theories and methodologies

Aural Speed-Reading: Some Historical Bookmarks

MARA MILLS AND JONATHAN STERNE

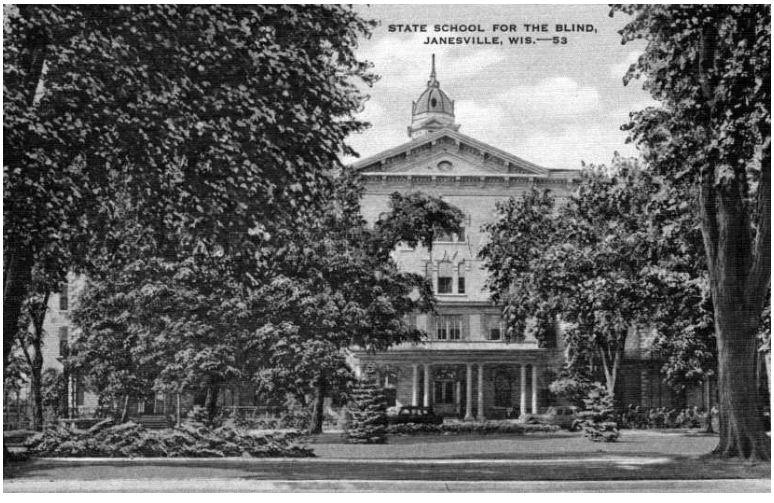

FIG. 1
Wisconsin School for the Blind, in Janesville, ca. 1953.

We write the history of aural speed-reading and time-stretching technology in two tracks, taking a cue from Annemarie Mol's *The Body Multiple: Ontology in Medical Practice*, with its "upper text" and "subtext" that invite readers "to invent a way of reading that works for them from scratch" (ix). In the spirit of the story that opens track 1, on the left, we decided to jimmy the format of the *PMLA* page. To differing degrees, each track provides context, describes events, raises questions, and applies analytic frames. Track 1 is our narration of a series of events recalled by Harvey Lauer to Mara Mills; the insights derive from his professional expertise and personal reading experiences. Track 2, on the right, does not benefit from the kind of omniscient sight known as hindsight; it reads alongside. Think of these tracks as an animated and mostly asynchronous conversation among people who care about instruments of sound and reading in distinct but similarly fanatical ways. For a cluster of historical recordings associated with this essay, tune in to the *Sound and Science: Digital Histories* database: acoustics.mpiwg-berlin.mpg.de/sets/clusters/aural-speed-reading.

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IN 1944, AT THE WISCONSIN SCHOOL FOR THE BLIND, IN JANESVILLE, A MIDDLE SCHOOL STUdent named Harvey Lauer and a group of his friends returned to the boys' dorm after history class, scheming about ways to speed through the night's reading. Their teacher had assigned several chapters in a talking book—*Ivanhoe*—as an entertaining (or so the teacher thought) supplement to their braille textbook. Talking books, on phonograph discs, allowed the students to read together as a group and were faster to get through than braille, but the boys were certain they could hasten the task even more to minimize their homework time.[1]

Before moving to the institution, Lauer lived with his extended family in Milwaukee. His grandmother had a mechanical record player from the early 1920s with a turntable powered by a hand-wound spring and a sliding lever that could vary the speed up to 100 revolutions per minute (rpm). Talking books became available in 1934, around the time Lauer was born, thanks to electrical recording as well as the long-playing records developed by the American Foundation for the Blind (AFB), in New York (Rubery; see fig. 2). When he began reading these books a few years later, their

FIG. 2
Readers sharing a talking book in the 1930s. Photo courtesy of the National Library Service for the Blind and Print Disabled, Library of Congress.

THIS ESSAY IS A CONTRIBUTION TO THE GROWING TAXONOMY OF TECHNIQUES OF LISTENING. Although scholars still sometimes stereotype listening as passive and immersive, the last two decades of cultural and historical research on sound have shown that like any cultural practice, listening is composed of techniques, such as directive and diagnostic listening, sequential and mobile listening, auditory memory, auditory accommodation, and environmental sound interpretation.[1] Aural speed-reading is a very recent technique, set against the backdrop of compulsory literacy in the United States and sound reproduction, which makes it possible to play back speech at a rate beyond what any fast-talking human being can produce. It represents one among many techniques of listening that were explicitly theorized (sometimes invented), taught, and disseminated from blind schools beginning in the 1930s. And, most important, it legitimated aural reading *as reading*, granting new tools of control over pace, search, and access.

