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Listening and musical acoustics...

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- 1 I meet with Michèle Castellengo in her small apartment in the 11th arrondissement in Paris. Before we start the interview, she shows me her beautiful clavichord and plays a passage from a piece by Ligeti she is currently working on, passionately evoking her encounter with the world of baroque instruments, before moving on to the subject of our meeting: listening.
- 2 Michèle Castellengo is a key figure in musical acoustics in France, alongside Émile Leipp. She is the head of the LAM (Laboratoire d'Acoustique Musicale), and also teaches other musicians.
- 3 **Anne Sèdes:** I try to approach listening as a human, social activity. I observe listening with regard to what we are as living beings, to the physiological singularity of each human being. We are all unique, down to the physiological make-up of our two ears, our brain, our body and our constructions, while interacting with the physical world and the community of humans. Listening also means “lending an ear” to listen together, to understand together, to build something common, something shared, something that makes sense. It is a question of sensibility and knowledge, that can be strictly musical; it is also a professional question, that develops through learning to play an instrument, or working in a studio, through immersion in styles and listening communities. Your journey is that of a musician who pivoted into musical acoustics, always examining that tension, the gap between the activity of listening and the way musical acoustics describe a sound, said to be musical, with unerring scientific rigour. In 2015, you published *Écoute musicale et acoustique* at éditions Eyrolles, a substantial work that included 420 sounds and their spectrograms. This book was the fruit of a life's work of research dedicated to the examination of the gap between listening to sounds and the way the physical and psycho-physiological sciences try to understand or measure it.
- 4 **Michèle Castellengo:** This book came about, above all, as a result of a teaching method. I would not say that I invented it, but it didn't exist in that form previously. Obviously, I

was inspired by Émile Leipp's work, in other words, the possibility of simply presenting notions of acoustics to musicians. However, Leipp was, first and foremost, a violin-maker who was essentially interested in instruments. He was more oriented toward understanding physical phenomena, and he explained them very simply to the musicians.

As a musician myself, I could never understand why I was being told about the quality of sounds without actually listening to them. My work began at the Centre National de Télé-Enseignement that already had a mimeographed class in the archive that Leipp had written. I reworked it and made about three hours of sample sound tapes so that students could listen to the sounds. I found myself developing all of these questions about listening when I had the chance to teach at the Conservatoire de Paris. Musicians would come in with their listening knowledge, with their incredible experiences. However, as soon as we broached the subject of musical acoustics, frequencies, harmonics, they would panic and clam up.

So, I would start off by listening, and letting them hear a sound, an extract, and then I would ask, unexpectedly: "what did you hear?" To begin with, answers were not forthcoming... then someone would give one, immediately followed by another who claimed not to have heard that, but something else, then a third would pipe up, and so on. It goes to show how diverse listening experiences can be. The ear is not the answer. It comes from something else. Listening means looking for information, or more to the point, looking for meaning. Each individual looks for what they are interested in, either because they have been directed there by listening strategies from childhood, or because they have personal motivations. Whatever the case, when we collected all of the reports from each person, we found we had accessed a wealth of information. So often, we are confronted with educators who are interested in perception who say "you will hear... I will let you hear", and then we hear the harmonic of such and such... So be it, but we don't ever know what other people hear, and that has bothered me all my life, since childhood...

5 **A. S.:** How did this interest in music listening manifest itself?

6 **M. C.:** I started playing the piano as a child and after a while, I developed perfect pitch. I could hear musical notes, and could name them, and I couldn't understand why other children couldn't hear them. At summer camp, I would write down the melodies I heard around me... At Lycée Lafontaine, my classmates had problems with musical dictation, but could hear chords or themes. I could only hear notes, and nothing else. I was extremely poor at listening! Everyone told me I had an exceptional ear, except having perfect pitch seriously conditioned my listening. I began to question musical dictation. Perfect pitch is all very well. My classmates that heard the dictation cleanly, but a half tone lower, got zero marks. I thought that was stupid, it really made me think.

Later on, I took an interest in listening tests... I was destined to be a teacher, it was important to get children into music, not necessarily by making them listen to notes. I taught for two years, but I was really interested in research. I had discovered musicology and I signed up to do a doctorate at the Sorbonne with Jacques Chailley, and that is when I joined the LAM, the Laboratoire d'Acoustique Musicale which was run by Émile Leipp.

