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Phyllis M. Tookey Kerridge and the Science of Audiometric Standardisation in Britain

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ABSTRACT:

The provision of standardised hearing aids is now considered to be a crucial part of the U.K. National Health Service. Yet this is only explicable through reference to the career of a woman who has, until now, been entirely forgotten. Dr Phyllis Margaret Tookey Kerridge (1901-1940) was an authoritative figure in a variety of fields: medicine, physiology, otology, and the construction of scientific apparatus. The astounding breadth of her professional qualifications allowed her to combine features of these fields and, later in her career, to position herself as a specialist to shape the discipline of audiometry. Rather than framing Kerridge in the classic 'heroic woman' narrative, in this article we draw out the complexities of her career by focusing on her pursuit of standardisation of hearing tests. Collaboration afforded her the necessary networks to explore the intricacies of accuracy in the measurement of hearing acuity, but her influence was enhanced by her ownership of Britain's first Western Electric (pure tone) audiometer, which she placed in a specially designed and unique 'Silent Room'. The room became the centre of Kerridge's hearing aid clinic that, for the first time, allowed people to access free and impartial advice on hearing aid prescription. In becoming the guardian expert and advocate of the audiometer, Kerridge achieved an objectively quantified approach to hearing loss that eventually made the latter an object of technocratic intervention.

Interest and competition in the ‘deaf world’ is running very high now as everybody is anxious to ascertain how much it will be possible to improve the speech of the deaf with this scientific help...It would be premature to attempt to assess the progress that will be made in curing speech defects with the help of sound magnifying apparatus, but the present outlook is very promising.

Phyllis M. Tookey Kerridge, 1935¹

The most important single test is to find out how well the spoken voice can be heard. After all, what is wanted is to hear speech, not the pure tone audiometer or the tuning fork.

William Mackenzie, 1947²

In 1943, at the request of the Ministry of Health, the Electro-Acoustics Committee of the Medical Research Council began designing a portable light-weight electrical hearing aid. To facilitate their free provision to servicemen whose hearing were damaged in war service, the government desired a national standardised hearing aid that would provide increased amplification and speech intelligibility to users while also being economically feasible to produce.³ Five years later, when the instigation of the National Health Service (NHS) introduced universal provision to health care, the first state-sponsored hearing aid became freely available to citizens. The Medresco device—its name a contraction of ‘Medical Research Council’—became a symbol of the new egalitarian post-war Britain, the result of collaborations between several institutions, including the Medical Research Council (MRC), the National Institute for the Deaf (NID), the General Post Office (GPO), and the University of Manchester.⁴ Nearly 3,000 devices were issued by the NHS in 1948,

and 120,000 had been issued by 1951. The NHS continued supplying upgraded models until 1982, when it discontinued the Medresco in favour of commercial versions.⁵

Though the product of multi-institutional collaboration, the research data on hearing thresholds—necessary for the development of the Medresco—was principally derived from the work of Dr Phyllis Margaret Tookey Kerridge (1901-1940). Kerridge worked on hearing loss for a variety of seemingly disparate institutions: the NID, the MRC, and the Post Office. Beginning with her 1936 MRC-funded project surveying hearing loss in deaf schoolchildren, Kerridge relied on the audiometer to conduct careful statistical studies, quantifying data on hearing thresholds. Her studies were amongst the first of their kind and played a crucial role in promoting mechanical objectivity over embodied knowledge in hearing tests and prescription of hearing aids.⁶ Throughout this paper, we refer to ‘objectivity’ not as synonymous with realism, but rather as being the ideal of scientific representation, facilitated by precise measurements and standardised instrumentation.⁷ For Kerridge, bringing mechanical rigour to the question of hearing acuity was especially important as otologists and educators of the deaf frequently conflicted on testing methods. Since no standardised guidelines for hearing measurements were available, she approached her research not for ‘the discovery of new facts, but for measurements, as precise as human material and physical instruments would allow’ in order to empirically answer the question, ‘how deaf are the deaf?’⁸

By surveying hearing acuity, Kerridge developed parameters for configuring accurate levels for measuring hearing loss, which would later contribute to changes in the design and manufacture of hearing aids. Much of her data emerged from experiments in the ‘Silence Room’, a soundproof room of some 3,500 cubic feet in the basement of University College Hospital on Huntley Street in London. This was the first site in Great Britain to have a permanent Western

Electric Audiometer that used pure tone testing rather than speech recording. The engineering and manufacturing arm of the American telecommunications company AT&T, Western Electric supplied their early models mainly to otologists, though later commercial models were purchased by schools for the deaf and hospitals.⁹ As a clinic, the silence room can usefully be considered in the manner of Latour and Woolgar's framework of laboratory space, where scientific facts such as normal hearing were constructed using the audiometer as an inscription device.¹⁰ In addition to collecting data on hearing acuity, Kerridge developed approaches for determining levels of speech comprehension and conversational hearing, to examine how the intensity and distortion of different frequencies affected understanding. The result of a collaboration with experimental phonetician Dennis Butler Fry (1907-1993), this study on speech audiometry provided detailed measurements for configuring tone controls on a valve amplifier hearing aid. It was moreover pertinent to the Post Office telephone department's concern for ensuring clear transmission of speech over their telephone lines. In 1937 the GPO instigated collaboration with Kerridge to assist its investigation into the needs of their 'deaf subscribers', an investigation prompted by complaints from hearing impaired customers.¹¹

Kerridge's pursuit of audiometric standardisation reflects the nineteenth-century shift that no longer considered individual perception to be a sufficiently accurate medium for measurement. That the body could not be trusted as an objective source of measurement meant instruments were often required for accomplishing accuracy, and trust played an important role in defining degrees of accuracy. Trust, however, was not automatically assumed. As Graeme Gooday has written, since instrument users had to trust the maker, materials, and theory embodied in the device, they often artificially privileged preferred values by using easily measurable or surrogate parameters to achieve practical ends.¹² Kerridge's prioritisation of pure-tone audiometry was not a realistic

instrumental surrogate for hearing acuity (since pure-tones are not always accurate perceptions of speech); but at the very least, the audiometer allowed her to define an easily quantified ‘measurement’—or at least, the illusion of one, as in her attempts to define the ‘normal’ threshold of hearing. Similarly, Lennard Davis has shown that as the rise of eugenic-based statistics worked to create a standard of ‘normalcy’, increased measurement and statistical analysis created a symbiotic relationship between what could be defined as the ‘normal’ body and the ‘disabled’ body.¹³ The case studies from Kerridge’s clinic demonstrate the extent of this relationship, as new forms of instrument-based measurements were used to construct a standardised level of normal hearing.

Through Kerridge’s work, the deaf in interwar Britain were progressively rationalised and made more quantifiable through the pursuit of scientifically objective data, a process that was particularly facilitated through the audiometer. While the audiometer lent prestige and status to Kerridge’s studies and augmented her career, her desire to bring science to bear on the field of audiometry means that her legacy is complex.¹⁴ Although she raised the profile of hearing loss within the scientific community, her emphasis on standardisation conflicted with the diversity and individuality of hearing, hearing loss, and hearing aid prescription.¹⁵ Similar to Woods and Watson’s discussion of the Model 8F wheelchair, this account presents the standardisation of hearing—and hearing loss—as a sociohistorical product, with the hearing aid and hearing aid user constructed simultaneously in a clinical space.¹⁶ Kerridge’s pursuit of standardisation through the quantification of hearing loss constructed it as a legitimate scientific problem worthy of technocratic intervention.

