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The Rhetoric and Counter-Rhetoric of a “Bionic” Technology

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Development of the cochlear implant, discussed in this article, depended vitally on deaf people being persuaded to undergo implantation. Media “reconstruction” of the device as the “bionic ear” was typically encouraged by implant pioneers. Unexpectedly, however, a “counter-rhetoric” based on a very different understanding of deafness emerged. With it, deaf people are slowly succeeding in gaining influence over the further deployment of the technology. The analysis suggests modifications to existing theoretical models of technological change in medicine.

Out of the swords of war have been fashioned not only the proverbial plowshares but also the scalpels. At the end of World War II, medicine was widely identified as an area in which technical expertise, developed in the war, could profitably be redeployed. Growing industrial interest in medicine as an area of entrepreneurial activity catalyzed the emergence, in the Western industrialized world, of what has since become known as the “medical industrial complex.” Thus, by the 1950s, technological innovation in medicine came to be dominated by two powerful and socially central institutions: (multinational) industry and the medical profession. Each had acquired a major interest in a constant stream of innovations, which provided an important source of profits and corporate reputation for the one and of status and income for the other. Until relatively recently at least, other potential interests played a secondary role. The emphasis in government health policies was typically on enhancing the quality of care, and it was widely believed that new drugs and devices were essential in realizing this goal. Anyone who was, had been, or could envisage being a consumer of medical care (and which of

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us cannot?) was inclined enthusiastically to underwrite the search for wonder drugs and awe-inspiring machines. A medicine founded on technological advance was universally acclaimed, while society happily invested in health-related research and development. A great deal of medicine's general "technological dynamic" in the middle decades of the twentieth century can be understood in terms of the articulation of this common interest between medical and surgical specialities on the one hand and their industrial suppliers on the other. In earlier work, focusing on diagnostic imaging technologies, I argued that much of the process of "shaping" of these technologies (Bijker, Hughes, and Pinch 1987) could also be understood in terms of the complementary activities of these collaborating institutions (Blume 1992).

Whereas highly trained professionals are the principal users of imaging technologies, there are many medical technologies whose effective users are patients. Lacking professional expertise and status, patients are typically not seen as competent interlocutors in the innovation process. Insofar as (organizations of) patients place their trust fully in the professionals, the innovation model developed for imaging technologies may be assumed to hold. But what happens when trust diminishes and patients seek independently to influence the development of new therapies? In the following section of this article, I shall present the history of an electronic implant, following the earlier perspective. The cochlear implant's intended users were not hospital professionals but individuals who were to be assisted in their daily functioning by its use. The cochlear implant seemed to permit otologists (ear doctors) to intervene in support of a group for whom they had previously been able to do nothing: the totally deaf. Whether we interpret this in terms of strategically motivated extension of professional jurisdiction or in terms of medicine's healing mission, the attraction is clear. The crucial "coalitions" between otologists and industrial corporations emerged around 1980 on the basis of the technical promise of the new device and of optimistic assessments of its likely market. Common interests in the propagation of the technology tied medical and industrial partners together. On the basis of the model, we should then expect rapid growth in use, increasing investment in further improvement of the technology, and the search for new areas of application. Despite continuing positive assessments by professionals, this proved only partly to be the case. To understand this departure from expectation, we must attend to important changes taking place in the context of medical innovation.

In the last two decades, the social and political context of medical innovation has changed in a number of respects. The emphasis in health policy has shifted from quality of care to cost containment. Whereas previously technological advance was universally welcomed as contributing to the general goal

of enhanced quality of care, it has now increasingly come to be seen as a factor in rising costs. This critical stance is reflected in the growing numbers of economic (and recently more comprehensive) assessments of emerging medical technologies and in a variety of government attempts at controlling and regulating the diffusion of new technologies. This changing climate is probably beginning to influence the development process (Kessler, Pape, and Sundwall 1987). But beyond this, it seems that consumers are also more critical of the nature and quality of the care they receive. Although a general rejection of technological medicine may be a marginal phenomenon in industrial society, both sociological inquiry and public campaigning by patient groups indicate a more critical stance toward specific regimes, procedures, and techniques. Dissatisfaction may manifest itself in different ways: indirectly through sociological investigation (see, for example, the studies in Roth and Conrad 1987) or directly through political action as in the case of women's health groups or AIDS activists. Recent studies of the development of AIDS drugs suggest that patient activism can influence the development process, for example, through forcing modifications in the design of clinical trials (Epstein 1995). But we are as yet scarcely in a position to say much regarding the general circumstances under which these critical analyses may affect the development of therapies and other technologies.

In the case of the cochlear implant, it was essential that deaf people be convinced of the value of the technique and that candidates who seemed promising from a clinical perspective find it worthwhile to undergo a surgical intervention and a prolonged and rigorous rehabilitation process. For the clinicians, physiologists, and engineers involved in development, what was at stake was the convincing data with which credibility and resources could be secured. The response of deaf people, however, was quite unlike that of actual or potential AIDS patients, who (at least in the United States) stressed the right to earliest possible access to what might prove a life-saving drug. What was at stake for erstwhile deaf patients was not life or death (as it was with AIDS patients) but social functioning. This, of course, is a matter on which clinicians have no monopoly either of authority or of privileged insight. To engage the interest of deaf people, a rhetoric was deployed that drew consciously on deeply rooted assumptions about medical technology and about deafness. An arcane technical device, the cochlear implant, became the "bionic ear." Rhetorical reconstruction of the device was an essential and deliberate feature of its development and one to which the mass media contributed importantly. Unexpectedly, however, this rhetorical reconstruction provoked opposition and, ultimately, the construction of a "counter-rhetoric." The emergence of this counter-rhetoric, and the claims based on it,

suggest the two central questions of this article: How can we understand the emergence, and the salience, of such a counter-rhetoric? What modifications to the initial model does this rhetorical engagement suggest?

The Cochlear Implant as Medical Technology¹

In the 1950s, despite decades of progress in understanding basic physiological and psychophysical aspects of hearing, the medical profession could do little for anyone suffering total sensorineural deafness.² In February 1957 a totally deaf person about to be operated on begged Paris otologist Charles Eyries to find a way of giving him some hearing, however minimal. In deciding to implant an electrode used in physiological research on hearing, Eyries was taking a heroic step. He turned for help to A. Djournio, professor of medical physics. By stimulating the patient's (functioning) auditory nerve directly, the electrode should do the job of his nonfunctioning cochlea. The operation took place on 25 February. Despite the patient's ultimate disappointment and decision to have the device explanted, and despite technical limitations, Eyries and Djournio felt sure that the technique had a future (Djournio and Eyries 1957; Albinhac 1978).

