cause. This kind of “collective psychogenic disorder” is not especially rare. Diverse symptoms linked to a common cause easily chain out from individuals to many others who are in frequent contact with each other. A representative moment might be when one person mentions their scratchy throat and others soon notice the same condition in themselves.[18] For example, consider the low positive test results that showed up at various periods during the long COVID-19 pandemic. At some points well over 95 percent of the individuals tested did not appear to have contracted the virus.[19] But, like everyone else, the thought of the possibility and its known symptoms gave rise to a plausible cause.

The suggestion that Russians in Havana were behind the strange events also made sense. People who raised the idea cited the evident challenge that improving relations with the United States posed for Russia. After all, Russian “black ops” were known to resort to bizarre tactics such as poisonings to dispose of people with inconvenient views. We also know that Moscow-directed operatives flooded American social media especially in front of the 2016 election and probably earlier, evidently hoping to create more public support for the Trump candidacy.[20] In foreign affairs circles there is also the memory of the “Moscow Signal,” an espionage incident in the 1970s where

Soviet intelligence operatives beamed microwave signals into the U.S. Embassy to enable eavesdropping on the conversations of the United States ambassador. Some Americans working in the Soviet outpost were sickened by the microwave radiation.[21] Given this history, would a sonic bomb be out of the question?

The effects do not seem all that different from the complaints of bystanders assaulted by loud sonic canons in New York during a more recent Black Lives Matter march. One student who was taking pictures of the protest remembers fleeing in confusion, reported experiencing "a pretty strong migraine and dizziness [following] almost immediately."[22] Very loud sound—high, low, and in between—is disordering and disabling when it floods the fragile equipment of the middle and inner ear.

As of this writing in early 2021 there remain conflicting theories about the embassy sickness. Doctors have seen brain and psychological damage. But the FBI and other intelligence agencies are doubtful about Cuban government involvement.[23] And the Trump administration's partly hidden ties to Russia's Vladimir Putin may have weakened interest by the American intelligence community to pursue a Russian link, a pattern similar to the administration's dismissal of intelligence suggesting Russian involvement in the deaths of American soldiers in Afghanistan.[24] And there is the previously mentioned report of the U.S. National Academies of Sciences, Engineering, and Medicine, which finds beamed microwave energy a plausible cause. Whatever evidence may be added in years to come, many of the victims studied at the University of Pennsylvania and elsewhere angrily deny that they experienced just a coincidental and psychological tsunami. Most believe they were targeted by some ultrasonic device that was well within the known parameters for projecting destructive forms of sound. [25]

Sound Cannons

Sound cannons target people or animals by using sudden and loud explosions of noise. A so-called “scare cannon” that can be purchased from various retailers emits short bursts of high-decibel sound to frighten off foraging animals and sometimes intruders. It is a simple noise gun with a spark plug that ignites a charge of LP gas, issuing a loud burst of sound amplified by a three-foot tube. At this writing one of the devices, the “Good Life Guardian,” is available by mail order, with a promise to cover ten acres with a short “blast” as loud as 120 dB. A timer on the $400 item releases the charge at certain intervals, in what must be a nuisance to any neighbor who lives nearby.

The cannon’s short blast of noise is a milder variation of what the Israeli airforce is said to have used against people living in the Gaza Strip. They have allegedly created sonic booms with high speed jets flying near people living nearby.[26] The phenomenon of forcing an object through the air at a rate faster than than the speed of sound—767 miles per hour— “piles up” air pressure into a shock wave released as one loud bang.[27] The effect of this kind of low frequency explosion is literally earthshaking.

The more toxic form of a sound cannon is an LRAD (Long Range Acoustic Device) mentioned earlier. These are sold to law enforcement agencies as a non-lethal form of crowd control. They emit loud, continuous, and piercing sounds that overwhelm the senses. Used early in 2009 against protestors at the G20 Summit meeting in Pittsburgh, Pennsylvania, the quavering high-pitched assault recorded on one video news clip[28] produced frequencies in the ear-sensitive range of 6 to 11 Khz at about 110 dB.[29] This blare has the same cringeworthy shrillness of Bernard Hermann’s screeching strings in the famous shower scene of Alfred Hitchcock’s *Psycho* (1960). But it’s much louder and includes higher frequencies. LRADs can be dangerous in their physical

and cognitive effects, raising questions about the ethics and legality of what can amount to brute force.[30]

In recent years LRADs have been used by Japanese ships targeting anti-whaling campaigners and by large ships to ward off attacks by Somali pirates near the Gulf of Aden.[31] The device was also used against protesters in Minneapolis after the 2020 killing of the unarmed George Floyd. Law enforcement agencies around the world sometimes prefer them over the use of tear gas. But the effects are as bad or worse. Reporter Cory Choy was covering a 2014 Black Lives Matter protest in New York City when the police unleased an LRAD on the crowd.

> Horrible, nauseating pain hit my body, and then I realized it was sound. At first you just think, 'What's happening to me?' Your body goes into complete pain and panic mode. It's the sound equivalent of looking into the sun . . . People in the direct line of fire [of the LRAD] didn't run. They just dropped to the ground and started screaming.[32]

Whether LRADs cross the legal threshold of "excessive force" remains in dispute.[33] But there can be little question that they can maim a person by robbing them of much of their hearing.

Flash bombs or grenades can have the same effect but work with explosives rather than a focused beam of sound. Their most justifiable use is to distract armed subjects who may have hostages. So called "stun grenades" can momentarily distract a suspect with a single chemical explosion and a bright flash of light.[34] More problematic, they are deployed as another form of crowd control, leaving anyone nearby with potential deafness and sometimes serious burns. In a recent instance many flash grenades from police or rioters can be also be seen in videos of the insurrection at the United States Capitol Building on January 6, 2021.[35]

Most of us remember too late that our ears are extremely vulnerable in large public gatherings. This can be a risky mistake in an era where sonic devices are likely to be used more frequently by protestors or nervous law enforcement officials who may want to use destructive sound as a form of disablement that has the short-term appearance of leaving no one permanently harmed.

Misophonia

Humans are surely a noisy lot. Even everyday sounds can cause adverse reactions. In theory, almost any vocal or mechanical behavior can create the kind of aggravation in an individual that a clinician might diagnose as “misophonia,” the name given to extreme levels of discomfort with certain sonics.[36] Sometimes we are the inadvertent transmitters of a seemingly innocuous sound that can send a listener to the far side of annoyance. The popular press is full of accounts of individuals who can’t stand to be around certain people because of their loud chewing, endless pen-clicking, throat-clearing, or vocal tics that function as aural red flags. For example, silence-fillers such as “like” or “you know” are mostly harmless nonfluencies that can make it less likely for a small percentage of individuals to hear anything else. The tic is anticipated and dreaded in equal parts.

There is no shortage of ways we fall into repetitious routines that have their own sound signatures. The person with misophonia who is obsessing over certain audible triggers is frequently—if accidentally—matched up to an obsessive producer of them. One person’s preoccupation and annoyance with a particular tic is fed by another’s habit of using it. For example, part of the fun of Neil Simon’s classic film, *The Odd Couple*

(1968), is how Felix's allergy routines begin to grate on the laid-back Oscar. Endless throat-clearing is a typical case. Neither of the divorced men sharing an apartment has made a match that is any better than their failed marriages. The aggravations are funny because they would be recognized by any couple living under the same roof.

It is interesting to take this one step further. Imagine the intentional baiting of a sound-sensitive person with an audible irritant. It happens, often as a kind of rhetorical strategy that can be described as a "deliberate misidentification."[37] The human default in social relations is usually to meet someone halfway: to find common points of identification. By contrast, the intention to annoy is a break from our best selves: a misidentification and a passive-aggressive behavior that provokes someone who is seen as a deserving victim. For some it may be a barking dog let loose in a backyard as "payback" to a complaining neighbor, or a music system turned up as an answer to noise from the next-door apartment that never ceases.

Loud neighbors rank high as triggers for misophonia. It turns out that there is no shortage of online videos and articles on how to fight back against them. It is a common condition in poorly soundproofed buildings that can't help but stack many families on top of each other. Audio engineer Brett Houston offered an ingenious solution for the problem of heavy feet moving incessantly in the apartment above his. Houston's idea was to put loudspeakers in the ceiling cavities that he had inadvertently broken through after pounding on them once too often. In the opening he placed a large speaker between the ceiling joists directly under the neighbor's floor. He then put microphones at different points along the ceiling, routing the sound through an amplifier, with a short delay. He then fed the sounds back to the speaker under the neighbor's floor at a 1 to 3 ratio. The "karma"

he sought meant that any noise made by the neighbors was amplified and fed back to them three times.[38] After several complaints they finally moved.

These minor examples should not allow us to overlook the all-too-common use of music or even "musical" pure tones as antagonistic responses to another person or group.

Perverse Music

Imagine the surprise of members in an aggressively raucous band discovering that a military force has deemed their music a useful form of torture. That was the surprise that the United States' military sprang on the members of a Vancouver group, Skinny Puppy. Most might consider such use as a total affront: the ultimate critical thumbs down on the creative efforts of a group. Keyboardist cEvin Key had two specific complaints, lodged with some flawed logic. "I am not only against the fact they're using our music to inflict damage on somebody else," he noted, "but they are doing it without anybody's permission."[39] He wanted $600,000 in royalties from the military for the use of their sonic mayhem in the Guantánamo Bay prison complex kept by the United States.

