A FORAY INTO WORLDS OF VIBRATION

In 1934, Estonian biophilosopher Jakob von Uexküll penned a provocative text exploring animals' perception of their environments, the translated title of which is A Foray Into the Worlds of Animals and Humans: With a Theory of Meaning. In this work, Uexküll details his theory of Umwelten: that all living creatures experience life in terms of their unique, spatio-temporal sensory-perceptual world, or Umwelt. In this context, animals are not simply responding blindly to stimuli, but actively interpreting the signs appropriate to them; actions that bring their world into being. For von Uexküll, the Umwelt (of human and nonhuman animals alike) is thus a species-specific subjective construction.

The Umwelt or subjective sensory world particular to spiders is very different from our own. As explored in the papers by Friedrich Barth (The Vibration Sense) and William Eberhard (Art Show) , the spider's primary means of perceiving and understanding the world is through vibration . Spiders lack 'ears' for hearing, and despite having eight eyes, web-building spiders have very poor vision. Instead, the spider possess specialised organs for sensing airborne and substrate-borne vibrations: trichobothria (hair-like extensions that cover the spider's legs), and slit sensilla, which afford the spiders an acute sensitivity to the vibrations moving through their Umwelt. These are sense organs for which we humans possess no recognisable cognates.

A vibrational sensory capacity is not singular to spiders. The study of substrate-borne vibrational communication in animals is a relatively new subset of bioacoustics known as biotremology , introduced in this reader via the text by Peggy Hill and Andreas Wessel (Biotremology), and explored specifically in relation to spider vibrational signalling in Peggy's text (Quiet Listening). Matija Gogala's paper (Sound or Vibration: an Old Question of Insect Communication) also explores this phenomenon of vibrational communication, situating it in the context of the history of studies of insect acoustic communication.

For web-building spiders (which number roughly half of all known species), their web is an instrument for vibrational communication –a vibrant and organic network of silk threads, whose architecture is acutely attuned to the vibrational tremors that pass through it: the signals the spider sends through the web to gauge its tension and structural properties, the signals sent by other spiders (potential mates, or predators), the vibrations produced by the spider's prey, or even the low frequency tremors produced by the wind. Without the web, the spider cannot eat, or gain an adequate picture of her surroundings. The sensory capacities of the spider are thus extended through the material threads of its web, which acts as a network for conducting the vibrational semiotics through which the spider's Umwelt takes shape. In the paper by Hilton Japyassu and Kevin Laland (Extended spider cognition), they take this relationship further, proposing that the web not only extends the spider's senses, but also it's cognition: allowing the spider to offload cognitive tasks to its web. The spider and web are thus a deeply entangled and living assemblage; what Studio Saraceno has come to refer to by the neologism: spider/web.

The paper by Beth Mortimer et al (Tuning the instrument) explores how vibrations travel within spider/webs, and examines the spider's ability to tune this instrument. With its sensitive legs resting on the silken, trembling threads of this web, the spider is thus already a musician; playing, tweaking and responding to the vibrations that travel through this floating material body. This observation of spiders as vibratory musicians is not new –as we can see in the 1904 paper by Fred Lahee (The calls of spiders), the 1905 paper by James Porter (The Habits, Instincts, and Mental Powers of Spiders), or the 1915 paper by William Barrows (The reactions of an orb-weaving spider), which notes the spider's reactions to the tremulations of a tuning fork, or a vibrating rubber band. The essay by David Toop (Filament Drums) further explores a tangled history of relationships between spider silk and musical instruments in other cultural traditions.

Ultimately, what these instruments provocatively explore is the possibility of interspeciecs communication; of opening up a dialogue of sorts with nonhuman animals, who have persistently been denied a meaningful place in our conversations. If our sensory worls truly are uncommunicating, how might we begin a dialogue? Is a conversation even possible? The possibilities and problematics of communication with nonhuman animals is further explored in the text by Vinciane Despret's (in U is for Umwelt), which return us again to Uexkull's theories of Umwelten. In this text, Despret proposes that –rather than seeing animals as beings in unique worlds, we might think of them as beings with worlds: worlds that are multiple, porous, entangled.