In 1960 a Los Angeles otologist, William House, made a second attempt. House's implant was different from that used in Paris. Aiming at speech discrimination, House's implant stimulated the cochlea at five different positions along its length, each sensitive to a different range of frequencies. Once more, however, technical limitations led House to explant his device and to call a temporary halt to this work.

By the early 1970s, major advances in materials and electronics technologies had taken place. The implantable pacemaker had become a well-known symbol of the emerging "bionic" technology. Electrical engineers and materials scientists were more willing to collaborate with clinicians. The climate was changing, and House felt he could try again (House 1985).

House soon changed his strategy and decided to concentrate on a single-channel electrode. This meant trading the likely benefits of frequency discrimination provided by the earlier multichannel device for the greater ease of construction of the single-channel device. With the simpler device, he felt, they would be in a position rapidly to provide deaf people with a useful prosthesis. By the mid-1970s, a number of other groups had also started to develop cochlear implants. Technically and surgically, their approaches differed from that of House, and also among themselves. At Stanford, for example, F. Blair Simmons was convinced that implantation of the single-channel device was premature and that for speech to be made accessible to a

patient, an implant would have to be multichannel. A workshop that took place in San Francisco in 1974 showed disagreement about the experimental or "experimental/therapeutic" status of the technique (with most inclining to the former view); about the value of single-channel implants; and about the additional benefit to be expected from a future multichannel device. Nevertheless, participants generally agreed that the future was rosy: that of the 300,000 profoundly deaf individuals in the United States, as many as two thirds might derive some potential benefit from an implant device (Merzenich and Sooy 1974).

Not everyone shared the enthusiasms of these surgical pioneers. Within the basic research community, in particular, there was definite opposition.³ Many scientists working in the physiology and neurology of hearing (perhaps most notably Nelson Kiang of the MIT) took the view that current knowledge provided insufficient grounds for offering any kind of "therapy." Whatever clinicians' aspirations might be, far too little was known of how speech signals are coded at the level of the auditory nerve for proper design of an implant. Responses to critical opinions like those set out with authority by Kiang differed. While some groups changed the thrust of their work, House was unwavering. Convinced that he was doing the best he could for his patients, he carried on as before. And indeed, his work was beginning to attract attention from clinicians abroad.

Among those who listened with fascination to House's lecture at the 1973 international otolaryngological conference that took place in Venice was the Paris otologist Claude-Henri Chouard. Thinking back to what his teacher Eyries had told him years before, Chouard wrote of having "dreamt constantly of an electrical system, a James Bond-style gadget, which would be able to alleviate the formidable handicap of total deafness" (1978, 35). He had read of Simmons's work and the efforts of House. He had visited Los Angeles to see House operate. Aware of the need for expertise that he did not possess, in April 1973 Chouard secured the collaboration of a neurophysiologist, Patrick MacLeod. In May the two went to the Venice conference. Chouard rapidly concluded, as had Simmons, that his objective had to be to permit implantees to distinguish speech. This necessitated a multichannel device: the more channels the better. He and MacLeod chose a design that would sample different frequency bands in a speech signal, each band then stimulating a single segment of the cochlea. Chouard approached his implant patients less as an experimentalist than as a clinician and selected them less for their potential contribution to his research than on the grounds of perceived need. The first, "Madame D.," for example, was chosen because of an attempt to commit suicide.

Knowledge of developments in the United States had also reached London. Jack Ashley (now Lord Ashley) was a deafened Member of Parliament and an influential spokesman for the disabled. At his instigation the Department of Health and Social Security approached otologist Ellis Douek with the suggestion that his specialism was doing far too little on sensorineural deafness, and why did he not do something in that area (Douek 1992). It was suggested that he apply to the Medical Research Council (MRC) for research support. Douek decided that, before going off to the United States and seeing what House and the others were doing, he would try it himself. This he did by sticking a simple electrode to the *outside* of a patient's cochlea. Surprised by the results—which seemed to show that results like those of House could be obtained without surgically entering the cochlea and thereby destroying any residual function—Douek went off to the MRC. The council's basic scientists were unimpressed by his rudimentary experiment and skeptical of the approach in general. Everyone assumed that the objective of this work was to provide the deaf with access to speech. The problem was that language was far too complex for such a simple device to offer much access. At this point, the MRC put Douek in touch with London University phoneticist A. Fourcin.

Fourcin proved less skeptical than Douek had expected. He was convinced that providing a deaf person relying on lip reading with even a minimal acoustic stimulus could greatly facilitate receptive communication, even if it did not provide the possibility of following speech without lip reading. In 1977 they succeeded in obtaining funding from the MRC. Their project had two unique features that were repeatedly stressed: its commitment to a less invasive extracochlear approach, and its focus on the implant as a means of supplementing the information available from lip reading. Douek and Fourcin did not view the attempt to provide "hearing" as a realistic goal, at least not at first.

At the same time the British Department of Health (DHSS), concerned with the provision of clinical services rather than research (as in the case of MRC), also retained an interest. In 1977 they sent a group of three experts (two ear surgeons and a neurophysiologist) to review U.S. activities and to make recommendations as to what British commitment to the area should be. Their long report (Ballantyne, Evans, and Morrison 1978), though critical of the inadequate scientific grounding of much of the work, is nevertheless cautiously enthusiastic. Ballantyne, Evans, and Morrison came back convinced that the technique had a future but that it could not yet be provided to deaf people as a working prosthesis. They recommended a cautious approach, based on a careful evaluation of the single-channel extracochlear implant being developed by Douek and Fourcin.