There is an entire sub-species of academic research conducted by specialists who assess how seemingly ordinary environments can act as deterrents. Anyone strolling through a city will see brutalist walls of stone or masonry on first floors that allow occupants to turn their backs on the street-life outside. Ledges bordering buildings sometimes have spikes or metal ridges built into them to discourage someone pausing to rest, or skateboarders looking for a new challenge. While attitudes about the homeless are changing, many cities have been careful to limit

public seating outside of parks or some squares. Prior to the 2020 pandemic a visitor to midtown Manhattan would find only a few attractive places to sit, the nicest of which remains Bryant Park, beginning at Sixth Avenue and 40th Street and extending to portions of Fifth Avenue.[40] The goal of minimal accommodation even extends to hotels, which have figured out how to build lobbies that feature uncomfortable seating. The goal is to keep people from remaining in a lobby for an extended length of time. One manufacturer of commercial furniture advertises a long faux-leather couch that is wide, but with a low back rising barely a foot. It looks like a couch but "sits" like a bench.

Our point is that there are direct equivalents in the use of sound to discourage lingering in one location. The options vary from aggressive to creative. The simplest auditory deterrent uses a high frequency speaker mounted on an external wall. The "Mosquito" looks like an ordinary outdoor fixture, but its electronics only put out a pure tone of 17.4 kHz, beyond what most older adults could hear, but still inside the audible spectrum of younger ears. The effect is not unlike the faint high-frequency buzzing heard from older florescent fixtures. Presumably, teens who might be inclined to hang around the outside of a convenience store may decide to move somewhere else. The maker claims brisk sales in the United States and Europe.[41]

Using simple tones or music as hostile forms of acoustic furniture is hardly new, though the research at this point is better at noting cases than specific effects. At one extreme, the best overview of how music is used as torture is still Suzanne Cusick's 2006 synopsis in the journal *Transcultural Music Review*. As she notes in her preface,

> I began desultory research on a phenomenon of the current "global war on terror" that particularly wounds me as a musician–wounds me in that part of my sensibility

> that remains residually invested in the notion that music is beautiful, even transcendent–is a practice whose contemplation would always lead me to contemplation of bodies and pleasures. Not bodies in pain.[42]

Instances of the use of music to harass military or police targets are easy to identify. Cases she cites include the 1989 example of U.S. troops blaring loud music into the Vatican Embassy to induce Panamanian president Manuel Noriega to leave. She also identifies various instances of harassment through sound and music employed by British forces in Northern Ireland, and police forces in Guatemala, Uruguay, Brazil, the Philippines, Chile, Iran, and Argentina. Others have pointed to the use of loud music to keep prisoners awake in Cuba, Afghanistan and elsewhere. Various formalized tactics of "no touch torture" have also showed up in reports of Iraqi detainees captured after 2003 who were subjected to Metallica's "Enter Sandman" (1991) and Barney the Purple Dinosaur's "I Love You" (1993). [43]

Notwithstanding the saccharin Barney, battle-hardened fighters in the United States military seem to prefer scary sounds or deafening rock music that frequently shows up in distinctly male pursuits such as drag racing or video shooter games.[44] The music often reflects a self-referential display of muscle-car manhood.

Taking a longer view, audio theorist Steve Goodman recalls the PSYOPS (psychological operations) efforts by the Army to scare the Vietcong into submission in the 1970s. Helicopters equipped with a loud audio system called "the curdler" would fly just above the trees in the jungle playing ghostly noises that were meant to mimic deceased ancestors, with the hope that "haunting sounds" would "perturb the superstitious snipers. . . ."[45] In later wars in the Middle East the goal was often to break down detainees by forcing on them various forms of aggressive rock

music. By some estimates, music that is alien to a prisoner's world eats at their sanity and feeds their insecurities. As one PSYOPS member in Iraq told a reporter, "These people haven't heard heavy metal. They can't take it. If you play it for 24 hours, your brain and body functions start to slide, your train of thought slows down and your will is broken. That's when we come in and talk to them."[46] The pop hits of one society may not transfer well to another culture, where the presumptive norms embedded in a song are destabilizing. Flamboyance defines most Western and Korean pop genres and can be expected to be insulting to prisoners used to different proscribed cultural norms. Combined with male-macho stereotypes that thrive in some military cultures, it is easy to imagine taunts of rap or heavy metal music that would be understood by a prisoner as an assault on their values. At the other extreme, ostensibly "feminized" musical forms such as disco, show tunes, or song-celebrations of trans or gay sexuality can have the same effect on detainees.[47] James Parker cites the intended impact:

> The logs detailing the interrogation of Mohammed al-Qahtani at Guantánamo, released by *Time* magazine in 2006, show that music was a central and particularly brutal feature of his captivity. Music to wake him, music to keep him awake, music to humiliate, music to punish, music to disorient, music to isolate, music for short periods, music for hours on end, Arabic music, Western music, instrumental music, relaxation music, Christine Aguilera, white noise: all with the intent of inducing a state of 'futility,' a 'feeling of hopelessness and helplessness on the part of the source,' as the most recent version of the army's 'human intelligence' field manual puts it.[48]

This case is a long way from how inappropriate music is used as an unwelcome presence in domestic settings. In

terminals and stores the music is more old-fashioned and less of an assertion of dominance than an expression of alien class or musical values. For example, Baroque music has been a favorite for many American retailers and transportation officials. As one law enforcement official noted, “There’s something about Baroque music that macho wannabe-gangster types hate.”[49]

We don’t fully understand, but it is at least plausible that the use of music as hands-free torture may do as much to produce sagging morale in the guards as their victims, who are supposedly made to be more psychologically pliable. Studies of “brainwashing” and PSYOPS torture include mountains of questionable research and faulty assumptions. Obviously, independent researchers cannot easily work in the locked-down confines of a military prison. Some first-hand accounts and popular media have suggested that inappropriate music can be easy to break down a recalcitrant prisoner. The idea sells books. But there is a great deal of countervailing evidence for the durability of attitudes and behaviors.[50]

There is final irony to note about weaponizing sound. Complete isolation—the near absence of all sound—is also a known hardship. Similar effects of alienation and disorientation can happen with extreme deprivation in which all aural sources are muted.[51] We have evidence that it can be equally cruel to subject a prisoner to complete silence,[52] a reminder again of the centrality of our sense of hearing as an important link to human communities.

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Chapter 10

CREATING AURAL ISLANDS

> *Our aural diet is miserable. It's full of over-rich, non-nutritious sounds served in inflated portions—and we don't consume nearly enough silence.*[1]
>
> —George Prochnik

We might think that our salvation from a very busy life comes when we escape its noise and routines. That is at least the cliché. But in fact, we are very different in how we want to relieve everyday forms of stress. What a child might seek is not the same as the kind of reprieve that could be ideal for an adult. Everyone can imagine an aural island—an escape filled with companionable sounds that reassure and give pleasure. Sheer quiet may be enough for some, but not for all. I have a childhood memory of an unfathomable summer week on what seemed like the surface of Mars, where frenetic activity about very little would have been an improvement. Long days spent at a Methodist church camp on the prairie was the low point, yielding wisps of still, hot air that I took to as a confirmation of my temporary abandonment. The rickety school bus taking my group from the leafy precincts of Denver would deliver us six hours later to a landscape of low bluffs and eerie silence. Sanford Gilford's old

painting of the “Valley of the Chug Water” (circa 1870) captures the red and brown sandstone that dominates the eye.[2] It was as he saw it: not a single tree is evident in the naked landscape.

Today the two hundred residents of Chugwater in southeast Wyoming are surely self-starters and resourceful ranchers. But the few structures in the “town” are mostly boarded up. And even back then it seemed clear to an urban teen that the high desert of sandstone bluffs and low box canyons was enough reason for the Cheyenne and Sioux to move on. Far from any cities, the night sky visible after dusk must have been glorious. I did not notice. I wanted my old life back. The dusty camp, a former cattle waystation, was an unintended gulag for our group of pampered middle-schoolers. The land would sing nothing to us. As an older adult now, the space and quiet seems more promising.

Everyone can find or at least imagine their own perfect arcadia. The philosopher Friedrich Nietzsche liked to work in a small house near Sils-Maria, high in the Alps. His routine of writing and walking seldom varied. Most days he also spent several hours in the evening simply sitting and thinking in the dark.[3] Indeed, it seems to be an accurate assumption that many writers are happy to settle into a quiet corner of their home, or even a separate space nearby. Composer Aaron Copeland favored his wooded summer retreat in New York’s Hudson Valley,[4] a home now available as a haven for young musicians. The polemicist William F. Buckley wrote in a study over the detached garage near his Connecticut home.[5] Writer Michael Pollan went several steps further, devoting an entire book to building a small writing sanctuary in the woods further away from his New England house,[6] pursuing some of the solitude Virginia Woolf sought when she celebrated “having a room of one’s own.”[7] In truth, any favorite spot may offer a chance for productive work or rest.

Those less used to solitary work may want a break from the familiar clutter of their lives. Every summer millions of people trek to retreats promising open space and fewer auditory distractions: places like the spacious national parks in the West, the sparsely populated Adirondacks in New York State, the nearby Berkshires, California's Big Sur, or tranquil villages on the shores of the Great Lakes. All offer the nearly universal appeal of a cabin in the woods.