Since the invention of audio recording, auditors have noted the connection between rate of playback and pitch: accelerate the playback and the pitch goes up, slow it and the pitch goes down. Experiments with the playback speed of turntables were crucial to the first public demonstrations of sound recording technology (Feaster, "Compass"). If the phonograph acquired a popular reputation as a medium of faithful reproduction, musicians and sound artists persistently undid that convention, using the machine's affordance for variable speed to distort the pitch of recordings and to make new sounds. An iconic example is the Grammophonmusik concert performed by the composers Paul Hindemith and Ernst Toch in Berlin in June 1930. Hindemith tweaked the playback rate of three discs with recorded vocals and instruments (xylophone and cello), calling these trick recordings. A teenage John Cage was in the audience; nine years later, he composed his first electroacoustic piece—

playback machines—like most new record players—included synchronous electrical motors and only two or three options for turntable speed.[2]

In the case of the first talking books, the rate was set to 33 and 1/3 rpm. Lauer always played his books on his grandmother's old phonograph instead of the AFB machine. The faster he let the spring unwind, the more the narrator's voice increased in pitch. Pressing his ear against the horn to hear the soft sounds, he could just barely make out the words at double the speed. This is how he liked to read.

At the institution in Janesville, Lauer recalls asking his teacher if he could borrow an older phonograph player, to read *Ivanhoe* and other schoolbooks at higher speeds than the fixed-rate machine allowed. The answer was no. So he and his friends, hoping to skim through their homework, decided to jimmy the classroom record player. They wrapped tape around the motor shaft to increase its circumference and thus drive the turntable faster. They wasted some time coming to a consensus about just how fast they all could read. It turns out they could not quite double the speed. One problem was that *Ivanhoe* had been recorded at the American Printing House for the Blind (APH), in Louisville, Kentucky, where the studios had a slight echo; the drier the recording, the more it could be sped up. Negotiations completed, the boys read together at high speed for several weeks until the record player broke, its bearings ruined by the vibrations caused by the tape.

When Lauer went to college and became active in the National Federation of the Blind (NFB), he learned that these sorts of hacks had been taking place at state institutions across the United States, where blind students everywhere longed for the return of variable speed turntables to control the rate of their reading. It did not yet occur to them that one day a machine might be

Imaginary Landscape No. 1, for piano, cymbal, two turntables, and a few Victor tone records, which were otherwise used to calibrate instruments or test room acoustics. Performances like these prefigure practices that manipulate recorded audio in real time, like turntablism, tape manipulation, and remixing (Katz 175).

Whereas the variable speed experiments of contemporary musicians (and other artists, like film projectionists) aimed for the overall distortion of sound recordings, aural speed-reading aspired to distort a talking book in time without distorting its playback in frequency.[2] For everyday users and other technologists—for instance, communication engineers who wanted to speed up and slow down speech to save bandwidth in transmission—the relation between speed and pitch came to be understood as a problem to be solved, both for synchronous and asynchronous audio. It existed not as a technological imperative but as the object of a set of audile techniques (Sterne 91–98). Distinct from general listening techniques, audile techniques foreground mediation and issue from "the episteme of modern acoustics" (Tkaczyk).

A fixed speed-pitch relation would later be erroneously described as the ontology of analog audio by Friedrich Kittler and other media theorists, who argued that analog phonographs somehow corresponded to the nature of sonic time because adjusting speed also changed the pitch of playback (Kittler 15; Krämer; Ernst). Yet it turns out that analog audio has no such limitation. Speed and pitch can vary independently, techniques now called time stretching and pitch shifting. Time stretching eventually became an umbrella term to describe the acceleration or deceleration of playback, also known as time expansion, time compression, or rate adjustment (among other names). Today these techniques are everywhere, but they first existed as a set of possibilities. We offer one time line for time-stretching, pitch-shifting, and audiobook technology, building on Aimi Hamraie's idea of "access-knowledge"

built to allow aural speed-reading without a coincident increase in pitch of the narrator's voice—what would later be called a "chipmunk" effect.

According to complaint letters and other feedback to the AFB, talking-book readers also agitated for a standardized aural interface to facilitate speeded playback with less distortion of the resulting high-pitched speech. Specific demands included unembellished recordings with even, legato narration (Helms 8). Many also preferred unaffected delivery—what they called "neutral" or "informative" speech—in order to leave all interpretation to the blind reader.