Levels of Intensity: The Audiometer and Audiometric Surveys

As historian Mara Mills notes, as early as 1878, psychoacoustic researchers were repurposing the telephone to manipulate the intensity of electric currents to provide a precise measure of loudness of sound necessary for diagnosing hearing difficulties. Named the ‘audiometer,’ these early instruments were attached to a battery and movable induction coil, and could ‘produce up 200 different grades of intensity for a given frequency,’ to measure the points at which a subject could hear the difference between clicking sounds (Fig. 1).¹⁷ Otolologists, however, did not consider the instrument a viable diagnostic tool. Even though later models of the audiometer emitted pure tones for identifying hearing threshold levels, most otologists insisted that pure tones could not adequately measure the human auditory mechanism.¹⁸ Indeed, despite technical improvements in audiometer design, scepticism over the instrument prevailed well into the end of the nineteenth century. The Royal Society of Medicine’s Section of Otology, for instance, issued guidelines for hearing tests that favoured only conversational voice, whispered speech, ticking watches, tuning forks, and the Politzer acoumeter, a tool for testing conductive hearing loss due to damage in the middle ear (the eardrum or ossicles).¹⁹

The onset of commercial vacuum tube audiometers in 1922 brought the device into general use and introduced a new threshold for measuring hearing capacity, one that could be plotted on a graph. Referred to as an ‘audiogram,’ the graph indicates the sound intensity (loudness) and frequencies (pitches) a person is able to hear (Fig. 2). Intensity is measured in decibels (dB) and marked on the vertical axis from a threshold of ‘0’, which indicates ‘normal hearing’, or the softest sound heard by the human ear; normal conversation speech is approximately 45dB. Hearing loss

is measured in negatives (e.g. -30dB), and thus represented as a deviation from this norm.²⁰ The horizontal axis marks the range of frequencies measured in Hertz (Hz), with pitch increasing from low (64 to 125 Hz) on the left of the graph to high (8192 Hz) on the right.

The audiometer thus represented a new mechanistic understanding of auditory perception, one that merged a physical instrument with a more precise and measurable way of tracking perceptions of sound.²¹ The instrument could also be used to configure hearing necessary for speech acquisition: since ordinary speech comprehension falls between the range of 125 to 6000 Hz, targeting this range would enable researchers to focus rehabilitation specifically on ameliorating deaf speech. As Jennifer Esmail explains, such technological incursions were part of a larger shift coinciding with an oralist ideology, the belief that speech restoration was necessary for integrating deaf and deafened persons into hearing society.²² By concentrating on speaking, rather than hearing, ability, audiometers became crucial tools for the deaf to be, in the words of educator Irene Ewing (1883-1959), 'hearing minded'. For instance, as early as 1885, Alexander Graham Bell (1847-1922) reported that the audiometer could be used to determine the hearing capacity of schoolchildren, in order to assess their educational capacities and speech. Bell discovered that out of seven hundred pupils tested, more than ten percent had some form of hearing impairment. Likewise, Glasgow aurist James Kerr Love (1858-1942) reported that only ten percent of pupils at the Glasgow Institute for the Deaf were totally deaf.²³ The majority had residual hearing, a finding Love argued could be exploited for therapeutic purposes with medical care or aids; he further claimed that activating this residual capacity could readily improve the speech of pupils at the institution.

By the 1920s, researchers were using the audiometer to conduct wide-scale surveys of hearing in schoolchildren, with the aim of assessing hearing thresholds to ascertain how residual

hearing could be exploited to improve speech acquisition. For instance, between 1924 and 1925, Herbert E. Day and Irving S. Fusfield (1883-1977) of Gallaudet College, together with Rudolf Pinter of Columbia University, conducted a National Research Council survey on hearing loss in American schools for the deaf. Their 1928 report revealed that the mean residual hearing of deaf children was about 21 to 25 percent (i.e. a loss of 75-80 percent of normal hearing), with only three percent of children discovered to be totally deaf.²⁴ Another survey conducted by Ruth C. Partridge and Donald L. McLean at the School of Hygiene at University of Toronto discovered significant hearing loss in 22 of 399 children; of those 22, three had conditions easily correctable by removing their tonsils and adenoids.²⁵ A more unusual study took place at Manchester University during the early 1930s, where Irene and Alexander Ewing (1896-1980) demonstrated that children with residual hearing, taught with group hearing aids (individual receiver units all connected to an amplifier worn by a teacher), made rapid progression in their acquisition of speech and language. The Ewings argued that hearing aids made children more familiar to varying modalities of speech, significantly reducing the monotonous and unpleasant 'deaf voice'.²⁶

These studies suggested that with residual hearing (or 'serviceable hearing', as in some reports), the connection between hearing and speech was both physiological and psychological. Such claims were particularly crucial for the MRC's interwar agenda in addressing the 'deafening' of returning ex-servicemen. Conditions such as shell shock and the new medical category of 'deafened' were amongst the recognised medical consequences of warfare and impacted the broader cultural visibility of hearing impairment. Julie Anderson has shown how the First World War was a catalyst in increasing the British public's awareness of disabled people, translating into better public services and charities, and the emergence of a new class of biomedical research that sought to 'normalise' the disabled body for social integration.²⁷ Seeking to merge clinical research

with scientific efficiency, the MRC financed a number of research programs that explored wartime and post-war medical problems, including hearing impairment. Under the leadership of David Munro, the MRC Hearing Committee oversaw projects investigating diseases of the ear and the prevention of certain kinds of deafness, such as chronic otitis media; statistical projects investigating amplification, however, were given special consideration, particularly for the purpose of rehabilitating deafened ears. As a means for promoting the normalisation of auditory perception,—an issue the MRC framed as a national concern—the audiometer became central to these studies.²⁸

Since early audiometers, however, did not allow differentiation between conductive and sensorineural hearing loss, calibration varied between models. Audiometric tests thus required intensive comparative studies before they could eliminate the unreliable and subjective medium of the voice, the most common method for testing hearing. It was precisely this lack of methodological standardisation that prompted the NID Medical Sub-Committee and MRC to call for more regulated empirical testing. Regulation would not only provide more rigid measurements for hearing acuity, but also better assist the otologist in making a prognosis of deafness and determining the long-term benefit of hearing aids.²⁹

Help to Hear: Kerridge as an Expert

In 1934, the MRC funded a new study aiming to assess the aural conditions of deaf children at London County Council (LCC) schools. Firmly rooted within the MRC's agenda of 'pure science', the project aimed to fulfil several purposes: to assess whether residual hearing was present; to express the relationship between deafness and speech; and to test different mechanical

apparatuses for hearing amplification. The MRC hoped studying the ‘measure of deafness’ would determine whether hearing loss in schoolchildren could be prevented through earlier diagnosis, or improved with prescribed hearing aids. Moreover, the results could have broader applications, particularly for the MRC’s promotion of rehabilitation and normalisation of wartime and post-war bodily injuries. Phyllis Kerridge joined the study upon recommendation from Guy P. Crowden (1894-1966), whom she worked with at the London School of Hygiene. The MRC study was Kerridge’s first foray into audiometry and would propel her career as a renowned expert on deafness.

Born in Bromley, Kent in 1901 to William and Edith Tookey, Kerridge was educated at the City of London School for Girls and later at University College, London (UCL), where in 1922 she received her Bachelors of Science in Chemistry (Fig. 3). With an impressive list of postgraduate credentials—an M.S. from UCL in 1924, a PhD in 1927, a M.D. in 1932, membership of the Royal College of Surgeons and licentiate of the Royal College of Physicians in 1933—Kerridge distinguished herself as a prominent scientist, renowned collaborator, and dedicated educator: all this at a time when women were struggling to secure university positions in the male-dominated fields of chemistry and physiology. It is especially notable that she received all of her degrees from UCL, for although London medical schools opened their doors to women matriculates during the First World War, fears of overcrowding in the profession led several institutions to cease admitting women in the 1920s. Even UCL considered banning women, but ended up strictly limiting the number of female admissions instead.³⁰

Kerridge asserted her aptitudes, capability, and scientific authority by holding prestigious appointments at numerous institutions, including: UCL, the London School of Hygiene and Tropical Medicine, the Marine Biological Association Laboratory at Plymouth, the Carlsberg

Laboratories in Copenhagen, the Medical Research Council, the National Institute for the Deaf, and the Medical Unit of the London Hospital. She was especially commended for her development of the first miniature pH glass electrode that could be used for blood sample analysis and her textbook *Principles of Chemistry for Medical Students* (1927) was well received.³¹

These early achievements depended substantially on collaboration with male scientists. Collaboration enabled Kerridge strategically to advance her interest in scientific analysis and experimentation by building a network of allies that later enabled her to secure several publications as a single author. In her audiometric work, however, Kerridge had considerable autonomy, though she continued forging collaboration with international scientists on a breadth of physiological projects, including nutrition, artificial respiration, and colour-blindness.³² Her focus on standardisation, however, fit within the general drive for increased standardisation of sound in this period. Not only was the decibel introduced as the standard unit for measuring sounds, but the construct of the standard concert pitch was further developed.