But for every fantasy retreat to nature there are alternate diversions that are not silent, but filled with the sounds of pleasure that many seek: sandy beaches in Cape May or Santa Cruz, or perhaps the distractions of nearby boardwalks or bars, or maybe the domestic equivalents of European summer escapes to Lake Como or Venice. "Vacations" are frequently about finding solace by a lake or, for the wealthy, in grand old hotels with vast spaces that turn most conversations into whispers. These themes reappear in classic works by writers like Thomas Mann (*Death in Venice*, 1925) and E. M. Forster (*A Room With a View*, 1908). Refuges for those who could afford them were meant to represent a more measured pace than was possible in the cities. Even winter offers its own rewards in the slopes above busy ski towns. Snow is one of the great tamers of ambient noise. A visitor to the frigid north from the American South may be more impressed by the hush produced by a recent snowfall than by its depth.

And then there are those who thrive on noise as its own kind of sonic whiteout. Before his untimely death, the powerful writer Christopher Hitchens professed that his favorite place to work was the Timberlakes Bar near Washington D.C.'s Dupont Circle.[8] The prolific writer Pete Hamill similarly recalls seeing too much of his life through the haze of a hangover, but his ideal was a "Great and Good Place" in a garden spot "with bougainvillea spilling down whitewashed walls, fountains playing in the blaze of noon.

In the Great Good Place I would work like a monk on my writing. I would be a good husband and father. I would be far from the tumult of saloons . . .”[9]

Others have found the settled routine of a train journey to be a reason to focus on capturing ideas. Spurred by encouragement from novelists, ten years ago Amtrak experimented with a rail Residency for Writers program, with a discount on two trips a year.[10] As Jessica Gross wrote in the *Paris Review*, trains can be a “writer’s garret.”[11]

All of these impressions suggest the need to have a wider view of what an aural sanctuary can be. We can sense this variety if we ask others about short micro-moments of sound that trigger positive associations. Julia Furlan at *Buzzfeed* had a whole list of favorites: the sound of wood burning in a campfire, the contented purr of a cat, a baby’s giggle, or the rev of an expensive car engine.[12] Most people also like the sound of rain on a roof, a modest wind blowing through pine trees, water cascading over rocks in a stream, or the call of a western meadowlark. More spine tingling is the nighttime song of an eastern screech owl, or the sundown calls of rutting and “bugling” male elk in a distant mountain meadow. Add in the possibilities of particular musical moments and we all have our favorites. A friend loves the tenor saxophone sound of Lester Young. My high moments of musical nirvana are reached in different pieces: the grand entry of the pipe organ with a C-major chord and four-handed piano runs that set up the finale of Camille Saint-Saëns’ *Third Symphony*; the last brutalist minutes of Sergey Prokofiev’s *Fifth Symphony*; or the ways Nashville’s Jerry Douglas riffs with others on the guitar-like dobro.

So it is not only the absence of sound that can gain mental clarity, but the right sounds in the right place. It depends on the person. We will briefly consider four categories suggested by

these introductory examples. *Acoustic isolation* is almost by definition an aural sanctuary. But there are other forms, including *designed commercial spaces*, the use of cognitive tools to tame *disruptive brain chatter*, and seeking out a sonic "stew" of *persistent ambience* to gain focus on a specific task.

Acoustic Isolation

In a city where real estate is nearly always top of mind, the questions are often the same: is it possible to find a bigger and quieter spot? If they have sufficient resources, those living amidst the clamor of New York City may want to retreat to the Aire Ancient Baths in Tribeca. For a little more than a hundred dollars, a person can spend ninety minutes in a dimly lit cavern with its own subterranean saltwater pool. Carved out of the bowels of an old warehouse, the Ancient Baths guarantee a quiet experience and lots of soothing extras far removed from the rest of the city.[13] More likely, the same affluent clientele will have already survived the high density by having chosen a home that shuns the drone of noise. If a new residence is loud, one of the city's many acoustical contractors can wrap it under a blanket of high-tech insulation.

But even substantial buildings can shake from the subterranean activity of nearby subways, garages and heavy equipment housed in adjacent basements. And then there is the noise from air handling, elevator, and ventilator equipment. The latter devices are usually designed to vent away from the edge of a building, pushing its noise out to others. Also, because of the nature of the city's most desirable blocks, nearly all deliveries and building maintenance must be approached from the street. With these potentially invasive sources, the quest for a quiet living space is an aspiration many never put aside.[14]

Property owners spend huge sums to shield their living and sleeping areas. Acoustical renovation may be rare in less densely populated areas, but it is common and expensive for owners of space in a building or an entire townhouse. Solutions involve heavy insulation between the “party wall” that separates one home from another, and elaborate floor padding or thickening that will muffle the movements of those living on the next floor. The best remedies usually require building partitions within rooms that will break the seepage of sound coming from a neighbor’s space. This may mean making double walls, with the small gap between them filled with soft fiberglass batting, and thick insulation wrapped around utility pipes that run between floors. Contractors also use soundproofed windows that add another inside layer of glass to what was already in place. The additional glass is usually thicker and installed several inches back from the original windows, then sealed tight to stop leakage from even small openings. Some makers claim to reduce street sounds by ninety percent.[15] Even so, an ongoing challenge is low frequency noise that is not easily blocked. The low rumble of a cement truck on the street is nearly impossible to stop.[16]

It could not be more different in other parts of New York State. Its boundary with Canada includes vast spaces of calm. The wide and open expanses of Lake Ontario and Lake Erie border most of the western portions of the state, with the St. Lawrence River dividing the eastern side. And what a boundary the St. Lawrence is. It flows out of the last of the chain of Great Lakes and then narrows into an archipelago that extends 700 miles past Montreal to the sea. North America offers no other river quite like it. At its western end it starts nearly five miles wide near Cape Vincent in New York opposite Kingston, Ontario, narrowing to a width of one or two miles and scattered with nearly 2000 pine-forested islands. The largest have state parks and

small hotels. But many more have single homes that are only accessible by boat. The St. Lawrence region offers the inviting possibility of retreating to an island of one's own.

My own experience included a week of quiet and rest in a small chalet on a water-bound acre with the requisite pine trees. Boat traffic in the vast open waters was negligible. And if a person likes the sound of water lapping against the island's rock face on the windward side, or a panorama of the archipelago's quiet channels, there may be no better place. Water and electricity are surprisingly available via a network of underground connections lacing many of the tiny atolls together. But, of course, any supplies will need to be brought in by boat from sleepy towns on either side of the international border. It was another form of a cabin in the woods, and completely peaceful. No wonder so many anglers find this part of the world a haven, whether or not they catch any of the river's perch or northern pike.[17]

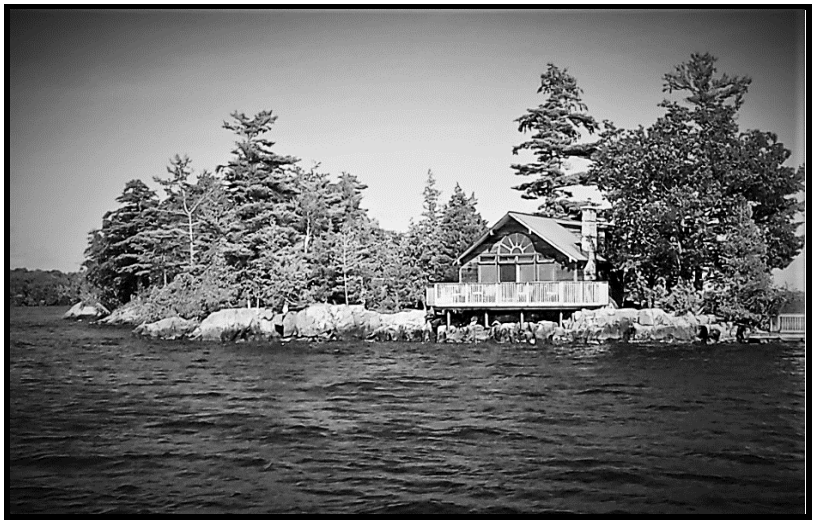

Figure 10.1
The island "chalet" in the Thousand Islands Archipelago.

The week of solitude was temporary and accidental. My wife and I got luckier than we knew when we “won” the use of a private home in a silent auction. Brooklyn resident and writer George Prochnik was far more deliberate in his quest for peaceful seclusion. In his book *The Pursuit of Silence* he noted that he had long been ready for a break from daily assaults on the ears coming from nearby buses, helicopters, construction projects and neighbors. That motivation provided the will and the tools to seek aural islands that were both near and far.

He started with the Quaker meeting house near his home. Quakers usually shun long-winded sermons, music and the din of celebration that would have happened in most churches. Silent mindfulness is the cornerstone of a Quaker meeting. If someone is moved to speak, the norm is to be brief and mindful of the quiet. A meeting is supposed to proceed as an affirmation of the Quaker belief that we should resist excess chatter long enough to hear God speak to us. Members share a comment if the spirit moves them, but hopefully just a few sentences. Even here, though, some members arrived late through clattering doors. And, of course, the occasional cell phone ring broke the silence.

Visits with an astronaut soon followed. Suni Williams logged almost 3,000 hours in space, with a portion of the time spent in spacewalks. She told Prochnik that even was that not as quiet as it would seem, given the hums of her life support equipment and the constant chatter from ground control in Houston. Quiet finally descended during the “night pass” when the spacecraft was momentarily out of radio range.[18] That’s when she felt awe for the vastness beyond her tiny metal island.