We conclude with an excerpt from Stefan Helmreich and Michele Friedner (When sound studies meet deaf studies), in which the authors raise the possibility that vibrations –which 'edge between tactilty and hearing'– are transgressive sensory intercessors, and thus might be capable of travelling between and interrupting different sensory worlds or Umwelten. Following this provocation forward, we speculate that perhaps vibration might be a way for us to begin a shared conversation with our nonhuman kin.

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A reader on the vibrational sensory world of the spider/webs

Yes, but how do they do it? For many people some of the most intriguing questions regarding spider webs center on how a small, nearly blind animal with limited brainpower can build such precisely organized, complex webs that have such uniformly spaced lines and such finely balanced tensions.

Perhaps it is easiest to appreciate an orb weaving spider's achievements if you put yourself in her place, and imagine what it would be like if you were attempting to build a new orb. To start, you must first blindfold yourself: the spider's eyesight is very poor, her eyes are on the wrong side of her body to see the web's lines as she hangs below them; and in any case she often works at night. Nor can she see any of the potential attachment sites, such as branches and leaves in her vicinity. The closest human analogy would be that of a blind man who must explore and climb through the tangled branches of trees on the basis of touch, leaving a silk line behind wherever he goes. And you will not be able to explore any of the spaces where you have been by swinging or flapping your lines, because the air is highly viscous at the scale of the spider; for a human, an analogous situation would be building a web of elastic ropes under water.

Finding and recognizing an appropriate site in which to build your web will be one of the most challenging stages. The supports to which you might attach lines are arranged extremely irregularly in space, and each site is different (the smooth rectangular frames that spiders used in this exhibit are NOT fair approximations to natural conditions). You cannot even sense the presence or absence of nearby attachment points or obstacles, much less their positions relative to each other until either you or your lines contact them. And even if you could have seen these objects, you will be unable fly to them, to shoot out your lines to reach them, or even, in many cases, to walk to them (imagine making a line between the widely spaced twigs on two different branches, or on different trees). You must instead depend on the vagaries of the wind; you will have to launch new lines, allowing their tips float away on irregular air currents, and hope that they will eventually snag on objects that can serve as supports for your web. As you discover attachment sites in this haphazard way, you will need recognize whether they border an open site that is sufficiently large to accommodate orb that you are planning, and whether this space it is free of further protruding objects that could interfere with your orb. You will need to adjust the area of the open space that you are planning to occupy in accord with the amount of silk you that have available in your silk glands (this will vary with how much you ate and how much silk you have spun recently). The space must not be too large, and it must have sufficient attachment sites on its perimeter that are all in the same plane, and this plane must have the slant (horizontal, vertical, in between) at which your particular species

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builds its orbs.

Once you have found a good site, there are many further challenges. You must determine the approximate center where you will place the hub (no peeking from behind the blindfold!), and you must clear away all the potentially distracting lines that you produced while you were exploring this area, but avoid removing any of the lines that you will need for the final web. You will have to adjust several of the design features of the web that you build, such as the number of radii and the spaces between the sticky lines, to the amount of silk reserves that you have, and you will have to adjust the overall form of the web to the positions of the attachment sites that you have found.. In fact, you will have to be quite extraordinarily flexible in your behavior, because many factors are known to influence orb web geometry, including climate (especially wind velocity and direction), satiation, growth stage (e.g., nymph vs adult, proximity of next moult), reproductive state (e.g. proximity of oviposition), and the presence of conspecifics. For instance, each one of the several hundred decisions on where to attach the sticky spiral to each radius that it crosses is known to be influenced by six or seven different types of stimuli (gravity, the distance from the hub, the distance travelled to reach the current radius, the length of your legs, your recent feeding history, whether or not you have built a web at this site previously, etc.). Happily, you have eight legs, and can execute several different tasks simultaneously! But this wealth has a flip side: you must keep track of and manage all of these legs at the same time.