The programs of House, Simmons, Chouard, and Douek illustrate the work going on in the late 1970s. Looking back from the perspective of 1997, it could well be argued that the most significant work was that of an Australian otologist, Graeme Clark. Influenced in particular by the work of Simmons (Epstein 1989), Clark seems also to have been much influenced by having grown up with a partially deaf father. Like Simmons and Chouard, Clark was convinced that a multichannel device was needed for speech to be made perceptible. The development of such a device, he believed, would depend upon considerable basic research, starting with animals. After a decade of work, in 1978 Clark felt able to try out a prototype he had developed. A forty-eight-year-old man who had been deafened in an accident two years earlier, and who had read about Clark's work in a magazine, approached him and eventually became the first subject. Clark's experience with his own deaf father may have made him more aware of something that most or all of these pioneers shared: a sense of the terrible isolation that deafness brings. There are clear parallels with the life's work of Alexander Graham Bell, who was also much influenced by the experiences of his deaf mother and deaf wife (Bruce 1990). A number of the pioneers speak of having been prompted by people rendered desperate by their condition. Surely modern science had something to offer? It is difficult for the medical profession to admit powerlessness, and the tendency to take risks in the interest of potentially promising therapy is well established in the history of medicine.

By the beginning of the 1980s, although the number of implants was small, cochlear implantation was acquiring a degree of credibility in professional otological circles. The results of an independent assessment of House's implantees, showing modest but definite benefit (Bilger et al. 1977), contributed significantly to this change, as Ballantyne, Evans, and Morrison confirm. In 1982 these British experts published an update of their earlier report (Ballantyne, Evans, and Morrison 1982), in which they argued that progress in the intervening period had led them to revise their earlier emphasis on the need for caution.

By this time, industrial corporations were also becoming interested. In 1981, after a number of abortive involvements with other groups, 3M entered into a licensing agreement with William House. In that same year, the Australian government agreed to support a collaborative program of work involving Clark at the University of Melbourne and the Australian Nucleus group of companies. In the United States and Britain, and indeed internationally (though not in France), these two devices—the single-channel House/3M device and the multichannel Nucleus device—were to dominate the following years. 3M sought premarket approval from the Food and Drug Administration (FDA) for its device in October 1983. The legislation of 1976 had

extended FDA authority to medical devices, and it became incumbent on manufacturers to seek approval of the efficacy and safety of new products before they could be marketed in the United States. Implants of all kinds were placed in "Category III," in which rigorous scrutiny, similar to that given to new drugs, was required (Foote 1992, chap. 5). 3M submitted data on more than 350 patients implanted with the (modified) House device. The FDA decided that the device was safe and that it provided access to environmental sounds. It was found that for some patients it "may aid" with lipreading. In October of 1984, the 3M/House device became the first cochlear implant to be approved for use in deaf adults (age eighteen or over). FDA approval of the Nucleus device, based on Clark's design, followed twelve months later. The number of implants, which had grown from fewer than 100 worldwide in 1978 to nearly 500 by 1984, would grow more rapidly as devices could be marketed and used, backed by the authority of FDA approval.

In fact, the market grew far more slowly than had been anticipated. Deaf people were not coming forward in anything like the numbers anticipated by professionals and manufacturers. Concerned by the slow growth of the market, 3M launched a campaign to persuade physicians to promote the technology among patients (Garud and Van de Ven 1989, 504), but the results were still disappointing. From 1986, 3M slowly began to reduce its commitment to the field (p. 505). It halted active marketing of the existing device and stopped research on an advanced model. What was going on?

Part of the explanation was financial. By the 1980s, the emphasis in health policy had come to be placed very firmly on cost containment and on controlling the inflationary implications of new devices and procedures. In the United States, by far the most important market, the Health Care Financing Administration (HCFA) began to consider Medicare reimbursement of both the 3M single-channel and the Nucleus multichannel devices once the FDA had granted approval. Its subsequent decision meant that cochlear implantation, like usage of various other expensive technologies emerging in the 1980s, would be reimbursed at less than the actual cost (Kane and Manoukian 1989). Hospitals thus faced strong financial disincentives to performing cochlear implantations. In fiscal year 1987, only sixty-nine cochlear implantations were reimbursed by Medicare.

But there may have been other reasons. An industry representative interviewed by Garud and Van de Ven suggested that perhaps "patients had become accustomed to a world of deafness and may fear the risk of entering the world of sound" (quoted in Garud and Van de Ven 1989, 504). Were deaf people inhibited by such psychological considerations? An argument like that was a step in the dark. Not only did it lead beyond the realm of audiological and medical expertise, but it hinted at matters of which little or nothing was

known. What did deaf people actually think about implants, about the possibility of "reentering the world of sound"? It had simply been taken for granted that deaf people viewed their deafness in the same terms as medical and audiological professionals: as a loss of hearing. It stood to reason that those so deprived would seek the benefits of corrective technology.

Meanwhile, a further development was taking place. The group for whom the implant was considered appropriate was being extended from deafened adults (who could, hopefully, be reintegrated in the world of sound) to children (who may have heard for a very short time before becoming deaf or who may never have heard at all). In purely quantitative terms, this meant a considerable increase in the possible implant population (Thornton 1986). A few years earlier, it had been generally felt that the technology was not at a stage at which it could be offered to deaf children. Although Chouard in France had taken this step in the late 1970s, other surgeons were hesitant.⁴ House had started implanting children in 1980. Ballantyne, Evans, and Morrison, in their 1982 "revision," suggested that in Britain the "special problem of whether pre-lingually deaf children should be included" required investigation. Despite profound disagreement regarding the appropriateness of this step and, once more, objections from neurophysiologists,⁵ by the early 1980s the idea of implanting deaf children was securely on the professional agenda.⁶

Focusing on professional and industrial commitment, we can reasonably claim that by 1985 a collaborative structure existed within which further development could take place. Rappa and Garud's (1992) data suggest that the number of scientists publishing on cochlear implants doubled between 1980 and 1985. At the same time, while surgeons and audiologists were looking to extend the scope of the device to children, firms (among them Nucleus and 3M) were engaged in product improvement. All of this is in line with expectations based on my earlier model. Nevertheless, as we have seen, there was also a sense of disquiet—a sense that reception of the device was less enthusiastic than was desirable.