Staying on the subject of listening, I remember that in the fifties, my father brought home a small tape recorder which was relatively rare for the time, and at the age of fifteen, I heard the sound of my own voice for the first time, which was quite surprising. I remember having a small transistor radio and I would stay up listening to

voices from all over the world, I preferred them to the voices around me... I remember when I was a student, to make some extra money, I answered a small ad from a record producer, who was looking for musicians to listen for faults in recordings. I sat a test and didn't get the job! My so-called perfect pitch meant that I didn't listen for faults, I didn't hear them; I listened to music, I hadn't learned what it was to listen for problems, for faults in recordings. Then I also had to deal with deafness in some of my elder relatives...

All of these small hints, these little flashes, led me to listening as a topic to study, myself relative to others, others relative to myself, what they listen to, how they listen. And throughout my career, I worked on that extensively with my students, and I learned so much from them. Why is it difficult? Like you said earlier, we are all different, we can hear a sound and talk about it... but it has already disappeared. Sound is temporal. It is a completely different world to that of representation through images. The image is there, I watch the needle moving, and we can talk about it. This leads straight away to complicated issues around memory, what did our memory retain, why do we retain some things and not others? The thing is, we cannot separate listening from the cognitive, from the person listening, it is interesting to have information from the ear, but in fact it is a loop that begins with a subject. This is how I became interested in what today, we would call the cognitive sciences that, at the time we called psychophysiology. Psychology calls into question an entire philosophical tradition where it was considered that our senses were made to grasp the world... To be a good subject, you needed good eyes, good ears... to see, to listen, was to be a receptacle. We studied perception through sight. It was stable, it didn't budge, we could talk about it, develop a conversation around an object that is there, on the table. Then we extrapolate, to touch, to listening.

Today, with phenomenology, the cognitive, ecological approach takes us the opposite way. The sense organs are for grasping senses in the outside world, to capture what is going on, to find out if anything is dangerous, if there is something interesting, to find food, find nice things, etc. There is always a motivation when we look, when we listen, given that we are conditioned as living beings attempting to be in harmony with their environment. The motivation builds, develops and refines itself. Listening to a sound is the same thing.

7 **A. S.:** The problem then, is to be able to talk about it...

8 **M. C.:** Yes, we attribute qualities to sound, but all of the vocabulary around it is polysemic, borrowed from vision (clear) or from touch (soft) or from taste (bitter). The only vocabulary that is specific to sound is that of physical acoustics.

For me there are two completely different worlds, the physical world, we can describe with the tools of science, and the world perceived by humans but describing is not really the problem. We should really ask, what makes meaning for the person? The person initiates the act of perception, and does so with motivation: they listen to this, and not that. So, making meaning takes us into the realm of phenomenology; I will recognize a car by its sound, but not because I am measuring frequency or amplitude or anything else. Perception cannot be measured by parameters. Acoustics can describe all the parameters of sound, and psychophysiology can describe all the parameters of the treatment of the signal. But once it goes to the brain, meaning takes over for each individual, in each situation. Perception is a world where we constitute categories and references that make it possible for humans to locate themselves in their world. We carry out acoustic analysis in the laboratory, and it has to be done, and perhaps we can

get to the cognitive down that path. But when you work with musicians or listeners, who are living beings, their approach to listening and all senses is incarnated in a lived, bodily experience that is filtered through desire and knowledge and not through the analysis of parameters... except when one is a composer, but that is a separate case, a separate situation.

