

# BAT EXPERIENCE

## POLLINATION THROUGH SOUND

Marthin Rozo Castaño

11743215

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## INTRODUCTION

This project started during a conversation I had with the biologist Juan Felipe Sehuanes. Juan Felipe is a candidate for the PhD in Bioacoustics of Bats at the University of Tübingen, Germany.

The goals of my biologist friend include transdisciplinary work, scientific dissemination and the intention to experiment with other media. I was looking for the opportunity to work alongside a biologist for some time, as well as to develop art and conservation of biodiversity with a non-human perspective, already deeply rooted in my intention as an artist.

Thus arose the possibility of working together to develop a project that studies the perception of bats, so that we as humans can get a little closer to the way these wonderful creatures communicate with their surroundings.

So that the reader has an idea about my work and my interest as an artist, here is a brief presentation. I studied plastic and visual arts at the National University of Colombia and did an Erasmus semester at the Academy of Media Arts Cologne. Nature has always filled me with curiosity and inspiration and very early in my undergraduate degree I began to mix art with biology. I had the opportunity to take some biology classes where I learned a bit about scientific rigor, specialized language, and how important this is to my work as an artist. For me, observation consists of recognizing the rhythm of existence of other beings. This is the first and perhaps most important step in my creation process. When I manage to be inwardly silent and with attentive senses, events on other scales become visible that would normally go unnoticed. My motivation is to share those small / giant observations, the scientific knowledge and the poetic and philosophical value that they carry with other humans. I consider nature and the knowledge of biology in my work as a means to better understand ourselves as a species in relation to others and to a whole. My website is [marthinrozo.com](http://marthinrozo.com) if anyone wants to see examples of what I just told in slightly abstract words.

I would like to express my joy regarding this collaboration. For bureaucratic reasons, I introduced myself as the author of this project. Throughout the text, the voice of Juan Felipe will appear, since I consider his input, as a scientist and as a person, most valuable in this transdisciplinary construction. I decided to do so, as I am doing my thesis in a Master of Arts and Science, which implies transdisciplinary collaboration and the creation of a hybrid area that manages to erase the border between these two fields. I do not want to incur in the conflict resulting from the impossibility of presenting a Diploma of shared authorship with a scientist from another institution, especially in an environment that promotes these interactions but would ultimately deny the common rights. Nevertheless, I do want to express my disagreement with that and leave the discussion open.

This text is made up of several layers like lattices through which the project will be seen from different perspectives. The reader will come across a series of intimate landscapes that in one way or another have been a basis for the creation of this project and also a result of it. From the question of bioart and its borders, through the sad political and social situation in Colombia, my experience in collaboration between different disciplines, and finally the bat from a personal and later scientific experience.

I hope that the reader finds something valuable in this text and gets to see all the different sides of the project through the lattices that I build.

## 1. DESCRIPTION OF THE PROJECT

This collaboration in art and biology aims to make visible the sound communication between pollinating bats and some plants.

Bats use ultrasound to see the world around them, which is an active kind of perception. This is especially difficult to understand from a human perspective since our senses are passive. We don't have to do anything to see or hear. Bats, on the other hand, are in constant communication with their environment to perceive it. From this acoustic way of navigating, some plants developed different strategies to reflect the ultrasound more clearly and attract these winged mammals. Hundreds of years of coexistence were needed to achieve a sophisticated form of communication, between the vocal-auditory organs of the bat and the sexual organs of the plant. Living together and shaping each other.

*Winged messengers that plunge their snouts into the sexual organs of another being, sinking their long tongue to feed on the sweet nectar. Meanwhile, the cunning flower smears the fertile lunar yellow pollen on their coats, and innocently, they fertilize by satiating their appetite. From stamen to stigma.*

Do humans play a bat-like role with plants? Could it be that we are vital to some other species on this planet from naivety and vital innocence?

Through the use of Virtual Reality, the observers are going to have an immersive experience where they get to explore an ecosystem through sound waves that will render visible the surrounding space. We, humans, are mostly visual beings compared to bats, that, on the other hand, achieve an image through sound waves. For this reason, in the VR experience, the observer will have to activate a light-sound sling that will make visible and audible space as it expands and disappears. Like the bat, the human will have to continually activate his

echolocation to explore. The objective will be to find the flowers of certain plants that will react more effectively to the call of the bat and for this reason, they will not only shine brighter than other objects but will also generate an echo capable of being located at a 360° angle by the viewer. In this way, both the visual and the sound will play an essential role in understanding the terrain and locating the flowers to pollinate.

The project is designed as a sound and visual installation where one person will be the bat and the experience will be projected in real-time so that other viewers can hear and see what is happening. Due to the impossibility of meeting in a physical space, the work could be presented virtually. However, the installation in the real space is ideal and aims to create a space for meeting and dialogue.

It is also proposed as a model to help better understand the plant-bat relationship and for this, scientific data from Bioacoustics are used that will make the experience as faithful to reality as possible. It is hoped to contribute to research in the biological field. Among the challenges of perceiving this sound relationship, Juan Felipe has recorded the shrieks of the bat normally inaudible to the human ear, with the help of ultrasound microphones and then modified this sound to make it audible. Likewise, the interpretation according to real data of how this sound is reflected in space and how much it decreases as it is dispersed.

With this participative installation, we seek to create empathy between species. Transcending the human perspective to be able to see the world and interact with other species from the experience of another form of life.

The current Covid 19 crisis that humans are facing, was probably caused by the way humans relate to bats. Bats carry the virus but it does nothing to them. The habit of some humans to eat them and also the unsanitary handling of exotic animals in the wet markets was the most probable cause that the virus mutated to affect humans. Following rumors and misinformation, bats are being slaughtered all over the world in an impulsive and ignorant attempt to prevent or lessen the spread of the virus. We hope with this project to inform about the life and work of these animals on which humans and other beings depend since they are the main pollinators of plants such as mango, banana, cocoa, guava, agave, date, peach, fig, avocado, and many other plants that are not useful for humans but are useful for entire ecosystems.

