

The Maniac-Making Machine: A Media Genealogy of Delayed Auditory Feedback

Owen Marshall

Abstract: This paper examines the development and use of delayed auditory feedback (DAF) technology by military, medical, and scholarly speech-hearing researchers beginning in the late 1940s, focusing particularly on its role in the work of speech scientist Grant Fairbanks. Employing a media-genealogical approach, it argues that the emotional and spatio-temporal ambiguities of DAF became key perceptual resources for the construction of modern speech-hearing science as a discipline, as well as its ideal model of the speaking-hearing human subject. By prying open the interval between vocalization and self-audition, DAF techniques afforded researchers a new domain of experimentally performable auditory subjectivity within which one could more readily distinguish students and patients from research subjects, “emotional” from “organic” deafness, and cybernetic “closed-loop” from stimulus-response “open-loop” audiological models.

Biographical note: Owen Marshall is an NSF Postdoctoral Fellow in Science and Technology Studies at the University of California, Davis.

Acknowledgements: The author would like to thank the article’s anonymous reviewers, editor Suzanne Moon, and the archival staff of the University of Illinois Urbana-Champaign. This research was supported in part by an NSF Doctoral Dissertation Research Improvement Grant, Award #1455647: “Rearticulating the voice: Vocal correction technology in design and practice.”

Introduction: Feed-Back to Idiocy

On 15 December 1950, American newspaper readers first learned about a strange new piece of scientific equipment: “A calm, normal person may become an emotional shambles in five minutes” the New York Times reported, “when subjected to a new speech and hearing device at the University of Illinois.”¹ Dubbing it “the maniac-making machine,” the article went on to explain the device’s experimental utility: “Psychologists interested in the study of emotions have gone through all sorts of procedures trying to produce emotions in laboratories. Many methods have required much time. The ‘maniac-making’ machine, the U. of I. assures us, ‘will produce excellent results in five minutes.’”² The Washington Post quoted Professor Grant Fairbanks, Director of the university’s Speech Research Laboratory, concerning the machine’s effects. “‘The longer the test continues the more frustrated and excited the subject becomes’, Fairbanks said. He begins ‘talking louder and louder and stuttering, repeating, and trembling.’”³ A few weeks later, under the headline “Feed-Back to Idiocy”, Time magazine described the “fiendish apparatus” in detail:

Dr. Fairbanks' gadget, which consists chiefly of a microphone, a tape-recorder and a playback amplifier, delays the reports [of the sounds of one's speech] on their way to the brain... The result: the speaker is slowly driven toward the gibbering stage. His words won't come; he stammers, repeats, screams in agonized frustration. His face

¹ W.L.L., “New Device Tests Human Emotions.”

² Ibid.

³ Washington Post, “Machine Can Turn Normal Calm Person into Emotional Shambles.”

turns red; he sweats and trembles, showing many of the symptoms of emotional disorder.⁴

As I will show, these initial press clippings were only the beginning of the maniac-making machine's involvement in speech-hearing work. Below, I discuss the broader story of delayed auditory feedback from two socio-historical perspectives. First, I consider it as a technological "breaching experiment,"⁵ wherein the historical emergence of a new technological practice serves as a sort of experimental provocation analogous to the "breaches" of expected behavior advocated by sociologists in the ethnomethodological tradition.⁶ This framing allows us to examine the unspoken assumptions or interests that delayed feedback helped articulate and/or complicate in its various sites of use. Second, I consider how delayed feedback emerged as a recognizable technological practice in the first place, asking what materially embedded interests and ideas went into its development and evolution over time. In other words, I venture what Alexander Monea and Jeremy Packer have termed a "media genealogy."⁷ I trace this genealogy through DAF's role in three moments of social contestation: the professionalization of speech-hearing work, the emergence and adjudication of the category of

⁴ Time Magazine, "Feed-Back to Idiocy."

⁵ Pinch and Bijsterveld, "'Should One Applaud?' Breaches and Boundaries in the Reception of New Technology in Music."

⁶ Garfinkel, *Ethnomethodological Studies of Work*. As a graduate student, ethnomethodology's founder Harold Garfinkel read the Time article on Fairbanks and was so impressed that he referred to the delayed feedback device in his early writings and even secured a device of his own to use in seminars (see Garfinkel, "Work Memo #2, Organizational Behavior Project, October 4, 1951," 254.) The reflexive implication of this is that the breaching experiment method I draw upon here may not have come into being without Fairbanks' influence (delayed feedback indeed!)

⁷ Monea and Packer, "Media Genealogy and the Politics of Archaeology."

“emotional” or psychogenic deafness, and speech-hearing science’s somewhat abortive venture into the contested meta-discipline of cybernetics.

In attending to these cases I make the following argument: following World War II, the emotional and spatio-temporal ambiguities of tape-based auditory delay became key perceptual resources for the construction of modern speech-hearing science as a discipline, as well as its ideal model of the speaking-hearing human subject. By opening up the interval between vocalization and self audition, it created a new domain of experimentally performable auditory subjectivity within which one could more readily distinguish students from research subjects, “emotional” deafness from “organic” deafness, and closed-loop cybernetic from open-loop stimulus-response models of the speech-hearing faculties.

Sound studies, technology, and cybernetic historiography

Recent work in the interdisciplinary field of sound studies has examined the role of technologies such as the phonograph, the artificial larynx, and the MP3 data compression codec in the sociotechnical articulation of the auditory subjectivity.⁸ The possibility of sound’s reproduction, the commensurability of spatially-experienced sound with electrical signals, and our emotional relations to pre-recorded or otherwise mediated sounds have all been shown to be situated within specific socio-historically contingent projects.⁹ Often these projects involve debates over the proper understanding and practical implementation of the distinction

⁸ Kittler, *Literature, Media, Information Systems*, 31; Mills, “Media and Prosthesis: The Vocoder, the Artificial Larynx, and the History of Signal Processing”; Sterne, *MP3: The Meaning of a Format*.

⁹ Sterne, *The Audible Past*; Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America 1900-1933*; Hui, “Sound Objects and Sound Products : Standardizing a New Culture of Listening in the First Half of the Twentieth Century.”

between “signal” and “noise” in contexts ranging from environmental noise regulation to telephony and early 20th century avant-garde music.¹⁰ A general finding of these works is that the emergence of new types of noise (i.e. unwanted sound) within particular sociotechnical ensembles, and its subsequent appropriation or elimination, often speaks volumes about the practical and symbolic commitments of a particular culture or historical period. The story of delayed auditory feedback, which emerged as a new kind of noise associated with methods of sonic reproduction via magnetic tape and was incorporated into a variety of practical applications, charts a similar path by indexing how audition and vocalization were politically configured at mid-century.

The story of delayed feedback is also a part of the history of cybernetics, a broad interdisciplinary movement concerned with the role of feedback in human-machine interaction. The historiographic literature on cybernetics is extensive, with science and technology studies (STS) scholars drawing on it both as empirical topic and theoretical inspiration. Orit Halpern and Geoffrey Bowker, for example, have each analyzed the specific temporalities of cybernetics at the level of the archive and the feedback system, especially with respect to the role of temporal delays and disciplinary narrative.¹¹ Others have examined the movement’s historical and methodological affordances for the fields of literature, feminist theory, anthropology, and the

¹⁰ Bijsterveld, “The Diabolical Symphony of the Mechanical Age. Technology and Symbolism of Sound in European and North American Noise Abatement Campaigns 1900-40”; Mills, “Deafening: Noise and the Engineering of Communication in the Telephone System”; Pinch and Bijsterveld, “‘Should One Applaud?’ Breaches and Boundaries in the Reception of New Technology in Music.”

