

Listening to Acoustic Energy and Not Hearing

By Maria Blondeel

I am an artist working in the field of sound art. After studying painting in the late 70s, I became fascinated with audio and visual technology. Since then I have worked on artistic experiments that are intrinsically connected with the lapse of time as visualized through sunlight, as well as through changes in light as day becomes night. I use sonification to obtain insight into this complex visual process. I have devised an electronic system that allows me to turn visible light into audible frequencies ranging between 60 and 16,000 Hz (sound waves), using photoelectric resistors to modulate the frequency of square waves. The generated pitch rises with the intensity of the light falling on a sensor. Fading light, in contrast, causes the pitch to drop to a point where it converts into clicks. I have experimented with the sonification of light in both urban and rural environments. In most of the site recordings I have made, particularly at night, electric light has a major impact on the sonic image. When using wireless systems and radio waves I often noticed interference from other sources. I became interested in waves that lie beyond the range of sensory perception as pollutants of the contemporary environment and in their influence on people.

Since 2002 I have suffered from a moderate noise-induced hearing loss, with a noise notch at 4 kHz and permanent tinnitus (see also the article “Tinnitus and Sound”, p. 15 of this Journal). Because of my artistic sound work and my participation in numerous intermedia productions I have operated for many years in continuous sound environments. There were often high work-stress levels, late nights, and a lot of car driving. And I exposed myself regularly, though not always voluntarily, to excessively loud music. Owing to damage to the hair cells in my cochlea the external sounds, though received, are not adequately transmitted to my brain. Whether scientifically correct or not, I imagine the damage as a vacuum preventing the transmission of external vibrations to my hearing brain. Initially I experienced the tinnitus, which is a consequence of this damage, as being external in origin. And, possibly because I work with the sonification of light, I imagined it as some sort of radio wave—something like an electromagnetic field. In my listening experiments I even

tried to shield myself with metal in order to make sure that my inner sounds were not external radiations (the Faraday shield, see self-portrait on page 23).

A lot of research has been conducted in the past century into hearing impairment, tinnitus, audiology and neuro-otology, and there is a significant amount of interesting literature available, both in print and on the internet. My own research stemmed from a purely artistic interest in listening to the acoustic energy within our hearing range, which I am no longer able to hear completely. For my experiments I searched for silence, in spite of the fact that I find silence unbearable—because it is in silence that inside noise attains maximum clarity. In a silent environment I can hear only that and thus can listen to it best.

I can best describe my tinnitus as multiple frequencies without simple mathematical ratios. Our ears have the fascinating capacity to perceive sound waves and vibrations and to transform them into information that our brain can understand. But I cannot find an acoustic equivalent for the inner sound they produce. I imagine I am hearing my own bioelectric activity in my hearing brain, 8 kHz/65 dB, 4 kHz/50 dB, 2 kHz/35 dB, 1 kHz/30 dB, 500 Hz/15 dB and 250 Hz/10 dB. Right and left have a different fundamental and seem to have two separate sources. But that is not where the sound is produced; it is where I hear it. I hear numerous frequencies and they can behave very differently. I can also hear them stereophonically, in which case I hear patterns with continuous minimal shifting, like *moiré*. I would compare the sound with an electronic sound wave, like a sine wave, but a very complex assemblage of sine waves. I have tried to reproduce it with my square-wave generators but very quickly came up against my hearing impairment. When I find a frequency that comes close to what I hear inside and try to fine-tune it, it will always either sound too low or disappear on the loudspeaker, out of my hearing range.

In the area where I live there is a pond, protected as a natural reserve, where birds and waterfowl come to breed. It is surrounded by a 2-km path. West of the pond there is a motorway intersection (A10, E40) and, when the wind comes from the west, which is often the case, the hum of the vehicle engines pervades the area. The intensity of the traffic noise matches the loudness of the sound inside my head. Both are between 30 and 50 dB, but the

frequencies are quite far apart. My tinnitus is at its loudest between the highest audible frequencies and 4 kHz, fanning out and diminishing in intensity down to a soft 250 Hz. The sound of the motorway traffic peaks between 50 and 100 Hz, with some surges up to 2 kHz and occasional higher frequencies from a siren.

Last year I started learning to listen with two digital hearing aids. For a period of ten months I had the opportunity to compare different brands, which is a little bit like choosing between different microphones and loudspeakers for a recording studio, except that it is for my head. At first I experienced my hearing aids as a highly technological instrument allowing me to understand voice again and providing me with an accurate perception of sound levels. It became a digital extension of myself that I can switch on and off. And I still have the impression that now I can in fact open and close my ears. In most situations, without this device, I rely on lip reading and body language to be able to understand speech. I wear the hearing aids all the time and only remove them for sleeping. It does help, but most of the higher pitched sounds above 6 kHz remain inaudible. This is the range that matches the sibilant sounds inside my head.

I have four different settings for my digital hearing aids: two programs for speech comprehension and two programs for music audition. After the first six months I mainly listened using the music programs, in which the sound is amplified without much processing. I only use the speech programs when the surrounding noise is over 80 dB. I have looked very carefully at where I hit this level, and it happens more often than I would have expected: a busy office, heavy road or railway traffic, flushing the toilet, filling the bathtub, the ringing of a bell, a mixer, electric power tools, shouting, a busy supermarket or shopping centre, a bar, heavy city traffic, driving a fast car, a symphony orchestra, percussion, amplified concerts, a group of noisy children, an alarm.