During the process of building the project, we came across three important references that, like us, have been inspired by the acoustic perception of bats or other animals. One is the work called BatVision, developed by Jesper Haahr Christensen, Sascha Hornauer and Stella Yu in 2019. It is a project that, unlike the next ones, consists of applying in a real way the physics behind the operation of echolocation of bats, making a robot capable of generating images of space by sound. There is a video available (the link to the video is attached in the bibliography) and it is very interesting to see how it works. I think it is a technology that promises great things (Christensen, Hornauer, and Yu 2019).

The next one also called Batvision, from Raffaele Grosjean and Eliane Zihlmann in cooperation with The Immersive Arts Space Zürich was launched in 2020. It is a VR experience in which the user is in the body of a bat and is carried through a rural space and another urban while activating with its own voice a wave of light that shows the space. It is very well achieved in the visual and interactive part but it is not possible to move freely through space (Zihlmann, Grosjean, and Sahli 2020).

The third project is called "In the eye of the animal", from Marshmallow Laser Feast. This is also a VR experience where you can see a landscape from the perspective of an owl, a frog, and a dragonfly. Each one with different characteristics according to the preponderant senses of each animal. The sound work is especially good and the overall experience is quite attractive. They are currently developing the experience from the point of view of a bat (Steel, Ersin, and McNicholas 2017).

Each of these works has specific qualities that make them valuable in human attempts to understand the world from the perception of another being. On the one hand, I am surprised to corroborate this idea that there are moments in the history of a species in which the same idea appears in a similar time frame but in isolated communities. There is the example of a species of monkeys that were distributed in several islands and biologists realized that without having contact between them, the habit of washing food in the sea instead of eating it with sand arose separately but slightly synchronized in the communities. When the idea of developing this project with my biologist friend came up, it was the beginning of 2019. The first of the references that I named came out that same year, and even if it is a little different, the idea of applying

echolocation to human technology, was part of our conversation back then and we wondered how no one had done that yet. The second project I named came out in 2020, so they sure had the idea in 2019 or maybe a little earlier. And the other project is currently under development just like ours. I imagine that surely it is also about the technological level in which we are as a species where Virtual Reality is increasingly advanced and prompts us to imagine this type of ideas. Anyway, I am surprised by the level of synchronicity of these projects including ours.

Despite not being the only one or the first to work on this issue, I have happily recognized certain characteristics that make this project special and give us the opportunity to innovate. All the previous projects focus on the perception of bats and how to make it visible to humans (leaving the first project aside). We are not doing an experience to see from the perspective of a bat, we are making visible the relationship between pollinating bats and plants. We are currently facing the challenge of being as faithful as possible to the biology and bioacoustics of pollinating bats so that perhaps it could serve as a tool that helps the scientists in charge of this field. I also believe that to touch issues of multispecies and non-human perspectives, the pure experience of seeing like a bat is not enough. We want to get closer to the relationship between two beings that we do not fully understand and try to be part of it. To experience how beings relate in ways that we cannot see or imagine. Complex and ancient forms that are both fragile and must be respected and from which we can learn as a species.

Two very important issues for me that have arisen during the creation of this project are the conception of time and the perception of the image through sound information. We, as humans, perceive the world through the information that our sensory organs send to the brain. In this way, factors such as the speed of sound, light, gravity, etc., determine a human *normality*. While deciding on our project at what speed to put the visible sound wave emitted by the bat, the first answer from my biologist friend was that the speed of sound is always the same (343.2 m / s). However, the answer to this question could be very different if we were not humans but bats. For a bat the speed that would be considered *normal* would undoubtedly be faster than for a human. And not only is his movement speed faster; since its way of understanding the world is through the activation of ultrasound waves and the reception of those, its auditory organ is designed to perceive a wider range of wavelengths and likewise, its brain is capable of using this information in such a way that they manage to create an image. Taking into account the Doppler effect and the capacity for sound perception, these small mammals may perceive

sound in their own *normality* slower than we humans would. In this way, not only the speed of the wave produced by the bat would go slower than the standard speed of sound, but also all the sounds present in the project such as ambient sound and other specific sounds. This hypothesis is partly inspired by the text by Jakob von Uexküll, *A Stroll Through the Worlds of Animals and Men* and the Receptor Time chapter (von Uexküll 1957, 29-30), and by the book by Alberto Maturana and Francisco Varela *The Tree of Knowledge* (Maturana and Varela 2003). Regarding the construction of an image through sound, I would like to refer to a conversation between Richard Dawkins and Neil deGrasse Tyson (Dawkins and deGrasse Tyson 2013). During this talk, Dawkins makes a parallel between how humans and bats see. Humans and other mammals that primarily use their eyes to see, do not see directly with their eyes. The eyes send the information they receive to the brain, and that is where this information is translated into an image with colors, depth, texture, etc. In the case of bats, and that is where Dawkins ventures to make his hypothesis, the information received by the ears is what the brain uses to reconstruct an image of the space around them. In that image, according to Dawkins, the animals could use different colors to create labels, be it a hairy moth or an armored beetle. In addition, it would have most of the normal characteristics of an image that serves to survive on the planet; and I would dare to say that it is probably a much more elaborate and complex image than we imagine. For example, sound interacts with matter differently than light does. Sound can pass through objects. Science gives us the bases to make approximations but it does not always give the complete answer. It is at this point that creativity and imagination play a fundamental role to be able to give life to a new and strange world, especially for human beings.

## 2. BATS

In my life, I have had few direct encounters with bats. More present has been the feeling that they are around, when you can barely see them fly by rapidly and hear some of the high pitched sounds they make. These commonly nocturnal beings tend to sleep in caves, grottos, or other sheltered spaces to protect themselves from the sun and from predators. They're also sociable mammals that can live in small families or large communities. Out of the circa 1200 registered species, only four feed on blood, and because of their commonly nocturnal quality and those very few hematophagic species, these animals carry the weight of a very bad reputation among humans. It's most common to find them portrayed in negative or terror related contexts, opposite to being portrayed as the authors of all the benefits they have on the world and the human species. Before starting this project, I was unaware that bats are the main pollinators of avocado, agave and many other plants. We therefore owe them this wonderful fruit and all the products derived from agave such as tequila, mezcal, agave syrup, among others.