- 9 **A. S.:** Listening is an activity for the living... in these times of ecological crisis, could we extend that notion to animals, and plants?
- 10 **M. C.:** Em, I restrict listening to sound. Listening to what sound? Can trees hear? That means extending the senses... or we could talk about affordances, but I am in the world of sounds... in terms of the sounds in our environment, we are no better than the animals, cows or bats. We are not looking for the same thing, animals look for what makes sense to them. A cat who runs when you open the fridge doesn't do an acoustic analysis of the door; he memorizes the spatiotemporal form of the sound, it makes a sign: you open the door, and it comes!
- 11 **A.S.:** We could outline sound in temporal terms. On a physical level, we are still dominated by the representations of sound in terms of frequency...
- 12 **M. C.:** Yes, on the one hand there is musical theory, but it never works, we can go in any direction... Then, in 1722, Jean-Philippe Rameau tells us that the harmonic 7 cannot give us an "agreeable interval"¹. But to call that a "musical theory of harmony"... When physicians began to discover and mathematise harmonic function as with Fourier's series², they thought that it would allow them to describe the tone of musical instruments. Hermann von Helmholtz³ uses it, but what could the poor man, who should really be rehabilitated, use to produce sounds to study? He only had resonators, harmonic analysers, that needed an ongoing sound, that didn't stop. Helmholtz did outline the importance of attack transients, without being able to prove anything, and could not resolve himself to studying the stable part of the sound, on the model of organ sounds. It followed that in acoustic class, for almost a century, tone became synonymous with "harmonic content of sound", or spectrum.
- 13 **A. S.:** Out of time... On the subject of the micro-temporality of the attack transient, we had to wait for recording and digitally synthesized sounds to make work on the subject, notably by Pierre Schaeffer⁴ and Jean-Claude Risset⁵, possible.
- 14 **M. C.:** Musicians already knew, through practice, how important the attack transient was: we are sensitive to newness, to change, the beginning of a sound is essential. In my work, I have often relied on Husserl's work on the phenomenology of perception. In "*Leçons pour une phénoménologie de la conscience intime du temps*" (what a great title!)⁶, he takes the example of a melody. So, the act of listening is made up of memory, expectation and reconstruction. A melody only exists in time, we listen to very short moments, instants of presence, before the reconstruction by the listener of the phenomenon as a whole intervenes; the before is what we have in our memory, the present and the afterward is what we anticipate. In the act of listening, memory is unique to each individual. Their perceptive capacities in the window of the present are their own.
The notion of objectivity was the tragedy of scientific development in the 19th century. The attempt to outline general rules that would apply to all meant the development of laboratory tests to explore physiology, but it was to limit experimentation on stable sounds; we developed ranges of sounds adapted to experiments, but on phenomena

that did not correspond to usual listening practices. We should have taken into account the fact that listening is an act, in time.

- 15 **A. S.:** Yes, and this is why many musicians and researchers linked listening to the enactive approach to cognition introduced by Francesco Varela⁷...
- 16 **M. C.:** Yes, it is very interesting. Getting back to multi-scale time, when we listen to music, we can change scale, according to our motivations, from one instrument to another, our scales of time and listening are completely personal, which explains that there is no limit to the amount of times we can listen to a well-written, multi-layered piece of music. Each time we listen to a different world, and when we discover pieces by composers like Helmut Lachenmann, who works on transitions, we enjoy them on a micro-temporal level, on the scale of the milliseconds that intervene in the transitions, as much as we enjoy listening to Wagner.
- 17 **A. S.:** In fact, this is the multi-scale, cognitive approach. Michèle, you also contributed greatly to the spectrographic visualisation of sound. Is this a way of objectivizing musical listening?
- 18 **M. C.:** A spectrogram is an objective medium; it is the *Gestalt*. It is, in fact, used to analyse electroacoustic music, and badly, in my opinion. You change time scale, display scale [and the result is altered] ... with spectrograms, I wanted to show what I could hear. Sometimes it took me a week to finalise a spectrogram. These days, I think it's sad that anyone can just press a button. The time scale should not be regular, it should reflect the way we zoom in at the start of a sound [when we hear the transitions]. We miss out entirely on what we should see, as the graphic, linear temporal scale does not correspond to the way we listen. It is a physical representation.
[In the interaction between listening and seeing], for me, the use of Audiosculpt⁸ software was revolutionary. My first experience at the IRCAM in 1978, as a guest of Jean-Claude Risset, allowed me to develop an almost daily form of analytic listening process, as an acoustician. We have to make the connection between what we hear, the physical representation of an image and what is in the sound.
- 19 **A. S.:** What about the musical use of spectrograms, I believe your exchanges with Gérard Grisey were decisive for spectral music⁹... Could you elaborate please?
- 20 **M. C.:** At one point, Leipp was teaching at the Conservatoire de Paris, or more exactly, students were coming to the laboratory. The GAM (Groupe d'Acoustique Musicale...) would hold meetings. In the end, word of mouth brought attendance numbers up to about thirty. This was the mid-seventies; I was in the process of finishing my thesis. One year, Grisey showed up. Grisey was researching acoustics, he read German, he had bought the textbooks in German, as well as Leipp's book. He was looking for spectrograms and Leipp sent him to me. I had two or three binders with images and I used to say "they're of no use, they don't come with sound". I will never fall for that... spectrograms only ever make sense with sound... "it doesn't matter" Grisey used to say. Maybe I gave him some trombone spectrograms. A number of composers asked me for spectrograms, so I would give them documents that I had no use for. But Grisey went much further. So, in the end, I told him to come back with musicians, if he wanted to. We made a real connection. He was going through a phase where that was what he needed. He had already composed some things, and he was working on others. He needed a sort of dictionary: mufflers, trumpets, trombones, we did chromatic scales, I made spectrograms, at the time they could only be 2.4 seconds long. Then very soon after, I worked with the double-bassist Joëlle Léandre, we went to