Kerridge's emphasis on collecting data on how sounds were registered by the deafened ear would later be crucial for her facilitation of the audiometer as an inscription device, an apparatus whose end-product constructed the concept of 'normal hearing'.³³ The MRC study, for instance, concentrated on two aims. The first was to collect quantitative data on LCC schoolchildren who were hearing impaired and receiving special education facilities, approximately 500 pupils from a total school population of 500,000. The pupils had their hearing loss measured with different apparatuses to assess which method provided the most accurate data: a pure tone audiometer, a gramophone tone audiometer (for testing up to 40 pupils at a time), and calibrated tuning forks with voice tests. The voice test was designed to be like the more familiar 'Snellen Test' that examines eyesight by assessing how far down the tester can read increasingly minimal text on a

chart on the wall. Similarly, for hearing tests the tester would stand at a prescribed distance from the patient and move closer until he or she could hear what the tester said. This took no account of the size or acoustics of the room, or the clarity, volume, and content of the tester's speech, but was still widely used during the early 1930s.

The second aspect of the MRC study was to determine whether hearing could lead to the 'improvement of the children's own speech, not necessarily their understanding of the speech of others'.³⁴ This concern for correcting 'deaf speech', which Kerridge notes 'defies description', though the 'abnormalities are of tone, accent, and rhythm, rather than of articulation', clearly reflects the prevalence of how oralism aimed to normalise deafness through speech. More importantly, Kerridge's study emphasized how the audiometer could be used to *aid* deaf speech, rather than simply measure hearing acuity. As she outlined in her 1937 MRC report, 'Speech is an urgent necessity for the normal and psychological development of these children, as well as for their educational and social needs'.³⁵ Working with Arthur C. Wells, the appointed otologist for LCC schools, the study revealed that a pupil's proficiency of speech was correlated to their use of hearing augmentation technology. An 'experimental' group was given a Group Hearing Aid by the Multitone Electric Company for classroom instruction, while a 'control' group was not. The report revealed a 25 percent improvement of speech acquisition and comprehension in children within the experimental group. Kerridge and Wells concluded that if hearing impaired children were properly aided with acoustic devices and sound amplifiers, they would eventually demonstrate substantial improvement in speech. Their findings not only drew attention to the importance of regular surveillance of hearing acuity, but also helped garner the MRC Hearing Committee's approval for additional large-scale projects investigating hearing impairment.³⁶

Comparing these results to other similar cohort groups however, was problematic. Since the numbers generated by these instruments needed to be interpreted in relation to standard values (e.g. obtained from 'normal' populations) to be clinically useful, the lack of standard values for measurement meant it was often difficult to secure accurate references to mechanically define 'deafness'.³⁷ Kerridge demonstrated that by testing different audiometric methods and groups, the 'normal' level of hearing set by the audiogram presented a complication with regards to the 'zero line' of the pure tone audiometer which was supposed to represent 'normal' hearing. There was no indication in the literature supplied with the instrument whether variations among the normal existed; furthermore, Kerridge disputed the fact that the audiogram assumed that the normal limits were the same for children as for adults. The zero line to which Kerridge refers here was the standard of normal hearing, or the average threshold level of listeners. As she was using a Western Electric audiometer, the average threshold level was set according to the hearing of listeners working at the Bell Telephone Laboratory. This threshold of perceived normalcy proved contentious, however, as the American zero level did not match the British zero level. There was with a difference of around 10dB, and it was not until 1964 that a single international standard zero (R389) was agreed upon by both the U.S. and Europe.³⁸ The zero line of the audiometer is significant because of its use as a clinical standard for assessing hearing. This standard was considered to the definite level upon which to base assessment of normalcy or pathology yet Kerridge's assessments demonstrated the arbitrariness of its construction. Moreover, measurement parameters often hinged on political considerations.

Experiments in the Silence Room

After her LCC project, Kerridge expanded the scope of her research. In so doing, she became aware of territorial conflicts over research domains, especially from Irene and Alexander Ewing, then the leading experts on speech education for deaf children. Based in Manchester University, much of the Ewings' research focused on educational, rather than clinical, applications. During the 1930s for instance, the Ewings collaborated with acoustic physicist Tom S. Littler (1901-1969) at the Royal Deaf School in Manchester in a project to outline the efficacy of group hearing aids in improving speech in children and adults. Initially Kerridge was very anxious to avoid impinging on the Ewings' field of work, as she had, in her own words, 'a very high opinion of their pioneer endeavour'.³⁹ While the Ewings focused on the perfection of large schoolroom amplifiers for deaf children, Kerridge designed her research to focus on small individual portable sets. The Ewings, however, apparently found even this reduced scope problematic. David Munro had written to them on behalf of the Medical Research Council explaining that since Kerridge had been to Manchester on several occasions to demonstrate the benefits of hearing aids for teaching, it was unnecessary for her to consult with them. He also emphasised that the MRC had already funded Kerridge's project separately.⁴⁰ Unhappy with what they perceived to be a significant amount of analytical overlap, the Ewings insisted that Kerridge's unfamiliarity with deaf education threatened the validity of their own work; 'could it not be proposed to her by someone else', they asked, 'that the objects of her investigation might be more strictly defined?'⁴¹ While it is unclear how these disputes played out, a letter from Munro indicates that Kerridge refused to co-publish her 1937 MRC report in the same volume as the Ewings.⁴²

Distancing herself from the Ewings, Kerridge concentrated her work on the scientific basis of audiometry, leaving group testing and education to the Manchester scholars. Extending her LCC survey findings, she focused on designating parameters for audiometric surveys in the prescription

and fitting of hearing aids. The problem of adequately measuring hearing acuity, however, posed a challenge as disputes between organizations providing hearing tests meant that the U.K. still lacked a standardised approach to audiometric tests. For instance, as early as 1931, the NID Medical Committee was looking at developments in telephony for constructing superior gramophone tests on behalf of their members. Their inquiry centred on the standardisation of gramophone records and speech intensity in order to develop a standard of hearing for speech using the ‘decibel index’.⁴³ To verify a connection between telephony and the classification of hearing acuity, the committee intended to purchase an audiometer to test their clients’ hearing at the NID headquarters. They were intermittently delayed, however, due to lack of funds.

Even Kerridge encountered problems with acquiring an audiometer. She had been borrowing the Western 2B audiometer from Crowden but it was inconvenient to transport the heavy apparatus back and forth from the London School to her new position at UCL.⁴⁴ After her application for a Royal Society Government Grant was rejected, she appealed to Munro for assistance in purchasing a pure-tone audiometer with a bone conduction receiver so that she could carry on her work for the Board of Education. As the audiometer belonged to the MRC, and Crowden was assigned the device with the disclaimer that it could be transferred to other work the Hearing Committee deemed necessary, Crowden wrote to the MRC agreeing to give the audiometer to Kerridge. It is unclear whether he volunteered to do so or was instructed by the MRC, as private correspondence suggests that Kerridge ‘foresaw some personal difficulty with Crowden’ over control of the audiometer.⁴⁵ What is clear, however, is that researchers and stakeholders almost universally perceived the audiometer as a central and crucial tool for hearing studies. Kerridge’s ability to secure an audiometer also suggests the value of her work for the MRC and the importance of the tool in securing her own professional prestige.