Just before travelling to Vienna to begin my Master's degree in Art and Science, I had two encounters with bats, and perhaps these were premonitory events for what my thesis would be. The first took place in a country house two hours from Bogota in the Zipacon region. It's a mountainous place with a temperature varying from -2°C at dawn and 20°C at noon, with an exuberant vegetation from a misty and humid forest. It was nighttime and I was getting ready to go to sleep. I had already turned the light off and suddenly started hearing wings flapping inside the room. My first thought was that a big moth was looking for a way out, so a bit frightened, I turned on the light so as to find it and help it. Having turned the light on, I couldn't find it, but instead I saw a little furry ball clinging to one of the wooden beams in the ceiling. I had never been that close to a bat before, so I got very excited and set out to grab an empty garbage bin to try and catch it and set it free outside the house. I remember it being very small, measuring about half the size of my thumb and when remaining still, its head and detail of its wings were not visible. Then, in a quick motion I tried to place the bin over it, but right in that moment, the tiny animal flew out of the room with great agility, and I failed my mission.

The second encounter happened in another country house located on the eastern plains of Colombia called Los Llanos Orientales. A very extensive region with no mountains that stretches into Venezuela and has a temperature of between 14°-31°C. This time, the bat was some 30cm above the floor on a living room wall. It was also nighttime and the rest of the people that were there with me were a bit nervous with the animal's presence, so I seized the opportunity to have a closer look and get a hold of it to release it outside. I put on some strong gloves and managed to catch it. While holding it, the both of us were rather nervous, so it tried biting me so that I would release it, but the gloves protected me. The only clue I had on how to manipulate it, I had from watching wildlife documentaries. I knew that if I grabbed it by the part of the wings closest to the body, I would not harm it, so I held it for a while and looked at it up close. It had sorts of wrinkles on its face, and its ears and nose were proportionally bigger than its tiny eyes. Its body was furry, of a dark brown color and its hairless wings exposed very small but skilled claws. When holding such a delicate but also potentially dangerous animal, a weird feeling occurs when the adrenaline makes it so the amount of pressure applied to prevent it from escaping is not noticeable. So, faced with the choice between applying possibly too much pressure and harming the animal or applying less than the necessary to keep it in my hands, I chose the second one and the bat managed to escape. At that moment I realized it could not fly from having an injured wing. I was able to catch it as it moved with small leaps across the floor of the house. The others told me I'd better just leave it outside because they were scared of its presence, so I took it out and left it on a tree. One hour later after having dinner I went to see if the bat was still there and I couldn't find it. I felt guilty not to have put it in a box and taken it to the wild animal clinic in the National University in Bogota.

These two experiences increased my interest in these winged mammals as well my fondness of them.

The conversation I had two years after with Juan Felipe would be the beginning of this project. My biologist colleague studies the way bats simultaneously communicate and feel the world. I have asked him to contribute to this thesis with his knowledge and his own perspective:

If I asked a person to name the first five mammals they could think of, I would be very much surprised if anyone included bats in their list. Bats are perhaps the most fascinating but also the most uncomprehended and underestimated group of mammals on earth. Though they are the second largest group of mammals and their existence is vital to our human species, bats have

throughout history been associated with evil, disease, darkness and have thus been segregated as outcasts.

Ever since I started my PhD in Bioacoustics at the department of Neurobiology in Tübingen three years ago, I have learned not only about how bats navigate using sound, but also a lot about their morphology, physiology, ecology, life-history and diversity. The more I learn, the more bats intrigue me. Almost every aspect of their life is spectacular, fascinating. They have made me develop a strong wish to discuss and share about their biology not only with my peers, but also outside the scientific community. This is where Marthin and I found an ideal scenario for developing a scientific dissemination project together.

I'm a Colombian biologist who very early found a passion towards the study of animal communication, particularly acoustic communication. The animal world is full of all sorts of fascinating sounds. These acoustic signals can travel large distances and are rich in information for prey, predators, conspecifics in search of mates and many more. Three years ago I joined the department of Neurobiology at the University of Tübingen as a PhD Student in Bioacoustics to increase my knowledge and understanding in the world of animal sounds. Here is where I started to learn about bats in more detail and got fascinated by the way they use a form of autocommunication to navigate the world using echolocation.

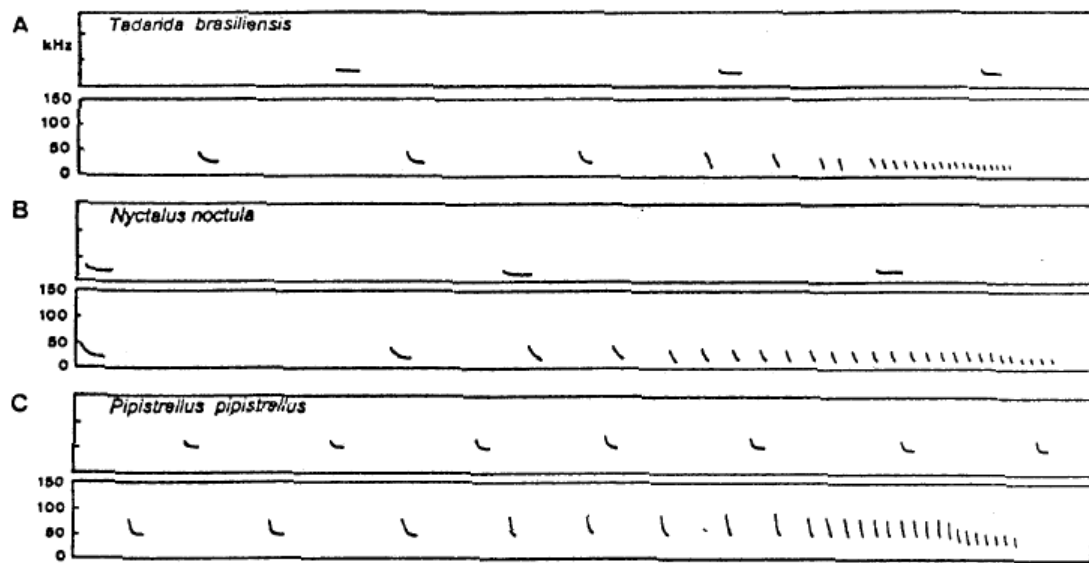
Interestingly, my research actually is not focused on pollinating bats, but rather on bats that feed on insects (insectivorous bats). In particular, I'm interested in understanding how bats can decode prey information out of the echoes they receive when they are echolocating. Not all bats hunt in open spaces, where prey detection seems rather easy. There are several groups of bats that chase moths and other insects deep in the forest canopy, where the echo of these tiny prey animals gets mixed with noisy reflections and echoes of all other possible objects to be found in the canopy such as leaves and branches of all different sizes. In these acoustic complex scenarios, the bat needs to search and eventually find the important information it's after (the echo of the prey) out of all other distracting 'clutter' echoes it receives. My research project aims to understand how this process takes place.