The Emergence of the "Bionic Ear"

Neither apathy nor downright opposition was anything new to protagonists of cochlear implantation. The French pioneer, Claude-Henri Chouard, had long been aware that the difficulties he faced were by no means only surgical and technical. In 1977, although a few other surgeons had begun to collaborate with him, professional opinion in France was largely (though discretely) hostile. Persuasive evidence for the efficacy of cochlear implan-

tation was vital if funds and support were to be secured. How could sufficient numbers of patients be implanted for persuasive results to be obtained if funds were lacking? One possibility was of course to secure the interest of candidates able to pay for their own implantations. The mass media could play an important role in the development of the program. In a book published in 1978, Chouard is quite explicit about this. He realized, he writes, that people become enthusiastic about “the magic words, discovery, science, hope”:

[W]hatever their directors may say, government offices open more readily to someone presenting something new that has just been talked about in the press or on the television than to an obscure and hesitant researcher. It was this obligation to be effective that led me in January 1977 to call a journalist and offer our first results, under the pretext of the international conference in Buenos Aires. (p. 179-80, my translation)

[T]elevision served us well. In the course of a broadcast that took place in March 1977, undecided potential patients and parents were given an objective picture of what we were doing and of its current limits, of our doubts and of our hopes. The serious and careful tone of these few minutes was convincing because they showed the essence of our work: that is, they showed live word comprehension. (p. 124-25, my translation)

Media presentations of implant technology constantly articulated a central theme. The wonderful new technology promised the possibility of overcoming deafness, of “making the deaf hear.” Press reports painted a distinctly different, and much less nuanced, picture of what cochlear implants could provide than was to be found in the medical and scientific literatures. An international audiological congress held near Paris in 1974 had earlier provided Chouard with an opportunity of publicizing his work. Whereas in a professional forum the results had to be expressed with caution, the media preferred to see it differently. Headlines proclaimed “HOPE for 2 Million Deaf and 17,000 Deaf Mutes” (“Espoir pour 2 Millions de Sourds et 17,000 Sourds-Muets” 1974, 1) and “Victory over Total Deafness: Two French Researchers Find the Means of Curing People Born Deaf and Dumb” (“Victoire sur la Surdit Totale” 1974, 83). Although they did not endear Chouard to his professional colleagues, they did succeed in attracting favorable attention to his work.

What justified Chouard’s faith in the supportive role of the mass media?

The answer, I suggest, must be sought in the cultural assumptions with which we typically approach technological medicine on the one hand and deafness on the other.

The latter is much the older and more deeply rooted. The idea that man’s special character, humanity’s very essence, is bound up with the capacity for speech lay behind an evangelical drive to lead the deaf to scripture. At the

end of the seventeenth century, Johann Conrad Amman⁷ was one of many who gave expression to this view: "it will be shown from the nature of God, that creatures formed in his image ought, of necessity, to be able to speak, and in this respect resemble their Creator" (Amman [1700] 1965, 12).

There followed the long history of religiously inspired attempts to teach the deaf to speak. Though mitigated in France by the more sophisticated views of language propagated by philosophers such as Condillac and La Mettrie (Seigel 1969), this was the dominant view through much of Europe. A century and a half before the cochlear implant was even dreamt of, attempts were already being made to harness new technologies to alleviate the effects of deafness. At the end of the eighteenth century, some claimed that prolonged application of a galvanic current to the ears of the deaf could give them hearing (Vestberg 1994). In the early 1870s Alexander Graham Bell, working as a speech therapist and in love with a deaf girl (Mabel Hubbard), was becoming preoccupied with the notion of "electrical speech." Bell's biographer suggests that his work with the deaf was intimately connected with the origins of his work on telephony (Bruce 1990).⁸ The advent of telephony quite naturally inspired dreams of its being used to help the deaf. Deafness continued to be widely identified with frightening isolation of the individual from human society, as two scientists from Bell Laboratories pointed out:

[A] small defect of speech or hearing can put a man in isolation from the complex social behavior which has been built on those abilities. Complicated disorders in the use of language will make a person seem to us scarcely human, however rational and competent he may be in his other mental faculties. If a man is unable to represent or comprehend thought in the conventionalized symbols of language, he is mentally cut off from the most human characteristic of human society, and that on which all that is distinctly human is built. (Pierce and David 1958, 179)

There is also a potent myth of medical technology. More than thirty-five years ago, René Dubos (1979, 157) wrote that "There are always men starved for hope or greedy for sensation who will testify to the healing power of a spectacular surgical feat or of a new miracle drug." More recent writers have seen faith of this kind as a characteristic feature of modernity. The integration of medical practice with the promise of advancing technology appears consonant with that "delocalization of trust" that Giddens (1990) has identified as a hallmark of modern society. People today apparently want to place their trust less in the individual physician than in medical-technological progress. To be sure, when the technologies at issue are not those of diagnosis but artificial organs implanted into the body, other sentiments are also at stake. We can see this in a wide variety of contemporary sources. Philosophers may agonize about the implications of a blurring of the boundary

between human and machine (Sheehan and Sosna 1991), while science fiction writers⁹ (and a few social scientists) may celebrate it, but what does the man or woman in the street think? What is at stake here of course is not a philosophical dilemma (can machines be creative, for example), but the possibility that an implanted device can take over the function of a failing bodily part. It seems to me that in Western culture, though not necessarily in non-Western cultures (Ohnuki-Tierney 1994), we typically subordinate our fears of compromised bodily integrity to our hopes of restored functioning. Though there is surely much work to be done here, I suspect that most able-bodied people's perception of artificial organs derives more from a reassuring faith in medical technology than from a disquieting sense of the blurring of the boundaries of humanity. In the last chapter of their most recent study of transplantation, Fox and Swazey (1992, 206) write that "it is the intensity and expansion of the drive to sustain life and 'rebuild people' through organ replacement that has progressively alienated us." Their work makes clear how the mass media systematically look to reinforce this popular faith in the seemingly limitless possibilities of modern scientific medicine. In the course of a study of end-stage renal disease and the place of dialysis and transplantation in dealing with it, Plough found similar media enthusiasm. He suggests a different, though no less powerful, basis for media messages concerning technology in medicine:

As in the case of the space program, the miracle technologies of medicine represented a symbol of progress into a new frontier. Such Promethean examples of human mastery of the unknown and feared domains of inner and outer space are culturally quite powerful. The images and stories presented in the media tap into the core metaphors through which we give meaning to life and attempt to deny the certainty of death. Hence, the power of the technology is borrowed, at least in part, from deeply rooted cultural symbols of hope and deliverance, literally for a *deus ex machina*. (Plough 1986, 19)

This cultural rhetoric surrounding medical technology was mobilized in the development of the cochlear implant, just as it was in the case of the artificial heart studied by Fox and Swazey. It was frequently expressed in popular accounts of the technology.