The issue of the NID's access to an audiometer was further complicated by Kerridge's research proposal for University College Hospital. In January 1937, Kerridge and Myles L. Formby (1901-1994), ear surgeon at UCH, convinced the NID Medical Committee to refer all individuals requesting hearing tests or fittings to UCH, where Kerridge was working to establish a hearing clinic. They argued that the clinic had better facilities and superior audiometers, and would thus provide more accurate hearing tests.⁴⁶ The NID Chairman was initially unhappy with the suggestion, for the proposal limited the jurisdiction of the NID and reduced its activities to merely sending cases to UCH. Such territorial attitudes may have resulted from the NID's founding goal of unifying all deaf services under one umbrella organisation. The NID Medical Committee regretted that the scheme would dissociate the Institute from UCH's hearing clinic, but agreed to allow Kerridge and Formby to proceed as long as they were apprised of the activities there.⁴⁷

Kerridge deflected criticism by pointing out there were greater amenities at UCH than at the NID headquarters, 'including a silence room, an audiometer, a wide assortment of hearing aids, and the specialist personnel so that the work could be carried out with efficiency and without difficulty'.⁴⁸ Her push for integration between the NID and UCH's clinic encompassed another agenda: to provide herself and Formby with a supply of patients that would enable them to conduct further research into audiometric standardisation. In April 1937, Kerridge and Formby proposed a six-month research project to UCH's Board of Governors to conduct surveys of hearing acuity in the hospital's unique silence room.⁴⁹ By eliminating external sound interference and providing the necessary features for conducting tests in a controlled setting, the silence room enabled Kerridge and Formby to investigate how different external variables could interfere with the accuracy of audiometric readings—a crucial aspect in framing better prescriptions of hearing aids (Fig. 4).

Designed to be a ‘world-focusing point for the most advanced knowledge’ as a research centre, the silence room was made possible by a generous donation from barrister Geoffrey Edgar Duveen (1883-1975) for the new Royal Ear Hospital building in 1920.⁵⁰ Nearly 3,500 cubic feet, with ‘walls impenetrable to extraneous noises and which will never reflect, deflect nor refract sounds’, it was ‘a chamber of the stillness of death, where absolute accuracy and complete consistency in results will be obtained’.⁵¹ As one observer commented, the room was so impenetrable to external sounds that the beat of the heart could be heard, and even ‘the flick of quickly closed eyelids’.⁵² With thick walls, massive doors, and no windows, the silence room clearly possessed the features of an early anechoic chamber.⁵³ Furthermore, its simple décor—two chairs, a table, and an English Mains audiometer type 2BE—was designed to limit any unnecessary environmental interference with hearing tests. Distance points for measuring comparative tests with ticking watches and tuning forks were marked on the floor.

Kerridge and Formby initially tested and fitted 29 patients for hearing aids, patients likely sent to the clinic from the NID. Their work, however, impressed the UCH Board of Governors, who then extended the contract, expanding the research scope to include hospital patients. By 1939, Kerridge and Formby examined 170 cases, helping many to obtain properly fitted hearing aids ‘to enable them to carry on with their works’.⁵⁴ Two additional basement rooms were provided for use as an office and waiting room, as well as the services of a Miss W.J. Wadge as assistant.⁵⁵ Together, these rooms formed the newly inaugurated Hearing Aid Clinic, the first of its kind in the United Kingdom, under Kerridge’s directorship.⁵⁶ It served a charitable purpose—though it was far from being a charity—in allowing patients to be properly tested and fitted for a hearing aid that best suited their life circumstances, occupation, and psychological attitude, a necessity in an age of rapid development and modification of electric aids.

‘Deaf persons’, Kerridge wrote in 1935, ‘want help to hear’.⁵⁷ The choices available for them, however, were often muddled by ‘unscrupulous’ salesmen profiteering out of the chaos with their exaggerated advertisements. Without clear guidelines in the prescription of hearing aids or regulation of quality, it was difficult for hospital clinics and specialised practitioners to provide proper hearing aids for clients.⁵⁸ If any improvement in this scheme was to be made, Kerridge insisted it would depend on medical advice, rather than commercial firms and their advertisements. Reliability and certainty in hearing aid fittings, she explained, would only be possible once the instruments become more standardised.⁵⁹ While some otologists recommended specific hearing aid manufacturers, others sent patients to agents, believing them to be more capable of providing unbiased advice. Kerridge disagreed with this practice, arguing that the decision to select a hearing aid was a complex one, requiring a ‘combination of medical science and an appreciation of human requirements and weakness, which is extremely difficult to obtain, even in the best commercial atmosphere’.⁶⁰ Additionally, she emphasised that it was crucial to disabuse patients of ideas they received from advertisements, vendors boasting miraculous new ‘cures for deafness’ or cheap, ‘more powerful’ hearing aids that were unregulated.⁶¹ The NID also maintained a register of recommended hearing aid manufacturers that followed certain regulatory standards (e.g. allowing home trials) and frequently advised their clients to seek out medical advice and avoid the solicitations of nefarious firms.

As James Sumner and Graeme Gooday point out, standardisation is a negotiated process, made more efficient with the converge of machines and testers, of the expert and the patient.⁶² At the Hearing Aid Clinic, Kerridge perfected the fitting and prescription of hearing aids by investigating how audiometric data could provide objective standards to be applied to a broader spectrum of hearing loss. Her experiments in the silence room with music and the wireless to test

hearing in lieu of, or in combination with, the audiometer also testifies to a diagnostic emphasis on hearing ability rather than speech adaptation. The wireless was as important as conversation as a measure of the ‘success’ of amplification with hearing aids, as outlined in Kerridge’s fascinating case studies on the lives of hearing impaired persons. One man who relied on a carbon microphone valve amplifier reported that he ‘could hear the wireless and the band in the park’ while another emphasised that he had ‘heard the news bulletin and most of the talks on the wireless’.⁶³ The wireless may simply have been used to provide an indicator of ‘normal’ hearing, but its application also reveals the cultural importance accorded to music and the wireless during this time. Kerridge’s use of the wireless likewise suggests that she perceived music to be as important to hear as speech, and was aware of the importance of adapting the hearing aid to lifestyle.⁶⁴ For instance, a 50-year-old male garage worker refused his recommended valve amplifier with a crystal microphone, preferring a less suitable bone conduction instrument so that ‘he could answer the telephone at work without stopping to take an instrument off, and his hands had to be free’.⁶⁵ Cases such as this indicated to Kerridge the value of merging audiogram readings with a consideration of the patient’s occupation to prescribe a more suitable hearing aid. It also reveals her interest in examining the way people heard through different mediums, a notion that explains why she would later expand her audiometric research to include Post Office amplified telephone sets.

Even as audiometric testing attempted to perfect hearing acuity for hearing aids, Kerridge faced a broader problem with the prescription of hearing aids. Patients resisted the devices not only due to their cumbersome nature, but also and indeed mostly because of their enormous expense. Relief charities were available to help defray these costs, but most of these insisted that patients supply a medical certificate specifying precisely the name and maker of the prescribed aid—a drawback if patients were unsure which model to select.⁶⁶ Since improper hearing aids

risked further damage to already impaired hearing, Kerridge coordinated with several charitable and relief agencies to supplement the costs of hearing aids in conjunction with the clinic. For instance, ex-servicemen's hearing aids were variously paid for by the British Legion, the Deafened Ex-Servicemen's Fund, the Soldiers' and Sailors' Help Society. Other organisations included: churches, the Helper's League, the Metropolitan Society for the Blind, and even patients' own employees, such as the 'Friendly Benefit Society of Managers of Printing Machines Approved Society'. Under Kerridge's leadership, the clinic became a place for people on lower incomes to get free and impartial advice about the suitability of hearing aids as well as assistance in recovering the cost of the instrument. These principles would later define how the Medresco was distributed.

Assessing Speech: A Telephonic Point of View

In 1935, Kerridge remarked: 'Although the telephone has been developed and exploited almost entirely for the use of those who hear normally, it was originally invented for the benefit of the deaf by Alexander Graham Bell, who was a professional teacher of the deaf, and had a deaf mother and a deaf wife'.⁶⁷ The telephone, however, had become a purely aural device that further isolated hard of hearing people from everyday life—an isolation which intensified when the telephone was taken up more broadly during the interwar years, especially as an essential business tool. The clinic bore out Kerridge's claim that research into the limits of hearing thresholds had significant practical applications, particularly as a cross-fertilisation between telephony and hearing aids. By expanding the scope of her audiometric research, Kerridge thus played a crucial role in creating and defining audiometric standards that would be integrated in the development of

hearing assistive devices created by the British Post Office. The collaboration would prove influential not only for telephony but also for the post-war design of the Medresco hearing aid.