¹¹ Halpern, “Dreams for Our Perceptual Present: Temporality, Storage, and Interactivity in Cybernetics”; Bowker, “How to Be Universal: Some Cybernetic Strategies, 1943-70”; Bowker, “Synchronization 4: Hermes, Angels and the Narrative of the Archive.”

sociology of science.¹² Historians, meanwhile, have offered critical and sometimes deflationary accounts of the movement as such, emphasizing cybernetics' (and the cognate field of information theory's) contingency, multiplicity, and less-celebrated precursors.¹³ Comparative international studies of cybernetics have been particularly illustrative of the movement's heterogeneity and its tendency to articulate a wide range of political and cultural concerns.¹⁴ Delayed feedback, I suggest, presents this historiography with an as-yet unconsidered tendril of the cybernetic rhizome. Because it engages concretely with the topic of emotional experience, it also offers a way of connecting cybernetic histories with broader accounts of emotional experience, or "emotionology" in the twentieth century.¹⁵

Tape delay comes to America

Around the same time that Fairbanks' machine made its press debut, a similar technique was being put to use, albeit for different emotional ends, in the recording studio. Radio listeners and television audiences of the early 1950s were being treated to the first major instance of what would become a staple of popular music production: tape delay, also known as "slap-back" echo. Reverberation tanks and echo chambers were already in common use in-

¹² Hayles, *How We Became Posthuman*; Haraway, "A Cyborg Manifesto"; Downey, Dumit, and Williams, "Cyborg Anthropology"; Pickering, "Cybernetics and the Mangle. Ashby, Beer and Pask."

¹³ Kline, "What Is Information Theory a Theory Of?"; Kline, *The Cybernetics Moment, or, Why We Call Our Age the Information Age*; Kline, "Where Are the Cyborgs in Cybernetics?"; Mindell, *Between Human and Machine: Feedback, Control, and Computing before Cybernetics*.

¹⁴ Aumann, "The Distinctiveness of a Unifying Science: Cybernetics' Way to West Germany"; Gerovich, "Love-Hate for Man-Machine Metaphors in Soviet Physiology: From Pavlov to 'Physiological Cybernetics'"; Medina, *Cybernetic Revolutionaries: Technology and Politics in Allende's Chile*.

¹⁵ Stearns and Stearns, "Emotionology: Clarifying the History of Emotions and Emotional Standards."

studio by this point, but the slap-back tape delay played with sound and time in a new way. Instead of a dispersed, textured trailing-off, as though you were standing inside of a large cathedral, the delay effect reproduced the same discrete sound at repeated intervals.¹⁶ Guitarist Les Paul and singer Mary Ford used it on their recording of the jazz standard “How High the Moon”, which was recorded in January 1951 and went on to top the sales charts for several weeks thereafter. Paul was first introduced to magnetic tape recording in 1946, courtesy of a Signal Corps colonel. Three years later he acquired a machine of his own, A gift from Bing Crosby, who had gotten his through the US military.¹⁷ Paul proceeded to develop the technique of multi-track recording as well as the aforementioned tape echo effect. Regarding the latter, he recounts his eureka moment:

every Friday night this guy Lloyd and I would sit in a saloon and watch the fights on TV, and one time he asked me to explain what I was after in terms of echo, and when I said like a guy shouting “Hello” in the Alps and hearing it come back to him multiple times, he said, “You mean, like if you put a playback head behind the record head?” Oh my God, we were out of that saloon so fast... we had that thing up and running in no time at all. We quickly realised that by moving the playback head forwards or backwards we could also change the delay — the whole neighbourhood could hear “Hello... hello... hello...”¹⁸

¹⁶ For more on the historical phenomenology of artificial reverb, see Sterne, “Space within Space: Artificial Reverb and the Detachable Echo,” 112.

¹⁷ Paul had at least one previous successful collaboration with the U.S. military, having released an earlier, echo-free version of “How High the Moon” in 1945 through the War Department’s in-house record label “V-Disc.”

¹⁸ Buskin, “Classic Tracks: Les Paul & Mary Ford 'How High The Moon'.”

In his history of reverberation and echo effects in popular music, Peter Doyle argues that the late 1940s to the early 1950s saw an important transformation in the acoustic representation of space. In the first several decades of sound recording, beginning in the late 19th century, popular recordings had typically featured a “dry” non-reverberant sound, leaving the use of acoustic space largely to “fine” orchestral classical recordings. By the 1930s, however, echo and reverb had crept into the popular recording aesthetic, with the use of echo chambers to evoke “Edenic” spatialities and “pictorial” scenic effects. By the late 1940s, however, Doyle notes that “the ever more overt suggestion that these sonic *mises en scenes* were as much landscapes of the psyche as they were empirical... a growing in power and mobility of the hitherto unseen other.”¹⁹ For Doyle, this shift is best illustrated by the 1949 hit single “(Ghost) Riders in the Sky: A Cowboy Legend”, which juxtaposed Vaughn Monroe’s dry verse vocals with a supernaturally reverberant chorus refrain.²⁰ This transition from the idyllic landscape to the psychology of the Other would seem consonant with the juxtaposition of Paul’s Alpine range and Fairbanks’ gibbering, red-faced victim. If the causes of the changing connotations of the echoing voice in music production can be traced further than the fancies of post-war record producers, they might be found in the particularities of the post-war military-entertainment-industrial complex. What sorts of psychological terrains were being surveyed in this period, and what “unseen others” were thought to populate them?

¹⁹ Doyle, “From ‘My Blue Heaven’ to ‘Race with the Devil’: Echo, Reverb and (Dis)Ordered Space in Early Popular Music Recording,” 37.

²⁰ Doyle suggests, citing Sanjek (1988), that this was itself an instance of tape-echo—a claim that, if true, would give Monroe’s song precedence over Paul and Ford for musical use of the effect. I can find no evidence to support this claim, however, and to my ears the “Ghost Riders” chorus sounds more like reverb than delay.

Paul's tape machine was likely a German AEG Magnetophon seized by Allied troops in Luxembourg following the country's liberation in September 1944. Fairbanks, at the time an Army Captain and Chief of Aural Rehabilitation at Oklahoma's Borden Hospital, had gotten his hands on two of the machines, which he immediately put to "heavy" use in Borden's Speech Correction program for soldiers with speech disorders.²¹ As with Paul, it took Fairbanks and his colleagues in speech-hearing research a few years to decide that tape delay might be put to practical use. In this case, the effect was independently discovered in 1950 by John W. Black, a Professor of Speech and Director of Speech Science at Ohio State, and Bernard S. Lee, Assistant Chief of the Photographic Branch of the Squier Signal Corps Engineering Labs at Fort Monmouth, New Jersey. Black, under contract with the Office of Naval Research, had been conducting research at the Naval School of Aviation Medicine in Pensacola Florida on the effects of architectural acoustics on speech. By having pilots-in-training read test phrases in rooms of varying shape and reverberation time, he showed that the way one's voice sounded in a room affected vocal rate and intensity.²² A dedicated delayed feedback device, built by engineers N.B. Marple IV and Scott N. Morrill, allowed Lee to investigate these effects in a more controlled way, precisely varying the time delay and intensity with which subjects heard their own voice returned to them.

Lee was interested in the ability of delayed feedback to probe the human-machine relationship. In a piece titled "Artificial Stutter," he described (in the third person) his first encounter with delayed feedback: "In the course of operating a magnetic tape recorder, the writer found himself part of a new stuttering hybrid, half human and half electronic, and was

²¹ Fairbanks, "History of the Hearing Program at Borden General Hospital," 83.