A desert setting was another option. But deserts obviously challenge our comfort levels in other ways. The brain does not always process the senses with the simple uniformity suggested by the different names we use for them. Heat and an unremitting

midday sun can turn into their own forms of shrill sensations, a kind of pseudo-synesthesia that can leave us as exhausted as the noise of a loud factory.[19] And then there is the question of what may be too quiet. A whisper of wind through desert grasses can be soothing. Another recent explorer also noted that the sound of even drips of water under a desert outcropping can refine the senses to appreciation of a precious resource.[20] But deserts can also begin to weigh on anyone used to the more varied auditory textures.

Prochnik found the greatest comfort with kindred spirits living at the New Melleray Abby in the vast flatness of Peosta, Iowa. Over a few days he warmed to the Trappists' life of contemplation and silence. The setting, the company, and the sonic tranquility matched what he needed. A resident told him that "These giant, snow-covered fields are the desert. It's where monks have always been drawn. We come for a radical confrontation with ourselves. Silence is bumping into yourself. That's why monks pursue it."[21]

Composer/philosopher John Cage would probably have suggested that the monks are actually in pursuit of a different ambience, but not literal and absolute silence. What we think of as a satisfying kind of quiet is usually different from existing in a bubble of no sound. That particular realization came to him after spending a few minutes in Harvard University's anechoic chamber. As noted in Chapter 1, these specially constructed rooms are among the quietest spots on earth. But like most people who spend a few minutes inside these purposely hushed spaces, Cage realized that even his body was far from silent. The sound of the heart beating and blood coursing through vessels are easily audible and, for many placed in the same setting, somewhat disturbing. He also sensed that the idea of absolute

quiet was a kind of fiction. It was an insight that informed his unusual music that incorporated auditory elements from everyday life.

> [S]ilence becomes something else—not silence at all, but sounds, the ambient sounds. The nature of these is unpredictable and changing. These sounds (which are called silence only because they do not form part of a musical intention) may be depended on to exist. The world teems with them, and is, in fact, at no point free of them.[22]

Indeed, the continuity of sound was one of Cage's recurring themes throughout his life, literally playing out in one of his schemes involving a specially built pipe organ "playing" a piece that is supposed to run 639 years. The device is a small and unique instrument of just a few pipes that sits amidst the stone walls of an abandoned German church. When the sexton inserted a new pipe into the wind chest recently there was a hardly noticeable chord change that will drone on for another seven years. Others will follow after the same long interval, if one should want to hear "music" in what is closer to a geological rather than musical time frame.[23]

Though unusual efforts to reach a nirvana of peace and quiet can come in the form of some of these extraordinary applications, it is important to not lose the point that quiet is a common human wish that naturally grows with age. Almost everyone reaching middle age is willing to relinquish the din of their daily routines for at least the temporary respite of a thinned-out soundscape. It makes whatever we choose to add to the scene stand out even more.

Commercial Ambience

Walk around a Disney park or nearly any shopping district and you will find that someone has designed a "sonic atmosphere" to put you in the mood to have fun, to buy, or both. The presence of music and or any augmentation of ambient sound is meant to create a sense of familiarity or anticipation.

In the case of Disney, no organization is more conscious of using sound to augment but not challenge the expectations of visitors. Indeed, you can hear the "loops" or repeated cycles of familiar songs selected by Disney "imagineers" that constantly recycle in specific locations within the parks. Guests enamored with what they are hearing can take these atmospheric soundtracks home on CDs that are available for purchase. For example, visitors to the "Pixar Pier" will hear Pixar Studio's hits in full orchestra arrangements, more or less the equivalent of the usually innovative films that the setting is intended to evoke.[24] To get a sense of how much these audio loops mean to the thousands who adore all things Disney, the occasion of a "refreshed" Main Street loop available for purchase was introduced in a company news release with the fanfare that usually comes with a new music album from a popular artist. As a press release noted:

> This time around, over a dozen new tunes, arranged and recorded specifically for Main Street, U.S.A., will join many of the existing songs. Included in the new mix are such iconic period pieces as "Meet Me in St. Louis, Louis," "In the Good Old Summertime," "Alexander's Ragtime Band," "Oh You Beautiful Doll," Scott Joplin's "Maple Leaf Rag," and a recent tune given a turn-of-the-last-century arrangement of Michael Giacchino's "Married Life" from Pixar's "UP." So the next time you're ambling

> down Main Street, U.S.A., keep an ear out for some new – and old – classics![25]

A similar constructed audio environment is noticeable at many stores. Before they announced their intention to close, visitors to an Abercrombie and Fitch store in a shopping mall would immediately experience the lighting and "club music" of a late-night magnet attracting young revelers. [26] As with most consumer marketing, the target audience is encouraged to buy products "positioned" to evoke an aspirational lifestyle.[27] A particular buyer may not be a regular at a late-night spot, but they can own the clothing on offer in the presence of its music.

Themed restaurants work the same way. Hard Rock Cafe and Rainforest Cafe have carefully selected music loops and—in the case of Rainforest—elaborate animal and musical effects placed around the jungle-themed interior. In general, the idea of careful "sound design" discussed in Chapter 8 grew from simpler radio "sound effects" into something that has become ubiquitous in retailing and elsewhere. Game designers now compete for talent and composers to give their products the caché of a movie a player partly controls. And with wide availability of sound effects libraries, any ambitious commercial outlet may want their own evocative loops of prerecorded material. One company, Mood Media ("We put people in the mood to buy"), offers help in the form of music for a range of commercial firms including breweries, stores, banks, healthcare facilities, hotels and spas.[28]

As with Rainforest Cafe, the sounds are contrived and theatrical. In other businesses, auditory content can be selected to promote a sense of normality, especially in regions guests might think of as more volatile. A useful illustration of this kind of calculated auditory reassurance was demonstrated by researcher Anna Lerchbaumer and her colleagues. They examined three resorts in Egypt, Tunisia, and Turkey as "standalone" microcosms

in what they considered were politically unstable countries. They found that the hotels used non-descriptive and recognizable music to build a neutral "touristic bubble." "The three hotels investigated all follow[ed] a globalized scheme of a non-place, where tourists feel at home everywhere and the sites are interchangeable."[29] For a traveler from the West who may have felt jostled by the crowds or bustle beyond the hotel's front door, the relative normalcy of a hotel playing instrumental "covers" of Western standards might be its own familiar sonic island, even though musical choices are not so easily calibrated to please all. Hotels work to be aural islands. Choices of selections may be made to offend as few customers as possible: part of what Lerchbaumer seemed to find.

It is a more difficult step to identify the particular forms of music a person might *choose* to hear. For example, some political reporters puzzled over the frequent use of the Village People's "WMCA" and "Macho Man" at Donald Trump's 2020 rallies.[30] These "gay" anthems seemed unintentionally funny to beam to audiences attracted to Trump's brand of traditionalism. Similarly, a local grocery store in my town that vigorously supports LBGTQ causes routinely plays country music on its in-store system. My sense is that it is also out of sync with the preferences of its patrons, and a reminder that background music is difficult to match to any mixed group of Americans. Even so, if we should ever doubt its significance, ambient music is part of nearly every form of film or video narrative. Its presence is expected if not always loved.

Quieting Brain Chatter

A Google search using the three words that title this section yielded 1,670,000 results. And using just the last two words

increased the search findings nine-fold. There is obviously an interest to explore our own recurring streams of “self-talk” and its more compulsive forms psychologists sometimes describe as “rumination.” In a basic sense, self-talk is simply thinking.[31] At some points it is our own shelter from an outside world that can seem alien or strange. At other times it offers no island retreat, seemingly taking our reluctant selves on a roller coaster tour of ideas and worries we would have preferred to skip.

An active consciousness is partly what makes us human. As Jonathan Smallwood and Jessica Andrews-Hanna note:

> The lengths that the mind goes to self-generate thought, coupled with its apparent functionality, suggest that the mind places a higher priority on such cognition than on many other mental acts. Although mind-wandering may be unpleasant for the individual who experiences it and disruptive to the tasks of the moment, self-generated thought allows consciousness freedom from the here and now and so reflects a key evolutionary adaptation for the mind.[32]

We claim to “know our own mind,” which can be a mixed blessing, given how disabling and sometimes disturbing a person’s own interior thoughts can be. Indeed, consciousness is the gift that language allows for an active interior life. We also recognize this power when we refer to another’s mind: the vast but mostly unknowable store of their accumulated experience.[33]

One common assumption growing out of widespread interest in stressed residents living in complex societies is that we dwell too much on our life circumstances. For example, inner thoughts and doubts are, to writer Tim Parks, the crippling obsession of too many of the twentieth century’s novelists. “It is hard not to congratulate oneself on the quality of one’s unhappiness,” he notes, citing Virginia Woolf’s *Mrs. Dalloway* as a representative

case.[34] Others such as Christopher Lasch have similarly written about an inward turn in the American character driven by advertising and other forces. Our focus on our own needs has ostensibly made Americans narcissistic and self-obsessed.[35]

There is evidence for this shift to a cultural romance with figures who seem to go against the grain and set a life course based on their own passions. Socially challenged innovators—perhaps Thomas Edison or Steve Jobs—are often seen as having a kind of single-minded preoccupation that plays out in desultory conversations with others, but intense conversations within themselves. Yet *Scientific American'*s Farris Jabr is not so sure, at least with regard to the alleged fixation on interiority present in modern popular fiction. He challenges the idea that there is a culture-wide weakness for endless rumination. "Yes, we talk to ourselves—our minds chatter incessantly—and we are the saner for it."[36]

But what about individuals who complain that their lives are interrupted by worries and "what ifs" that they can't easily set aside? While we expect that teens and young adults are carrying backstories that sometimes weigh them down with more than they can handle, we expect that it is largely a function of the instability of passing transitions into work, or more independence from their families. Interestingly, therapists working with senior citizens at the opposite end of life regularly guide many who are unable to set aside doubts and second guesses over events that happened over a half century ago.[37]

The obvious disruptions of lives during the 2020 pandemic clearly put more challenges in front of people than many could handle. Common complaints of family frictions and thoughts of hopelessness seemed to be more the rule than the exception, especially among younger adults.[38] They lend credence to the aphorism that a person alone still has another partner to address.