For this purpose, I need to record the repertoire of calls the bats produce when they navigate an environment, search for prey and eventually when they catch it. Since bats produce their calls in the ultrasonic spectrum, I have to use state of the art custom made ultrasound microphones to be able to record their calls. But before any call can be recorded I need to catch them. For that I went to their natural habitat in Colombia and looked for them in the caves they roost. That is where I grabbed them and then released them in what we call a "flight cage" (a giant cage made of mosquito net). Inside of it I have an array of these special microphones placed strategically so that I can later compute the bat trajectory if I want to. Alongside the audio recordings, I also record video using an infrared camera. All of this happens at night, short after dusk. While I record the bats, I release a couple of previously captured moths hoping the bat gets interested in them and actually hunts them. After many nights of work and patience (I'm talking about months of field work) I only get a handful of good quality recordings that I can later analyze in the lab.

The analysis consists of writing a software that can simultaneously detect the calls in all the microphones I recorded from. The goal is to be able to determine how the bats change the call parameters (call duration, time interval between calls, call frequencies and/or frequency bandwidth) according to which behavior they are performing. Is there a change in call length or frequency when the bat transitions from exploration behavior to chasing behavior? These are the kinds of questions we try to answer.

Perhaps the biggest relevance of a scientific dissemination project on bats is that we need to replace the myths, misunderstandings and even ignorance we have in relation to them with facts and information. We need to replace the bad reputation bats have in our society with knowledge on their fascinating ways and understand how they are essential to our existence. Marthin and I thought a first step in this direction could be to make people relate more to bats by putting them in a virtual environment where they have to solve daily bat problems using something that resembled a bat's sensory experience.

As humans, the brain area of our primate brain devoted to orientation and navigation mainly processes information acquired by our visual sense. For bats (and surprisingly also for some human blind patients) the input for navigation comes from the auditory pathway. But perhaps more interesting than navigating the world using sound is the fact that bats do it with an active sense; something we can hardly relate to. It is relevant here to differentiate between passive and active sensing. All of our sensory input is acquired passively by our sensory organs. We hear, see and feel what is out there. We do not send something to the outside world and analyze how it returns. This in turn is exactly what bats do with Echolocation. They emit sounds, which waves collide with surrounding objects and then bounce back to their ears as echoes. By analyzing the time between the sound emission and the returning echoes, bats can make an "acoustic picture" of the outside world. They can even use different types of calls to enhance the "resolution" of this acoustic picture and thus vary several call parameters (s.a. call duration, time interval between calls, call frequencies and/or frequency bandwidth) depending on the task at hand. For example, many bats produce longer echolocating calls with larger intervals between calls when navigating in open spaces, but reduce both call duration and interval between calls when near forests or when the environment they are navigating has more obstacles in general (see Figure 1; Kalko & Schnitzler, 1993). It is precisely this active sensing of the environment what we wish to make the user experience in this project.



**Figure 1: Call plasticity in foraging bats** (adapted from Schnitzler & Kalko, 2001). Three sonograms (a time vs. frequency representation) of three insectivorous bats are shown. Each sequence corresponds to a catch event in which we can observe how the bats change the call parameters as they approach the target at the end of each sequence. At the beginning, calls are long and the interval between calls is long, whereas towards the end of the sequence the calls are much shorter in duration and the intervals are also shorter. Frequency parameters also change: Narrow-band calls are produced at the beginning, but replaced with broad-band calls at the end.

Yet besides the experience of navigating the world as a bat, we also wish to increase awareness on the tasks bats do. These flying mammals perform many important ecological services such as pollination, pest-control, seed dispersion and many more (Kasso & Balakrishnan, 2013). Pollination is perhaps an interesting example to address, for without bats, the health of many important crops s.a. Agave, Avocado, Banana, Mango, Cacao, and many more would be jeopardized. Without bats pollinating them, all these important plant species would eventually cease to exist and we would not be able to consume them. So by forcing a human player to pollinate a flower using an active sense, they are not only having an interesting sensory experience, but also a pedagogical one. The chance that a person remembers that bats are important pollinators is higher if they "lived the experience", than if they were just lectured about it.

Interestingly enough however, the story on plant pollination by bats has also an intriguing tale from the perspective of some plants. There are plants that have evolved flower shapes that can better reflect the energy of the bat's echolocation calls so that it's easier for the animal to spot them (von Helversen & von Helversen, 1999). The concave shape of the flowers of *Mucuna boltonii* act as an "acoustical mirror" that better reflects the echolocating sound-waves, so that the bat hears the echoes louder when targeting the flower from a straight angle. This is just one of the many beautiful examples we can find when we explore the world of bats.