²² Black, "The Effect of Room Characteristics upon Vocal Intensity and Rate."

encouraged to investigate the phenomenon further.”²³ The delay produced in this early instance was not by design, but an accidental byproduct of the fact that separate magnetic heads were used for recording and playback, and that the tape ran across these heads in this order. Recording his own voice while monitoring from the playback head’s signal, Lee found in the brief interval between recording and playback an “unusual opportunity afforded to experimentally hybridize a neural and electronic network.”²⁴

Drawing on conversations with Fort Monmouth speech instructor Neil G. Smith, Lee spun a model of the speech mechanism as a set of nested loops (akin to spliced loops of magnetic tape) ranging from the lengthy outer loops of abstract thought to the progressively smaller loops that control the production of words, syllables, and phonemes. Lee’s metaphorical nested loops mingled with more explicitly military imagery as well. Delayed feedback, he suggested, reveals the “trigger-like” nature of the speech mechanism, concluding that “a study of the errors in speech induced by the delayed feedback reveals that the speech mechanism is similar in operation to the machine gun.”²⁵ Lee passed his discovery along to researchers at MIT and went about building a continuously-variable delay unit with which he could substantiate his machine gun metaphor experimentally. He published his findings in the *Journal of the Acoustical Society of America (JASA)* in 1950 and the *Journal of Speech and Hearing Disorders (JSHD)* in 1951. Fairbanks, the editor of *JSHD*, published in the same issue a design for a continuously variable delayed auditory feedback device he had separately developed with electrical engineer Robert Jaeger.

²³ Lee, “Artificial Stutter,” 53.

²⁴ Lee, “Effects of Delayed Speech Feedback,” 824.

²⁵ Lee, 824.

It is not clear whether Fairbanks had included the words “maniac-making machine” in his press release about his and Jaeger’s invention, or if it was instead a poetic contribution from the Times reporter. Either way, the phrase’s historical connotations are worth pausing over. Prison historian David Scott attributes the phrase to a 1922 account of nineteenth century England’s notorious Millbank penitentiary, described as a “‘monument of ugliness’ [that] became a ‘maniac-making machine.’”²⁶ North London’s Pentonville penitentiary – which, like Millbank, employed the recently devised “separate system” of general solitary confinement – was criticized by the Times of London as a “maniac-making system.”²⁷ Whether the word choice was intentional or incidental, the carceral imagery of “maniac-making” gives us a further sense of the interpretations delayed tape feedback was subject to in its earliest days. Depending on its application, delayed feedback could evoke either alpine mountain ranges or the walls of a prison cell. All of this is to say that delayed feedback constituted a breach of previously established configurations of voice, audition, temporality and emotional experience. The character of this breach, and the way that it was gradually woven back into the social fabric, can be traced in the world of speech-hearing research concerning three questions: the professional status of the speech-hearing field as research or therapy, the diagnostic management of non-organic deafness, and the role of cybernetic theory in its models of the speech-hearing system.

Vocalization as a science: the competing callings of speech-hearing work

²⁶ Scott, *Penology*, 73.

²⁷ “Solitary Imprisonment in England,” 4.

Fairbanks and his colleagues' excitement over delayed auditory feedback needs to be understood in terms of the broader social currents of the time, particularly the evolution of speech-hearing work as a professional category within the broader technoscientific investments of the post-war period. Fairbanks was deeply committed to the development of speech-hearing research as a scientific field, as opposed to a more applied form of occupational therapy or pedagogy. The split in the speech and hearing community between scientific-experimental and applied-therapeutic approaches had long preceded Fairbanks, as speech-language pathologist and field historian Judith Duchan has documented in depth.²⁸ The modern fields of speech-language pathology and speech-hearing science have roots in two groups—the National Society for the Study and Correction of Speech Disorders (NSSCSD) and the American Academy of Speech Correction (AASC)—which sought in the early 20th century to organize and credential what had previously been an unwieldy and diverse field of speech practitioners, largely focused on the treatment of stuttering, many of whom were considered “quacks.” The NSSCSD, founded by Walter Babcock in 1918, was a subgroup of the National Education Association and consisted mostly of schoolteachers turned speech correctionists. The AASC, by contrast, was founded in 1925 by a group of university-level researchers and physicians. A more research-focused and exclusive operation, AASC required its members to have at least a master’s degree. By the end of the 1930s, Swift’s group had disbanded, but by that point a new generation of treatment-oriented clinicians had transformed the AASC into the American Speech Correction Association (ASCA). Among the new guard was Charles Van Riper, who recounts the transition this way:

²⁸ Duchan, “A History of Speech-Language Pathology.”

Our founding fathers... viewed themselves as an elite group of academic scholars. They weren't particularly interested in therapy: they just wanted to understand the nature of those puzzling human disorders, especially stuttering... Fortunately, among them we also had some founding mothers--Mabel Gifford, Pauline Camp, Eudora Estabrook, Sara Stinchfield--speech teachers who were already offering remedial services in the schools. These women, together with some of us who stuttered (C.S. Bluemel, Sam Robbins, Wendell Johnson, and I) and who had been victimized by the quacks of the day, insisted that treatment should also be emphasized.²⁹

The tug-of-war between the field's research and treatment factions continued, however, with the founding of the research-focused *Journal of Speech Disorders*. Under the editorships of Fairbanks and his successor Gordon E. Peterson, the journal further distanced itself from clinical practice. The particular divisiveness of Fairbanks' "scientific" orientation during this period even leaked into the pages of *Time Magazine*. Responding to a story in the previous issue on Fairbanks' work on time-compressed speech, University of Maryland Theater professor and occasional Hollywood vocal coach Lyle V. Mayer penned an acidic letter to the editor:

For quite a few years, a goodly number of Professor Grant Fairbanks' colleagues in the field of speech have watched with indulgence and some amusement the earth-shaking experiments of this self-declared wizard... If the gentleman will step out from behind

²⁹ Van Riper, "Recollections from a Pioneer."

that oscillograph and into a classroom, he might be startled to discover what all teachers of public speaking have long known[.]³⁰

The letter was at least partly a promotional stunt. Mayer's "Fundamentals of Voice and Articulation" had come out that same year and was in direct competition with Fairbanks' already well-established "Voice and Articulation Drillbook" (1940). Mayer, like Fairbanks, was a savvy self-promoter and had made his share of impish press cameos (The Washington Post, for example, once quoted him pontificating that the Maryland accent has "none of the niceties of the Southerner and most of the crudities of the Easterner."³¹) What Mayer's letter highlights, however, is the schism between the pedagogical-therapeutic and experimental-scientific currents of speech-hearing work in this moment. The conflict largely concerned the status of speaking-hearing subjects as either students of the art of speech, as Mayer would have it, or, as Fairbanks preferred, objects of a systematically experimental speech science. The delayed feedback device was exactly the sort of gadget that, for Mayer, was leading the speech profession down the wrong path.

Murray S. Miron, Fairbanks' former student, was similarly frank in his preface to a bound collection of Fairbanks' publications. Writing in June 1964, mere weeks after Fairbanks' untimely choking death during an in-flight meal, Miron eulogized that "Fairbanks could often be vitriolic about the practice of unsystematic research... This impassioned devotion to science often, in fact, motivated ungenerous comments concerning other researchers who in his opinion were not so dedicated." The preface concludes, bracingly,

³⁰ Mayer, "Letters: Block That Plosive."

³¹ "Maryland Speech Teachers Stick Necks 'Aeout.'"

Science, as Fairbanks would often proclaim, is a way of life; and I know of no other person to whom such a philosophy was more fitting or appropriate... Fairbanks' human faults are well known to most and need not, for these purposes, be detailed. On the other hand, I shall refuse to lessen the stature of this man by playing the maudlin fool; Fairbanks was always intemperate when ignorance was to be exposed. He was always ungenerous in his evaluations of poor quality in any workmanship... That this paints the picture of a man at once devoted to his field and yet manifestly intolerant of error and ignorance is only paradoxical to those who have never fully committed themselves to their profession as Grant Fairbanks did.³²

These sketches of Fairbanks as an ardent perfectionist, meticulous system-builder, and polarizing devotee of the science-as-vocation, contextualize his interest in delayed feedback as a source of mechanical objectivity in an all too subjective field of research. For Fairbanks, delayed feedback's disruptive effect was significant in its ability to produce emotional responses in a systematic and experimentally legible way. Whereas Signal Corps engineer Bernard Lee's immediate fascination was with DAF's ability to forge new human-machine hybrids and provide an entry point into their cybernetic interaction, Fairbanks initially framed the delayed feedback technique as a way to reliably generate laboratory-grade nervous breakdowns.