You will have to make the thousands of decisions during web construction in a hurry (approximately 30-40 min), and without losing your concentration at any point along the way. At times you will be making a new attachment every second or less. Some decisions will also be complex in terms of the variables themselves; for instance, as you will need to have accurate memories of the distances and directions that you have moved recently; you will also need to sense the distances and angles between your legs when they are holding different lines, and to sense the direction of gravity. In addition to the mental challenges, there are the purely physical demands of orb construction. Calculations based on scaling an orb like that of the typical 1.2 cm long araneid Micrathena duodecimspinosa to the size of a human body (about 1.8 m long) show that you will need to build an orb whose sticky spiral covers an area about 45 m in diameter, with some support lines anchored to leaves and branches that are 150 m or more apart. The physical endurance you will need to build your web is not be trivial: you will have to produce > 2 km of line, and run about twice that distance in about 30 - 40 min. In building a vertical orb, you will have to climb something like 1 km upward, and an approximately equal distance downward. You will also need to adjust the tensions on all the lines as you lay them, and correct nd correct for the local distortions in the web that are produced by your own weight, so that lines laid later in the process do not cause earlier lines to go slack or become overly tight in the finished orb. Truly, when translated to human terms, a humble orb-weaver's daily achievement is spectacular! Appreciating these hurdles and achievements of a spider has its own intrinsic interest. But orbs also offer a window onto more general questions about what goes on inside the brains of other animals. Orb weavers have the potential to serve as especially useful subjects for a new wave of studies that explore the limits of the behavioral capabilities of small invertebrate animals, and that involve concepts such as animal 'attention' and animal 'errors' which are otherwise generally very difficult to study. These difficult topics are accessible because of the conjunction of several special traits in an orb: an orb web is an exquisitely perfect material record of the spider's behavior, and it is possible to store precise records of orbs because they are planar and can thus be captured precisely and completely in a photograph; the particular aims of a spider at different moments during the construction of an orb are often quite clear (now she is building a radius, now she is measuring with her front legs the angle between radii to see if an additional radius is needed, etc.); many processes are repeated over and over, so the precision of her behavior can be measured accurately; and the stimuli that she uses to guide her behavior are generally limited to those from her web itself, so it is thus possible to deduce them from the same photo. The evolution of different behavioral details can also be studied, because evolutionary homologies in the behavior of different species are also easily accessible. Our improved understanding of the how spiders organize their behavior to build orbs has them poised to lead new advances in the study of animal behavior that will get us closer to finally understanding age-old questions about what it is like to be an animal (other than a human).

Sound is the word humans use to describe airborne vibrations that propagate from a source and are detected by some sort of auditory mechanism. Sound, as we know it, moves through three- dimensional space, through the fluid of the atmosphere without being appreciably changed by the medium. A solid or liquid medium each filters the waves that move through it in ways that we often do not expect nor fully understand, but at the boundary of each with the atmosphere, waves in the soil or water transfer energy to the atmosphere and from the atmosphere energy is transferred back.

Spider webs are different, perhaps unique in the natural world, not only as the medium through which spiders communicate with each other, but likewise in the ways that waveforms propagate within the web. Even though the air on either side of the web is of the same density, temperature and pressure, the web does not represent a boundary between two media, such as between the solid earth and the fluid air above. Because the web is suspended in the atmosphere, the biotic features and intricate geometries of its structure allow the atmosphere to be continuous rather than being separated into compartments on either side.

What happens to the waveforms as they travel along the web threads contributes to the uniqueness of the web. Web threads are not all arranged in a series, where waveforms propagate linearly, to or from a central hub. Nor are webs fluid, like the boundary between water and air at the surface of a pond, so that waves can travel away from a point source in symmetrical concentric circles. The threads of a web intersect other threads in ways that are characteristic of the spider that builds the web, but the most unique quality of the web may be that when a waveform traveling along a radial thread reaches an intersection, the waveform not only continues linearly, but energy is also transferred laterally into the intersecting threads.

An orb-weaver then sits quietly on the web, patiently listening with one leg resting on a radial thread where longitudinal waves provide them with directional information on the source of the vibration. Beyond the surface, the airborne vibrations are transferred from the spider's web creating pathways of vibrations that are transferred back to the surrounding air, soil, and water.