Since the Telegraph Act of 1869, the Post Office had retained legal control over the nationalised telephone system, which meant that anyone struggling to hear over the phone could not use hearing aids or private telephones on their lines without contravening its monopoly. As a result, and in response to intense aspirational activism, in 1922 the Post Office offered a ‘telephone service for the deaf’. By 1936, however, newly integrated telephone headsets led to an unexpected surge of complaints from hard of hearing users who had been using the older candlestick models to listen through bone conduction. One deaf subscriber, for instance, had ‘encountered difficulties since the introduction of [the] hand micro-telephone’, as he had been ‘accustomed to holding the bell receiver to the bone at the back of the ear to obtain best reception for his particular deafness’.⁶⁸ The unanticipated level of complaints eventually led the Post Office to consider redesigning their amplified telephone to assist their deaf subscribers (Fig. 5).⁶⁹

Kerridge’s collaboration with the Post Office helped move the responsibility for hearing loss from the province of engineers into the province of medicine. However, this shift was marked by the elevation of mechanistic standards over user’s needs and opinions. As the S1 branch of the Post Office launched their investigation into amplified telephony, they repeatedly referred to Kerridge’s audiometric studies, particularly a 1935 article in the *British Medical Journal* in which she discussed ‘what practical advice a general practitioner can give to help those deaf patients who are left with a permanent disability after the best has been done for them on medical and surgical lines’.⁷⁰ Kerridge’s statement is indicative of the disputes during the 1930s as to whether medics or manufacturers were responsible to aid the deaf.⁷¹ For their part, the Post Office engineers were chiefly concerned with Kerridge’s study of bone conduction and quoted her extensively in their

investigative reports and internal memos, referring to her as a ‘medical authority’ on the subject of hearing aids for the deaf.⁷²

Between 1922 and 1938, the Post Office developed an amplified telephone service by responding to complaints and even the personal designs for amplification of their users. Kerridge’s studies and assistance were implemented to create a new telephone that amplified the higher frequencies; yet this model could not be offered as a standard, because it was only compatible with the newest telephone exchanges. When the engineering department decided to create a new device, the public relations department designed a questionnaire through which they could canvass the specific needs of their individual deaf subscribers. The project was abandoned, however, after Kerridge agreed to make amplified telephones part of her clinical investigations in the silence room.⁷³ In this way, Kerridge’s provision of mechanical objectivity was given a higher authority over the opinions of the users.

Kerridge had already done work for the Post Office telecommunications department by testing the hearing of telephonists using a Western Electric audiometer. When the Board of Governors at UCH extended her research project, Kerridge installed Post Office repeater telephones 17a and 17b in order to test them during routine examinations with patients. She also notified the Post Office that she had ‘about twenty deaf persons’, whom she had ‘trained as observers in connexion with her research work.’ She offered ‘to take early steps to test them all’.⁷⁴ Her description of these observers as ‘trained’, crucially, indicates that they had already been taught what they were supposed to be listening for during the telephone tests. They were, in other words, ‘intelligent deaf subjects’ as an internal telecommunications memo stressed.⁷⁵ ‘[I]t has been found’, Kerridge observed, ‘that trained observers are necessary to assess the usefulness of a deaf aid, or at least the test should be made under the guidance of a trained observer’.⁷⁶ Her emphasis

on the need for objectivity further persuaded the Post Office to refrain from seeking out the views of individual subscribers, and instead favour an institutionally-led investigation that prioritised standardised measurements of hearing over individual experience.

Kerridge was instrumental to the design of the new amplifier. As the engineering department stipulated, her experiments ‘will probably give material help in evolving the final design and in this respect perhaps she will be asked to keep in direct touch with the Research Branch’.⁷⁷ Kerridge’s clinical data and scientific measurements were far more useful for the engineering department’s design process than the public relations questionnaire would have been, since she provided instrument-derived quantifiable data rather than anecdotal user experience and evidence. By collaborating with the Post Office to investigate the needs of hard-of-hearing telephone users, Kerridge was broadening her research scope on electric hearing aids, particularly focusing upon the micro-telephone and valve amplifier aids that incorporated the same technologies as the repeater telephones. After, all, she stressed, ‘the underlying telephonic principle is the same in all’; even GPO engineers utilised the principle to improve speech clarity over telephone lines.⁷⁸ Though she offered hope that standardisation of hearing tests would increase their accuracy and efficacy, Kerridge still complained that ‘it must be obvious to workers in the scientific fields where exact measurement is the rule how much is lacking in this sphere [in audiometry]’.⁷⁹

Much of Kerridge’s investigation for the Post Office on speech transmission over the telephone sprang from her collaboration with Dennis Butler Fry. Their joint examination of how the intensity and distortion of different frequencies affected understanding was directed towards application to the standardisation of hearing aid prescription. It was also of key concern to the Post Office telephone department in ensuring the clear transmission of speech over their telephone

lines. In a similar manner, the GPO paid attention to Kerridge's research on the pitch necessary to ensure vowel quality. Such an approach to hearing loss, which prioritised a technological 'fix' over individual perception, would have long-lasting effects in the creation of the first Medresco hearing aid, which was unpopular because it did not consider the needs of users in the design process. Rather, the MRC Electro-Acoustics Committee in charge of designing the Medresco used Kerridge and Fry's phonetic tests to assess different hearing aids, instead of incorporating individual perceptions during the testing process. Following this procedure, further tests were carried out with sentences spoken across a table using one or more aids found to give the best articulation test results.⁸⁰

The technocratic approach to hearing aid assistance prioritised by the Post Office and in collaboration with Kerridge led to a lasting loss of user input and decreased awareness on the part of manufacturers of the social circumstances in which their devices would be used. This drive for standardisation was in stark contrast to Kerridge's attempts to include the lived circumstances of her patients in the prescription of their hearing aids. Even as early as 1935, she was investigating the design of new apparatuses that would give deafened patients greater autonomy over hearing tests.⁸¹ Such a patient-centred approach would seem to be incompatible with the technocratic objectivity that her work promoted. Yet an illuminative comparison may be made here to Timmerman and Berg's analysis of the way that medical insurers used standards and guidelines to professionalise, while also maintaining discretion in dealing with individual patients on a case by case basis. They explain that the social basis of authority was at least as important as the authority and power associated with quantitative objectivity; mechanical objectivity lent authority to expert communities trying to professionalise.⁸² Like medical insurers who were perceived as less authoritative than doctors in other fields, otologists used mechanical procedures and numbers to

demonstrate their expertise. Moreover, as a woman in a male-dominated industry, Kerridge's ownership of the audiometer endowed her with an external means of legitimising her work.

However, the priority given to quantitative values profoundly affected the construction of the Medresco hearing aid and its relationship with telephony. Furthermore, as access to telephony was not considered by the MRC to be a medical issue, improvements to telephone services for the deaf were not funded alongside the Medresco. Similarly, Daniel Wilson has shown that our conception of Alzheimer's disease has been created through the Medical Research Council's preoccupation with standardised test measures. Just as with the development of standard assessment of hearing, '[t]he rationale behind the development of standard assessment guidelines was less about arriving at a firm diagnosis and more about facilitating research by generating data that could be easily compared across the disciplines and sites that constitute modern biomedicine.'⁸³

Not only did this lead to stagnation of the service (with the 1922 model still on offer in the late 1950s), it also meant that people with hearing loss continued to pay a surcharge to access telephony. However, Kerridge's influence on the Post Office's research into hearing assistive devices went beyond her influence on the physical construction of the Medresco hearing aid. She ensured a situation in which the principles of free access to hearing aids were enshrined into the NHS as basic medical care.