Back to the important ecological services bats perform, pest control is also to be seriously taken into account. Colonies with large numbers of insectivorous bats can eat thousands of insects in

a single night, which is crucial for controlling pests of some economically important crops such as cotton or rice (Cleveland et al., 2006; Puig-Monserrat et al., 2015). The decline of bat populations worldwide can thus negatively affect us economically and even decrease the quality of the crops we eat.

As I hope to have clarified throughout this small text, bats should be a subject of fascination and respect, instead of fear and rejection. Sadly like any other group of animals on earth, bats are on decline due to human activities, but they might even suffer more, because society despises them. Their conservation remains unimportant for most people. It is thus mandatory to clean the name of bats and educate people on their importance. We believe that by creating a virtual reality experience and developing an interesting video game, we can change how people think of bats. We also believe that by joining the beauty of Arts with the fascination of Science, we can create a channel to increase awareness and aid the conservation of this astonishing and captivating group of flying mammals.

### 3. BIOART AND CONSERVATION

During my time at the angewandte, I had the honor of taking part in some amazing lectures from the professor and bioart theorist Ingeborg Reichle. Thanks to this experience, I had the opportunity to learn more about bioart and questions arose that still drive me to investigate further.

Since the earliest art and science hybrid projects, we find many examples of how art interacts with different aspects of the field of science and vice versa. Starting with the first works from Joe Davis, and passing through many other artists and scientists, there are some trends that emerge in this blurred area. One of the biggest sub-genre is related to microbiology. In this field the artists or biologists use the techniques of microbiology to manipulate life in a practical or conceptual way. The exterior and interior of an organism get modified by changing how it looks and how it functions.



1. Eduardo Kac: *GFP Bunny* 2000

The work *Alba* by Eduardo Kac is an example related to gene manipulation. The project was a collaboration with the French geneticist Louis-Marie Houdebine in the year 2000. It consists of a rabbit that was genetically modified with the genes from a jellyfish *Aequorea victoria*. When the rabbit was illuminated with blue light, its fur glowed green.

There are still some doubts about the existence of the rabbit because of the almost non existing visual archive.

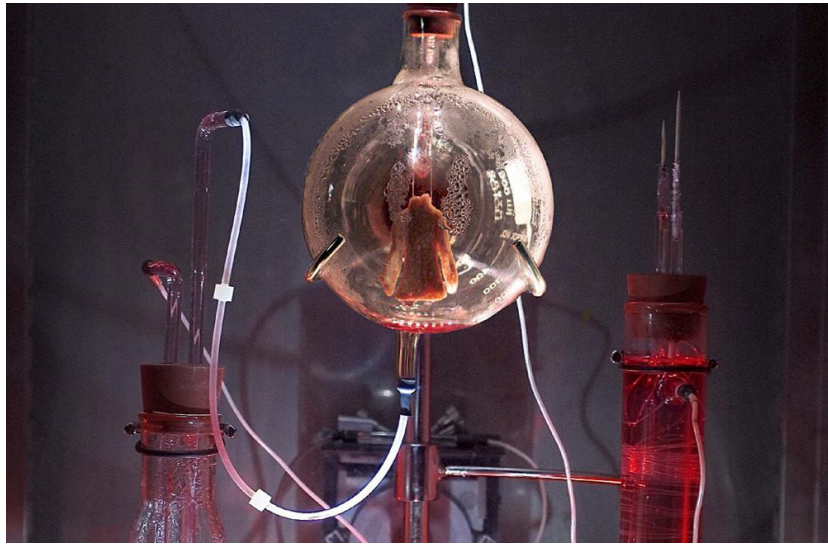
Another example is *Nature?* from Marta de Menezes. The work was a series of modified patterns on butterfly wings presented in 1999. The artist went to a laboratory to modify the butterflies during the metamorphosis process. The result was butterflies with asymmetrical patterns on their wings. In this case also, the work was possible thanks to a group of scientists.



2. Marta de Menezes: *Nature?* 1999

The manipulation of mother cells is another process used in bioart to sculpt living shapes. For example the art collective *The Tissue Culture and Art Project* created the *Victimless Leather*. A Small jacket made from mice mother cells, displayed inside a glass capsule, with the necessary nutrients and humidification to keep it alive and in the desired state.

To make the shape of a jacket possible out of mother cells a biopolymer with the desired form is needed along with a bioreactor to facilitate the specific conditions for this process.



3. The Tissue Culture and Art Project: (John Curtin Gallery, Perth, Australia) *Victimless Leather* 2004

The act of thinking about possible futures and its inhabitants in the micro world is also part of this flow. Some of the works from Sussane Anker, for example, are situated in the near-future, showing possible microworlds inside petri dishes or plants growing inside imaginary spaceships in small cubes with artificial UV light.



4. Susane Anker: *Astroculture (Eternal Return)* 2015

The use of scientific tools to create an artwork often aims to criticize or show society what is

happening inside the laboratories. Processes that are normally not visible or that we are not aware of, because of the extreme specialization of language and facilities, and the overall hermetic functioning of science. Regarding the examples previously mentioned, a conflict is visible between science and art. Some of the works are criticizing the reality of laboratories, but very often they use the same intrusive methods. The way to understand and deal with life is also the same, where living organisms as complex machines perform specific processes. There is a somewhat confusing situation in which the will to discover new knowledge, the aesthetic and the ethical concepts all mix in a gray area.

These four examples that I mention are some of the most characteristic works of bioart. Meanwhile, other works that perhaps do not use microbiology methods and are interested in macro-life issues, find it difficult to be under the label of bioart according to a general conception of what this group makes up, which is mostly in the line of the examples given above. As a general term for any work related to biology on both a macro and micro scale, one can speak of “bio-media” as a broader term. Still, I question this strange distinction that is made with bioart and I wonder what its limit is and how to expand it. In order to more generously cover works that are related to the study of life or biology, as the term bioart dictates.

As Stephen Zepke says in relation to the work of Robert Smithson, making land art in the time of the Anthropocene implies a global consciousness of the human being as a geological force. (Zepke 2009, 200-215)

Likewise, I consider that doing bioart or working with bio-media currently represents a challenge of responsibility for that living being used as a medium, either in a theoretical or practical way and its implications. You must have a responsible ethical position and at the same time, it results in a political action whether you like it or not.

