

Deficient hearing, implants and devices: qualities and sensory data in perspective

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Résumé

L'article analyse l'audition humaine à partir d'une perspective philosophique et technique inspirée principalement de l'œuvre de Gilbert Simondon, en articulant organismes, milieu et technologie. L'audition n'est pas comprise comme une simple réception de signaux, mais comme un processus actif d'individuation, au cours duquel l'organisme interprète et donne sens aux informations sonores en fonction de ses besoins vitaux, de ses capacités sensorielles et de son contexte d'existence. L'auteur montre que l'information sonore n'acquiert de valeur que lorsqu'elle devient significative pour l'organisme, ce qui suppose un engagement pratique et une intégration avec d'autres modalités sensorielles. Le langage et la musique sont analysés comme des formes de domestication des sons, permettant la constitution de répertoires partagés et culturellement situés. La perception auditive apparaît ainsi comme multimodale, dynamique et profondément liée à la mémoire, à l'attention et à l'affectivité. Dans le domaine technique, l'article présente une généalogie des prothèses auditives et des implants cochléaires, en mettant en évidence le passage de l'amplification acoustique au codage numérique. L'implant cochléaire est décrit comme une substitution sensorielle radicale, qui impose à l'organisme un nouveau régime de fonctionnement fondé sur des signaux électriques et des algorithmes de sélection de l'information. Bien qu'efficaces pour l'intelligibilité de la parole, ces technologies tendent à appauvrir la richesse de l'expérience auditive en privilégiant la distinction entre signal utile et bruit. L'auteur critique l'idéal d'une automatisation totale de l'audition, qui ignore les dimensions interprétative, affective et attentionnelle de l'expérience sonore.

Mots-clés : Audition humaine; Individuation perceptive; Philosophie de Gilbert Simondon; Implant cochléaire; Expérience sonore.



Abstract

The article analyzes human hearing from a philosophical and technical perspective inspired primarily by the work of Gilbert Simondon, articulating organisms, environment, and technology. Hearing is understood not as a simple reception of signals, but as an active process of individuation, in which the organism interprets and gives meaning to sound information according to its vital needs, sensory capacities, and context of existence. The author shows that sound information only acquires value when it becomes meaningful for the organism, which implies practical engagement and integration with other sensory modalities. Language and music are analyzed as forms of domestication of sounds, allowing for the constitution of shared, culturally situated repertoires. Auditory perception thus appears as multimodal, dynamic, and deeply connected to memory, attention, and affectivity. In the technical domain, the article presents a genealogy of hearing aids and cochlear implants, highlighting the shift from acoustic amplification to digital coding. The cochlear implant is described as a radical sensory substitution that imposes on the organism a new mode of functioning based on electrical signals and algorithms for selecting information. Although effective for speech intelligibility, these technologies tend to reduce the richness of auditory experience by privileging the distinction between useful signal and noise. The author criticizes the ideal of total automation of hearing, which ignores the interpretive, affective, and attentional dimensions of auditory experience.

Keywords: Human hearing; Perceptual individuation; Gilbert Simondon's philosophy; Cochlear implant; Sound experience.

I. The nature of hearing in context

Gilbert Simondon places the human organism — and human existence — in continuity with the biological realm. Individuation involves matter and form, anchored in a unified process¹ at the level of a system. Here, the generation of form-taking comes first because this complex is a metastable system. The system's internal resonance, through confrontation with its environment, is a condition for the development of its potentials. Simondon compares the artisan appropriating a material to the subject facing the constraints of its material condition. The first challenge for any organism concerns its orientation toward resources conducive to its development and the avoidance of threats to its integrity. Likewise, we are constantly caught in a necessity of form-giving that holds both terms of the relation: organism and environment. That information is transmitted ultimately says nothing about its practical

¹ Simondon, G., 2005, *L'individuation à la lumière des notions de forme et d'information*, Grenoble, Millon, p. 61.

usefulness for the organism concerned. This is where Simondon opposed the theory of information with an appeal to meaning through the practical engagement of the organism with such a resource.