Conclusion

When the Second World War broke out, Kerridge resigned from the Hearing Aid Clinic, joining the Emergency Medical Services as an assistant pathologist at St. Margaret's Emergency

Hospital. After her resignation, the clinic was abandoned; however, in cooperation with the hospital surgeons, otologist Henrich G. Kobraik continued testing hospital patients during the war. Shortly after, the silence room experienced a resurgence in testing the hearing of patients suffering from ‘bomb blasts’ and damages from air-raids.⁸⁴ Though Kerridge may have felt she was fulfilling her patriotic duty, not all agreed with her decision to resign. David Munro, for instance, expressed his feelings to her: ‘I think that you are rather wasted as a pathologist in a small hospital’.⁸⁵ At the hospital, Kerridge not only set up an improvised laboratory for pathological and blood transfusion work, but coordinated the formation of a small orchestra for entertaining injured patients—another indication of how she viewed the therapeutic value of music. It was at St. Margaret’s where Kerridge eventually contracted the illness that led to her untimely death on 22 June 1940.⁸⁶

Kerridge’s desire to allow deafened persons to socialise, communicate, and even hear music demonstrates that she was not approaching the problem of deafness from a purely medical perspective. Her work was so valuable that after her death her brother and a group of friends attempted to create a commemorative hearing aid named after her.⁸⁷ She held the needs of her patients to be paramount and worked with them to negate the influence of unconscious bias in testing, in order to lobby for better care for hearing loss through scientific attention. Moreover, as devices were trusted to give greater accuracy than people—perhaps deaf people especially—the deaf individual’s needs were made less visible as they were replaced with measurable data. This is especially apparent in the case of the Post Office’s investigation into the needs of their ‘deaf subscribers’. By designating their hard-of-hearing customers as patients in the context of clinical research, the Post Office accorded less agency to this group, reducing clinical reliance on individual’s bodily perception, which was no long considered sufficiently accurate for collecting measurable data.

The connections between Kerridge's clinic and the Post Office telecommunications in developing services for the deaf were also expedited by the intervention of the medical profession into the regulation of hearing aids. Such disciplinary integration resulted in user input being considered relevant only when collected by, and filtered through, specialist organisations.. Additionally, increased trust in instrumentation and distrust in individual sense perception meant that the technical was prioritised over the social, particularly in the variety of hearing assistance required by 'deaf subscribers'. Such variety called for a single standardised model for measuring hearing acuity. Kerridge's work also amalgamated the authority of medical experts over the expertise of hearing aid manufacturers and even ear specialists, who struggled with accusations of 'quackery' that had been levelled at them indiscriminately since the nineteenth century.⁸⁸

By bringing increased scientific accuracy to the study of audiometry, Kerridge was able to cement her professional authority to exert precision measurement through the audiometer. Yet, her lifelong work was nearly lost. In 1962, geneticist Julia Bell (1879-1979), a colleague and friend, described her attempts to secure Kerridge's papers:

On the way to her funeral I looked in at the M.R.C. and said that if I could help in any way to utilise her materials I would be very glad to do so – the idea in my mind being to erect some sort of tribute to all the devotion and care she had given to the problem [of measuring hearing acuity]. Hearing nothing I assumed the M.R.C. had other plans and that perhaps somebody was carrying on the work.⁸⁹

After a fire in the basement of UCL in the 1960s, a large chest full of Kerridge's materials was discovered. In the chaos of war, the box may well have been dumped there by a porter during the

evacuation of the college. As Bell put it, Kerridge's work 'was in fact a war casualty'.⁹⁰ Though the materials were saved, wartime research had drastically changed the face of audiometry, and the MRC no longer considered Kerridge's once ground-breaking studies relevant for establishing a standard UK method for measuring hearing acuity—an ironic move given Kerridge's career devotion to standardisation.

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¹ Phyllis M. Tookey Kerridge, 'Speech Defects and Deafness', *Speech* (October 1935) 1.2, pp. 16-20.

² William Mackenzie, 'Diagnosis and Treatment of Chronic Deafness', *Post-Graduate Medical Journal* (January 1947) 23, p. 5, pp. 3-15.

³ Roberta Bivins, 'Medresco: Hearing Aid and the National Health Service?' *People's History of the NHS* <http://peopleshistorynhs.org/encyclopaedia/the-national-hearing-service/>

⁴ For a detailed history of the development of the Medresco, see: Sean McNally, 'Medresco: The History of State Sponsored Auditory Assistance', University of Leeds PhD Thesis, forthcoming.

⁵ Laura Dawes, *100 Years of Deaf Education and Audiology at the University of Manchester, 1919-2019*, Manchester: University of Manchester, 2014, p. 26.

⁶ *Medical Officer* memo, 17 April 1937, Medical Research Committee and Medical Research Council Files, National Archives, Kew, FD1/2329, Folder, 'Hearing: Mrs. P.T. Kerridge' (subsequently MRC Kerridge I). On mechanical objectivity, see: Lorraine J. Daston and Peter Galison, *Objectivity*, New York: Zone Books, 2007.

⁷ Theodore M. Porter, 'Objectivity as Standardization: The Rhetoric of Impersonality in Measurement, Statistics, and Cost-Benefit Analysis', in Allan Megill (ed.), *Rethinking Objectivity*, Durham and London: Duke University Press, 1994, pp. 197-237.

⁸ Phyllis M. Tookey Kerridge, *Hearing and Speech in Deaf Children. Medical Research Council: Reports of the Hearing Committee*, No.221, London, 1937, p. 8.

⁹ Mara Mills, 'Deafening: Noise and the Engineering of Communication in the Telephone System', *Grey Room* (2011), 42, pp. 118-43.

¹⁰ Bruno Latour and Steve Woolgar refer to the end product as 'literary inscription' in *Laboratory Life*, New Jersey: Princeton University Press, 1979, p. 63.

¹¹ Her collaboration was tied to her interest in electric hearing aids, particularly micro-telephone and valve amplifier hearing aids, which incorporated the same technology as the Post Office repeater telephones. See: Coreen McGuire, 'The 'Deaf Subscriber' and the Shaping of the British Post Office's Amplified Telephones 1918-1939', University of Leeds PhD thesis, 2017.

¹² Graeme Gooday, *The Morals of Measurement: Accuracy, Irony, and Trust in Late Victorian Electrical Practice*, Cambridge, Cambridge University Press, 2004.

¹³ Lennard J. Davis, *Enforcing Normalcy: Disability, Deafness and the Body*, New York: Verso Press, 1995, p. 30.

¹⁴ Audiology, the offspring of speech pathology and otology, traces its professional roots to post-WWII rehabilitation *en masse* of soldiers returning home with significant hearing losses, though

experiments in hearing acuity and standardisation of hearing loss dates to the 1910s; it was not recognised as a field in the UK until the 1960s. Audiometry concentrates on measuring hearing acuity. See: Brenda Jo Brueggemann, *Lend me Your Ear: Rhetorical Constructions of Deafness*, Washington, D.C.: Gallaudet University Press, 1999.

¹⁵ Kerridge, op. cit. (7).

¹⁶ Brian Woods and Nick Watson, 'In Pursuit of Standardization: The British Ministry of Health's Model 8F Wheelchair, 1948-1962', *Technology and Culture* (2003), 45.3, pp. 540-568.

¹⁷ Mills, op. cit. (9), p. 125.

¹⁸ S.D.G. Stephens, 'David Edward Hughes and his Audiometer', *Journal of Laryngology and Otology* (January 1976), 93, pp. 1-6.

¹⁹ T.J. Watson, 'Breaking the Silence: The Development of Audiology in Britain During the Last Hundred Years', in *Ian G. Taylor and Andreas Markides* (eds.), *Disorders of Auditory Function III*, London: Academic Press, Inc., 1980, pp. 1-22; Albert Mudry, 'The Role of Adam Politzer (1835-1920) in the History of Otology', *American Journal of Otolaryngology* (2000) 21, pp. 753-763.

²⁰ Mara Mills traces the development of the 'normal' threshold on the audiogram in 'Signal and Noise: The History of the Audiogram', Chapter One of 'The Dead Room: Deafness and Communication Engineering', Harvard University PhD Dissertation, 2008. See also Mills op. cit. (9).

²¹ Jonathan Sterne, *Mp3: The Meaning of a Format*, Durham: Duke University Press, 2012, p. 36. See also: Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction*, Durham, NC: Duke University Press, 2003; Tony Grajeda, 'Early Mood Music: Edison's Phonograph, American Modernity and the Instrumentalization of Listening', in Marta García Quiñones, Anahid Kassabian, and Elena Boschi (eds.), *Ubiquitous Musics: The Everyday Sounds That We Don't*

Always Notice, Aldershot, Hants, and Burlington, VT: Ashgate, 2013; Daniel Morat (ed.), *Sounds of Modern History: Auditory Cultures in 19th and 20th Century Europe*, New York: Berghahn Books, 2014.