Now throwing a rope to the branch of biology in charge of conservation, I would like to highlight a few thoughts. During the biology classes I took during my undergraduate degree in fine arts, I learned about some realities that made me feel less regretful for not having studied biology. There are classes such as herpetology or zoology where the teachers order their students to collect a large number of specimens in order to acquire enough data and be able to make a reliable study. The term collect refers to a less explicit and more academic way of sacrificing and extracting individuals from an ecosystem to the scientific study of it. In normal and prudent cases with respect to the number of individuals sacrificed, the scientific collection is very

important to make a biological sampling that not only serves as proof of the study for which the specimen is collected. It also serves for future research as a comparative sample and archive of the species in its past ecosystem.

Herpetologist professor John Douglas Lynch was banned from several natural reserves in Colombia because of the number of animals he collected with his students. They went to the reserves and took whole boxes with dead snakes or frogs to later analyze their physiological characteristics in the university laboratories. All this to make contributions to the field of Zoology. But at what cost? How is it that this natural science in charge of the "study of life" and that fascination that every biology student has for nature, are transformed into an academic coldness that in order to obtain knowledge, life goes into the background? A biologist friend did her thesis on a species of frogs found in a lake at the University. To do a rigorous study on the species in question she had to collect some frogs for analysis. When she finished her study she confessed to me that she almost completely wiped out the lake's frog population. In this situation, as in many others, there is a dichotomy between the interest in better understanding a way of life and at the same time the very life of that being. Between the pressure to do a rigorous study that is valid in the field of science and recognized by the academy, and the love for life itself and its conservation.

Paradoxically, in the area of conservation biology, a similar situation occurs in some cases. When biologists are going to do conservation work on a particular species, most of the effort is invested in collecting data and statistics. The work of speaking with the communities of humans that live in the habitat of this species is done very weakly or in some cases it is not done. No matter how much data you have, if there is a threatened species, this is generally due to human action. That is why the most important thing to generate a significant change is to make a rigorous process of awareness about the general and particular importance of this way of life. Many times there are fears and superstitions about it and it is also important to put children and adults in contact with the species in question if possible and thus generate some empathy. To conserve a species it is not necessary to know exactly which family or evolutionary subfamily it belongs to. It is different and almost goes in the opposite direction, the need of the Western academic human to classify everything, to the task of conserving and helping a species live in its ecosystem. As Alberto Maturana and Francisco Varela explain in *The Tree of Knowledge*, nature is not constantly evolving with respect to its ecosystem. What drives life to change is not a will to be more efficient or better. Since everything is in constant change, both on a geological

and biotic level, the quality of change and variation that is implicit in living beings consists of maintaining a continuous balance with the environment in which one is and with other nearby species (Maturana and Varela 2003, 98). This idea of evolution as a way of being better and more efficient, faster, stronger, etc., is a human interpretation that was reinforced with the ideals of the economic system of the time, industrial revolution and later capitalism, and with the base of most of the preponderant religions of hierarchical stratification between the species where the human being is at the top and the world was given to him for his care and disposition. Going back to what Varela and Maturana tell us, an organism that is successful in its environment is not better or more efficient, it is simply in constant balance and that is what its evolution consists of.

The academy, paradoxically, continues to function under a capitalist mentality. Either because it was created with that mentality or because this is the system that currently governs us as a species. The premises are that the more knowledge you have, regardless of the consequences or sacrifices in the process, the better. There is a major imbalance between life itself and knowledge. What if we better understand what is written by these two biologists and look for an equitable path between learning what surrounds us and their lives? To assimilate this knowledge of biology as a species and use it to live responsibly, consciously and in balance. How, then, could our economic, social, academic and religious system change, if we understood life and its relationships better?

In a conversation with the biologist Johannes Jaeger, who is now dedicated to scientific philosophy, he explained to me the need during the formation of scientists to understand and reflect about their own process of thinking. Along the curriculum from biologists and I would dare to include all natural sciences, there is hardly a space dedicated to self-knowledge and philosophy of knowledge. According to Johannes, it is an issue which is not common as a scientist to be aware of nowadays and is very important to reflect on the own process of inquiry as a scientist.

After my brief stint at the biology faculty, what I felt, and still think, is that, inspired by the actual economic system, the scientific institution is pushing strongly business entrepreneurship among young students and the romantic idea of knowledge is less and less common. If an investigation doesn't promise profitability and utility, it's not going to be supported or accepted in most cases.

It is almost as if science was taking the business market's place, the business market that of the art fairs, and art that of research without an exact utility just for the love of knowledge and experimentation.

Bioart and macrolive or bioart for conservation has not been a main topic. Nevertheless, there are some artists and cultural projects who come close to this intention like Tomas Saraceno in his works with spiders, Kuai Shen in all his research with ants and The Ocean Space project in Venice.

Scientific research is important in all of those projects together with a point of view from another discipline. In the case of Tomas Saraceno, it is through the lense of architecture that he analyzes the spider web's building characteristics to create installations.



5. Tomás Saraceno: *In Orbit* 2015 / Düsseldorf, K21 Ständehaus



6. Tomás Saraceno: *In Orbit* 2015 / Düsseldorf, K21 Ständehaus

Kuai Shen is literally living with the ants, taking care of them and researching their behaviour in relation to self-organisation, post-human ecology and technology.



7. Kuai Shen: *Obm1gas* 2012



8. Kuai Shen: *Obm1gas* 2012

The Ocean Space is a project involving science, humanities and art, to dive into the importance

and the problems related to the sea. Those works question our relationship with this non human world. There is a strong philosophical and poetical approach, which creates and reinforces the link between the viewer and the work while touching other axes of sensitivity and understanding, implying an expanded form of perception.

It is not a sort of science communication but it does completely fulfil such an intention.