The effects may show up as insomnia, generalized anxiety, or even doubts that they have a future worth trying to claim.

Most self-help tracts follow the same route in exploring methods to quiet what can be the disabling nature of constant brain chatter. The idea of "controlling our thoughts" is acceptable if treated conventionally with exercise, meditation, or the psychotherapist's tool of cognitive behavioral therapy, which works to correct "inaccurate" or "negative" thinking by finding more productive mental images. The therapist is used as a resource, offering alternate narratives to the worn out "tape loops" that keep playing in someone's head.[39]

A less acceptable route is also common and far more clinicalized. Yet the common cliché that people "drink to forget" can't be easily dismissed. Alcohol and some drugs can quiet the chatter, mostly by slowing brain activity generally. Few own up to using alcohol just for its stress reduction effects.[40] But every age has its stories, though the functioning drinker as a type is more out of favor with modern story tellers.[41] In the 1920s and 30s the *New Yorker* writer Dorothy Parker managed to turn drink into an antidote for any nagging insecurity or self-doubt: "*Bartender*: What are you having? *Parker*: Not much fun." Drinking famously took her out of her own low moods that were sometimes converted into her short stories.[42] But most self-told narratives from drinkers are usually air-brushed to avoid even the hint of using it as a way to control recurring and depressive thoughts. Few want the pity that comes with the impression a person drinks to make it through the day. There is perhaps slightly less of a stigma attached to using marijuana, indeed, making all sorts of edible goods with it. And the anxiety reducers offered by the drug industry—Xanax, Librium, Valium, and Ativan, among others—are still used by many and clinicalized as "treatments" available through a doctor's prescription. Do these substances create

shelters from the non-stop chatter? Though current fashion does not favor dwelling on their quieting effects, many users note that they often help.

Finding Satisfaction in an Acoustic Stew

If you regularly travel by train or plane, you will have noticed that passengers who are on business trips will often use the time confined to their seats to do routine work. Sleep may be a close second here, but many people seem comfortable getting down to tasks they might perform in their more spacious offices or home workspaces. A laptop and phone is usually on hand to complete the picture of a temporary office. How can frequent flyers be productive “on the road?” After all, in-flight noise levels on airliners can easily reach 80 dB. That is conventionally loud. Is it still possible to work against this competing noise, which would hardly seem to be anything but an “aural island?” Is it possible that a “sonic stew” of a whole range of sounds in the background may help a person gain focus?

There is at least some anecdotal evidence that the “integrative complexity” of travel spurs creativity and effort, if not a complete escape. Getting onto an airplane, BBC reporter Tiffanie Wen has noted, seems to give some people a mental boost. Never mind the noise and loss of easy personal mobility. Travelers tend to get work done, spurred on in part by the stimulation of a new environment and a change of scenery.[43] Literally putting ourselves in different places can increase our success in working through a problem or pondering different possibilities.

If the idea of productivity amidst a sonic stew seems counterintuitive, it can work for someone if certain parameters

apply. It seems better if conversations and background noise are heard as a blur rather than as distinct and loud. And ambient noise needs to be coming from expected and predictable sources: anything from a barista's coffee machine in a Starbucks to the drone of aircraft engines, to the mostly unintelligible voices of other passengers on a train.

That advantage of this blended mix of noise seems not to extend to overhearing specific conversations between others or—as reporter Wen discovered—a sea cruise, where attractive distractions like food or music are always available. "I pictured myself working on a deck overlooking the sea for hours at a time, a productive working machine. What actually happened was a mix of seasickness, fatigue and non-stop distractions."[44] In contrast to shipboard life, short story author Bliss Broyard found planes and airports surprisingly conducive to work:

> I worked on the story while I waited for my plane, for the entire three-hour flight, and then kept writing in the terminal in Boston until I'd finished.... When I come to think about how the story came to be, it is the circumstances under which it was written that loom largest in my mind. The anonymous, unanchored feeling of being in an airport terminal and flying high above the earth liberated me from some of my normal writing anxieties.[45]

The story is familiar to many. I can work in a car dealership showroom while I wait for repairs on my aging vehicle. Not so in the dealership's official service area waiting room, with a television that is a perfect distraction machine. We also assume that people planted with their laptops in coffee shops are simply making the best of a work situation that takes them from better workspaces. But some like the stimulation—caffeinated and

social—that comes from being around other seemingly productive people.

And there are other indicators that a degree of shared chaos can be stimulating. A favorite includes stories told by older newspaper staffers who recall the satisfaction of hearing one of the sweetest sounds a journalist working in the twentieth century might have encountered: the low rumble of basement printing presses starting up sometime after 10:00 in the evening. The noise meant that a paper was beginning to print the first editions for the next day. The massive letterpress machinery usually made the building vibrate as they started up and reached full speed: a signal to the staff that the paper had saved the city from ignorance for another 24 hours. “The vibration from the presses would shoot up through their shoes,” recalls Bob Green, “It was glorious, part of the romance of newspapering.”[46]

The kind of lift some may get from a communal work environment is not unusual. For example, WeWork is a “co-working” office rental service that has recycled older buildings in many cities, renting private offices or desks in shared workspaces—approximately 400 dollars a month for a desk and some other privileges. Entrepreneurs and younger self-employed people have flocked to co-working sites, which offer a degree of collegiality mixed with evident productivity. In 2018 WeWork became Manhattan’s largest private office tenant. To be sure, many would prefer to work in offices that allow more privacy than is possible in many open-space plans.[47] But one recent study suggests the buzz of activity in a co-working environment did not deter renters. Most preferred the social and business connections this shared environment makes possible.[48] Home offices can be isolating and notoriously too close to other family responsibilities. In contrast, workers sharing a co-office arrangement can model their own efficiency to each other, at the same time escaping the

hierarchical frictions that inevitably occur in traditional organizations housed under the same roof.

There is also an interesting twist in stories of concentration in the midst of an auditory stew. Blended sounds that are as mixed as a long simmering pot of ingredients may actually have some advantages over the stillness we associate with “quiet.” As we have noted, “quiet” is a relative term. Even a library where the norm is to avoid interruptions can be surprisingly distracting, in part because any sound can stand out against a relatively blank auditory canvas. In a smaller and shared library space it is easy to get sidetracked by the unusual tic of a nearby reader, or whispers between two people at the next table that invite guesses of what is being said. That is clearly less likely in the New York Public Library’s Rose Reading Room, which is nearly two city blocks long and capped with ornate ceilings painted with billowing clouds. It has the murmur of the scores of readers and researchers seated at its long tables, far too many to focus on any single group. It is little wonder it is a favorite aural island in the city: a Beaux-Arts feast for the eyes but an auditory respite from traffic-clogged Fifth Avenue just beyond huge arched windows.

Hearing is not a sense that can be turned off. We have the option to rest our eyes. If you will, they come with their own doors. And so, by default, we live with the constant sentry that is auditory awareness. In an era when humans have managed to fill their lives with electronic and digitized social activity, it falls to the auditory chain that links our ears to our brain to process a constant parade of stimulation. It is little wonder we occasionally seek a lifeboat—stillness, music, an intimate’s familiar voice—that allows us escape. It is not that we want the world to be silent. We mostly seek sound streams that are less insistent and more coherent. The trick for every individual is to find that unique

personal refuge that gives them a level of clarity that makes the rest of an overstimulated life bearable.

Chapter 10 Notes

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Chapter 11

POSTSCRIPT: COMING TO OUR SENSES

> *We must feel everything, everything we can.*
> *We are here for that.*[1]
>
> —Henry James

The beginning of a human life offers the chance to gain clarity about what matters. An infant in the womb first connects to the world they are about to inherit with their sense of hearing. Well before their birth they have already been listening to the environment they will join. Just thirty weeks into a pregnancy sound has started leaving impressions, orienting a developing individual to the characteristic phonemes of their mother and the language that will pass on the keys to the culture.[2] Even after they are born, a child's eyes will need weeks to focus and track movement; but functioning ears have a significant head start.

The First Sense

The argument made in these pages is that reception of sound is our leading sense. It is the one perceptual capacity that

functions all the time. We can shut our eyes. We can be fickle about what we allow ourselves to see, feel or taste. And there is no easy way around the limits of our 210-degree visual field. Sound is different. It is the first and clearest passageway into a lifetime of experience—sometimes through the vast aural pleasures of music and the natural world—but always through language: the defining birthright of our species. Even a child's early cries represent a significant marker. They are a newborn's first replies to the world. We listen and are pleased to hear these initial assertions of self.

As we have noted, the capacity to hear orients us to the physical and social worlds of others, often surpassing its routine functions of picking up ambience cues that keep us safe. Like others in the animal world, we depend on these recurring auditory signals. A pedestrian knows that they may hear the effects of imminent disaster well before they can see the risk. We similarly learn to initially "read" a public space by the murmurs from voices rising from it. The wellbeing of friends and co-workers, machines and engines, hearts and lungs, get at least a first assessment centered on how they sound.