When the first talking books were recorded in the 1930s at the AFB and APH studios, long before audiobooks were available commercially for mainstream audiences, they employed theatrical narration and experimental sound effects. Yet particular subsets of blind readers—mostly university students and employees in reading-intensive work environments—quickly became dissatisfied with this approach. Tools such as the SoundScriber, a dictation machine released in 1945 to allow home recording of vinyl discs—approximately fifteen minutes long—yielded a massive increase in the quantity and kinds of materials available. The category of "talking books" had long included periodicals as well as novels and plays, but now volunteer groups, most important among them Recording for the Blind (founded in 1948 and today known as Learning Ally), began to record assorted academic materials for blinded veterans returning to college. Some of these readers wanted merely to keep up with sighted students, and not necessarily to race through their homework.

Talking books were intended as a supplement to braille, which many blind people—especially those who lost their sight later in life—did not read; moreover, only a miniscule proportion of the world's ink (5; see 5–11), which privileges the knowledges developed by people with disabilities as they use and transform technologies.

The jimmying of record players by blind students is another word for what we would today call hacking. Disability studies is full of stories of technological modifications by people with disabilities, or with disability in mind, that led to major changes in whole fields of practice: from the curb cuts and ramps now common in American cities and buildings, as well as the Americans with Disabilities Act itself (Hamraie), to closed-captioned video (Downey) to the handgrips on kitchen tools (Williamson) to miniaturized batteries and electronics (Mills) to universal broadcast coverage (Kirkpatrick) to the shape and contours of the Internet (Ellcessor). Yet the burgeoning literature on hacking still largely conceptualizes technology access in terms of open or free as opposed to something that is facilitated (Ellcessor), and it still conceptualizes the figure of the hacker as a nondisabled, normate subject. Even in disability studies, hacks are not usually imagined to take place in institutionalized settings. As Gabriella Coleman and Alessandro Delfanti have shown, the figure of the hacker is heavily mythologized, sometimes aligned with the goals of industry and capitalism, and sometimes against them (Coleman 15–20; Delfanti 56–61). Scholars like Christina Dunbar-Hester have treated hacking and related practices as contradictory, espousing democratic values while also reinscribing hierarchies of gender and class. Like Christopher M. Kelty's "geeks," disability publics are often focused on producing and reproducing the technical and procedural conditions of their own existence—for instance, gaining access to the capitalist workplace—in part because they operate in relation to disabling social and technical worlds that undermine their right to exist (35; see Piepzna-Samarasinha). Lauer and his classmates were very much hackers—driven to it as much by

print had been transcribed into braille. To some extent, talking books were always designed for rapid reading. Expert braille readers achieved speeds from 90 to 100 words per minute (wpm), as compared with 250 or so by sighted adult readers (Lowenfeld 14, 20). At the (supposedly) fixed speed of the playback machines, talking books could be read at 180 wpm (Lowenfeld 18). As more material became available to read by ear, for purposes beyond entertainment, speed and reader control more thoroughly governed the narration and composition of talking books.

At stake was not simply the conversion of print from one format to another (ink to sound) but also the conversion of reading behaviors from one sensory mode to another. Readers like Lauer transferred certain reading habits, shared by readers of tactile embossed print and visual ink print, to the medium of recorded speech—especially those habits associated with so-called extensive reading: speed-reading, but also skimming and skipping ahead.

Phonography is often said to fix sound, turning it into a persistent physical artifact, but sound recordings must be educed to be experienced, and in that process of output transduction a sound recording is converted from a stationary, spatial object back to a kinetic, temporal one (Feaster, *Pictures*). How to treat an ephemeral sound wave as a page? How to navigate on that page, or speed through several pages, without changing the speech sounds themselves? Aural speed-reading is something distinct from simply listening to words at high speed. To read entails a measure of control (scanning, searching, perusing) that does not take place when listening to words in conversation. Nor is aural speed-reading identical to listening to any kind of high-speed sound. Nonverbal sounds—those that do not require decoding—can often be sped up with less appreciable distortion. (In fact technophilia as by the desire to modify a world not entirely built for them.