Media reconstruction of the cochlear implant as the "bionic ear" was an essential element in the attempt to mobilize resources for the technology. According to Carlo Laurenzi, a sociologist working for the British National Deaf Children's Society, the term "bionic ear" appears to have been spawned in Australia,

which by mere coincidence is where one of the major manufacturers of cochlear implants is based. Melbourne is host to the "Australian Bionic Ear and Hearing Research Institute" whose name gives one an image again of

scientific triumph over nature's weaknesses. . . . A recent book entitled "The story of the Bionic Ear" (1989) has done little to alter the public perception of potential medical/scientific cure. The term is too seductive for implant programmes' fundraisers to resist. (Laurenzi 1993, 1)

The notion of the "bionic ear," and the majority of media stories reporting on it, drew implicitly on these two deeply rooted cultural dispositions.

In Britain the attempt to mobilize resources came later than in France, as did media interest. By the early 1980s a group of British otologists wished to offer a clinical service, as House was doing. These surgeons did not share Douek's research interests and did not seek to develop implant technology. With this push toward clinical application, publicity began to develop. The first clinical implantation in Britain was carried out at University College Hospital in 1982, but the technology was brought to the attention of the general public only in 1984. In August of that year Morrison, an ear surgeon at the London Hospital, implanted a device into a twenty-one-year-old Oxford undergraduate, Jessica Rees, who had been deaf for seventeen years. Miss Rees was subsequently seen on television, humming along to music. Journalists' attention was drawn to the event, and it was duly reported:

Hope of Restoring Girl's Hearing with Electrodes Implant

She said: "It is hard to explain but I am going to have to learn how to hear again. I will be hearing sounds that I have not heard before and I will have to learn what they are." (Jones 1984b, 11; © The Telegraph plc, London, 1984)

and then

Electrodes Work for Deaf Girl

Jessica Rees, 21, the deaf Oxford undergraduate who had a pioneering operation at the London Hospital on Tuesday, last night heard her first sounds for 17 years. (Jones 1984a, 7; © The Telegraph plc, London, 1984)

This pattern was to be reiterated as surgeons in other British cities gradually began to seek funds for new implant programs. In the absence of National Health Service funds, appeals to charity and to local communities were made repeatedly. The mass media played an important role in attracting sympathetic attention and financial contributions, as Laurenzi (1993) has made clear.

Bionic Miracle or "Final Solution"?

Much of the early work on cochlear implants was invisible as far as the deaf were concerned. Work such as Douek's, conducted strictly within a research framework, was reported only in professional media: at scientific

conferences and in journals of medicine and audiology. It received little or no attention from the mass media or newsletters of deaf associations. Recruitment of the handful of volunteer subjects needed for research purposes typically took place via existing contacts. With the desire to provide a more extensive service came the need to convince deaf people of the value of the new technology. Through the subsequent involvement of the mass media and stories in the press and on TV, the deaf began to learn of cochlear implantation. What the deaf learned of the implant thus reflected the somewhat extravagant claims made by the media, rather than the more modest claims made in the professional periodicals.¹⁰

In France deaf organizations soon began to respond to the media representation of Chouard's work on cochlear implantation. In April of 1977, the UNISDA (National Union for the Social Integration of the Hearing Impaired)—an umbrella organization representing the deaf, the hard of hearing, parents, and educational and social work organizations—issued a statement expressing concern. This statement, which appeared in the periodicals of a number of these organizations, stressed the need for caution and drew attention to the dangers of exaggerated publicity. Only a small number among the deaf were likely to profit, at least for the moment; little was known of the physiological effects of implants; the risks and uncertainties in implanting children were great. According to the signatories,

while recognizing the good intentions and the seriousness of the research, [we] nevertheless invite all those involved to show extreme prudence. The confidence of deaf people and of their families risks being destroyed if the results of the operation fail to correspond with the accounts that are being given. The confidence of deaf people and of their families risks being destroyed by hasty communications not based on controllable results. (Quoted in Albinhac 1978, 95, my translation)

In both France and Britain, whatever the personal hopes of many individual parents may have been, the beginnings of child implantation occasioned still greater concern among the organizations of parents of deaf children. In France the parents' organization (ANPEDA) enjoyed close links with the otological and audiological professions, and generally speaking, they shared the doctors' faith in the possibilities of cochlear implantation. Even the ANPEDA, however, was outraged at what was seen as premature application to children. Opposing the idea of children being used (as they saw it) as guinea pigs in experimentation, ANPEDA managed to secure expressions of dissent from leading figures in French otology, notably Professor Portmann of Bordeaux. Portmann's status led to his concerns achieving widespread publicity. Thus in February of 1979, the daily newspaper *L'Aurore* reported:

Professor Portmann Is Indignant: The Artificial Ear Is Premature and Dangerous

"It's scandalous. To spread by a book, by interviews resounding in the mass media, the hope that the deaf—the deafened and even the born-deaf—can now hear is unacceptable." (M. F. 1979)

Five years later, following the operation on Jessica Rees, the British organization (NDCS) became similarly concerned, not least because of the flood of inquiries to which the publicity had given rise. The NDCS director, Harry Cayton, interviewed in the society's journal, said:

Medically these operations are still experimental. Five or six operations on adults in Britain do not yet provide a basis for extending the programme to children. Nor do we know what the effect of having the implant for 10, 20 or 30 years is going to be. It might be very interesting for doctors and audiologists to study the reactions of a child with an implant but sometimes they seem to forget that deaf children are people, not just a set of non-functioning ears. (Quoted in O'Hagan 1984, 10)

As in France earlier, the objections of the parents' organization also attracted the attention of the media. Yet reports of the NDCS position were not unanimously sympathetic: "Jessica's treatment is 'raising false hopes' "; "Surgeons warned on ear operation" (Standard Reporter 1984, 3). But an article in the quality weekly *Sunday Times* of 12 November 1984 entitled "Charity Blocks 'Bionic' Hearing" countered that "A new 'bionic' ear implant that could bring hearing and speech to totally deaf children is being blocked by one of the country's leading charities for the deaf" (Ballantyne 1984, 8).

The concern of ANPEDA and NDCS focused principally on the inadequacy of available knowledge, a point of view shared by many basic scientists and clinicians though rarely articulated publicly by them. While these organizations possessed the social resources necessary to gain publicity for their views, the same was not true of deaf adults whose concerns found little public expression. It was becoming apparent that the vast majority of the adult deaf did not see themselves as possible candidates for cochlear implantation, in contrast to earlier medical assumptions. While they were apparently unhappy at the publicity given the new technology, little about their views was known to outsiders.