The mastery of language outlined in Chapter 4 emphasizes the centrality of conversation in the human experience. As tools of engagement, talking, listening, and questioning are as durable now as they ever were. But we have evidence that time in front of screens is rendering our children nearly mute.[3] Screen-based distractions in the young especially pose a threat to their abilities to acquire the social intelligence needed to thrive. Because we are now tethered to devices, too many of us are now senders more than receivers, observers rather than participants. Recent studies also suggest that many adolescents now fear the prospect of communicating in person with adults.[4] Speaking directly to outsiders is essential behavior that is withering from

neglect. Parents alert to the problem are aware that they need to budget time for unfettered exchanges for children, arranged as explicit set asides to bring them into contact with others. Welcoming the unmediated chatter of everyday life is part of a parent's obligation to keep the pathways to language use busy and open.[5] Additionally, those same caregivers will sometimes need to intervene to preserve the pristine hearing of their charges. We have experienced enough to know that noise in the modern world is not simply a nuisance, but a threat to the set of receptors we were given at birth. Young ears can easily be overwhelmed by the brutish noise of careless commercial and industrial interests, one reason so many adults arrive at middle age with diminished hearing.

And then there is music, the magnificent kingdom that so clearly feeds our needs for invention and expression. Music can reach deeper into the epicenters of feeling not easily tapped in other ways. And it is all the more remarkable to remember that Western music springs from a small 12-tone scale that repeats over the ten octaves in the audible range. The apparent simplicity of this fact, along with the straightforward doubling of pitch in each succeeding octave, would appear to make this auditory form imminently transparent. That might be the case if we were describing the conditioning of a person to respond to a visual image. Visual learning that relies on recognition and learned associations is usually established through repetition. We know a stop sign or a "beautiful landscape" by judging form and color learned from prior examples. But music is metaphysical and brilliantly unpredictable in producing affective reactions. By one estimate this human invention allows for 30 trillion different melodies.[6]

This kind of organized sound thrives off the brain's plasticity—its nearly infinite neural pathways—to create

impressions, feelings, emotions, expectations, associations, pleasant surprises, and sometimes disappointments. This neural routing is more mysterious than the known superhighways used for language acquisition.[7] For reasons we have only begun to fathom, as Oliver Saks has noted, “our auditory systems, our nervous systems, are indeed exquisitely tuned for music.”[8]

Our natural affinity for sound suggests that it is a mistake to treat it as just another language. Language acquisition is—among other things—a result of learning and memory, yielding description and stipulation: important, to be sure, but different from a form that is more generous in offering ranges of meanings.[9] We let music stand in as proxies for the highs and lows of living. Where well-known, text-based conventions of language use can be easily understood—indeed, often growing too predictable—music is open to alternate understandings that need no further proof than a receptive listener.

Consider one representative difference between visual form and musical form revealed by looking at the allied art of film. The conventional structure for narrative films generally mandates the following of certain rules, such as “foretelling:” the expository device that gives a viewer cues dropped into early scenes that suggest challenges that will follow. Among other things, foretelling is bait for the promise of an interesting plot yet to unfold. Think of the character who had a bad cough in the first act who is unsurprisingly dead by the third.

Alfred Hitchcock’s classic *Rear Window* (1954) allows us to further explore vision’s narrower pathways. It is a visual feast for any first-time viewer.[10] Incapacity caused by a broken leg is the key set-up in the piece. It has left the world-traveling L.B. Jeffries with too many empty days to fill in his studio apartment, leaving him time to gaze into the open windows that ring a shared courtyard. His second-floor view puts him front and center to

catch glimpses of worlds he was never meant to see. If his compulsive voyeurism initially seems harmless, a woman's scream in the middle of the night convinces him that he has heard a murder. With Hitchcock's camera always at his side, we see what Jimmy Stewart's Jeffries sees. Hitchcock is predictable in letting Stewart's face register Jeffries' growing alarm when a bed-bound woman in an apartment has vanished. The remaining spouse seems to be cleaning a sawblade at his kitchen sink. Has he killed his wife? What is in the suitcase the old man dragged out of his apartment at two in the morning? Grim as it sounds, the film has aged well and is still wonderful fun, lifted in part by the repartee between Stewart's character and Grace Kelley's Lisa, who would like to tame some of Jeffries' obsessions. The story is masterfully put together. But the fabric of the narrative can begin to look a little threadbare on a second or third viewing. The written script[11] forces an accomplished actress in the role of an insurance company nurse to keep repeating to her home-bound patient that something bad is going to happen. Screenwriter John Michael Hayes was probably duty bound to give Thelma Ritter her lines warning of brewing trouble. Yet, once we know the outlines of the narrative, we do not want the usual discursive rules to apply. Foretelling and backstories shoehorned into the dialogue only work once.

Our point is that what needs to be obvious to the eye can be far more nuanced to the ear. The only counterpart to narrative foretelling in almost any composition might be considered the first statement of a central melody or key theme. And the results are much more rewarding. Most music embellishes on a basic motif: from a Mozart symphony to a jazz standard. These variations rarely grow stale with repeated hearing. Indeed, picking up the threads of reused ideas makes music more sensible. The doubling back on a prior chord or phrase adds interest. The

difference is form serving a utilitarian function in a film versus aural form as a structure that opens up possibilities for surprising twists of meaning.

This may seem like a minor distinction. But the uniqueness and durability of music is revealed in its nature as open-ended. The subjectivity that sound invites has the advantage of sometimes being a cognitive stimulus rather than a signpost: something to be puzzled out rather than followed. So, if music is to be considered in the common but misleading formulation of a "language," it is also a non-language that gains power through the power of endless invention. As the ground-breaking philosopher Suzanne Langer noted, the real power of music is that it can be "'true' to the life of feeling in a way that language cannot; for its significant forms have that ambivalence of content that words cannot have."[12] This distinction is sometimes overworked into an empty cliché. But it is a profound one and sets the experience of sound on a very different conceptual path.

Sound is best thought of as the work of the ear and the brain to track the *processes* rather than the *products* of human action. The perception of sound involves a continuous unfolding of *moments advancing through time.* It is about the trip rather than the destination. And it does share one common element with narrative forms, including film. Even while "filmic" elements—sets, scenery and locations—are usually static, the aurally-based conversation of a play or film progresses as a partial analogue to music, reborn from the page as spoken language. So, while we may sensibly ask a painter what a given work "means" or "represents," the properties of music are less amenable to a forced conversion into imagistic terms: words that turn expression into a product or thing. Of course, we do have all kinds of music and lyrics that were intended to match specific places, feelings, attitudes, and the like. Yet few of us feel bound to accept some a-

priori stipulation of what a given piece “represents.” A work as a sequential unfolding of sound allows the mind to free-associate in real time: from minutes to hours. We are likely to offer a whole collective chain of adjectives that spill out as an entire world of feelings: clumsy conversions of meaning for some, and perfect word essences for others. In truth, something is “musical” in its own mysterious way. And we are often adept at accommodating our ears to the journey it offers.

In aural terms, we are experienced time-travelers. For instance, at the micro level, many of us would find perfect fifths to be more satisfying than diminished fifths. But that would not be so for Bela Bartok and others. Indeed, the more sinister sounding diminished fifth chord (a span of 6 semi-tones) was once thought to be the work of the devil and banned in early church music.[13] Even so, the sour dissonance of the latter *can* be effective, as it surely is in the introductory first measures of Leonard Bernstein’s melody for “Maria” in *West Side Story*.[14] In this instance, the serendipitous *process* of listening allows us to imagine Tony’s initial tentativeness resolve in a short step to a perfect fifth when he first sings her name. The song and Stephen Sondheim’s lyrics allow us to share his sudden awakening.

Screening Our Senses

The separation of the visual from the aural can be made in several ways that challenge our conventional thinking. A person who self-describes as oriented to the “visual” may find an evening spent in a concert hall too boring for their tastes. They might have the impression that there is not much stimulation for the eye, a feeling that can remind someone of the aphorism that “a picture is worth a thousand words.” It is one of those mental props that is at

once so self-satisfying, but also so flawed. The logic is in fact inverted.

A picture is sometimes inaccurate for what it seems to portray, and—in many cases—a distraction that costs us because it can waste our cognitive gift for symbol-using. It seems as if we are naturally disposed to sell our lifelong auditory capacities short, expecting to see first and receive sound as an involuntary response. But there is a problem in relying on this comfortable view.

While video and the digital display of material have been celebrated as relatively new ways to pass on information, a better assessment is that these forms are often functionally inhospitable to information and ideas.[15] Imagine ideas as the non-material but potent bases for understanding the world around us. Ideas order our thinking but may have no conclusive visual forms. In plain words, visual media tied to commercial goals of enticement or entertainment will easily get more attention than ideas that illuminate policies, values, concepts and trends. For many of us it is easier to see some event than to listen to an explanation of its meaning. Longform media of books, lengthy discussions, or documentaries face a withering of interest in favor preferences for visual variety. For example, a seasoned television producer tackling a problem like health care reform probably understands that the topic is ultimately about equity and the fair distribution of medical services. But they will also know that the subject is not an especially visual story, and they would be right. Stock B-roll footage of doctors and hospitals would have to be used to visually cover an aural narrative that will have to carry most of the information about the topic.