This framing can be further attributed to Fairbanks' long-held interest in the effects of emotion on speech, a research topic he had long been pursuing. In September 1950, Fairbanks

³² Miron, "Preface To Grant Fairbanks' Experimental Phonetics."

prepared a proposal for research on “The Acoustical Elements of Emotional Speech” on behalf of the University of Illinois at Champaign-Urbana’s Speech Research Laboratory, of which he was the director. “It is proposed to develop a sort of acoustical, vocal ‘emotionometer’” the proposal opens, “and use it in a program of experimental research.”³³ The emotionometer would measure changes of pitch, timing, and intensity during various emotional states so that these relationships could be characterized more generally for purposes such as “propaganda analysis and lie detection.”³⁴ Before he came to Illinois, Fairbanks had studied the effects of “simulated” emotion, employing actors as research subjects and having them recite standardized texts with specified emotional inflections.³⁵ ³⁶ Following these studies, what Fairbanks sought was non-simulated emotion that was still experimentally legible:

One study should be made in which ‘stagefright’ is experimentally produced by varying the size of the group of listeners from zero to several thousand. Situations could readily be contrived to test the hypothesis that strong polarities of attitude and opinion on

³³ Fairbanks, “A Proposal for Research: The Acoustical Elements of Emotional Speech.”

³⁴ Fairbanks, 11.

³⁵ This was itself a continuation of Fairbanks’ long-standing interest in dramatic speech. Beginning in his high school years and throughout his undergraduate study with Public Speaking authority E.R. Nichols at the Baptist-founded University of the Redlands, Fairbanks served as “yell leader” and athletic events and was active in school theater productions. He took the title role in the senior production of “Merton of the Movies” – a 1922 Broadway spoof in which an inept would-be dramatic actor unwittingly makes it big in silent film comedy (“Plans for University Play Told: Redlands Seniors to Give ‘Merton of the Movies.’”) The satire editor of his class yearbook, Fairbanks evidently had a sense of humor; at the age of 18 he took the award for “fewest whiskers” in his school’s beard-growing contest (Los Angeles Times, “Students Win in Contest for Whisker Growth.”)

³⁶ Fairbanks and Pronovost, “Vocal Pitch during Simulated Emotion”; Fairbanks and Pronovost, “An Experimental Study of the Pitch Characteristics of the Voice during the Expression of Emotion*”; Fairbanks and Hoaglin, “An Experimental Study of the Durational Characteristics of the Voice During the Expression of Emotion.”

emotionally saturated topics would be evidenced in vocal deviations during speech on such topics.³⁷

Other experiments would collect and analyze recordings of “persons with personality deviations” and “maladjusted persons” which could then be compared with “normals” in order to discover whether particular disorders have distinctive styles of speech.³⁸ The emotionometer project was apparently never undertaken as written, but it was likely on Fairbanks’ mind when he first heard about (or simply heard) the effects of delayed auditory feedback. Also on his mind, no doubt, was the scientific status of his burgeoning profession. Fairbanks was, again, deeply invested in the transformation of the field of “speech” from a primarily applied and occupational-therapeutic area of work to a properly systematic science. In this way, he helped precipitate a split between the worlds of speech science and speech pathology along these lines while also bringing the messiest, most subjective aspects of human behavior under technical control. DAF proved useful as a way of objectifying the speech-hearing system by making it break down in a manageable way. One benefit of this reifying process was that emotion could be defined in such a way as to make the moral and physical traumas of war more tractable.

Deafness: emotional or organic?

A key set of questions regarding the relation between emotion and the speech-hearing faculties during this period involved the phenomenon of “emotional deafness.” This phrase was used to refer to hearing disorders that were primarily psychological, as opposed to physical, in

³⁷ Fairbanks, “A Proposal for Research: The Acoustical Elements of Emotional Speech,” 11.

³⁸ Fairbanks, 12.

nature. The World Wars were, among other things, unprecedentedly loud, and professional audiology largely came into being as a result of the massive number soldiers deafened by bomb blasts.³⁹ Combat-related hearing damage was often permanent, but not always. Because of the ease with which hearing loss could be faked, and the intimate relation between the psychological and physiological aspects of the speech-hearing system, the question of the genuineness of claims to permanent hearing loss proved especially difficult for experts to answer. The auditory malingerer became a figure of concern for both military and insurance interests, which were jointly invested in distinguishing the “organically” deaf from the “functionally” deaf—i.e., those who had either convinced themselves they were deaf or, worse, were simply trying to convince *others* that they were. The institutional demand for this diagnostic distinction raised hard moral and epistemological questions for the emerging audiology profession. By what criteria can one distinguish between a malingerer and someone afflicted with a mental condition that keeps them from hearing or speaking properly? What is the appropriate relationship between a clinician’s diagnostic judgment and the ethico-judicial one it implies in the case of malingering?

Along with the question of the scientific or therapeutic status of their profession, then, speech-hearing clinicians strained at the burden of moral and legal judgment that the problem of emotional deafness seemed to place on them. As a 1938 article in the *Journal Laryngoscope* argued, “The use of the term malingering... places the otologist in the position of having made a very positive statement, not only as to the state of the... auditory condition, but also as to the patient’s honesty and character, and throws the onus of proof on the otologist rather than on

³⁹ Bergman, “On the Origins of Audiology: American Wartime Military Audiology.”

the individual feigning deafness, to whom it rightly belongs”⁴⁰. Otologist N. Rh. Blegvad, writing in the *Journal of Laryngology and Otology*, emphasized the importance that such diagnoses be correct, “for the sake of the patient, of course, but also for the sake of the public and the insurance company lest their expenses become unnecessarily high.”⁴¹

By the end of the first world war, auditory malingering tests had begun to proliferate. Unilateral deafness, where only one ear is affected, could be verified relatively easily by some version of what is known as the “Stenger test.” This test exploited the tendency of listeners to locate a single tone, presented to both ears at differing decibel levels, entirely in the louder ear. The same tone would be applied to both ears, but at a lower volume in the subject’s undamaged ear. The malingerer, mistakenly locating the tone entirely on the side of the “bad” ear, would pretend not hear it at all, whereas a genuinely deaf ear would leave the other ear free to notice the fainter tone. Claims of bilateral deafness could not make use of the Stenger effect, however, and thus required more elaborate tactics. At Borden Hospital, where Fairbanks ran the aural rehabilitation program from 1944 to 1946, clinicians employed so-called “dark room treatments” where, in a darkened live voice distance testing room, the technician “by shuffling his feet, attempted to mislead the patient to believe that he was approaching or receding, but kept his voice at the same level all of the time.”⁴² A variation of this method involved a second technician sneaking into the room after the lights were out and allowing the patient to hear him approach as the voice of the first technician remained stationary. Sometimes the patient would be allowed to know that two technicians were present, but “by

⁴⁰ Firestone, “Volitional Deafness versus Malingering or Simulation of Deafness. A Comparison of Ototerminologic Values.”

⁴¹ Blegvad, “Psychogenic Deafness (Emotional Deafness),” 176.

⁴² Fairbanks, “History of the Hearing Program at Borden General Hospital,” 49.

alternating speech and shifting distances back and forth the patient became so confused that he was trapped into a true response.”⁴³

Some techniques verged on abuse. At New York’s Beth Israel Hospital, according to a 1926 report, one clinician would make “insulting remarks about the patient in his presence, as well as that of his nurse or assistant. In this way the patient will sometimes betray himself by flushing or changing expression, which indicates existence of auditory perception” ⁴⁴.