Compared with the bioart and microbiology described before, it is not about creating new life or dealing with the last scientific technology, but instead it focuses on the present and what is right now inhabiting the planet in an attempt to recognize and claim this particular life, while learning about it and sharing this fascination and knowledge.

Human beings are related to all the other living beings on the planet in a direct or indirect form. To help in the effort of conservation and the recognition of a multispecies world arises the need to show it in an interesting and attractive way. Bioart is a strong device to reach minds and feelings that could support the field of biology of conservation. Working side by side with biologists to share the importance of a species with the communities to raise awareness and empathy. And this is exactly where I want to position myself as an artist and what we want to achieve with Bat Experience. I would like this way of proceeding in art not only to be widely accepted as bioart but to be the most common branch of this practice.

## 4. PEACE IS JUST FOR HUMANS

Next, I am going to talk a little about the situation of the place where I come from and how that wonderful and at the same time sad reality has been vital for my position as an artist. The topic may feel distant, but it's actually deeply connected.

I was born in Bogotá, Colombia in the year 1991. The conflict between dissident groups with other political interests and the state, started in the 1960s and after the peace agreement in 2016 the conflict is still not over and the situation is even more complex than before.

In the presidential term of Juan Manuel Santos from 2010 to 2018, peace was one of the top items on his political agenda. During the peace negotiations, there was a democratic consultation to vote yes or no for the peace agreement, in which, sadly, the NOs won. After a long process of at least four years of pacts and negotiations with the right-wing population against this process, the peace agreement was finally signed. Now, ironically, the situation is not peaceful, and even less for the nonhuman inhabitants of the Colombian territory.

Beyond questioning a political position from left or right or even the potential success of the peace agreement, after all these big discourses and political propaganda in favor of and against the peace, what does peace mean? And for whom is this peace intended?

In the context of a country in constant war conflict for more than fifty years, there are many sectors interested in ending this war. Especially if the soil where the conflict is occurring is full of minerals such as gold, oil, coltan; and on the surface an enormous amount of biodiversity. Vast extensions of ground were already sold to mining multinationals in times of war. For them, for example, the peace was more like a green light to enter those places to extract the minerals and on their way pollute the water, destroy the ecosystems and as war does, displace the communities away. For the conservative people, the peace was the threat of a mixture of oblivion, having to recognize the other war side as human beings, the obligation to live with them politically and not being able to continue the revenge until the end. For the ones who wanted peace this was the opportunity of a new beginning after more than half a century of war,

to grow as a country, the end of the excessive violence, the possibility to travel freely without concerns, a romantic idea of harmony, complicity, and community.

I had the honor to go to the deep south of Colombia where the wide savanna merges with the Amazon rainforest. We were in a group of Bogotá citizens invited by the FARC guerilla to a peace vigil. It was in the demilitarized zone of the FARC guerrilla called San Vicente del Caguán. We had the possibility to talk with them, to see how they were living, and to be part of this meeting full of hope for peace. For them, the peace was the possibility to start a normal life, to make a family, to live in one place, and maybe cultivate the land instead of living in constant movement hiding and escaping with the threat of death at every step. It was also the possibility to leave the guns and support a political proposal. In the end, there was a lot of hope and illusion.

For some of the fighters on the other side, it was the same, a possibility of a new way of living. But for most of the paramilitaries, right-wing mercenary groups, the military forces, and some dissident groups from the guerillas, it was the end of possibilities of success and good money. And this is always attractive when the conditions of the normal Colombian people are the injustice of the displacement, the exploitation of resources without equality, the abandonment from the state, and the lack of education and therefore, fewer possibilities.

After the peace agreement, right-wing politicians came to power. They manage to break the peace agreement which is now almost over, for not complying with what the government promised. At the same time, there are now dissident groups from the guerrillas and from the paramilitaries working together with no other arrow to follow than the money. Hundreds of social leaders have been killed since the end of the previous presidential term and the actual one. And the mining multinationals are already in most of the sold places extracting the resources.

Since the peace agreement, biologists are discovering a lot of new species of all sorts of life forms that were being protected by the war. One of the most biodiverse territories in the world is in great danger. And here is where things turn upside down. When humans were fighting each other, the multinationals were not able to enter those places and the nonhuman world was in peace. Now that there is “human peace”, the nonhuman inhabitants are facing the war. What is the meaning then of that word so used from different perspectives, almost to the point where it begins to lose its meaning? What is clear is that it’s being pronounced from a completely human perspective. It is human peace. Always more for some privileged humans than for the rest.

Sometimes used in politics as propaganda, sometimes used as business freedom, sometimes as the banner from the opposition, or maybe as a romantic idea of a new beginning. But in the

end, it is still from humans for humans in the frame of humanity.

As humanity, we still do not understand to which extent we depend on the world around us. We live in a made-up, collective image of the Earth and likewise, we are unconscious of our species in relation to others. For a matter of scale, it is very difficult for a person to see the impact that the entire human community is having as a geological force.

Examples like the one I have named about my own context and experience occur throughout the world. Still, human rights and social equality are at a low stage of development. With each social problem, many more are being created at an ecological level. It is normal, and in my opinion also sad, that the first thing in relevance is the human context. For the development of humanity, to coexist and relate with the non-human from a horizontal perspective, could give clues about the construction of a society more aware of itself and egalitarian.

To look from the perspective of a bat for example, or any other living being is of great relevance and urgency and therefore the need to bombard society with as many nonhuman views as possible.

It is so important now to make the effort to conceive all the conjunctural situations from a nonhuman perspective as well. As humans, it is natural to understand the world in terms of humanity like the squirrels would understand the world in terms of "squirreliness". But if humans are so evolved and self-conscious beings, it is getting late to understand that this way of understanding is not enough, is harmful, is poor, self-compassionate, and self-centered. During a talk in 2019 at the Biennale Sessions about the future of society and the place of art and art education called "Digital Transformations, Society And Arts At The Turning Point", Ute Meta Bauer (professor, curator, and founding director of the Center of Contemporary Arts in Singapore CCA) explained how nowadays we are going so fast in terms of technology and science, and to look forward is what everyone is thinking about, the future. (Universität für angewandte Kunst Wien 2019). But as important as knowing and thinking about this future that has already arrived, it is necessary to recognize our world and the interrelations that have been occurring for millions of years, to find the knowledge that could actually let us visualize a possible future in which humanity could coexist.