The sentiments latent in the deaf community did in fact go beyond apathy and some concern for exaggerated publicity. In December of 1977, a group of French deaf people prepared a text that was subsequently publicized by the writer Jean Grémion.¹¹ It presents a different kind of concern regarding the cochlear implant:

What do we, the deaf, see in all the newspapers and on the television?
"Extraordinary invention of doctor Chouard—17,000 deaf mutes can hear and

“speak.” We smile. Why not bleach the blacks and blacken the whites? When are they going to stop using us as guinea pigs, once and for all? We are astonished that everyone is talking about this invention, while normally there is never a word about our life and our world. For years there has not been a single line about us in the press. . . . When are they finally going to accept our world as a reality? . . . Many among us are married, have children, and these children are happy. . . . It is society that has oppressed us and continues to oppress us. The proof: this invention of Dr. Chouard. We speak only with a gestural language, that is, our mother tongue, and it is marvelous to speak this language. (Quoted in Albinhac 1978, 86, my translation)

The public would have found this view much harder to understand than that of the UNISDA. The need to proceed cautiously in introducing a new medical technology is widely recognized. Grémion's text evokes a different theme, and a most unfamiliar one for the late 1970s. Deafness is not identified with hearing loss. Could being deaf conceivably be equated with being black? This theme would become central to deaf protests a decade later, but in the 1970s it was no more than an off-stage sign.

Sociologists, however, were beginning to discover that more lay behind deaf people's lack of enthusiasm for “being made hearing” than fear of entering the world of sound alone. In a pioneering study the American sociologist Paul Higgins (1980), himself the son of deaf parents, showed how deaf people's lives were by no means dominated by feelings of exclusion and isolation. On the basis of extensive ethnographic research, Higgins confirmed and elaborated what Grémion's text had declared. Deaf people have created a distinctive way of life, a community, with its own structures, institutions, norms, and values.

In the last few years, the deaf have moved beyond individual lack of interest in being implanted and beyond complaining about the publicity given to implantation. In the language of the sociology of technology, they have become an actor (a “relevant social group”; Bijker, Hughes, and Pinch 1987) in shaping the future of the technology. How has this been achieved? How has a stigmatized and relatively powerless group become a significant actor in the process of technological change? With the aid of the accumulation of social and cultural resources, an alternative view of the development of cochlear implantation could be constructed and made plausible. The deployment of this view enabled the deaf to challenge the use of the technology.

Central to this accumulation of resources was the work of a few linguists, who, in the face of widespread skepticism, began in the 1960s to study the sign languages used by deaf people (Baker and Battison 1980). It gradually became clear that sign languages had the properties of natural language, and were not simply mime or gesture. The deaf could no longer be seen as a collection of deprived individuals handicapped by lack of (reflexive) com-

munication and could begin to lay claim to being considered members of a unique community of sign language users. Some authors began to use the term "Deaf" (with a capital D) to distinguish cultural deafness from audiological deafness or hearing loss. Sign linguistics research both led to and legitimated sociological interest in the functioning of the Deaf community, as well as historical research on the (social) life of deaf people.

In light of these changes, we can better understand what lies behind Grémion's text protesting the publicity given Chouard's work in France. When this text was written, in December of 1977, a remarkable action research project had recently been established at the Centre for the Study of Social Movements in Paris. Bernard Mottez, a sociologist, and Harry Markowicz, a sociolinguist, had taken it upon themselves to chart and contribute to the process of emancipation then taking place among the French deaf (Mottez and Markowicz 1979; see also Grémion 1990). Through a series of seminars, they introduced the work of the major American sign linguists. Through the newsletter *Coup d'Oeil*, they provided regular information on activities related to sign language taking place in France and abroad. The first "half-clandestine" course in French sign language had started in late 1976. Similar events were taking place in Denmark, Sweden, and Great Britain, in parallel with—but totally separate from—the development of the cochlear implant.

The history that began to be written is one of oppression of deaf culture and deaf language. It is a tale of a flourishing deaf culture, its heroes and its vicissitudes, and of the suppression of that culture that began in 1880 with the infamous Milan congress on deaf education (Lane 1984). Life histories, where they have been collected, show the isolation suffered by deaf children unable to communicate with their families and frequently forbidden to use the only language in which they could freely communicate. They show the desperation of many older deaf people—"outsiders in a hearing world"—who, in many cases, achieved a degree of emotional stability only when they found and embraced the Deaf community (see Padden and Humphries 1988; Taylor and Bishop 1991). Writing deaf history, like black history or working-class history, commonly has an emancipatory objective.

The cochlear implant has come to be conceived by deaf intellectuals and their hearing allies in terms of this new historiography of deafness. On this basis, a new critical discourse has been constructed that differs greatly from that used by parents of deaf children in the 1970s and early 1980s.

A few months after Harry Cayton, Director of the (British) NDCS, had expressed his concern regarding the uncertainties and the publicity surrounding cochlear implantation in children, a British deaf intellectual published an article on implants in the *British Deaf News*. Paddy Ladd began with a brief

characterization of attempts, since 1880, to make deaf children hear and to suppress deaf culture (Ladd 1985). The cochlear implant, for Ladd, represented the “fourth phase” in this terrible history:

The medical profession, for so long the enemies of the deaf community, are eager to get their hands on deaf children of our community. We *will* make these children hearing, they imply, if we can't get oralism to work any other way, then we'll *make* them into hearing children; as if they could. (1985, 5)

The deaf community, Ladd argued, has a responsibility toward deaf children and must mobilize to protect and preserve their rights to grow up as members of the Deaf (signing) community. He called on members of the British Deaf Association to protest at a forthcoming international conference on deaf education that had taken implants as its major theme. His article ends with the slogan “COCHLEAR IMPLANTS—ORALISM'S FINAL SOLUTION.”