Polygraph-style skin galvanometers, sometimes called “psychometers”, were also employed to measure skin conductivity as a proxy for emotional arousal. A 1949 textbook on hearing testing recommends the following procedure for use on a blindfolded subject:

If a subject feigns total deafness, a sudden loud shout from a distance of two or three feet may bring a marked response on the Psychometer that indicates residual hearing. If the word shouted is an accusation (such as the word ‘FAKE’), it is likely to bring even more of a reaction through indignation or fear if heard.⁴⁵

At the Hoff Center in Santa Barbara, one of Borden’s sister aural rehab units, the staff psychologist was inspired by accounts of psychoanalytic “narcosynthesis” treatment for war neuroses by the Air Force in North Africa. Plied by light doses of narcotics and strong doses of suggestion, it was thought that the neurotic patient more readily “synthesizes the emotions and memories connected with his experience,”⁴⁶ freeing the ego of repressed emotions and

⁴³ Fairbanks, 49.

⁴⁴ Scal, “Malingering Deafness: Tests in Its Detection and Report of Two Cases,” 237–38.

⁴⁵ Watson and Tolan, *Hearing Tests and Hearing Instruments*, 179.

⁴⁶ Grinker, *War Neuroses*, 123.

allowing the patient to deal with the trauma at the root of the disorder.⁴⁷ Hoff's anesthetist administered thiopental sodium to dozens of suspected emotionally-deaf soldiers until they became incoherent, at which point their external ears were sprayed with ethyl chloride in order to produce numbness and cooling sensations. Throughout the process, patients were repeatedly reassured that their hearing was being restored. Ninety-three patients at Hoff were given narcosynthetic treatment and reportedly showed "marked improvement" in their hearing. Seventeen others reportedly showed similar improvement upon simply learning that such a treatment was being administered, and three patients with "organic" hearing loss who requested the treatment reported improvements even though none were noted in formal testing.⁴⁸

The unpleasant and complicated nature of these tests led otologists to employ delayed feedback as way to test the emotionally deaf, the idea being that if patients were truly deaf their speech would be immune to feedback effects. The methods and effects disclosed by Lee, Black, Fairbanks, and others underwrote this technique after 1950, and seemed to provide a way of detecting non-organic hearing loss with a minimum of mind games.⁴⁹ It was Lee's article that spurred the deliberate use of delayed feedback in malingering tests, however. "Artificial Stutter" mentions the phenomenon's potential anti-malingering application, attributing the idea to Dr. E.G. Witting of Signal Corps Engineering Laboratories.⁵⁰ Researchers at the Speech and Hearing Clinic at the University of Washington, meanwhile, worked from 1950 towards this purpose and in 1954 reported the use of delayed feedback tests on two veterans referred to

⁴⁷ Bergman, "On the Origins of Audiology: American Wartime Military Audiology," 9.

⁴⁸ Bergman, 10.

⁴⁹ Though for an interesting precursor, see Brownfield, "Detection of Pretended Hearing Loss With Special Reference to Unilateral Deafness," 598.

⁵⁰ Lee, "Artificial Stutter," 55.

them for hearing aids. One “came into the clinic wearing his aid turned to full volume and showed no measurable pure-tone response. He evidenced marked speech breakdown at about 40 dB of feedback”, the second “showed a 95 dB average loss for pure tones but possible response to delayed feedback at 50 dB and probable response at 60 dB.”⁵¹ Both were tentatively diagnosed with psychogenic deafness and referred for further reappraisal. One eleven-year-old girl, diagnosed with bilateral hearing loss and a case history suggestive of emotional trauma, was administered 50 dB of delayed feedback as she read a story book, resulting in a change in reading pattern. Two other adolescent girls, demonstrating moderate-to-severe hearing loss via pure tone tests, “showed marked speech breakdown at about 30 dB of delayed feedback.”⁵² One patient, a Mr. H.M., had been struck in the head by a hand truck while on the job and claimed bilateral deafness. He was suspected, however, on account of his unusually proficient, and rapidly acquired, lip-reading ability. After being asked to whistle “Yankee Doodle” while being administered 20-80 dB of feedback, however, the clinicians were able to report that his reported hearing loss was greatly exaggerated.⁵³

Delayed auditory feedback thus proved useful to speech-hearing practitioners who were interested in establishing their field’s scientific status, and it did so in two ways. First, it made “emotion” (understood as agitation or instability) experimentally legible as a measurable variation in an objectified speech-hearing system. Second, it provided a way to demonstrate non-organic or “emotional” deafness in patients in a way that was not as procedurally messy or ethically fraught as certain previous methods had been. As the next section will discuss, it also helped bolster the scientific status of the field by linking it with the then-ascendant discourses

⁵¹ Hanley et al., “Auditory Malingering and Psychogenic Deafness,” 199.

⁵² Ibid.

⁵³ Ibid.

of cybernetics and closed-loop feedback systems. This construction of the speech-hearing faculties of the human body as a cybernetic “servomechanism” was closely related to the aforementioned technological framing of emotion in that it assumed a particularly cybernetic concept of emotion as instability.

The otology of the enemy: Grant Fairbanks and cybernetic audition

Fairbanks’ emotionometer was never built, but delayed auditory feedback helped inspire his work on a similarly ambitious project, the recasting of the speech-hearing faculties as a closed-loop feedback mechanism. In a 1954 issue of the *Journal of Speech and Hearing Disorders* (for which he had served as editor since 1949), Fairbanks published “The Theory of The Speech Mechanism as a Servosystem.”⁵⁴ The first of series on systematic research in experimental phonetics, this article depicted a speech-hearing system turned inward, not simply responding to a series of external control points (as would be the case in an “open loop” system) but actively correcting its control signals in response to errors produced in the process of articulation. At issue was not the fact that a speaker is able to hear herself as she speaks—something well established by 1954—but rather the centrality, and particular temporality, of self-hearing with respect to the speech process.

In constructing this model, Fairbanks drew a key distinction between self-hearing as “monitoring”, which he characterized as a past-oriented “checking-up” process, and self-hearing as future-oriented “auditory feedback” which is incorporated into the control system. He compared this with the distinction between estimating the weight of a watermelon versus

⁵⁴ Fairbanks, “Systematic Research In Experimental Phonetics : 1 . A Theory Of The Speech Mechanism As A Servosystem.”

pouring a particular quantity of sugar. The act of measuring does not change the watermelon's weight, which remains the same regardless. Pouring a quantity of sugar, by contrast, is a control relationship based on feedback, where the amount of sugar changes from one container to the other and this change is taken actively into account in the act of pouring.⁵⁵

This was an explicitly cybernetic model of the speech-hearing system, one which replaced the sequential temporality of passively received stimulus and active response with a continuous control loop. The cybernetics movement emerged largely from the work of MIT mathematician Norbert Wiener, the primary evangelist of the burgeoning meta-discipline. Wiener cultivated cybernetics as a sprawling interdisciplinary project, with the concept of the feedback mechanism at its core. In his classic essay "The Ontology of the Enemy", Peter Galison analyzes cybernetics' roots in Wiener's wartime work on anti-aircraft prediction technology, a practical problem which was eventually extrapolated into a broader model of servomechanically controlled human-machine action.⁵⁶ Galison places the servomechanistic model under the label of the "Manichean sciences", arguing that it is marked by the fundamentally antagonistic social relations for which it was originally designed. As the case of malingering testing shows, the servomechanistic model of the speech-hearing system was similarly born, at least in part, out of a military context that was concerned with identifying and countering deception. The unseen enemy other was both within and without.