²² Jennifer Esmail, *Reading Victorian Deafness: Signs and Sounds in Victorian Literature and Culture*, Athens, Ohio: Ohio University Press, 2013, p. 164.

²³ James Kerr Love, *Deaf-Mutism: A Clinical and Pathological Study*, Glasgow: J. MacLehose and Sons, 1896.

²⁴ Herbert E. Day, Irving S. Fushfeld, and Rudolf Pinter, *A Survey of American Schools for the Deaf, 1924-1925*, Washington, D.C.: National Research Council, 1928. ‘The deaf’ is a historical phrasing and is still used today in some instances to identify schools for deaf children. Within Deaf culture there is a distinction of referring to the culturally Deaf with a capital D and deafness in medical terms with a lowercase d. Throughout this paper, we have reproduced the historically accurate phrasing which may not correspond with the modern distinction. For an overview of d/Deaf history and the history of hearing loss, see: Graeme Gooday and Karen Sayer, *Managing the Experience of Hearing Loss in Britain, 1830-1930*, London, UK: Palgrave Macmillan, 2017.

²⁵ Ruth C. Partridge and Donald L. MacLean, ‘A Survey of Hearing in School Children’, *Canadian Public Health Journal* (November 1933), 24.11, pp. 524-539.

²⁶ A.W.G. Ewing, *Educational Guidance and the Deaf Child*, Manchester: Manchester University Press, 1957.

²⁷ Julie Anderson, *War, Disability and Rehabilitation in Britain*, Manchester University Press, 2011. See also: Beth Linker, *War’s Waste: Rehabilitation in World War I America*, Chicago: University of Chicago Press, 2011.

²⁸ Annual Report of the Medical Research Council, 1936-7, MRC Kerridge I.

²⁹ MRC Report, 26 January 1937, MRC Kerridge I.

³⁰ Carol Dyhouse, 'Driving Ambitions: Women in Pursuit of a Medical Education, 1890-1939', *Women's History Review* (1998) 7.3, p. 334, pp. 321-343.

³¹ Phyllis M.T. Kerridge, 'The Use of the Glass Electrode in Biochemistry', *Biochemical Journal*, 19(4), 1925. pp. 611–617.

³² A selection of publications: L.E. Bayliss and Phyllis M.T. Kerridge, 'Recent Developments in Physical Instruments for Biological Purposes', *Journal of Scientific Instruments* (1935) 12, pp. 1-5; L.E. Bayliss, Phyllis M. Tookey Kerridge, and Dorothy S. Russell, 'The Excretion of Protein by the Mammalian Kidney', *Journal of Physiology* (1933) 77, pp. 386-398; K. Furusawa and Phyllis M. Tookey Kerridge, 'The Hydrogen Ion Concentration of the Muscles of Marine Animals', *Journal of the Marine Biological Association of the United Kingdom* (1927) 14, pp. 657. The National Archives contains memos in reference to Kerridge's involvement on projects on nutrition and color-blindness (MRC Kerridge I). In 1934, Kerridge was recommended by Dr. Poulton at the London School of Hygiene and Tropical Medicine to assess the physiological benefits of an artificial respiration apparatus constructed by Sir William Henry Bragg (1862-1842) and Robert W. Paul (1869-1943). William Henry Bragg RI Admin Correspondence 1933-39, Royal Institution of Great Britain.

³³ Phyllis M.T. Kerridge, 'Instrumental Aids for Defective Hearing', *Reports on Progress in Physics* (1938) 5, pp. 150-163.

³⁴ Phyllis M. Tookey Kerridge, 'Hearing and Speech in Deaf Children', *Proceedings of the Royal Society of Medicine* (October 1937), 30.12, p.1494, pp. 1494-1511.

³⁵ Kerridge, op. cit. (35), p. 1507. Kerridge expressed that teachers of the deaf would benefit the most from the finding, for the detailed reports conclusively demonstrated the importance of electric

sound magnifier apparatuses, leading several schools to keep accurate record of deafness in pupils and conduct their own studies on hearing acuity. The Ministry of Education for the province of Ontario, Canada, for instance, obtained a copy of Kerridge's report and conducted a survey based on her methodology, discovering that 117 pupils in junior schools had significant hearing loss requiring special educational assistance. *Report of the Minister of Education, Province of Ontario* (Toronto, 1937), p. 72, Archives of Ontario.

³⁶ The minutes of the committee for 27 November 1936 reveals a discussion over Kerridge's proposal for a four-scheme research project: (1) to collaborate with otologist Dr. Max Ellis to investigate deafness in relation to middle ear disease; (2) to investigate deafness due to middle ear disease arising from infectious fever, a project in conjunction with the Fever Hospital; (3) to outline more accurate prescription of hearing aids; and (4) to investigate the incident of industrial deafness. The first and third proposals were accepted, while the others were deferred for further details. Minutes of the MRC Hearing Committee, 27 November 1936, MRC Kerridge I.

³⁷ Lundy Braun, *Breathing Race into the Machine: The Surprising Career of the Spirometer from Plantation to Genetics*, Minneapolis, MN: University of Minnesota Press, 2014.

³⁸ Susan Gregory and Gillian M. Hartley, *Constructing Deafness*, Bloomsbury Publishing, 1990. For a longer history of the debate over the standard of normal hearing, see W. G. Noble, *Assessment of Impaired Hearing: A Critique and a New Method*, New York, San Francisco, and London: Academic Press, 1978, pp. 173-198.

³⁹ Phyllis M.T. Kerridge to David Munro, 11 November 1935, MRC Kerridge I.

⁴⁰ David Munro to Sir Alexander Ewing, 13 November 1935, MRC Kerridge I.

⁴¹ Sir Alexander Ewing to David Munro, 21 November 1935, MRC Kerridge I.

⁴² In a letter to his colleague Dr. Cleminson, David Munro writes: ‘I think too, that it would be as well to let the Ewings have their blow in first, partly because they have been working at the subject for a long time, and partly because if their work is published first it may make Ewing less inclined to be ‘dog-in-the-mangerish’!’ David Munro to Dr. Climinson, 28 May 1936, MRC Kerridge I.

⁴³ Meeting of the Medical Committee of the National Institute for the Deaf, 6 March 1931, Action on Hearing Loss Library (subsequently AOHL).

⁴⁴ Sir Henry H. Dale to Edward Mellanby, 21 November 1935, MRC Kerridge I.

⁴⁵ A. Landsborough Thomson to Sir Henry H. Dale, 22 November 1935, MRC Kerridge I.

⁴⁶ Proposal by Dr. Kerridge and Dr. Formby, Medical Sub-Committee, 28 January 1937, AOHL. Formby was appointed to UCH in 1937. Ringo Starr, whose tonsils he removed in 1964, is among one of his most notable patients.

⁴⁷ Kerridge and Formby, op. cit. (47)

⁴⁸ Kerridge and Formby, op. cit. (47).

⁴⁹ Royal Ear Hospital Minutes of Governors Meeting & Annual Reports, Royal Ear Hospital, University College Hospital Special Collections, National Archives, Kew UCH/MED/H/REH/1-2 (subsequently REH).

⁵⁰ Pamphlet, *He that hath ears to hear*, REH. The building on Huntley Street was formerly named the Royal Ear Hospital before its amalgamation with University College Hospital as its new ENT department. In 2016, the building was demolished.

⁵¹ Op. cit. (51), p. 11.

⁵² Newspaper clipping, n.d., REH.

⁵³ The room is described as such: ‘This room is 22 by 10 by 8 feet and is constructed with an outer shell of 9 inch brickwork with a concrete floor, inside which there is a framed timber box forming

the Silence Room. This box is carried on the concrete floor, and has no contact with the outer brickwork shell or the floor above. This inner timber shell has, therefore, an airspace of about 4 inches extending all around the walls and ceiling. All the inner surfaces of the outer shell are covered with a lining of cabot quilting (a sound-deadening material made from seaweed). The outer and inner surfaces of the inner timber shell are covered with the same material and finally, the inside walls and ceiling of the Silence Room itself are plastered with Sabanite, a porous acoustic plaster. There are double entrance doors with felt-lined rebated frames and each door is cork-lined on both sides. In spite of this special construction the room is not completely sound-proof, and the ears of the subjects were stopped with cotton wool as an additional precaution'. Abraham Greenbaum, Phyllis M. Tookey Kerridge, and Eric John Ross, 'Normal Hearing by Bone Conduction', *The Journal of Laryngology and Otology* (1939) 54.2, p. 88, pp. 88-92. Bell Labs' anechoic chamber, built in 1940 in Murray Hill, New Jersey, is considered the first chamber of the sort, as it absorbed over 99.95% of incident acoustic energy over 200Hz.