In the 1940s, when Lauer faced his homework problem, phonographic playback was standardized and consumer audio technologies offered fewer and fewer controllable options—a trend also found in radio and, later, in television (Shapiro; Murray). A gramophone playing a recording of a thespian dramatically delivering literary passages at speeds that could not be altered had the ironic result of enforcing one aesthetic mode of textual engagement—slow contemplation—over an aesthetic shaped by more pragmatic concerns. This is a classic case of what Tobin Siebers calls the ideology of ability, where people with disabilities are asked to conform to the norms of able-bodied culture more rigidly than nondisabled subjects (7–11).

In the case of fixed-playback-rate phonographs, features intended to facilitate ease of use for one set of users—people listening to musical recordings—introduced difficulty of use for another set of users—those who wanted to read by hearing. The proliferation of playback formats and rates only confounded this problem, as 33 and 1/3 rpm and 45 rpm joined the 78 rpm standard. Blind readers thus hacked their phonographs in order to restore lost functionality and, in the process, showed the degree to which neither a recording nor a technology is ever fully finished, set, or black boxed.

Imagine having to read this entire essay in DESDEMONA or some other highly expressive font.[3] For many readers, it would interfere with the standard techniques of academic reading (beyond, even, our two-track approach). This was essentially the problem with early talking books: they were produced as theatrical enterprises, with the assumption that the listener would want to pay attention to the subtleties and expressiveness of the narrator's voice. But blind speed-reading required the opposite assumption about what listeners would want: an easy sonic "font"—a flatter vocal affect—that did not call attention to

some types of noise can be sped up without any change apparent to a listener's ear at all.)

In the early 1970s, decades after leaving the Wisconsin school, Lauer became one of the test subjects for the Varispeech, a so-called time compression device designed by Francis F. Lee, an engineering professor at the Massachusetts Institute of Technology (MIT) whom he met at a conference for instructors of the blind in Florida. Lauer was by then the technology transfer specialist for the Veterans Administration (VA) hospital outside Chicago, and he volunteered himself and a dozen of his students—blinded war veterans—after hearing Lee's presentation about a new electronic tape player that converted recorded sound into a stored signal, which could then be sampled at a rate determined by the user, pulling out and discarding a miniscule fraction of a second with each sample so that the tape could be sped up without any change in pitch or loss of intelligibility.

Other researchers had also been exploring electronic solutions to accelerate and slow down audio playback during the years when talking-book readers were hacking their phonograph players. In Germany in the 1930s, Edward Schüller developed a commercial tape machine for the Nazis that decoupled pitch and playback rate, and the Jewish engineer Berthold Freund came up with a way to achieve the same effects for sound on film, though he did not live to see his work come to market. After World War II, Dennis Gabor in the United Kingdom, Douglas Fairbanks in the United States, and Anton Springer in Germany developed more reliable machines for decoupling playback rate and pitch. While still incredibly expensive, these machines began appearing in American schools for the blind in the early 1960s, and research into rate-adjusted reading became a national field of study by the middle of that decade. Even so, devices like these itself and that allowed the auditor to skim, to easily find chapter and section headings, and to move through the text at different rates.

Lauer's homework problem was thus at once cultural, technical, and aesthetic. It was cultural because he was compelled to read the texts. Schoolwork sits at the juncture of structure and agency, alphabetization and acts of reading (whether acts of simple phonics or long duration; consciously felt or instinctively performed; undertaken alone or in groups). Like other American pupils, Lauer was required to learn grammars and read canons. And like all students, he regularly failed to do so. He rebelled in small ways: skipped passages, read against the grain; let ears and hands wander; malingered; and pretended to have read. Nevertheless, reading for disabled children in state institutions was especially compulsory, homework without the relief of home. And unlike normate students, Lauer experienced massive structural constraints, including underfunded education and deprivation from environmental text, which were pinned by doctors and teachers on so-called personal shortcomings.

Institutionalization was a complex and ambivalent part of blind adolescence in American culture. Law and civil code segregated people with disabilities from the rest of the population even as pedagogy insisted on integrating them (Schweik). Institutionalized blind children at midcentury were the object of rehabilitative practices aimed at rendering them productive citizens, of which literacy was an important part (Rose; Davidson 55–79). In 1929, the *Encyclopedia Britannica* listed "inability to read" as "the greatest handicap" of blindness, superseding navigation and self-care (Fraser 721). Across all these examples, blindness began to be *defined* by exclusion from ink print, necessitating alternative reading technologies, which could never quite live up to the ink-print ideal.