The relationships between the solid elements of the ordinary world are founded on harmony². The volumes, formally tetrahedral, are elastic systems in equilibrium. Their excitation by an impact or by the resonance of another nearby structure provides the organism, equipped with mechano-sensitive cells, with clues that enable alertness and then analysis of the movements involved. These are the external auditory organs, but also our general sensitivity to movement³, *via* our inner ear, to the conditions of balance of our organism within its immediate environment. This combination of numbers and material structures has attracted the attention of all authors ever since. This is the question of acoustics, the dynamics of structures, the mechanics of objects, and architecture. Instead of being mere receivers, sound signals reveal the core of structures in reaction to different modes of excitation and resonance. They carry the potential for an organism to make sense of what is set in motion around it.

Many living organisms have the ability to signal themselves, but also to signal the presence of a third party to others, whether of the same species or a different one. Our walks in the forest, or even often in urban areas, bear witness to this when a dog or a bird signals our presence. These informational signals help to spread intelligence that has a collective value of alert or opportunity, depending on the organisms concerned.

It is also necessary to take into account the specifically linguistic register. The proper reception of human language is subject to numerous constraints of intelligibility. The masking of voices in ordinary situations is a major difficulty that we often overcome through a kind of puzzle-solving⁴ and by correctly identifying each speaker's voice. Communication and information through language constitute only one part of the mechanisms of human hearing. The situation of the organism within its environment, or environments of existence, is primarily one of weighing multiple alerts awaiting meaning. Opportunities concerning a living being must be considered in terms of potential, which cannot be determined by any external authority.

Simondon evokes the notion of an *auditory image* to refer in particular to the terms of language and their grouping in ways conducive to memorization⁵. This is a mnemonic dimension as long as writing does not so easily guarantee the recall of words and expressions. However, music then occupies an important place. In the same way, it is the guarantee of redundancy that enables memorization. For language and music, the image would be accessible because it is domesticated. More precisely,

² Simondon, G., 2010, *Cours sur la perception*, Paris, Éditions de la Transparence, p. 14. *Geometric numbers* physical characteristic numbers according to Simondon, from Pythagoras onward.

³ TMHS, 2012, "TMHS is an integral component of the mechanotransduction machinery of cochlear hair cells", in *Cell*, vol. 151, p. 1283; Berthoz, A., 2013, *Le sens du mouvement*, Paris, Odile Jacob.

⁴ Cherry, C., 1953, *On human communication*, Cambridge (MA), MIT Press. *Effet cocktail party*, common distinction in the psychoacoustic literature cited by Simondon 2010, p. 92, voir Bregman, *ibid.*, p. 529–530.

⁵ Simondon, G., 2014, *Imagination et invention*, Paris, Presses Universitaires de France, pp. 114–115.

music and language proceed from the appropriation of sounds, thus making it possible to easily share a repertoire. This repertoire is a common domain of hearing that varies according to cultures⁶.

The audio-phonatory coupling is relative when it comes to identifying sounds in the environment⁷. It is insufficient to domesticate the sounds of our surroundings, since their discrimination by the ear far exceeds the motor capacities required for their reproduction. However, we can rely on their evocation, as made evident by certain sound colorations in poetry or in oral expression through onomatopoeia and phonatory expressiveness. Simondon more broadly considers the sensory image insofar as it refers back to motor activity. These images most often turn out to be mixed⁸ (what we would today call multimodal), as they are composed of several senses.

Albert Bregman developed, with the concept of Auditory Scene Analysis, an authoritative theoretical and methodological framework. Its principle is that the listener organizes the entirety of the scene by grouping impulses into different streams. These streams operate through grouping and dissociation of cues based on proximity and regularity of various parameters. These abilities are linked, first, to organic primitives, but also to schemas acquired through experience, adaptation to a biotope and beyond that biotope⁹. All of these processes can be viewed as automatic processing; however, they can also be approached as decision-making architecture. Both approaches benefit from being considered together to best address this multifactorial resource.

II. Technical genealogy of sound devices and techniques

A person with a hearing disability bears the burden of shaping their environment in a particular way. They are, in fact, removed from direct engagement with external phenomena. When they can integrate external devices that promise access to a condition of normality, they face other difficulties in their relationship with others. The impaired organism is placed on the margins of the richness of ordinary interaction and thus finds itself in a situation of insecurity.