The challenge and the reward for humans is to learn about a world filled with vibrations that carry meaning for other lifeforms with which we share our planet. Waveforms travel in air and water and Arachnid Orchestra. Jam Sessions Quiet Listening Contributed by Peggy Hill www.arachnidorchestra.org 2 the soil. They travel through spider webs and honeybee combs and the bodies of plants and other life, and many of them bear messages. Most of these vibrations are not sounds. They are not heard by stimulating auditory organs, but

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they fill our environment with a rich and lush chorus of songs and noises that are detected with other receivers. A signal is not less intense or meaningful to the dialogue by being silent. We simply have to think of the voice of silent singers in a different way. Will the quiet listening of spiders and other arthropods attune us to a universe that is filled with music, conversation and noise, but no sounds?

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A door opens; loud sound (anthropomorphised) enters to occupy a bounded space. The human notes this sound, assumes an effect of the ears, reacts quickly to unwelcome audibility. The door closes and sound is pushed back yet still enters through other means, by vibration of walls, ceiling, floor. This sound is transformed by the solid mass of a visible medium, filtered of its higher frequency components, now perceptible as a different kind of intruder, less aggressive perhaps yet more insistently pervasive as a body effect with greater psychological depth,an undermining of the fallacy that the senses are distinct from each other, their sources only processed through the organs of reception, the ears, nose, mouth, eyes and fingers.

There is some familiarity with the fact that non-human species communicate and engage within their worlds by highly specialised means such as electrical impulses, colour and light, chemical systems, scent, ultrasonic and subsonic sounding and hearing, echolocation and, in the case of spiders, vibration. The so-called courtship dance of a spider is described as follows in Animal Communication[1]. "This usually involves specific movements of the legs, palpi, and body. In some lycosids, special hairs or colored areas on the legs are erected. In some salticids, the color of the eyes changes." All of these complex effects combine with vibratory signals generated by percussive, stridulatory and tremulatory actions.[2] The resultant displays, as can be seen on amateur video examples easily found on Youtube – https://www.youtube.com/watch?v=Et--lFINQOM and https://www.youtube.com/watch?v=AZszAaJyVTc – may seem strange and disturbing reminders of what biophilosopher Jakob von Uexküll defined as the Umwelt, the environment-world or unknowable world in which each animal lives.

Perhaps they are beyond description for human language, yet the unknowability of worlds interlocks, as Giorgio Agamben demonstrates in his description of the relationship between spider and fly: "The two perceptual worlds of the fly and the spider are absolutely uncommunicating, and yet so perfectly in tune that we might say that the original score of the fly, which we can also call its original image or archetype, acts on that of the spider in such a way that the web the spider weaves can be described as 'fly-like.' Though the spider can in no way see the Umwelt of the fly (Uexküll affirms – and thus formulates a principle that would have some success – that 'no animal can enter into relation with an object as such,' but only with its carriers of significance), the web expresses the paradoxical coincidence of this reciprocal blindness."[3]

If there is a gulf, perceived or otherwise, between human and non-human animals, how might it be crossed? In 1971 I came up with the idea of Bi(s)onics, a means of working with sound inspired by natural environments and the animal world, particularly the phenomenon of bioacoustics. Bionics, the science of systems based on living things, was a talking point during that period, an embodiment of an imagined future in which humans would further extend their understanding and application of animal capacities (radar and sonar, for example) into realms of the superhuman. Bionics was not just futurology, however, since humans had been learning from non- human entities and biological processes from the beginning. Evidence of intimate connections between human and animal can be seen in rock art, more specifically in music through the Hohle Fels flute, made from the wing bone of a vulture and dated back to 35,000 years ago and the Divje Babe flute, made from a cave bear femur, more controversially dated back to c. 43,100 years ago.