Lauer's experience also binds literacy to technical concerns. On the one hand, he was just another school kid with assigned readings

were not things most individuals could own or use at home.[3]

Lee's Varispeech, patented in 1972, worked with compact cassette tapes as an alternative to the cumbersome and expensive reel-to-reel tape machines and attachments then in use (Lee, "New Promises" 135; see fig. 3). The Varispeech could be used for either time compression (speeding up) or time expansion (slowing down, which otherwise turned recorded speech into a growl). Lee's company, Lexicon, went on to become a leader in the field of audio and studio technology, not only for the Varispeech but for a variety of digital reverberators. It won an Emmy in 1984 and a technical Grammy in 2014. Time compression and expansion eventually became standard features in audio recording and editing software.

The Varispeech also had a setting that allowed one to adjust the pitch of the recording without changing the length of playback time (in other words, the reverse of time stretching), and for this reason it is known as the first commercial pitch shifter, preceding Auto-Tune by more than twenty years.

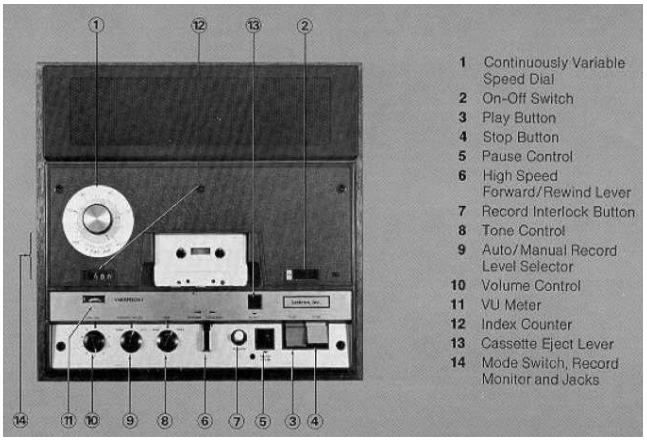

FIG. 3

Image of the Varispeech I, from a pamphlet that advertised it as "a remarkable new tape recorder for time compression and expansion." Pamphlet courtesy of Harvey Lauer, in the collection of Mara Mills.

to get through. On the other, the speed of playback was a new sort of problem to be overcome. In science and technology studies, the "appropriation" of technology by "users" can be a matter of interpretation or construction: assigning a new meaning to an object, finding a new use, or changing its very assembly (Eglash et al.). Aural speed-reading entailed all three.

Lauer's experience also requires that we rethink common aesthetic understandings of literature. As classic works by Lawrence Levine, Gerald Graff, John Guillory, Ian Hunter, and others argue, literary reading in school was part of the broader project of liberal subject formation. It was also preparation for a daily deluge of contracts and forms, instruction manuals, signs, Bibles, and telephone books. "Pragmatic and disciplinary" frameworks are thus needed to understand the aural speed-reading of literature, which in turn requires abandoning a more romantic attachment to any inherent aesthetic, moral, or leisure value of literary production (Robson 10). Practical relationships to texts have aesthetic dimensions and may lead to new kinds of aesthetic results, but they do not follow the conventions of traditional literary aesthetics—they require us to think differently about the modalities of reading as well as the modalities of attention (Have and Pedersen).

Counterintuitively, novels were easy for blind students to read, whereas short, ephemeral, and seemingly simple texts—e.g., labels, mail, manuals for household and workplace tools, money, government forms, and street signs—were at once urgent and rarely transcribed into braille or sound. Novels were roomy and had redundancy, as contrasted with the unforgiving binary of the +/- painted on a battery, the analog stringency of numbers on a thermometer, or the word-for-wordness of a recipe. Yet

Pitch-shifting and time-stretching techniques were quickly taken up by the radio and television industries, and by musicians and DJs and film sound designers.