⁵⁴ 1938 Annual Report of the Royal Ear Hospital, REH.

⁵⁵ 1939 Annual Report of the Royal Ear Hospital, REH.

⁵⁶ The idea for a hearing aid clinic was originally implanted by H.M. Wharry at UCH, though it's unclear whether it was widely used before Kerridge took over. By 1938, similar clinics opened in connexion with aural departments at Middlesex Hospital and St. Thomas Hospital.

⁵⁷ Phyllis M. Tookey Kerridge, 'Hearing Aids', *The Practitioner* (1935) 135, p. 654, pp. 641-654.

⁵⁸ In the 1930s, hearing impaired persons seeking aids could selection amongst: (1) non-electric aids, (2) microtelephones with air-conduction earpiece (3) microtelephone with bone-conduction earpiece, or (4) valve amplifier with a crystal microphone.

⁵⁹ Phyllis M. Tookey Kerridge, 'Recent Advances in Hearing Aids', *The Practitioner* (1938) 141, pp. 625-632.

⁶⁰ Phyllis M. Tookey Kerridge, 'The Administration of a Hearing Aid Clinic', *The Journal of Laryngology & Otology* (June 1938), 53.6, p. 370, pp. 370-385.

⁶¹ The confusing messages received by hearing impaired persons was an important issue Kerridge repeatedly addressed: 'The subject of instrumental aids for the deaf is one which has caused great interest and greater confusion. Most of both is due to exaggerated and even fraudulent commercial advertisement. Much of the trouble would be avoided if the medical profession could advise their patients more precisely on the subject, but there is no source of information readily obtainable, either in text book or in hospital teaching'. Phyllis M. Tookey Kerridge, 'Aids for the Deaf', *The British Medical Journal* (29 June 1935), 1.3886, p. 1315, pp. 1314-1317.

⁶² James Sumner and Graeme J.N. Gooday, 'Introduction: does standardization make things standard?' (Special Issue: 'By whose standards? Standardization, stability and uniformity in the history of information and electrical technologies') *History of Technology* (2008) 28.

⁶³ Phyllis M. Tookey Kerridge, 'Medical Inspection and Deafness', *The Lancet* (20 May 1939), 233.6028, p. 1178.

⁶⁴ Kerridge's husband, William Henry Kerridge, whom she married in 1922 and was nearly twenty years her senior, was a Professor of Music and a choir master so music may have been central to her life. Four years after marriage, she petitioned the court for divorce on grounds that her husband was still married to Irene Agnes Emma Kerridge of Fraudensadt, Germany, and has been since 1910 as the marriage was never formally dissolved. Kerridge later withdrew her petition.

⁶⁵ 'The Exploitation of Deafness', in *The Eleventh Annual Meeting of the National Institute for the Deaf*, 30 July 1935, AOHL.

⁶⁶ Phyllis M. Tookey Kerridge, 'Hearing Aids and Social Problems of the Deaf', *Ulster Medical Journal* (October 1939), 8.4, pp. 244-248.

⁶⁷ Kerridge op. cit. (62), p. 1315.

⁶⁸ Research Report no. 9150, 'Aids to telephone reception for partially deaf subscribers', Post Office Research Station, 21 April 1936, BT Archives. TCB 422 09150 Older style candlestick models had a separate transmitter and receiver so it was possible to press the transmitter to the mastoid bone and listen to the telephone while easily speaking into the receiver.

⁶⁹ Op. cit. (65).

⁷⁰ Moreover, Kerridge's paper outlines her proposal for a method of audiometric measurement that would be followed by GPs as a standard, in line with her work on increased standardisation of hearing testing and hearing aid provision. Kerridge, op. cit. (62), p. 1314.

⁷¹ For example, in relation to quack hearing aid manufacturers, she stated: 'Much of the trouble would be avoided if the medical profession could advise their patients more precisely on the subject, but there is no source of information readily obtainable, either in text-book or in hospital teaching', and 'ideally it should be possible to prescribe a hearing aid according to each patient's requirements. With modern methods of testing deafness accurately this end is perhaps within sight'. Kerridge, op. cit. (62), p. 1315.

⁷² Op. cit. (69).

⁷³ Internal memo, the Telecommunications Department, 15 April 1937, BT Archives. POST 33/1491C.

⁷⁴ Op. cit. (74).

⁷⁵ Memorandum, Amplifier Telephone for Deaf Persons. 3 May 1938, Accessed at BT Archives, POST 33/1491C.

⁷⁶ Telecommunications Department (TP branch) 15th April 1937, Accessed at BT Archives, TCB 2 172.

⁷⁷ Internal memo from the Engineering Department to the Telecommunications Department, telephone branch, 16 August 1937, BT Archives.

⁷⁸ Kerridge, op. cit. (62), 1315. On testing, she added: ‘The question of a suitable test is by no means simple. It is possible to use a series of nonsense syllables pronounced by a trained speaker, as used by the Post Office Research Laboratory for testing telephone apparatus’. Kerridge, op. cit. (34), 161.

⁷⁹ Kerridge, op. cit. (34), 162.

⁸⁰ Memo, ‘Clinical Tests of Working Models of Experimental Hearing Aids’, 2 April 1946, Reports of the Committee on Electro-Acoustics: Hearing Aids and Audiometers, Medical Research Committee and Medical Research Council Special Research Projects, National Archives, Kew, D4/261.

⁸¹ Kerridge wrote to Mr. Cleminson of the MRC outlining that she received preliminary interest from the Research Laboratories of General Electric Co. to design a calibrated filter apparatus that would enable deaf persons to adjust the testing set until they perceived the voice of the operator as intelligible. She claimed such an apparatus would possibly work best as a diagnostic apparatus and replace the audiometer as it heavily relied upon user intervention and adjustment, making for more accurate testing perception. Phyllis M. Tookey to Mr. Cleminson, 18 October 1935, MRC Kerridge I.

⁸² Stefan Timmermans and Marc Berg, *The Gold Standard: The Challenge of Evidence-Based Medicine and Standardization in Health Care*, Philadelphia, Temple University Press, 2003, pp. 138-9.

⁸³ Daniel Wilson, 'Calculable People? Standardising Assessment Guidelines for Alzheimer's Disease in 1980s Britain', *Medical History* (2017), 61:4, p. 500, pp. 500-525.

⁸⁴ 1940 Annual Report of the Royal Ear Hospital, REH. By 1941, Kobrak used the silence room to engage in research on 'the intra-tympanic musculature and the manner in which it can be affected by drugs'. 1942 Annual Report of the Royal Ear Hospital, REH.

⁸⁵ Memo, 'Further Research by Dr Phyllis Kerridge', Medical Research Committee and Medical Research Council Files, National Archives, Kew, FD1/2330, Folder, 'Hearing: Mrs. P.T. Kerridge II' (subsequently MRC Kerridge II).

⁸⁶ Kerridge's father, William A. Tookey, was named executor of will upon her death. On 22 June 1940, he wrote to the Medical Research Council to say, 'I regret to inform you that my daughter Dr Phyllis M. Kerridge passed away this evening at the London Chest Hospital Bonner Road after a short illness'. That she was placed at a specialised chest hospital indicates it might have been a respiratory illness that led to her passing; her death certificate, however, lists the cause of death due to ulcerative colitis. Thanks to Dominic Stiles for drawing our attention to this.

⁸⁷ Tookey Family Archive.

⁸⁸ Jaipreet Virdi [as Virdi-Dhesi], 'Curtis's Cephaloscope: Deafness and the Making of Surgical Authority in London, 1815-1845', *Bulletin of the History of Medicine* (2013), 87.3, pp. 349-379.

⁸⁹ Julia Bell to Richard Himsworth, 6 July 1962, MRC Kerridge II.

⁹⁰ Bell, *op. cit.* (91).