The construction of an alternative rendering of cochlear implantation, in terms of deaf people's own history, has been pursued by a number of scholars, among whom the American psycholinguist and historian of the deaf, Harlan Lane, has been particularly prominent. Lane's (1992) impassioned critique of the growth of child implantation engages the dominant account in two fundamental respects. One is that of the cultural vision that provides diffuse and emotional support for new medical technologies in general and for the “bionic ear” in particular. This vision is of course inspired by faith in the unlimitedly benevolent possibilities of medical science and of miracle bionic technologies. Like Ladd (1985), Lane places cochlear implants in a different historical context: not of progress but of oppression. Lane's history of the cochlear implant relates it to the suppression of sign language and deaf culture, and to the succession of “heroic” attempts to cure deafness. According to this interpretation, the primary historical antecedents of cochlear implantation are not the scholarly investigations of von Helmholtz and of the physicists and physiologists who followed his interest in mechanisms of hearing. They are the attempts of otologists like Jean-Marc Itard to cure deafness with electric currents and potions poured into the ear, or Alexander Graham Bell's eugenicist attempt to dismantle the institutions of the deaf community. The second aspect of this critique relates to the scientific evidence in terms of which the use of medical technologies is validated. Even though modern culture may be characterized by its faith in medical progress, the medical profession is constantly aware of the need to sustain belief in the scientific nature of its practice. Whatever the reality, the official discourse of medicine endlessly stresses the need to evaluate new technologies in terms as scientific as possible, hence the constant emphasis on the randomized clinical trial. Since the reality is very different, a stick is at hand. Lane engages

with this justificatory discourse as well, using the skills of a psychologist and a statistician to show the inadequacy of the data attesting to the "success" of childhood implantation. Not only do results indicate far more modest success than has been claimed for speech and language development, but virtually no research at all has been done on the implications for the child's cognitive, emotional, or social development.

Both these lines of analyses—the mythical-historical and the justificatory-rational—are of great importance for understanding the most recent history of cochlear implantation. Each of them has contributed to a rhetoric by which the fundamental notion of the Deaf as a linguistic and cultural community could be connected to concern regarding the cochlear implant. Gradually, this "counter-rhetoric" has been adopted by the organizations of the deaf and deployed politically to influence the ways in which the implant is used. The close connections between scholars like Lane and Mottez and the deaf communities of their respective countries have played an important role here. Lane, for example, chaired the (U.S.) National Association of the Deaf (NAD) Task Force that in 1991 produced a position paper on cochlear implants. To be sure, their diverse memberships and varied concerns constrain the rhetoric used by representative bodies like the NAD or British Deaf Association (BDA). Late deafened adults, who may be a significant part of their memberships, may identify less easily with more radical claims, and many deaf people are still fearful of public attention. Lacking information and remaining somewhat anxious, some deaf organizations preferred to avoid the issue. The BDA, for example, defined its position only in 1994 after long delay and heated debate.¹² The BDA's paper ultimately affirmed its "non-support" for the implantation of deaf children:

The drive to "normalise" Deaf people, by increasing the quantity of sound which can be sensed, carries with it the danger of alienating the Deaf person from their own self-identity, and from their own natural community and its living language, without allowing full integration and access to hearing society. (BDA 1994, 25-26)

The need to preserve unity in the face of heterogeneous memberships and representative functions has imposed a degree of caution on these groups; but other more radical voices have emerged. By far, the most intriguing of these is the French pressure group *Sourdes en Colère*, founded in 1993 and partly inspired by earlier Gay Liberation action. *Sourdes en Colère* made opposition to cochlear implantation their principal objective:

The cochlear implant is experienced within the Deaf community as yet another attempt at sociocultural genocide, on the same order as the banning of sign language at the Congress of Milan in 1880, bringing in its wake disastrous

consequences for Deaf culture. But this time, the Deaf are not lowering their arms. Thus *Sourdes en Colère* are organizing their first national demonstration, on 16 October, at Lyon, against the cochlear implant. (*Sourdes en Colère* n.d., my translation)

In February of 1994 Jean Dagron, a French physician-audiologist with a degree in social psychology, published a pamphlet on the subject of cochlear implants in which, like Lane (1992), he brought together the various dimensions of the critique. In a text accompanied by remarkable illustrations, Dagron (1994) criticized not only the lack of adequate knowledge of the implications of implants for deaf children, but also a system in which information provided to their parents totally disregarded the possibilities and the cognitive benefits of bringing up a child as a member of the signing deaf community. Dagron insisted on the need for thoroughgoing evaluation and for an adequate definition of ethical practice in this emotionally loaded domain.

The passion of *Sourdes en Colère*, of which a prize-winning and nationally famous Deaf actress (Emmanuelle Laborit) is a leading member, and the medical status and cool analyses of Jean Dagron were finally winning attention for the deaf point of view. In May of 1994, a group of twenty (including representatives of *Sourdes en Colère*, Dagron, the sociologist Mottez, linguists, educators, psychologists, and parents of deaf children) presented a document to the French national committee on medical ethics. They argued that given the uncertainties regarding the linguistic, psychological, and social implications of implanting deaf children, the technique should be regarded as experimental. Under French law, this would subject its use to rigorous control and oversight. A press conference was held to announce the document, and this resulted in a long article in *Le Monde* in which, almost for the first time in France, the concerns of the deaf received detailed and sympathetic coverage from a leading newspaper:

Language Quarrel among the Deaf

Supporters of sign language are concerned at the implantation of auditive prostheses in hard-of-hearing children. (Folléa 1994, 14)

Rhetorical Engagement and Medical Innovation

In December of 1994, the French Ethics Committee issued its report (Comité Consultatif National d'Éthique pour les Sciences de la Vie et de la Santé [CCNE] 1994). Though it rejected the claim that the cochlear implant should now be regarded as experimental, its report greatly pleased the French Deaf community. The CCNE wrote that doubts regarding the precise benefits

of the device were unlikely to be resolved in the near future. To avoid the possibility of compromising children's psychological and social development, they should all be offered sign language from an early age, whether they might subsequently become candidates for implantation or not (CCNE 1994).

Although implantation of children will certainly continue, it seems possible that changes will occur in the way in which the technology is used.¹³ The changes that I anticipate are partly a matter of the current economic climate of health care to which I referred in the introduction to this article. Growing concern with these economic issues is leading to an increasing collaborative effort involving both manufacturers and implant teams to establish an economic rationale for the implantation of children. The high cost of the technology, in an era of cost containment, poses widely recognized problems for the further growth of cochlear implantation. Yet the "counter-rhetoric" produced by the Deaf is also playing a part, as the French example makes clear.