Lee's early public statements in the 1970s describe the Varispeech as a device designed "for the aged and visually handicapped," with whose reading practices Lee was intimately familiar from his prior work at MIT on text-to-speech reading machines (Lee, "Time Compression" 738). Lee intended the Varispeech to enable blind people to overcome a number of drawbacks, articulated by talking-book readers themselves:

> The reading by listening rate is set by the rate at which the original speech was produced, normally around 110–175 words per minute. The second drawback is that the speed of listening is paced completely by the recording. One cannot skip sections or scan an audio recording similar to skipping and scanning a printed text.
>
> (Lee, "Time Compression" 738)

Thus, readerly protocols for talking-book narrators, and the speed listening they facilitated, set the stage for time stretching in the era of magnetic tape. In other words, the technique of aural speed-reading preceded the technology for audio time compression—as in many other moments in the history of sound, the practice precedes its mechanization. Blind readers soon became test subjects and a consumer market for commercial time-stretching machines, but they had already established aural speed-reading as a listening technique, and they had made significant progress in altering the conditions of playback, both in terms of hardware and the voice interface.

Talking-book readers created a social pull for time-stretching technology, but, more important, the aspiration to separate playback rate from pitch in aural speed-reading became a generalized technique, one

novels required *less* time and concentration to read than other books, regardless of format—they were often consumed in a sitting, because they did not demand rehearsal, memorization, rereading, or problem solving. In talking-book form, as Matthew Rubery points out, novels could be read while one was engaged in other tasks (229). Many avid readers like Lauer, who went to college and graduate school after leaving the state institution, preferred genres of long-form reading beyond the novel—as an adult Lauer took great pleasure, despite the effort, in technical reports, compilations of science news, lyrics books, and other nonfiction.

This aligns with the latest work on ink-print reading practices by Leah Price, who shows that casual reading was as common a mode of engagement with texts as deep reading—in either case, it could be a pragmatic activity rather different from the romantic idea of immersed literary reading. This combination of disciplinary structure, missions of subject formation, and functional literacy was the context to which the *Encyclopedia Britannica* was pointing when it singled out access to print.

The emerging technique of aural speed-reading was no doubt encouraged by the broader cultural imperative for visual speed-reading in the same time period. Speed is one of the central tropes of industrialization, closely linked to efficiency, and a number of media theorists and book historians have examined the rhetoric and apparatuses of visual speed-reading that emerged around 1900. Nicholas Dames, for one, argues that psychophysics researchers in Germany and the United States at the end of the nineteenth century began to positively correlate skimming to reading comprehension and intelligence—the faster the better, if done without any wasteful eye motions.

As Judith Wajcman argues, anxieties about the pace of life—the speeding up of production, transportation, and communication and the concomitant speeding up of human behavior and experience—date at least to the beginnings of industrialization.

that underpins (and in fact propels) the controlled temporal and pitch-based manipulation of sound today, from pitch correction software like Auto-Tune and Melodyne, to vocal special effects, to dubbing, to tempo matching for musical mash-ups, to time stretching that fits movies into established broadcasting time windows.

Lauer was not only a tester for the Varispeech, he was also effectively a collaborator with Lee, advising him on aspects of its usability, sound quality, and interface. After meeting Lee, Lauer trained ten blinded veterans on a single device in 1973. With seven hours of practice, they all exhibited good comprehension at 260 wpm (1.75 times the recorded speed). In 1974, the VA purchased a dozen units for veterans who were college students or otherwise had reading-intensive jobs. A second VA study demonstrated that most of these veterans were able to read compressed material at rates exceeding 400 wpm (Malamazian and Lauer 453). In 1978, Lauer was so invested in the technology that he wrote the owner's manual for the Varispeech II.

Nevertheless, when the Wollensak tape recorder that played talking books, then on four-track, was upgraded at the end of the 1970s, Lexicon did not update the Varispeech attachment. Instead, the company turned to making higher-quality time compressors for radio, television, and other, more profitable commercial media, which were designed to be placed in racks in professional audio environments and could not be attached to tape recorders.

Lauer and other blind aural readers were left, once again, without a workable speed-reading device.

The value of efficiency, so central to industrial capitalism, motivated time saving in the workplace (things like the division of labor and scientific management)—and yet saved time seemed to open new avenues for productivity instead of granting more leisure. As Wajcman shows, the sense of time pressure today is caused as much by multitasking, and the spillover of the productivity ideal into leisure practices, as it is by the simple acceleration of labor and communication.

Nonetheless, speeded reading (aural or visual) has not always correlated to straightforward speed-reading. Rather than skim, one might skip passages in a linear way or skip around, in which case one is not-reading as much as speed-reading. One speed-reads to access information; to look things up for one's own writing and hence slow both reading and writing down; or to find one's place after it has been lost, glance at a table of contents, flip through page numbers, or peruse an index. Speed-reading can be a browsing of titles, a quick-paced idling, a lazy sort of distracted reading, or an intensely focused memorizing. If used in the service of rereading, speed-reading might be part of an overall slowdown, where the reader works through a passage several times.