her house and asked her to play all kinds of things. I was thrilled. I had been dying to work with musicians! I still have all the recordings... We find all of that in *Espaces Acoustiques*, in *Partiels*. And then there was *Solo pour deux*, based on my study of multiphonic sounds when I was at the IRCAM¹⁰.

I have already mentioned this work in a number of conferences, I should publish it one day, put it online...

NOTES

1. Michèle Castellengo, *Écoute musicale et acoustique*, Eyrolles, 2015, Paris, p. 261.
2. Joseph Fourier, *Théorie analytique de la chaleur*, Paris, 1822. Réédition Paris, Jacques Gabey, 1988.
3. Hermann von Helmholtz, *Théorie physiologique de la musique fondée sur l'étude des sensations auditives*, Paris, 1874.
4. Pierre Schaeffer, *Traité des objets musicaux*, Paris, Seuil, 1966.
5. Jean-Claude Risset, *Computer study of trumpet tones*, Bell Telephone Laboratory, Murray Hill, 1966.
6. Edmond Husserl, *Leçons pour une phénoménologie de la conscience intime du temps* [class – academic year: 1904-1905], Paris, PUF, 1964.
7. Francisco Varela, Evan Thompson and Eleanor Rosch, *The Embodied Mind, Cognitive Science and Human Experience*, Revised edition, The MIT Press, 2017.
8. Audiosculpt V2.9 copyright 1995-2010- IRCAM.
9. Gérard Grisey, *Écrits*, new edition established by Guy Lelong in collaboration with Anne-Marie Réby, Paris, MF, 2018. This revised edition includes two letters from Gérard Grisey to Michèle Castellengo.
10. Michèle Castellengo, *Les sons multiphoniques aux instruments à vent*, IRCAM/DGRST report, 34, Paris, 1982.

AUTHORS

MICHÈLE CASTELLENGO

After studying music and musicology, Michèle Castellengo joined Émile Leipp's Laboratoire d'acoustique musical (LAM), where she did a thesis under his supervision. In 1982, she joined the CNRS and became the director of the LAM. Her research focuses on the acoustics of flutes, organ, sung voice and, more generally, the perception of musical sounds. She created in 1989 the classe d'acoustique musicale of the Conservatoire national supérieur de musique et de danse of Paris and ran the Atiam master (Paris 6 / IRCAM / SupTélécom) from 1999 to 2003. She is now director of research emeritus at CNRS. An author of numerous publications, her book *Écoute musicale et acoustique*, published in 2015 by Éditions Eyrolles, is a remarkable presentation of her work,

devoted to measuring the gap between the listening activity of sound and its scientific description.

ANNE SÈDES

She is a professor in the music department of Université Paris 8. Undisciplined, her research focuses on computer science and music creation, mixed composition, virtual environments and creation, spatialization of sound, music and cognition, the creation of research activity, be it musical, organological or software, and finally the epistemology of the sciences of art.

She has been involved in many projects such as "Creating sound spaces" (Young researchers project 2003-2006), "HD3D" (Cap Digital, 2007-2010), "Virage" (ANR 2009-2010), "HOA Library (Labex-Arts-H2H, 2012-2015), "Musicoll" (ANR, 2016-2018), "Infinite Body" (Labex Arts-H2H, 2016-2018).

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