The appearance of "auditory feedback" in the servosystem article was not accidental. In fact, Fairbanks directly addressed the role of delayed feedback, and its disruptive effects, in his conception:

⁵⁵ Fairbanks, 134.

⁵⁶ Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision."

The model can be caused to repeat, prolong and hesitate by several different manipulations, one of which is feedback delay. By manipulations that are revealingly similar it can be caused to make other kinds of mistakes, such as substitutions, distortions and omissions. As such disorders are demonstrably caused by component deficiencies. In the model *organic* and *functional* are one.⁵⁷ (Italics in original)

This was the same organic/functional dichotomy involved in distinguishing organic from functional (i.e. “emotional”) deafness. Unifying these two categories into a single control system provided a way of accounting for the physical and mental aspects of speech-hearing disorders in common terms. At the same time, it brought speech and hearing research more fully into the scientific fold by way of a then-fashionable cybernetic framing. As a more concrete example of how cybernetics was “in the air” for Fairbanks during this period: Heinz Von Foerster, founder of second-order cybernetics and editor of the Macy Conferences transcripts, was at Champaign-Urbana at the same time as Fairbanks, and even wrote a letter of recommendation for Fairbanks’ son, Grant Jr., who worked as a research assistant in his laboratory in 1961. “I leave for MIT tomorrow tense with expectation and anticipation,” the junior Fairbanks wrote in a thank you letter to Von Foerster, “I got engaged—but I believe my degrees of freedom are doing fine.”⁵⁸

The meaning of “emotion” employed by Fairbanks Sr. in his earliest work with delayed auditory feedback is not qualitatively differentiated (in contrast with his earlier, more

⁵⁷ Fairbanks, “Systematic Research In Experimental Phonetics :* 1 . A Theory Of The Speech Mechanism As A Servosystem,” 138.

⁵⁸ Fairbanks Jr., “Letter from Grant Fairbanks Jr. To Heinz Von Foerster.”

dramaturgical, experiments). Emotion was instead glossed quantitatively, as a degree of agitation or instability, a framing consistent with the servomechanical model. This was a homogenous and pathologized description of emotion as systemic noise, one that was—by design—useful to military concerns about whether a soldier’s emotions might keep the job from getting done. This comparison between emotional turmoil and uncontrollable oscillation had gained currency in the wake of wartime psychological discourse and the emergence of standardized questionnaires concerned with assessing “emotional stability,” telephone engineering practices which dealt with communication in terms of stability of signals and their amplifying oscillators⁵⁹, and a broader interdisciplinary interest in cybernetics alluded to earlier. Emotion in general was increasingly understood in terms of instability resulting from inner turmoil, a framing paralleled by the displacement of overtly emotional Victorian-era “elocution” by the more modern practice of conversational and well-controlled “public speech”.⁶⁰

The closed-loop “Fairbanks model” remains a classic of speech science, though less-so in the more clinically applied domains of speech-language pathology and audiology.⁶¹ This is unsurprising, given Fairbanks’ divisive stance on the priority of scientific research and training over clinical application. The year before Fairbanks’ death, he and Peterson coauthored a piece railing against the trend of clinicians taking little interest in basic research.⁶² Even in speech science proper, however, the servosystem model is now generally regarded as outmoded,

⁵⁹ Mindell, *Between Human and Machine: Feedback, Control, and Computing before Cybernetics*.

⁶⁰ Malin, “Electrifying Speeches: Emotional Control and the Technological Aesthetic of the Voice in the Early 20th Century US.”

⁶¹ A notable exception is Columbia Audiologist Edward Mysak, whose book “Speech Pathology and Feedback Theory” was dedicated to “the translation of certain cybernetic concepts and terminology into speech behavioral terms” (Mysak, *Speech Pathology and Feedback Theory*, vii.)

⁶² Fairbanks and Peterson, “Speech and Hearing Science.”

displaced by work arguing that speech is, for the most part, an open-loop system. Typically cited as a refutation of the Fairbanks model is the 1965 work of Russian speech researcher Ludmilla Chistovich and her husband Valery Kozhevnikov at the Pavlov Institute of Physiology.⁶³

Given their radically different political and institutional context, Chistovich and her Soviet colleagues brought a uniquely critical eye to the servosystem model. Whereas Fairbanks had roots in American speech science by way of public speaking and auditory rehabilitation, Chistovich's lab was concerned with understanding the speaking system as a means to develop automatic speech recognition technology. There was a disciplinary dimension as well; Chistovich was primarily trained as a physiologist, while Fairbanks had taken his PhD in Psychology. The fact that the researchers were conducting military-relevant communications research for competing cold war superpowers also had important implications. As historian Slava Gerovich has documented, under Stalinism cybernetic theory was stigmatized as bourgeois ideology, and by the mid 1960s had only recently become a permissible topic of scientific inquiry.⁶⁴ Pavlovian conditioning, with its accompanying metaphor of the reflex system as a telephone switchboard, had long been the dominant paradigm in Soviet Science. The physiologist Nikolay Bernshteyn, who had been advocating closed-loop interpretations of Pavlovian theory as early as 1940, was forced out of his job because of these views.⁶⁵

Following Lee's 1950 publication, Chistovich and Kozhevnikov had built a delayed auditory feedback system of their own and set about attempting to replicate Fairbanks'

⁶³ Raphael, Borden, and Harris, *Speech Science Primer*; Hixon, Weismer, and Hoit, *Preclinical Speech Science: Anatomy, Physiology, Acoustics, and Perception*; Kozhevnikov and Chistovich, *Speech: Articulation and Perception*.

⁶⁴ Gerovich, "Love-Hate for Man-Machine Metaphors in Soviet Physiology: From Pavlov to 'Physiological Cybernetics.'"

⁶⁵ Gerovich, 346.

findings. While their experimental results were largely in agreement with those of Fairbanks, they arrived at a fundamentally different interpretation upon which they built an interesting critique of the closed-loop model. Fairbanks' model, they argued, posits that units of speech are produced "as a reaction which occurs in response to the tactile, proprioceptive, and sound signals which accompany the accomplishment of the preceding complex."⁶⁶ If delayed auditory feedback is introduced, one of these signals will arrive later than the others, potentially resulting in a *single* re-triggering of the unit of speech that was originally intended. That only one repetition would be accounted for, they argued, is a result of the fact that all that a late auditory cue would do is trigger the subsequent unit of speech, which would then coincide with the non-auditory feedback which had not been delayed, allowing the speaker to move on to the next unit of speech. While Fairbanks and his colleagues had only occasionally found more than double repetitions, Chistovich *et. al.* found multiple repetitions much more frequently—a result, they suggested, of their using a louder audio signal than Fairbanks had. They also found that the errors produced were so diverse and unpredictable that they could not be accounted for in terms of the closed-loop system. "Thus" they wrote, "we are for the time forced to reject completely the hypothesis."⁶⁷

Fairbanks, unfortunately, did not live to read this critique, let alone respond to it. One can speculate, however, that he would have rejected the Russians' interpretation of his model, particularly in terms of its temporal structure. Chistovich's framing of the speech-hearing servosystem is a decidedly Pavlovian one, reducing the continuous control circuit with a series of discrete articulatory events which, upon successful completion, produce another event as a

⁶⁶ Kozhevnikov and Chistovich, *Speech: Articulation and Perception*, 150.

⁶⁷ Kozhevnikov and Chistovich, 153.

reaction. Far from this chain reaction model, Fairbanks had in mind a device that “continuously predicts by extrapolation the future time at which the error signal will be zero. Thus, advancement of the storage component to the next control point is not necessarily delayed until the actual moment when a condition of zero error signal obtains.”⁶⁸ In other words, the speech control system does not simply wait for a signal to be properly carried out before moving onto the next one, but instead actively projects itself forward in time. When the speech-hearing feedback system is knocked off balance, Fairbanks’ model suggests, the situation shifts from stable, sequential, and deterministic to unstable, integral, and emotional.