As everyday audiobook applications like *Audible* acquire tools for varying playback speed, sighted readers increasingly listen to accelerated human speech. The same thing is happening with podcasts, *YouTube* videos, and recorded university lectures. But too often, contemporary discussions leave out blind readers, treating the audiobook as an autonomous, sui generis piece of technology. While braille is the format of text most often associated in the sighted imagination with blind reading and blind education, today reading by ear is far more widespread. An accomplished blind reader with access to a computer will use a screen reader like *JAWS* to turn printed text into spoken words, and may even play it back at a speed so fast that, to the uninitiated, it sounds more like a bee stuck in a can than

Notes

1. We recount Lauer's story based on a telephone interview with Mills on 30 March 2015, as well as conversations Mills had with Lauer in person over the past several years.

2. Our account will restrict itself to the development of the industry in the United States. Only in 1961 did the American Printing House for the Blind, another publisher of talking books, begin to incorporate variable speed once again into their playback machines.

3. The details in this paragraph are drawn from longer stories we tell in our book manuscript, titled "Tuning Time: Histories of Sound and Speed."

a voice speaking. Speed listening is in many ways blind reading—and aural speed-reading is the technique that ghostwrites today's algorithms for "stretching" time-based media.

Notes

1. See, for instance, the work of Bijsterveld on "sonic skills."

2. Both Kursell and Raz have found other examples, like phoneticians who wanted to control playback speed in their labs to alter and investigate the timbre of vowel sounds.

3. In the original version of this essay, we mentioned Comic Sans as a comparatively illegible font, only to learn that Comic Sans is in fact *easier* for neurodiverse people to read. See Sins Invalid 32.

Works Cited

Bijsterveld, Karin. *Sonic Skills: Listening for Knowledge in Science, Medicine, and Engineering (1920s–Present)*. Palgrave Macmillan, 2019.

Coleman, Gabriella. *Coding Freedom: The Ethics and Aesthetics of Hacking*. Princeton UP, 2012.

Dames, Nicholas. *The Physiology of the Novel: Reading, Neural Science, and the Form of Victorian Fiction*. Oxford UP, 2007.

Davidson, Cathy N. *Revolution and the Word: The Rise of the Novel in America*. Oxford UP, 1988.

Delfanti, Alessandro. *Biohackers: The Politics of Open Science*. Pluto Press, 2013.

Downey, Gregory John. *Closed Captioning: Subtitling, Stenography, and the Digital Convergence of Text with Television*. Johns Hopkins UP, 2008.

Dunbar-Hester, Christina. *Low Power to the People*. MIT Press, 2014.

Eglash, Ron, et al., editors. *Appropriating Technology: Vernacular Science and Social Power*. U of Minnesota P, 2004.

Ellcessor, Elizabeth. *Restricted Access: Media, Disability, and the Politics of Participation*. New York UP, 2016.

Ernst, Wolfgang. *Digital Memory and the Archive*. U of Minnesota P, 2013.

Feaster, Patrick. "'A Compass of Extraordinary Range': The Forgotten Origins of Phonomanipulation." *ARSC Journal*, vol. 42, no. 2, 2011, pp. 163–203.

———. *Pictures of Sound: One Thousand Years of Educed Audio, 980–1980*. Dust-to-Digital, 2012.

Fraser, Ian. "Blindness." *Encyclopaedia Britannica*, 14th ed., vol. 3, Encyclopaedia Britannica, 1929, pp. 721–32.

Graff, Gerald. *Professing Literature: An Institutional History*. U of Chicago P, 2007.

Guillory, John. *Cultural Capital: The Problem of Literary Canon Formation*. U of Chicago P, 1993.

Hamraie, Aimi. *Building Access*. U of Minnesota P, 2017.

Have, Iben, and Birgitte Stougaard Pedersen. *Digital Audiobooks: New Media, Users, and Experiences*. Routledge, 2015.

Helms, Arthur. *Tape Recording Books for the Blind*. American Federation for the Blind, 1962.

Hunter, Ian. "Personality as a Vocation: The Political Rationality of the Humanities." *Economy and Society*, vol. 19 no. 4, 1990, pp. 391–430.