This "counter-rhetoric" was provoked by the initial rhetorical reconstruction of the cochlear implant as the "bionic ear": a reconstruction suggested by the resource requirements of pioneering implant groups. Recourse to the "heroic" myth of medicine and the "tragic" myth of deafness was invaluable (or irresistible) in mobilizing support and interest. The counter-rhetoric was—and continues to be—articulated by Deaf activists working together with social scientists, historians, and linguists whose shared cultural view of deafness is at odds with the usual medical identification of deafness with hearing loss. The passion of the Deaf, combined with the social and cultural capital of their scholarly allies, has succeeded in securing growing attention for this alternative conceptualization of the cochlear implant. The result is a reluctant but growing willingness of implant teams to negotiate how the technology is to be deployed. To be sure, this willingness is more apparent in some countries than in others. This success is smaller (and certainly less visible) than that of AIDS activists in the United States, where clinical trials of new AIDS drugs are being redesigned to take account of the concerns and experiences of AIDS victims and potential victims (Epstein 1995). Both cases involve building the right to participate in the social processes through which science and technology evolve. In both cases, strategies involved elements of "street theater" and elements of cognitive negotiation. In other ways, however, these are very different phenomena. Unlike AIDS activists, the Deaf are resisting the medicalization of their condition. And also unlike AIDS groups, Deaf communities have been obliged to build coalitions with sympathetic outsiders having essential social and cultural capital.

How does an excluded group (in this case the Deaf) achieve influence over the development and deployment of a technology? Recognizing that such

influence can be achieved has implications for understanding technological change in medicine. This study has shown, in the first place, that a network—or, as I called it in previous work, an interorganizational field—was constituted around the emergent technology. A network metaphor would lead us then to emphasize the continuous growth that subsequently occurred. Cochlear implantation is spreading to more and more centers in more and more countries. The (Australian) Cochlear Corporation, which easily dominates the world market, enjoys an excellent reputation among its customers, is a great commercial success, and continues to invest heavily in the further development of its product. Although I have not discussed it here, it seems likely that technical redesign (hardware, speech processing strategies, etc.) is explicable in terms of the model that I earlier developed for radiological imaging. Yet such an approach leaves much unexplained. Negotiation of the value and uses of the new technology, unlike imaging technologies, could not take place in professional fora alone. Not only did professionals have to make a place for the new technology in their practice, but deaf people (and the parents of deaf children) also had to reconceive of themselves (or their children) as potential implantees. The value of the technology had to be negotiated in a much broader forum, and the way was open for the rhetorical engagement on which I have focused in this article. The model that I developed for understanding the development of imaging technologies has to be seen as a limiting case in which two powerful actors (professional and industrial) succeeded—through a historical process akin to the familiar sociological analysis of professionalization—in excluding other (potentially critical) voices. The new context of health care technology, marked by governmental emphasis on regulation and cost containment as well as by increasingly critical consumers, suggests the need for a more general model. The theoretical agenda for a sociological understanding of medical technology is correspondingly broadened to include the processes by which participation (or relevance) is achieved in the varied fields in which medical practitioners engage (acute sickness, reproduction, aging, or public health) and in diverse societies and cultures. In place of an earlier focus in the sociology of technology on relevant social groups, we must now study the conditions under which relevance is achieved through the deployment of social and cultural capital. No simple answer is to be expected. Examples that come to mind from both inside and outside medicine—including AIDS groups, feminists opposed to the overuse of technology in obstetrics, and antinuclear groups—suggest rather different processes, depending on the nature and organization of the movement, the appeal of the discourse that it produces, and the specific features of a national political culture.

Notes

1. This section is based on Blume (1995).
2. Deafness is conventionally characterized as being either "conductive" (a failure of the mechanism of sound conduction usually associated with problems of the outer or middle ear) or "sensorineural" (a failure of the mechanisms by which sound waves are converted into neural impulses and subsequently processed by the brain). Sensorineural deafness can result from failure of the inner ear or cochlea, of the acoustic nerve, or of higher order processing by the brain.
3. Fox and Swazey (1992, 21) found a similarly "bivalent" response to early attempts at brain tissue transplantation, with neurosurgeons responding enthusiastically and neuroscientists responding more cautiously.
4. Ballantyne, Evans, and Morrison (1978, 113) comment on this: "The fact that there are apparently no problems about implanting juveniles and children in France means that, in time, information should become available which, at present, cannot be obtained elsewhere."
5. The principal justification given for implanting children was the notion of a "critical period," early in life, in which linguistic competence had to be acquired if it ever was to be acquired. Yet, just as happened earlier, neurophysiologists proved critical of clinicians' reasoning, as we can see from Gerald Loeb's comments at the 1983 conference: "I just wanted to add a cautionary remark about this notion of the critical period, which we suddenly have decided is a real thing. First, the fact is that this is a very hypothetical notion. [. . .] Second, the sort of pattern stimulation that we provide with electroneural prostheses may not fulfill its necessary inputs. Third, we have no idea at what age that period exists, or is critical, or ceases to exist. I think that it is worth thinking about, but I certainly would urge caution in taking this as some sort of blanket licence to go around putting hearing aids or electroneural prostheses in very young children" (Loeb 1985, 581).
6. FDA approval of the Nucleus implant for use in children aged between two and seventeen years was given at the beginning of 1990.
7. Amman was born in Switzerland in 1669 and qualified as a doctor of medicine. Soon afterward, he settled in Amsterdam, where he became interested in speech and hearing disorders. His work on teaching speech to the deaf acquired international renown.
8. In an 1874 lecture, his biographer tells us, Bell told his audience: "If some simple apparatus could be contrived to bring the vibrations of the speaker's voice to the hand of the lip-reader, one half of the ambiguities of lip-reading would disappear" (quoted in Bruce 1990, 120).
9. For one example among many, see Isaac Asimov's ([1976] 1993) moving story "The Bicentennial Man."
10. This statement does not apply to Sweden, where cochlear implantation began much later, and differently. For a comparison of Britain and Sweden in this regard, see Blume (1994).
11. Jean Grémion subsequently published a popular book on the deaf, *La Planète des Sourds* (1990).
12. In an interview held in August 1993, Austin Reeves (vice chair of the BDA) made clear that the issue had been avoided, that there was a total lack of information on the device, and that many deaf people were fearful of what it was said to do (Reeves 1993). In that same month a motion proposing that cochlear implants be banned was presented, and then withdrawn, at the BDA's annual general meeting.
13. I myself have prepared and circulated an English summary of this report among interested parties in Britain and the Netherlands. Mr. Osamu Nagase prepared a Japanese translation of my

summary, which was recently published in *Mimi*, the journal of the Japanese Association of the Deaf (Blume 1996). In this article I have avoided reference to my own growing involvement in the debate regarding the future of cochlear implantation. In a later publication I intend to focus specifically on this engagement and its implications for the conduct of my research.

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