Once again, Suzanne Langer is a helpful guide on these matters, noting that visual media are “presentational,” indicating that they are “read” more for what they reveal to the eye than to

the ear.[16] She has described the very different and easier access we have to communications we can see versus those that must be explained or elaborated through time-based "discursive media." Her work still resonates as a way to understand the importance of our cultural turns toward images, represented in mid-twentieth century by the rise of television that paved the way for other digital platforms that build on "visual interfaces." Langer was writing in the 1940s and 50s and could not have anticipated how video and computer technology would evolve. But she understood the easy consumption of the visual. Presentational forms tend to compress experience and meaning, as in a typical television commercial or the "fast cutting" of a feature film. They represent the kind of segmentation of effort that is now embedded in presentational media. It is revealing that a reader's time on a single internet page is usually under a minute. Similarly, Twitter imposes huge limitations on the expression of thoughts, matched by political ads that present a candidate in 30 seconds, or television news "sound bites" from experts that average around nine or ten seconds.[17]

The effects of more attention to what is screen-based reflects the culture's turn away from the conceptual toward the material: from what is *said* to what is *seen*. This can be illustrated by considering some moments in the recent history of ideas. For example, the flourishing growth of theoretical breakthroughs in psychology, sociology, and other fields in the first part of the twentieth century happened at the very moment when the seeds were planted to make them less noticeable. Analytically, Marshall McLuhan and the Canadian movement to understand "new media" in the 1960s documented and often celebrated this flight from older "discursive" forms of discussion in books and monographs.[18] While this shift probably mattered to just a scattering of intellectuals and professors, the analysis itself was

prescient in seeing the coming of a world dominated by visual content hostile to extensive time-based explanation. Picking the perfect word, the newer media was described by McLuhan as a fragmented “mosaic” of images.[19] The difference can easily be seen by comparing the discursive style of a locked down C-SPAN camera covering a senate hearing versus a commercial network’s ostensibly more interesting 90-second “packages” on the same subject. Commercial television networks churn their content with only slightly less speed than a blackjack dealer turning over cards.

Among other ideational breakthroughs that Americans in front of screens might have missed was the flourishing of innovative mid-century studies of social and civic life. Among them: Walter Lippmann on the nature of the American democracy,[20] George Herbert Mead on the construction of the self,[21] Kenneth Burke describing how language has its way with us,[22] or social scientist David Riesman creatively reconceptualizing the nature of the American character.[23] All were intellectual giants who offered important works describing how we consciously construct our worlds. All provided what Langer called “discursive understandings” which can best be understood if given enough time.[24] And most were impenetrable as subjects for the screen. To simplify, any potential culture of ideas is undermined by rapidly expanding access to the “presentational” forms presented on screens, which feed the already strong human impulse to feel rather than to think. By contrast, ideas live in language and deep description. They are inherently not entities that can be easily shown.

If this sounds like aimless armchair theorizing, it isn’t. Langer’s original insight has helped us understand the advantages and costs of visual media. As later writers noted, we don’t watch video content for the richness of its explanatory

power. In fact, a transcript of a supposed informational program usually looks sparse in print.[25] The quintessential moment of video is actually a person or face on a screen. Any television director learning their craft will know that a person's expressions *are* the informational content of television. Human features are expressive. We are hardwired to read them and absorb all the cues a closeup can give us. While a theater actor needs to project his character with their full body, counterparts working in television understand the key to success is mostly in how they use expressiveness centered on the eyes.[26] In spite of what we might think, we don't watch even a "brainy" television game show because "we can learn a lot." As Joshua Meyrowitz noted, we are mostly drawn in by the drama of an individual struggling to find the right answer. We like to see the expressive forms of relief or regret.[27]

If screens easily capture our attention, our emphasis on sound and music is meant to rekindle our awareness of how well-adapted we are to do so much more. The challenge of our times is to staunch the flood of screen-based devices that has made consumers vulnerable to these machines of self-absorption. For many of us, staring at a small screen has seemingly turned into our life's work. To be sure, visual media can be authentically meaningful. But "seeing" and "hearing" are not parallel concepts. We don't derive pleasure from sound in the same way we are struck by the views of a stunning landscape. As we have noted, listening comes in segments requiring time, with the need to hear music and often speech in a structure that is usually not just revealed, but cognitively processed rather than observed. As we grow increasingly susceptible to the electronic distractions of modern life, we also tend to succumb to events that have been tuned to accommodate fragmented attention.

Another corollate to the idea that “a picture is worth a thousand words” also deserves to be challenged as the cognitive handicap it is. Individuals now often speak of themselves as “visual learners,” which represents a drastic narrowing of what learning and knowing ought to be about. I have heard the “visual learner” defense many times from students who protest that it is hard to focus on discursive materials. They want to believe that it is enough to operate on a simple epistemology that “to see is to know.” In this narrow focus, as noted, something is meaningful if it comes to us in a visual frame.

There is no doubt that video as a pervasive daily presence has certainly played its part in making us ocular-centric. There is no better example of this sensory bias for the visual than in the previously mentioned decision by Apple’s Steve Jobs to adopt a Xerox research lab’s template for graphical interfaces in computers. As Walter Isaacson documents, working on the Apple II in the late 1970s, Jobs sensed the monochrome screen of text and code would need help if the computer was going to become an essential personal device. [28] Computers with green screens did not look like a winning product everyone would want to use. We now take for granted the colorful icons and “windows” that current computer and internet content contain. Most sites easily match the visual variety we associate with a magazine, video game or film. Add in video recording and easy-to-use cameras, and the transition to visual formatting of content was on its way to transforming the media landscape everywhere.

Especially for younger Americans, the eye had begun to fully extend its dominance over the ear, to the extent that people will sometimes accept bad sound even while they watch super high-definition video images. This fascination with “media” as a parade of graphic sequences is a norm for most commercial forms, with rapid “fast cutting” in films and videos reduced to average shot

lengths of one or two seconds.[29] “Virtual” screen reality shades most of what we know as the human experience. Though a lot has changed regarding the interactivity of modern media, screens are still functionally what they were in the early days of television in the 1940s: often small rectangular affairs with sound added mostly as an afterthought.

An additional feature of the visual perspective also retains a limiting dominance. I mentioned the narrowing of meaning that can happen with imagistic terms. And yet we have far more words, metaphors and analogies built from visual referents in discontinuous sequences than from distinctly aural images. Descriptions based on light or sight are everywhere in our depictions of the world. Earlier references in this book to “tubas” as producing “fogs” of sound, or high frequency noise as the equivalent of a “blinding light” are examples. We have also referenced noise as “aural litter,” “sound reflections,” “sound shadows,” or “soundscapes:” all are visual referents. And to many, music often sounds “dark,” or “bright,” “dry” or “wet:” states that we experience mostly through sight. The seeming dominance of visual imagery to describe sound represents a kind of rhetorical synesthesia. For reasons that remain obscure, we probably think less in pure auditory terms because our analogies based in another sense are visitors on foreign soil. While visual analogies can be useful, they can also be detours around what needs more direct understanding in its own terms. Except for the rarified Italian lexicon used in musical notation, we seem to have less than the rhetorical equipment we need to name sound qualities.[30] It is little surprise that active and involved listening—in whatever forms—is often considered our least developed cognitive capacity.[31]

A key feature of that neglected capacity is an ability for linear thinking. It’s becoming rarer, but still part of a process of active

engagement that can take many forms: avid readers content to devote large chunks of time to a single work of fiction or non-fiction, artists happily left alone to work through decisions that will end up as musical notation, the rapt attention that comes from appreciating a musical piece. Unbroken attention to a task allows synergies to develop from scattered thinking. This allows the emergence of connections and consequences that others may miss. The linear thinker looks forward to organizing their work or leisure time sufficiently to be able to get an unobstructed view of the horizon they want to explore. Undisturbed concentration gives them intellectual power. This is the realm of the problem-solver, the creator, the owner of a consciousness that will discover and understand what a fragmented thinker may never notice.

Imagine the sustained effort required in 1930 by William Lamb's architectural firm, who designed and prepared drawings for the Empire State Building in mere weeks, with the iconic skyscraper completed in just over a year.[32] Such dedication to single and complex tasks can be scaled down to what many creators, researchers and problem solvers sense when they notice the time that passes when they are absorbed in their work. George Frederick Handel wrote the great oratorio *Messiah* in a spurt of nearly unbroken absorption, finishing in just under four weeks.[33] The composer Joseph Haydn wrote over 106 symphonies, in addition to chamber music and operas. We could rightly wonder if he and the younger Mozart, who he mentored, would have been nearly so productive if given the minor diversions of the modern world.

Mozart is an interesting case for another reason. One of the features sometimes seen in a person at the higher end of the autism spectrum scale is a consuming and total passion for one thing. Subjects with Asperger's syndrome are especially known or imagined for their laser-focused interests, making them a

sometimes-awkward presence in a culture that rewards frequent pivots to different activities. The trials and triumphs of animal scientist Temple Grandin are well known.[34] Her obsessions paid off with new and thoughtful insights about the industrial treatment of animals. Psychological historians similarly believe we can thank mild forms of autism for the achievements of Mozart, Beethoven, Charles Darwin, and Lewis Carroll. And it is surely Asperger's that seems the dominant psychological trait of the world's favorite sleuth, Sherlock Holmes.[35] All showed the advantages of linear thinking.