This has been a rich, continuous history. Working in Nigeria in 1930, Professor Henry Balfour, first curator of the Pitt Rivers Museum in Oxford, became fascinated by a group of instruments used to disguise the voice for ritual purposes. Many of these simple instruments were speaking or singing tubes, but the attached material which added a buzzing timbre, the otherworldly quality that reinforced the impression that masked dancers or hidden singers were voicing ancestral spirits, was often taken from spiders' egg sacs or webs. Balfour wrote, for example, of the Katab male secret society cult of the Obwai, in northern Nigeria's Zaria Province: "The Obwai is not seen but his shrill voice is heard and I gather the quality of his voice is due to the vibratory interference of a membranophone . . . During the festival, the Obwai, who is apparently concealed in the roof, speaks to the assembly in a voice disguised by the use of a filament of spider's web."[4]

In ancient China the various methods of touching and plucking the silk strings of the Ch'in, the classical seven string lute or psaltery, were informed both by listening to the sounds of animals and through observation of their movements. Various touches of the left hand – pressure, movement and vibrato – called for mimesis of cicadas or the cry of a dove announcing rain; others were designed to evoke subtle natural phenomena, such as rain on bamboo, fallen blossoms floating down with a stream, floating clouds, a swimming fish moving its tail or the dim resonance of water heard in a mountain gorge. These touches were described in handbooks both with directive explanations and symbolic illustration. In Ming dynasty handbooks, vibrato was illustrated by a drawing of a cicada creeping up a tree, the plucking of one string by two fingers of the right hand by drawings of a wild goose carrying a reed stalk in its bill.

In his book, The Lore of the Chinese Lute, Robert Hans van Gulik gives the example of a rapid movement on one string, described for the student as "a purple crab walking sideways" (as van Gulik writes, "One should think of the rapid movement of the legs of small crabs when they scurry over the sand."). 5 The most refined of all these techniques established a threshold of perception accessible only to the most attuned scholar: "Remarkable is the t ing-yin – the vacillating movement of the finger should be so subtle as to be hardly noticeable. Some handbooks say that one should not move the finger at all, but let the timbre be influenced by the pulsation of the blood in the fingertip, pressing the string down on the board a little more fully and heavily than usual."[6]

This image of stillness at the far reaches of abstinence exemplifies a Taoist ideal state, translated from the Laot zi by François Jullien as:

The great square has no corners
. . . the great tone makes only a tiny sound
the great image has no form [7]

Action of inaction, the inner pulse of the body becoming the music, leads towards an intense listening practice, a state described by Jullien as "energetic capacity gathering itself up . . . Sight aggressively projects attention outward whereas listening gathers it up within."[8] Another image is also irresistible, the fingertip resting on silk strings, slightest of vibrations registering and producing sounds so fugitive that only the most sensitive spirits are attuned to their presence.

This is the spider, who seems to float in empty space, in contemplation and patience, waiting for vibration to signal a gathering in. Webs and nets are very powerful ancient symbols in human culture, strangely contradictory metaphors for entrapment, catching (both the fishing net and the safety net), spatial extendedness and complex interconnection. Of entrapment, there is the story related by Plutarch, who wrote of an ingenious military device employed by Brutus during his siege of Xanthus: nets laid deep under the river that ran past the city. When Xanthians tried to swim to freedom they were entangled, their presence betrayed by the sound of small bells attached to the uppermost nets. And for extendedness and interconnectedness we have the image of ourselves in our present-future, tapping on keyboards, tablets and smartphones, listening to vibration, developing tactile skills and gathering up from invisible lines of information within the online environment we describe variously as the (inter)net or (world wide) web.

Spiders, we now understand, have given us a model of which the present is a simulacrum, though not just the technocratic, seemingly intangible future-present of life online but also the real-world urgency of environmental relationships and their fragility. Jakob von Uexküll's pioneering work in biology was popularised by another pioneer, zoosemiotician Thomas Sebeok. As Dorion Sagan writes in his introduction to Uexküll's A Foray Into the Worlds of Animals and Humans, Sebeok

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spoke of Uexküll's conception as "a 'semiotic web' – our understanding of our world being not just instinctive, or made up, but an intriguing mix, a spiderlike web partially of our own social and personal construction, whose strands, like those of a spider, while they may be invisible, can have real-world effects."[9]

For the spider, the little drummer, its web is an evolving instrument without distinct boundaries, a near-invisible extension of its own body, infinite in the interconnectedness of its architecture, an endless yet temporary instrument whose purpose is not so much a percussive sounding-out drum as its reverse – an ear-drum receptor for listening-in, a gathering in of impulses or signals that we think of as sounds, even though many of them are inaudible to the unaided human ear. In the greatly expanded world of environmental sound recording, electronic music and sounding arts perhaps we can accept the spider as its most rarefied practitioner?