The failure of Fairbanks’ cybernetically-informed closed-loop model to prevail in speech-hearing science (at least for now) illustrates how socially and materially contingent the histories of scientific experimentation can be. The differences between the American and Soviet DAF apparatuses, the countries’ respective political histories and favored technological metaphors, and the construals of temporality that they employed all seem to have played a key role in the content of modern speech-hearing science textbooks. One could argue, not implausibly, that the major reason that Fairbanks model is no longer accepted is Fairbanks’ own premature death. This would not be to advance a “great man” theory of history, but rather to suggest that technologies of knowledge production, such as the DAF device, require continuous social shepherding and material-semiotic maintenance in order to function across institutional contexts. As Christina Dunbar-Hester has shown, this contingency applies to cybernetic theory in general, which encompassed both the “closed world” projects of military command and control and the openness and productive indeterminacy of early experimental electronic

⁶⁸ Fairbanks, “Systematic Research In Experimental Phonetics: 1 . A Theory Of The Speech Mechanism As A Servosystem,” 137.

music.⁶⁹ Ironically, it is the termination of Fairbanks' career that leaves his work on closed-loop speech-hearing processes, for us, largely undetermined.

Conclusion:

Delayed auditory feedback needs to be understood as a form of mediation, understood as a specific variety of in-betweenness, translation, or relationality, characterized by the introduction of a split-second temporal delay between self-expression and self-perception. This abstract definition only becomes meaningful, however, when considered in terms of what sorts of selves were doing the expressing and perceiving, what takes place in the delay interval, and for what reasons. These are all questions of power—military, medical, actuarial, economic, and disciplinary. In this account, DAF appeared as a new form of noise, understood as an unintended, disruptive consequence of a communication process (i.e., magnetic tape recording). As with other forms of noise it was gradually domesticated and enrolled, with varying degrees of success, in various projects of subject formation, or of what Ian Hacking calls “making up people.”⁷⁰

As a form of technological mediation, the maniac-making machine's social entailments remain radically open and interpretively flexible, if always historically conditioned. For example, in the book *Sensing Sound*, artist and voice studies theorist Nina Eidsheim takes inspiration from various more recent cases of DAF in practice. These include video artist Richard Serra's piece *Boomerang* (1974), wherein a performer reflects on her experience of delayed feedback in 'real time'; the “Speechjammer”, a device that produces targeted long-distance DAF effects

⁶⁹ Dunbar-Hester, “Listening to Cybernetics : Music, Machines, and Nervous Systems, 1950-1980.”

⁷⁰ Hacking, *Historical Ontology*.

by way of a directional microphone and speaker; and the more mundane experience of a lagging Skype call. For Eidsheim, these deployments of delayed feedback provide opportunities to creatively explore the non-logocentric capacities of the voice. Far from a proscriptive disciplinary technology, Eidsheim sees DAF as a technology of the voice that (quoting philosopher Adriana Cavarero) “transcends the plane of speech’ and indeed ‘plays a subversive role with respect to the disciplining codes of language’ and the fetishization of certain types of vocal sound.”⁷¹ Decades on, maniac-making machines still manage to draw popular attention. In 2018, Hasbro released “Speech Breaker”, a party game that challenges players to speak while hearing their voice delayed through a pair of headphones. As one headline puts it, “Hasbro’s new head games want to drive you mad.”⁷² History may not repeat so much as feed-back upon itself.

⁷¹ Eidsheim, *Sensing Sound: Singing and Listening as Vibrational Practice*.

⁷² Stein, “Hasbro’s New Head Games Want to Drive You Mad.”

Bibliography:

Archival Sources

Fairbanks, Grant. *A Proposal for Research: The Acoustical Elements of Emotional Speech*, 1950.

William L. Everitt Papers, University of Illinois Archives, Urbana-Champaign, IL.

Fairbanks Jr., Grant. "Letter from Grant Fairbanks Jr. To Heinz Von Foerster." Grinnel, Iowa,

1961. Heinz Von Foerster Papers, University of Illinois Archives, Urbana-Champaign, IL.

Published Sources

Aumann, Philipp. "The Distinctiveness of a Unifying Science: Cybernetics' Way to West

Germany." *IEEE Annals of the History of Computing* 33, no. 4 (2011): 17–27.

Bergman, Moe. "On the Origins of Audiology: American Wartime Military Audiology." *Audiology*

Today, 2002.

Bijsterveld, K.T. "The Diabolical Symphony of the Mechanical Age. Technology and Symbolism

of Sound in European and North American Noise Abatement Campaigns 1900-40." *Social*

Studies of Science 31, no. 1 (2001): 37–70.

Black, John W. "The Effect of Room Characteristics upon Vocal Intensity and Rate." *The Journal*

of the Acoustical Society of America 21, no. 4 (1949): 461.

<https://doi.org/10.1121/1.1917079>.

Blegvad, N R. "Psychogenic Deafness (Emotional Deafness)." *The Journal of Laryngology and*

Otology 65, no. 3 (1951): 166–82. <https://doi.org/10.3109/00016485109123643>.

Bowker, G. "How to Be Universal: Some Cybernetic Strategies, 1943-70." *Social Studies of*

Science 23, no. 1 (1993): 107–27. <http://sss.sagepub.com/content/23/1/107.short>.

Bowker, Geoffrey. "Synchronization 4: Hermes, Angels and the Narrative of the Archive."

Accessed February 4, 2019. <http://peterasaro.org/writing/bowker2.pdf>.

- Brownfield, R.R. "Detection of Pretended Hearing Loss With Special Reference to Unilateral Deafness." *Journal of the American Medical Association* 70, no. 9 (1918): 597–98.
- Buskin, Richard. "Classic Tracks: Les Paul & Mary Ford 'How High The Moon'." *Sound on Sound*, January 2007.
- Downey, Gary Lee, Joseph Dumit, and Sarah Williams. "Cyborg Anthropology." *Cultural Anthropology* 10, no. 2 (1995): 264–69.
- Doyle, Peter. "From 'My Blue Heaven' to 'Race with the Devil': Echo, Reverb and (Dis)Ordered Space in Early Popular Music Recording." *Popular Music* 21, no. 1 (2004): 31–49.
- Duchan, Judy. "A History of Speech-Language Pathology," 2011.
<http://www.acsu.buffalo.edu/~duchan/history.html>.
- Dunbar-Hester, Christina. "Listening to Cybernetics : Music, Machines, and Nervous Systems, 1950-1980." *Science, Technology & Human Values* 35 (2010): 113–39.
- Eidsheim, Nina Sun. *Sensing Sound: Singing and Listening as Vibrational Practice*. Durham, NC: Duke University Press, 2015.
- Fairbanks, Grant. "History of the Hearing Program at Borden General Hospital," 1946.
- . "Systematic Research In Experimental Phonetics : * 1 . A Theory Of The Speech Mechanism As A Servosystem." *Journal of Speech and Hearing Disorders* 19, no. 2 (1954): 133–39.
- Fairbanks, Grant, and LeMar W Hoaglin. "An Experimental Study of the Durational Characteristics of the Voice During the Expression of Emotion." *Speech Monographs* 8 (1941): 85–90.
- Fairbanks, Grant, and Gordon E. Peterson. "Speech and Hearing Science." *Journal of the American Speech and Hearing Association* 5 (1963): 539–43.