The development of hearing aids has been marked by technological breakthroughs. Today, it has reached an industrial phase that encompasses, within the same logic, the two types of aids mentioned: (a) prosthesis, (b) auditory implant. Even though the two approaches address different cases: people who still have hearing ability and those who no longer do, they are treated similarly from a technical

⁶Helmholtz, H. von, 1954, *On the sensations of tone as a physiological basis for the theory of music*, New York, Dover.

⁷ Simondon, 2014, Ibid.

⁸ Id., p.117.

⁹ Simondon, 2010, p.89-91

and fundamental research perspective.

Amplifying the relevant characteristic of the signal was already at work with acoustic horns, which made the disability visible. There is continuity between contemporary hearing aids and these older devices: both are based on the selective amplification of a portion of the signal to facilitate its processing by the aging organism suffering from the destruction of the hair cells critical for processing ordinary language.

The phonautograph, the first device for graphically recording impulses, is a major invention in the history of sound analysis and synthesis. It introduces transduction beyond simple amplification. This device transforms an acoustic signal into writing by means of a stylus. From writing to the convention determining its equivalence, one more step is needed, which leads from analog to digital techniques. We move: (a) from the physical characteristic to its strict definition, (b) from the thermodynamic continuity of a process to its formal decomposition, (c) from its strict material attachment to its multi-realizability through coding¹⁰.

Thus, the cochlear implant is not strictly an addition: it is a radical sensory substitution. It differs from the natural hearing apparatus by imposing an entirely different functioning that mimics the ear to directly convey the effective signal via an electrode array located in the tympanic ramp, then reaching as close as possible to the cochlear nucleus to impose electrical signals. These electrical signals correspond to an initial stage of capture via a microphone, their transmission to a processor that determines an algorithm for selecting and compressing relevant information and organizing it to ensure the greatest usefulness for the implanted person. The equipotentiality of neural circuits allows the functional reception of any type of signal, provided that the transmitted information is preserved. The shift to digitization enables the free imposition of any signal in any form. Adjusting the cues to guarantee the best verbal exchange means a transformation of the design axis. Automation would make it possible to delegate the function of hearing to a new organ, one that is entirely artificial. The merit of the code lies in overcoming the difficulty of noise inherent in any electrical transmission.

Let us note that where functionality is concerned, the more accurate question would be not only that of processing, but also of interpretation. The critical dimension lies in the behavioral and psychological integration of these technical externalities as a complement and continuation of our organic functioning¹¹. In more contemporary terms, the integration of technical instruments as an extension of our mind and body¹² is a major issue for understanding and projecting our future functioning as a social, political, and ecological body.

¹⁰ Pascal, F., 2014, "Esthétique et utilité", in Dallet, S. (ed.), *Esthétique et technologies contemporaines*, Paris, L'Harmattan.

¹¹ Simondon, (2005, p.206) raises the problem of ontogenetic and phylogenetic integration.

¹² Clark, A., 2006, *Supersizing the mind: embodiment, action, and cognitive extension*, Oxford, Oxford University Press; Clark, A.; Chalmers, D., 1998, "The extended mind", in *Analysis*, vol. 58, no. 1, pp. 7–19.

III. Technology of the future?

Future technologies, according to Simondon, are directed toward the care of individuals. However, the way implants and prostheses are developed and marketed follows the dogma of automating processes aimed at making human speech as intelligible as possible under all conditions, with the greatest ease and utmost discretion. This presupposes the best possible distinction between useful signal and noise.

At the forefront of prescribing hearing aids is the prevention of social isolation. Withdrawal and self-confinement quickly become a defense strategy for people at risk of deafness. As receptivity declines, repeated failures tend to continually diminish their understanding of everyday life. This is the main factor in cognitive aging and neurodegenerative diseases. The loss of interaction equally reduces the ability to understand oneself. The presence of interlocutor groups in people's daily routines is a key to their 'mental health.' These accumulating factors explain the overall cognitive deterioration and the resulting fragility of the social person¹³.

Developing digital technologies in which the definition of the "message" allows it to be applied to a code has the advantage of freeing the transmission of said message from the constraint of noise. The organism's dynamic quest for information is thus minimized or even eliminated, as it is deemed inherently unattainable. This principle of implant development is imposed as a model for devices. Adopting either approach has the primary effect of radically blurring the ordinary "vocabulary" of auditory phenomena. Following Simondon's analysis, it must be said that the individual effectively loses the mental images¹⁴ that constitute the ordinary basis of their relationship with their environment.