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[1] Hubert and Mable Frings, Other Invertebrates, published in Thomas A. Sebeok (ed.), Animal Communication, Indiana University Press, 1968, p. 258.

[2] S. Sivalinghem and A. C. Mason, Sensory communication in a black widow spider (Araneae: Theridiidae): From signals production to reception, XIV International Conference on Invertebrate Sound and Vibration, University of Strathclyde, UK, 2013, p. 54.

[3] Giorgio Agamben, The Open: Man and Animal, translated by Kevin Attell, Stanford University Press, 2004, p. 42.

[4] Henry Balfour, Ritual and Secular Uses of Vibrating Membranes as Voice Disguisers, Royal Anthropological Institute Journal, 1948, p. 51.

[5] Robert Hans van Gulik, The Lore of the Chinese Lute, Sophia University Tokyo, 1968, p. 129.

[6] ibid, p. 132.

[7] François Jullien, The Great Image Has No Form, or On the Nonobject through Painting, translated by Jame Marie Todd, University of Chicago Press, 2009, p. 47.

[8] ibid, p. 171.

[9] Dorion Sagan, introduction to Jakob Uexküll, A Foray Into the Worlds of Animals and Humans, University of Minnesota Press, 2010, p. 4.

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I visited Tom ás Saraceno's studio in late September 2015 to speak with Tomás and his team about spiders and art, about making aural webs that might resonate with -or within- the hybrid webs Tomás was building with his arachnid collaborators. However, the spiders themselves had different plans. As I arrived, I was told that a large Cyrtophora spider was shaking like crazy in a space scale-modelled to the exhibition Arachnid Orchestra. Jam Sessions at NTU Centre for Contemporary Art Singapore, and that this was quite a rare occurrence. We rushed to see it -bouncing and shivering, in ecstasy or epilepsy, it was not clear.

The massive web it had spun shook with it, in sympathetic vibration. I saw it vibrating, but I also heard it, with the help of the piezo microphones pointed at it and a set of headphones. I immediately thought about how I might translate what it was doing into something sonic that I could comprehend. Inevitably, I was confronted with the reality of the mediation: there is no such thing as the pure sound of a spider-only their vibrations which we subsequently translate into something that is humanly comprehensible or meaningful.

When I arrived at Tomás's studio I was unable to foresee what would happen. At a certain point, I thought, "I could certainly play with spiders", I was unsure as to why I had this thought, but it felt significant to me at that time. Seeing the Cyrtophora throbbing, I felt that I could play music with it, improvise together: bass clarinet and spider. I stood a few inches from the edge of its web, watching, listening to it, as any duo partner would.

Spiders don't sense as we sense, nor hear as we hear -this is something I have learnt with the intellect. But meaningful connection is always, at its root, intuitive. Spider and I were two kindred beings-sensing, sounding, feeling, and moving- in the same space with one another. As in all the best improvisational situations, the intellect, at least my intellect, became irrelevant. Whether or not the Cyrtophora and I had a dialogue, I can only know what I felt impelled to do, regardless of the origin of agency. I let go of thought and tried to resonate and vibrate with what I saw and heard- its movements, its rhythms. I felt that I crossed what would have seemed to be a clear, impossible experiential divide. Aural communication allows for this kind of ambiguity.

We do not know yet, and possibly will not ever know, what the spider heard or how it felt about our duet. Despite what scientific research might reveal about their sensory apparatus, it will still be an impossibility to feel as a spider does-or to feel what it felt like to be that Cyrtophora in Tomás's studio on that date. But we also never know what it feels like to be anyone other than ourselves- not our closest loved ones, certainly not the billions of people we've never met.