Katz, Mark. "Hindemith, Toch, and Grammophonmusik." *Journal of Musicological Research*, vol. 20, no. 2, Jan. 2001, pp. 161–80.

Kelty, Christopher M. *Two Bits: The Cultural Significance of Free Software*. Duke UP, 2008.

Kirkpatrick, Bill. "'A Blessed Boon': Radio, Disability, Governmentality, and the Discourse of the 'Shut-In,' 1920–1930." *Critical Studies in Media Communication*, vol. 29, no. 3, Aug. 2012, pp. 165–84.

Kittler, Friedrich. "Real Time Analysis, Time Axis Manipulation." Translated by Geoffrey Winthrop-Young. *Cultural Politics*, vol. 13, no. 1, Apr. 2017, pp. 1–18.

Krämer, Sybille. "The Cultural Techniques of Time Axis Manipulation." *Theory, Culture and Society*, vol. 23, nos. 7–8, Dec. 2006, pp. 93–109.

Kursell, Julia. "A Gray Box: The Phonograph in Laboratory Experiments and Fieldwork, 1900–1920." *The Oxford Handbook of Sound Studies*, edited by Karin Bijsterveld and Trevor Pinch, Oxford UP, 2011, pp. 176–200.

Lee, Francis. "New Promises in Reading by Listening." *Proceedings of the 1972 Carnahan Conference on Electronic Prosthetics*, edited by John S. Jackson and R. William De Vore, University of Kentucky, 1972, pp. 133–95.

———. "Time Compression and Expansion of Speech by the Sampling Method." *Journal of the Audio Engineering Society*, vol. 20, no. 9, Nov. 1972, pp. 738–42.

Levine, Lawrence. *Highbrow/Lowbrow: The Emergence of Cultural Hierarchy in America*. Harvard UP, 1988.

Lowenfeld, Berthold. *Braille and Talking Book Reading: A Comparative Study*. American Foundation for the Blind, 1945.

Malamazian, John, and Harvey Lauer. "Current State of the Research Effort at Veterans Administration Hospital, Hines, Illinois." *Bulletin of Prosthetics Research*, Feb. 1974, pp. 451–57.

Mills, Mara. "Hearing Aids and the History of Electronics Miniaturization." *IEEE Annals of the History of Computing*, vol. 33, no. 2, Apr. 2011, pp. 24–44.

Mol, Annemarie. *The Body Multiple: Ontology in Medical Practice*. Duke UP, 2003.

Murray, Susan. *Bright Signals: A History of Color Television*. Duke UP, 2018.

Piepzna-Samarasinha, Leah Lakshmi. *Care Work: Dreaming Disability Justice*. Arsenal Pulp Press, 2018.

Price, Leah. *What We Talk about When We Talk about Books: The History and Future of Reading*. Basic Books, 2019.

Raz, Carmel. "The Lost Movements of Ernst Toch's Gesprochene Musik." *Current Musicology*, vol. 97, no. 2, Spring 2014, pp. 37–59.

Robson, Catherine. *Heart Beats: Everyday Life and the Memorized Poem*. Princeton UP, 2012.

Rose, Sarah F. *No Right to Be Idle: The Invention of Disability, 1840s–1930s*. U of North Carolina P, 2017.

Rubery, Matthew. *The Untold Story of the Talking Book*. Harvard UP, 2016.

Schweik, Susan M. *The Ugly Laws: Disability in Public*. New York UP, 2009.

Shapiro, Danielle. *John Vassos: Industrial Design for Modern Life*. U of Minnesota P, 2016.

Siebers, Tobin. *Disability Theory*. U of Michigan P, 2009.

Sins Invalid. *Skin, Tooth, and Bone: The Basis of Movement Is Our People*. 2nd ed., 2019.

Sterne, Jonathan. *The Audible Past: Cultural Origins of Sound Reproduction*. Duke UP, 2003.

Tkaczyk, Viktoria. "From Sound to Knowledge." *Max Planck Institute for the History of Science*, 31 Mar. 2015, www.mpiwg-berlin.mpg.de/news/features/features-feature39.

Wajcman, Judith. *Pressed for Time: The Acceleration of Life in Digital Capitalism*. U of Chicago P, 2015.

Williamson, Bess. *Accessible America: A History of Disability and Design*. New York UP, 2019.