From the perspective of the engineer and the device manufacturer, the main task is to ensure the correct and easiest possible reception of ordinary linguistic exchanges. However, several major criticisms can be raised.

First, this function disregards the dynamics of attention in the apprehension of the artifact. The knowledge factor is erased in favor of habituation to the receptivity of a "message" *via* a specified information channel. Implanted patients who are experts and tasked with explaining their extraordinary performance have all emphasized their rejection of automation¹⁵. It is the ability to adjust relevance through the effort of dynamic focus that enables adaptation to the variety of situations. Training

¹³ Antoine Hennion has very thoroughly documented people's attachments in order to describe and understand the situations of elderly and/or isolated individuals. Cognitive disability mixes abilities and affects because health is linked to people's capacity for exchange within their social and family environments.

¹⁴ *id.* 2014, p.112

¹⁵ Results from study workshops with expert implant users carried out with the assistance of CISIC as part of an R&D project; from testimonies of prosthesis users during the 2015 National Hearing Days; and from interviews collected with the association MyHumanKit between 2018 and 2021.

in signal sorting promotes the development of its *affordances*¹⁶.

Next, all of the determining factors assume a caricatured understanding of language and linguistic interaction. The clear distinction of linguistic signals from others ignores how many significant sound manifestations relevant to linguistic exchange in real situations are unattainable. The relevances commonly established within communication situations go beyond the strict framework of exchanging statements. Prosody, postures, and more or less reciprocal forms of address determine what is said in relation to the context. The overlaps of reference frameworks enable understanding and adjustment between people in daily life. This is also the spice of *concrete communication situations*¹⁷. Implanted and aided individuals are therefore placed in an extremely abstract position with respect to the emerging meanings within ordinary exchanges¹⁸.

Finally, let us return to the affective dimension. Utility cannot be opposed to aesthetics¹⁹. An experiential situation will motivate a dynamic understanding. One implant recipient recalls a deeply distressing episode. The source of intense suffering turned out, upon examination of the signal's characteristics by the designers involved, to correspond to a family of high frequencies that had never been accessible to the individual²⁰. Once the nature of this signal was revealed, their perception was completely transformed, granting access to a level of meaning. This pain was converted into affordance. The dynamic of "*the effect it produces*"²¹ is thus closely linked to the benefit of cognitive potential.

That the aided person can be placed in a situation of failure calls for another approach. Support that takes into account the ecological constraints of individuals would address the *effects* imposed by the activation of the prosthesis or implant. By distinguishing or grouping waves into streams, establishing continuities between different signals makes it possible to follow the unification of a certain "sound", to identify the components of an actual event. Here, different determinants intermingle to form sequences and thus represent courses of highly diverse events. Now, musical composition works precisely through the weaving of combinations and dissociations accessible to the listener according to different competing criteria.

The technical ambition to standardize individuals' dynamics in relation to their environments according to predefined scenarios is a reductive task. It stems from a tendency

¹⁶ James J. Gibson (1966) developed this concept to refer to the sensory opportunities that support the organism along a favorable path with regard to its conditions of survival and flourishing.

¹⁷ John Perry and Jon Barwise, within the analytic philosophy tradition of semiotics and computer science, position their analyses at the intersection of contributions from J. J. Gibson as well as the Palo Alto school led by Gregory Bateson. One should also mention here the foundational work of ethnomethodology and linguistic anthropology for properly grasping the functioning of spoken language in practice.

¹⁸ Let us note here the gap between concrete linguistic practice and approaches to language reduced to the coding/decoding of messages or meanings conveyed from the lexicon through syntactic normativity.

¹⁹ Pascal, F., 2014, "Esthétique et utilité", in Dallet, S. (ed.), *Esthétique et technologies contemporaines*, Paris, L'Harmattan.

²⁰ Chorost, M., 2006, *Rebuilt: how becoming part computer made me more human*, Boston, Houghton Mifflin.

²¹ Helmholtz, H. L. F. von, *Ibid*.

to confuse the organism's dynamic functioning with the programmed execution of an automaton that would replicate them.

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