Somehow, playing with spiders is not that different from improvising with other musicians: it is non-verbal communication, and, similarly, you cannot really know how the other feels. Often musicians communicate

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different or even opposite experiences from the same improvisation.[1] We never really know what music sounds like to anyone else, in the same room, culture or even planet. With the spiders, we reach across to a far more radical other, where much larger leaps of faith are needed to assume empathy, common purpose, and resonance. What did our improvisations sound, feel like or mean to the spiders? To the observers in the room? At best, I have no idea.

John Cage noted that ''[t]here is no such thing as silence''[2] and made this the foundation for his art: this shared, impure silence -the noise that never leaves us- is our natural environment. But do we share it with spiders? As humans, we can only hear a small bandwidth of vibrations that we make sense of in a particular way.[4] We do not know what animals hear, nor do we have access to the same hearing experience. What we do know is that what they hear is not what we hear. We might make music together, but whatever the spider heard, whatever it felt, remains veiled: with the spiders, silence is not what is at stake; rather, they remind us that there is no such thing as sound.

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[1] Johns Hopkins researchers recently found that when improvising, the same regions of musicians' brains that would light up when having a conversation are activated. Adrienne LaFrance, ''How Brains See Music as Language'', The Atlantic, http://www. theatlantic.com/health/archive/2014/02/how-brains-see-music-as-language/283936/, February 19, 2014.

[2] 2 After the premiere of ''4'3'' in 1952, John Cage famously uttered, ''There's no such thing as silence. What they thought was silence, because they didn't know how to listen, was full of accidental sounds.'' Preceding this composition, a visit to the anechoic chamber at Harvard University is said to have revealed to Cage the density of sound even in sound-proof environments. The sounds of the environment hence became the core of ''4'3'', offering the audience a tangible experience of the inexistence of silence. Richard Kostelanetz, Conversing with John Cage (New York: Routledge, 2003), 70.

[3] The human ear has evolved to detect miniscule variations in air pressure, but onlyif they are in the audible frequency range of 20 Hz -20 kHz.

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Strings: The spider web is a sensory apparatus, it extends the spider's sensory capacities into the material world. With one leg rested on a radial thread of its web, some spiders detect vibration signals over a distance of one metre or more. These signals, conspecific or otherwise, appear as subtle vibrations which are normally inaudible to the human ear. The string instruments produced for Arachnid Orchestra. Jam Sessions used highly sensitive pick-up microphones to capture the movement of a spider in its web. Thin piezo elements were connected to the draglines of spider webs, thus receiving the vibrations by spider's movement, communication signals within the web, and structural (re)formations of the web. Using small needle-based transducers, this instrument allowed for an inter-species exchange, feeding external vibrations into the web, while at the same capturing and amplifying the arachnid's vibrations.

Percussion

The percussive section of the Arachnid Orchestra. Jam Sessions constited of circular ''drum'' membranes in variable dimensions. On the surface of the membranes, active ground- dwelling spiders used substrate-borne vibrations in order to communicate intra- and inter-specific signals. Signals are produced by repeated bouts of drumming of the spider's abdomen, pedipalp, or legs against the ground, which is covered with dry, deciduous leaves. In the exhibition these percussive vibrations were amplified using contact microphones attached to the drum membrane.

Wind

The family of wind instruments was represented in the exhibition by the Aeolic Instrument for a Lighter-Than-Air Ensemble, a sonic installation composed of spider silk. As visitors entered the exhibition space, the floating silk of a Nephila inaurata spider drifted above their heads following the rhythm of the spiders' airborne weaving. Informed by the social behaviour of the Stegodyophus dumicola spiders, the aeolic instrument alludes to the 'spider balooning', a method by which spiders use aerial dispersal as a means of collective travelling. Altered to optically capture the ongoing movement of floating spider silk and transform it into fluctuating sound frequencies, the instrument was aided by heat generated from the spotlights, whose thermal radiation caused the floating of the silk threads. Movements of the visitors also altered the flow of the spider web, shifting its various tensions, and creating different tones.

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