Receivers of Light but Producers of Sound

Finally, it is useful to close this study with a brief reflection of how the physics of the natural world can also work against our underappreciated sense of sound. Light waves which are the sources of all things visual are more insistent and durable in their penetration of human consciousness. Light from the sun has the power to overwhelm the senses. And if natural light is not enough to flood our perceptions, we have learned to easily add more to dazzle the eye with form and color. Little could Thomas Edison have realized that one of his inventions, a workable nighttime source of illumination, would turn into the perfect foil for the relatively fragile sound waves his new phonograph struggled to capture. Natural and artificial luminescence bristles with solar and electrical energy that is well represented in its speed. It travels as fast as anything measurable. By contrast, sound depends on the relative simplicity of its medium of air, and a vastly slower velocity: 1125 *feet* in one second compared to estimated 186 thousand *miles* covered by light in the same second.[36] Our

immense distance from the sun is a reminder of how far light penetration can extend.

In terms of the human senses, the cosmos gives us light that we *receive* but cannot directly create. Our bodies can produce sound waves but not visible light waves. We obviously have learned to modulate light for our own ends, with screens of various sorts functioning as proximate versions of what the eye can detect. But sound is the rare sense that arises from *within*. We are prodigious sound producers driven to expression through the very human mechanisms of speech, music, and the aural byproducts of our industriousness. We have evolved to make use of the acoustic energy we evolved to produce. The cosmos has enabled an atmosphere that can carry soundwaves, sustaining our carbon-based existence with nitrogen and oxygen, and thus also providing us with air that is the mother of all media. More than light, sound is the characteristic essence of our species. Human communities are created and sustained by a sense that is already established well before our young eyes can accurately take in the shapes of objects. These are the elemental facts of our nature.

Yet the differences between what we see and how we hear are therefore not necessarily aligned, especially, as we have shown, if the “second” sense is the authentic driver of our social temperament. The body’s attraction to all the ways we put light into motion ought to make us cautious that we might be putting our faith in a faulty map. The routes to consciousness are easily thwarted by the visually intrusive and cluttered realms of everyday life. In terms of our attention, sound is usually still playing “catch up” to match the brilliance of bright shiny things. And yet we are irrevocably tied to a different and more fragile perceptual sense. Even if we have the means to easily dominate

the eye and overwhelm the ear, we do so in ways that are alien to our nature.

Chapter 11 Notes

1. Henry James, *The Tragic Muse, Vol. 1* (New York: Charles Scribner's Sons, 1922), 30.

2. Perri Klass, "Language Lessons Start in the Womb," *New York Times*, Feb. 21, 2017, https://www.nytimes.com/2017/02/21/well/family/language-lessons-start-in-the-womb.html.

3. Sherry Turkle, *Reclaiming Conversation* (New York: Penguin, 2015), 3-17.

4. Turkle, *Reclaiming Conversation*, 22-23.

5. We now tend to see loquacious kids as an entertaining anomaly. Consider the many remakes of Lucy Maud Montgomery's *Anne of Green Gables*. Anne is rarely without an opinion to pass on to any adult. Any reader of biographies of individuals raised in the first half of the twentieth century will find descriptions of kids fully engaged in the conversational life of the family. In a case that is more typical than extraordinary, Francine Du Plessix Gary remembers that at age 14, she spent one night one a week with her step grandfather talking about his Russian past. She loved the stories and had lots of questions. *Them*: *A Memoir of Parents* (New York: Penguin, 2005), 290-291. If there is one, hers was not an average American family. Even so, her story is less unique for its content than for how it represents the norms of a different time.

6. This only works as an intellectual exercise since a melody can be defined in so many ways. See Rhett Allain, "How Many Different Songs Can There Be? *Wired*, April 17, 2015, https://www.wired.com/2015/03/many-different-songs-can/.

7. Natalie Angier, "New Ways into the Brain's 'Music Room,'" *New York Times,* February 8, 2016, https://www.nytimes.com/2016/02/09/science/new-ways-into-the-brains-music-room.html.

8. Oliver Sacks, *Musicophilia* (New York: Vintage, 2008), xiii.

9. As Daniel Levitan notes, language and music arise from different brain centers, though our understanding of what both of these elements “mean” is not precise in either case. See *This is Your Brain on Music* (New York: Plume/Penguin, 2006), 125-127.

10. Interestingly, it is also full of subtle ambient sound (mostly reflected sound at a distance) well ahead of what most other filmmakers at the time were attempting.

11. A script is visual and aural. But its structure is built on film’s narrative forms: a visual presentation—a worked out sequence—of people giving the written lines as natural conversation.

12. Susanne Langer, *Philosophy in a New Key, Third Edition* (Cambridge: Harvard University Press, 1951), 243.

13 Judith Kogan, “The Unsettling Sound of Tritones, The Devil's Interval,” *National Public Radio*, October 31, 2017, https://www.npr.org/2017/10/31/560843189/the-unsettling-sound-of-tritones the-devils-interval.

14. Sofia Rizzi, “Why Did Bernstein Build West Side Story Around 'The Devil's Interval’?” March 4, 2019, *Classic FM*, https://www.classicfm.com/composers/bernstein-l/bernstein-west-side-story-tritone/.

15. We need to acknowledge the obvious point that video in all forms includes audio. But the lead sense is usually visual. Those who control most commercial video sources are motivated most clearly by finding interesting images. This visual bias is evident even at the level of television news, where a case can be made for seriously treating ideas. Most typical news content, however, focuses on interesting images. In the cases of local news, fires, hurricanes, explosions, accidents and shootings tend to trump policy discussions. “If it bleeds it leads” is an old journalism aphorism. For a classic example, see Ellen Hume, “Why the Press Blew the S and L Scandal,” *New York Times*, May 24, 1990, A25. Top stories in 2018 include a royal wedding and footage of a North Korean soldier escaping into South Korea. Top 5 News Stories Of 2018 | *Today on NBC*, Dec 27, 2018, https://www.youtube.com/watch?v=Pzp9Z4zIpV8.

16. Langer, *Philosophy in a New Key*, 93-7. If this is the case, what are we to make of written language? A novel, for example, uses the visual sense to pick up what is a discursive text, extended and fully developed. Most written language, like film, is an exception that bridges both expressive and representational forms of communication. Our point, however, is that presentational forms tend to be more typically represented in material offered for the eye: photos, ads, memes, television content, videos and so on. Most are likely to be consumed at one time rather than over an extended period.

17. Ozen Bas and Maria Elizabeth Grabe, “Sound Bite,” *The International Encyclopedia of Political Communication, First Edition.* ed. by Gianpietro Mazzoleni. (New York: John Wiley & Sons, 2015), https://www.researchgate.net/publication/283494592_Sound_Bite, accessed September 25, 2020.

18. Bruce W. Powe, *The Solitary Outlaw* (Toronto: Somerville House, 1996), 182-198.

19. Marshal McLuhan, *Understanding Media* (New York: Signet, 1964) 273-282.

20. Walter Lippmann, *Essays in the Public Philosophy* (New York: Little Brown and Co. 1955).

21. George Herbert Mead, *Mind, Self and Society* (Chicago: University of Chicago Press, 1934).

22. Kenneth Burke, *A Rhetoric of Motives (*New York: Prentice Hall, 1950) and *Language as Symbolic Action* (Berkeley: University of California Press, 1968).

23. David Reisman with Reuel Denney and Nathan Glazer, *The Lonely Crowd: A Study Of The Changing American Character (*New York: Doubleday, 1953).

24. Langer, *Philosophy in a New Key*, 97.

25. For an extended look at another version of this argument see Joshua Meyrowitz, *No Sense of Place* (New York: Oxford, 1885), 115-125.

26. See, for example, Michael Caine, *Acting in Film, Revised Expanded Edition* (New York: Applause Theater Books, 1990), 34-74.

27. Meyrowitz, *No Sense of Place*, 103.

28. Walter Isaacson, *Steve Jobs* (New York: Simon and Schuster, 2011), 94-98.

29. David Bordwell, “Intensified Continuity Visual Style in Contemporary American Film,” *Film Quarterly*, Spring, 2002, 17.

30. In ordinary English, we may describe jazz improvision as “free form,” hinting at the possible visual referent of a flexible visual form. In musical notation the concept of “rubato” represents a similar idea. But the use of the term would be limited to understanding the more flexible playing of a musical phrase. At least in English, rubato has not been a ready candidate for metaphoric extension.

31. Debra Worthington and Margaret E. Fitch-Hauser, *Listening: Processes, Functions, and Competency Second Edition* (New York: Routledge, 2018), 4-8.

32. James S. Russell, “The Empire State Building: Renewing the Affair,” *New York Times*, September 19, 2019, https://www.nytimes.com/2019/09/19/arts/design/empire-state-building-observatory.html.

33. Jonathan Kandell, “The Glorious History of Handel’s Messiah,” *Smithsonian Magazine*, December 2009, https://www.smithsonianmag.com/arts-culture/the-glorious-history-of-handels-messiah-148168540/.

34. See, for example, Oliver Sacks, *An Anthropologist on Mars* (New York: Knopf, 1995), 259-274 and Temple Grandin, *Thinking in Pictures* (New York: Vintage, 1995).

35. Uta Frith, *Autism: Explaining the Enigma* (London: Blackwell, 1989), 44-45.

36. “Ask the Van, Q & A: Speed of Sound and Light,” Department of Physics, University of Illinois at Urbana-Champaign, https://van.physics.illinois.edu/qa/listing.php?id=6822is.edu/qa/listing.php?id=6822, accessed September 21, 2020.

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INDEX