I switch OFF: the harmonics disappear. I try listening to a low 20 Hz. I can hear an A” (27.5 Hz), A’ (55 Hz) sounds loud, A (110 Hz) still loud, a (220 Hz) sounds good, a’ (440 Hz) normal, a” (880 Hz) far too quiet. My hearing seems more focused on the low frequencies, which are perceived more richly than the middle range. The harmonics no longer cover the lower frequencies. Instead of the bass it is now the clarinet

and the voice that disappear. In the days before the hearing aids I slowly adapted, put felt underneath all the wooden objects that produced low, dull sounds and tried to insulate all the electrical appliances in the house as much as possible. I played music day and night. I listened with a different musical ear, hearing in a limited frequency range. Some tones I could no longer appreciate while others came to sound harmonic and pleasing to my ear.

I switch ON: much of my tinnitus disappears; only a thin layer of high frequencies remains. I hear a soft hiss. I hesitate: the microphone, the loudspeaker or the silence in the room? I switch to the second program, which has a compressor that modulates incidental surrounding sounds and reduces noise. The environment sounds quieter, and my tinnitus becomes louder and covers the hiss. I switch back to the music program. The surroundings are back, and the hiss is gone. My subjective experience alters the way things sound. After a while the changes I am able to make to my hearing with the hearing aids are exhausting. The first week all the sounds I could hear again had a similar intensity. It seemed as if everything was amplified with a contact microphone. Objectively the difference in intensity between the various ambient noises is limited. After a time my brain arranged the sounds back into different attention fields. The sound level produced in the ear and the intensity of the sound that we consciously allow to reach the brain differ greatly.

Now I can again hear sounds from the distance, from behind the walls. Objects have regained their own sound, the tabletop sounds woody when I hit it, and whatever is on it vibrates gently. On the path around the pond I can hear the singing of the birds and the splashing of the ducks in the water. I can hear the rustling of the leaves in the wind. I can hear my own footsteps, crisp, in the gravel. I can hear the sounds of the wooded area, reflecting off the surface of the water, diffused by the wind. Through this layer, which I estimate at between 100 and 3 000 Hz at a level of 50 dB, I can hear the rumble from the motorway intersection in the distance. In the clearings it sounds louder and it resonates in the treetops with the rustling of the leaves.

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Shield experiment by Maria Blondeel / (Self-portrait)

The Faraday cage is a metallic shield designed to prevent the passage of electromagnetic waves.

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Emerging from Loss: Hearing Regained

By Randolph Jordan

At around 12 years ago I found myself attending an outdoor rock concert at Autzen Stadium in Eugene, Oregon, USA. I had recently turned 20 and by this time had been to many such events. While I generally found them to be too loud I was not in the habit of making consistent use of hearing protection. I was still engaged in a youthful notion of invincibility and figured that, like a sun tan, post-concert ear-ringing was only a marker of a certain level of exposure rather than an indicator of impending permanent damage. Of course we now know differently about the imprint of the sun on our skin, and I certainly know differently about signs of auditory damage.

One such audible sign I experienced that night in Eugene has had a lasting effect

on the way I have conducted myself in the world since. I was standing at what seemed like a reasonable distance from one of the speaker arrays. Though I was experiencing some discomfort I had a good view of the stage. So I decided to stick it out. This was a classic case of putting more trust in my eyes than in my ears. The array looked far enough away, but what I was hearing told me something else. This says a lot about my attitude towards concert going at the time. While theoretically there for the music, I was quite enraptured by the visual spectacle that accompanied the experience—perhaps too enraptured. It was in the midst of such overemphasis on the visual that my hearing was caught off guard. Suddenly I heard a crumpling/crackling sound in my left ear. In that brief moment the usual sharp snatches of auditory pain sometimes experienced at loud concerts seemed to yield to something a little more temporarily forgiving, but ultimately uncompromising. It was as if my ear was overdriven in a way in which—I would later realize—it was unable to recover. I wasn't exactly sure what to make of it at the time.

Ever since I heard that inner crackling I have been far less tolerant of sound coming at me from the left. Instinctively I began to turn my head away from loud sounds where in the past I would stand defiantly, aware of the pain but unwilling to make any corrective adjustments. I was disturbed at what seemed like an oversensitivity on my part, ever proud of my poker-faced exterior and always striving to shield my reactions from the world. Thus, the way I presented myself in public changed. I became slightly less domineering and a little more ready to bend with the breeze, albeit reluctantly. And this was the first stage of a long and gradual change in the way I would subsequently interact with my environments.

The world had become unbalanced, but only ever so slightly. I would wear headphones and start questioning obsessively why all the music I liked seemed to be mixed with an emphasis on high frequencies in the right channel. I even asked some music specialists if there was some known tendency among sound engineers to work this way. But for the most part I was given blank looks in return. I decided that my headphones were faulty and took them back to the shop where I had bought them. Although the owner couldn't hear the problem, he was accommodating enough to change the drivers for me. This did not help and I started to feel like a bit