- Fairbanks, Grant, and Wilbert Pronovost. "An Experimental Study of the Pitch Characteristics of the Voice during the Expression of Emotion*." *Speech Monographs* 6, no. 1 (December 1939): 87–104. <https://doi.org/10.1080/03637753909374863>.
- . "Vocal Pitch during Simulated Emotion." *Science* 88, no. 2286 (1938): 382–83.
- Firestone, Charles. "Volitional Deafness versus Malingering or Simulation of Deafness. A Comparison of Ototerminologic Values." *LARY The Laryngoscope* 48, no. 6 (1938): 405–8. <http://www.worldcat.org/oclc/5156833765>.
- Galison, Peter. "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision." *Critical Inquiry* 21, no. 1 (1994): 228–66.
- Garfinkel, Harold. *Ethnomethodological Studies of Work*. Oxford, UK: Routledge & Kegan Paul, 1986.
- . "Work Memo #2, Organizational Behavior Project, October 4, 1951." In *Toward a Sociological Theory of Information*, edited by Anne Warfield Rawls, 248–65. Boulder, London: Paradigm Publishers, 1951.
- Gerovich, Slava. "Love-Hate for Man-Machine Metaphors in Soviet Physiology: From Pavlov to 'Physiological Cybernetics.'" *Science in Context* 15, no. 2 (2002): 339–74.
- Grinker, Roy R. *War Neuroses*. Philadelphia; Toronto: The Blakiston Company, 1945. <http://www.worldcat.org/oclc/639954>.
- Hacking, Ian. *Historical Ontology*. Cambridge, Mass. : Harvard University Press, 2004.
- Halpern, Orit. "Dreams for Our Perceptual Present: Temporality, Storage, and Interactivity in Cybernetics." *Configurations* 13, no. 2 (2005): 283–319. <https://doi.org/10.1353/con.2007.0016>.
- Hanley, Clair N, D Ph, William R Tiffany, and D Ph. "Auditory Malingering and Psychogenic

- Deafness." *AMA Archives of Otolaryngology*, 1954.
- Haraway, Donna. "A Cyborg Manifesto," 1991.
- Hayles, N. Katherine. *How We Became Posthuman*. Chicago: University of Chicago Press, 1999.
- Hixon, Thomas J., Gary Weismer, and Jeannette D. Hoit. *Preclinical Speech Science: Anatomy, Physiology, Acoustics, and Perception*. 3rd ed. San Diego, CA: Plural Publishing, 2018.
- Hui, By Alexandra. "Sound Objects and Sound Products : Standardizing a New Culture of Listening in the First Half of the Twentieth Century." *Culture Unbound* 4 (2012): 599–616.
- Kittler, Friedrich A. *Literature, Media, Information Systems*, 2013.
- <http://books.google.com/books?hl=en&lr=&id=CgWluUVmPicC&oi=fnd&pg=PP1&dq=literature,+media,+information+systems&ots=MckKaUDiEY&sig=1rJJISAlxVA4tf1O6-6FReLvsNM>.
- Kline, R. "Where Are the Cyborgs in Cybernetics?" *Social Studies of Science* 39, no. 3 (May 22, 2009): 331–62. <https://doi.org/10.1177/0306312708101046>.
- Kline, Ronald R. *The Cybernetics Moment, or, Why We Call Our Age the Information Age*. Baltimore, MD: Johns Hopkins University Press, 2015.
- . "What Is Information Theory a Theory Of?" *American Society for Information Science and Technology*, 2004, 13–28.
- Kozhevnikov, Valery, and Ludmilla Chistovich. *Speech: Articulation and Perception*. Washington DC: U.S. Department of Commerce Joint Publications Research Service, 1965.
- Lee, Bernard S. "Artificial Stutter." *Journal of Speech and Hearing Disorders* 16 (1951): 53–55.
- . "Effects of Delayed Speech Feedback." *Journal of the Acoustical Society of America* 22, no. 6 (1950): 824–26.
- Los Angeles Times. "Students Win in Contest for Whisker Growth." *Los Angeles Times*. October

27, 1928.

Malin, Brenton J. "Electrifying Speeches: Emotional Control and the Technological Aesthetic of the Voice in the Early 20th Century US." *Journal of Social History* 45, no. 1 (2011): 1–19.

<https://doi.org/10.1093/jsh/shr001>.

"Maryland Speech Teachers Stick Necks 'Aeout.'" *The Washington Post*, 1948.

Mayer, Lyle Vernon. "Letters: Block That Plosive." *Time*, 1953.

Medina, Eden. *Cybernetic Revolutionaries: Technology and Politics in Allende's Chile*.

Cambridge, Mass: Mit Press, 2011.

Mills, Mara. "Deafening: Noise and the Engineering of Communication in the Telephone System." *Grey Room*, no. 43 (2011): 118–43.

http://www.mitpressjournals.org/doi/pdf/10.1162/GREY_a_00028.

———. "Media and Prosthesis: The Vocoder, the Artificial Larynx, and the History of Signal Processing." *Qui Parle: Critical Humanities and Social Sciences* 21, no. 1 (2012): 107–49.

Mindell, David A. *Between Human and Machine: Feedback, Control, and Computing before Cybernetics*. Baltimore : Johns Hopkins University Press, 2002.

Miron, Murray S. "Preface To Grant Fairbanks' Experimental Phonetics." In *Experimental Phonetics*, v–vi, 1966.

Monea, Alexander, and Jeremy Packer. "Media Genealogy and the Politics of Archaeology."

International Journal of Communication 10 (2016): 3141–59.

Mysak, Edward D. *Speech Pathology and Feedback Theory*. Springfield, IL: Charles C Thomas, 1966.

Pickering, Andrew. "Cybernetics and the Mangle. Ashby, Beer and Pask." *Social Studies of Science* 32, no. 3 (2002): 413–37.

- Pinch, Trevor J., and Karin Bijsterveld. "Should One Applaud?' Breaches and Boundaries in the Reception of New Technology in Music." *Technology and Culture* 44, no. 3 (2003): 536–59. <https://doi.org/10.1353/tech.2003.0126>.
- "Plans for University Play Told: Redlands Seniors to Give 'Merton of the Movies.'" *Los Angeles Times*. November 27, 1930.
- Raphael, Lawrence J., Gloria J. Borden, and Katherine S. Harris. *Speech Science Primer*. 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2011.
- Riper, Charles Van. "Recollections from a Pioneer." *American Speech and Hearing Association Magazine*, 1989.
- Scal, J. Coleman. "Malingering Deafness: Tests in Its Detection and Report of Two Cases." *Arch Otolaryngology* 3, no. 3 (1926): 237–41.
- Scott, David. *Penology*. London: Sage, 2008.
- "Solitary Imprisonment in England." *The Times from London*. November 29, 1843.
- Stearns, P N, and C Z Stearns. "Emotionology: Clarifying the History of Emotions and Emotional Standards." *The American Historical Review* 90, no. 4 (1985): 813–36. <https://doi.org/10.2307/1858841>.
- Stein, Scott. "Hasbro's New Head Games Want to Drive You Mad." *CNET*, February 2018. <https://www.cnet.com/news/hasbro-head-games-toy-fair-heart-rate-audio-feedback/>.
- Sterne, J. *MP3: The Meaning of a Format*. Durham, NC: Duke University Press, 2012.
- Sterne, Jonathan. "Space within Space: Artificial Reverb and the Detachable Echo." *Grey Room* 60 (July 2015): 110–31. https://doi.org/10.1162/GREY_a_00177.
- . *The Audible Past*. Durham, NC: Duke University Press, 2003.
- Thompson, Emily. *The Soundscape of Modernity: Architectural Acoustics and the Culture of*

Listening in America 1900-1933. Cambridge, Mass: MIT Press, 2002.

Time Magazine. "Feed-Back to Idiocy." *Time* 57, no. 2 (1951): 54.

W.L.L. "New Device Tests Human Emotions." *New York Times*, December 17, 1950.

Washington Post. "Machine Can Turn Normal Calm Person into Emotional Shambles." *The Washington Post*, 1950, B3.

Watson, Leland A., and Thomas Tolan. *Hearing Tests and Hearing Instruments*. Baltimore, Williams & Wilkins Co., 1949.