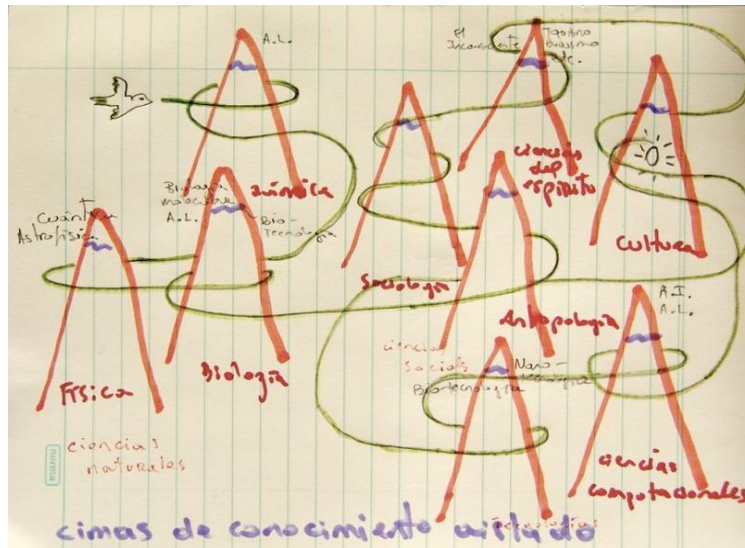
## 5. THOUGHTS ON THE CHALLENGES AND BENEFITS OF COLLABORATING

*“By interdiscipline we understand that models, laws, categories, techniques, etc., coming from different scientific disciplines, mix with each other to promote new knowledge, a product that is different from what existed in the disciplines that contributed to configure it.”*

*Follari (Duarte, G. 2016, 363)*

One of the main impediments to collaborate with other disciplines is language.

In a class called *Red* (which in Spanish means Network) about the union between art, science and technology at the National University of Colombia, Alejandro Tamayo, the orchestrator of the course, referred to the problem of language more or less like this: At first there is a plain where all knowledge is mixed, then, slowly the information that is similar gets closer and closer. Groups are created from particular contexts and delimited by that belonging. Now we have a plain that presents fenced areas. What originally was a completely flat plain, now begins to show hills. Each of these hills, which at the same time represent an area of specialized knowledge such as chemistry or psychology, grow and grow with the new knowledge produced. A completely flat terrain, became now a terrain with towering mountains and snowy peaks that touch the clouds. The vocabulary was smaller and simpler in the flatness, now the tips of those mountains speak in such complex and specialized terms, that between the different snowy peaks, they don't understand each other. As a branch of knowledge becomes more specialized, new terms are created. All the specific vocabulary forms a complex lexicon, that varies greatly from one science to another. This is for example, what makes the distance between physics and sociology more tangible.



9. Courtesy of Alejandro Tamayo

With this intention, I ventured to take some biology classes in parallel to my studies in visual arts. Classes such as insect genetics, biotechnology and ethology helped me to become familiar with the biological jargon and to arouse my imagination and curiosity.

This new lexicon learned or at least not completely strange to me, became the key to a new world of ideas, friendships and collaborations.

In the process of combining art with science I have faced two modes of creation. One way is to approach another field of knowledge, gather information and use it to develop your own project. This has been the way in which I have developed most of my works related to biology until now. It has worked for me to do specific projects in a controlled and calm way that is sometimes important to make a work of art. However, now that I am in a different work situation, I recognize certain characteristics that I did not see so clearly before. When you consult with a specialized person on a subject, in the best of cases you receive a good amount of information, and that is where that brief interaction ends. The specialist in this case is nothing more than that, a container of information where the experiences and opinions of the person are not taken into account and do not generate any significant contribution to the project. The creation of the work takes place in solitude and with few dialogues with people from other fields of knowledge. Another way to collaborate is when people from different disciplines decide to work in the creation of a project together.

I must confess that such complicity is not easy to achieve. It implies, above all, a mutual intention, the will to share ideas and energy. To invest time and risk it to experiment is a luxury. In the merging process of an idea, to arrive at a result that is not necessarily part of any of the disciplines involved, there are challenges of communication, adaptation and concretion. The ability to understand specialized language between different academic thinking, the versatility to discuss opinions, give up ideas and accept others, the determination to gather the common points of the conversation are conditions *sine qua non* is possible to materialize the project.

When this collaboration began, the labels of each person as a specialist in something specific were very marked. The biologist had the absolute say in scientific matters and so did the programmer, the 3D modeler and the artist. As we spend more time together building the project and getting to know our different work processes, we are also daring to contribute opinions in the fields of knowledge of others. I have seen myself contributing in a significant way in terms of characteristics of the biology of bats. Likewise, my colleague biologist has done it in the installation part. We are there with our academic training to serve as a basis in that field, but in the end we are people with valuable opinions and experiences and capable of thinking from other points of view to create something in common. There is a moment in the creation process in which the labels that each person wears are blurred and people with their own identities and their different ways of understanding the world appear.■

From an art full of apparent uselessness and a science loaded with apparent utility, arises a further challenge; between those who are accustomed to a procedure structured by the scientific method and those, who have been developing their own variable method. As I briefly commented before, the utility factor in science is imperative. Few researches are not linked to a condition of profitability and welfare for the human species. This poses a specific way to inquire and confront the world. On the side of art, utility is not a necessity. Experimentation and the ability to make connections between isolated events that may not have something in common, determines another form of relationship with the world, almost opposite to the one of science.

When these two ways of proceeding meet to work together, they fill each other's gap. This does not mean necessarily that science or art are being created. The presence of both perspectives complement each other and the level of utility gets balanced. The combination of the artistic, the

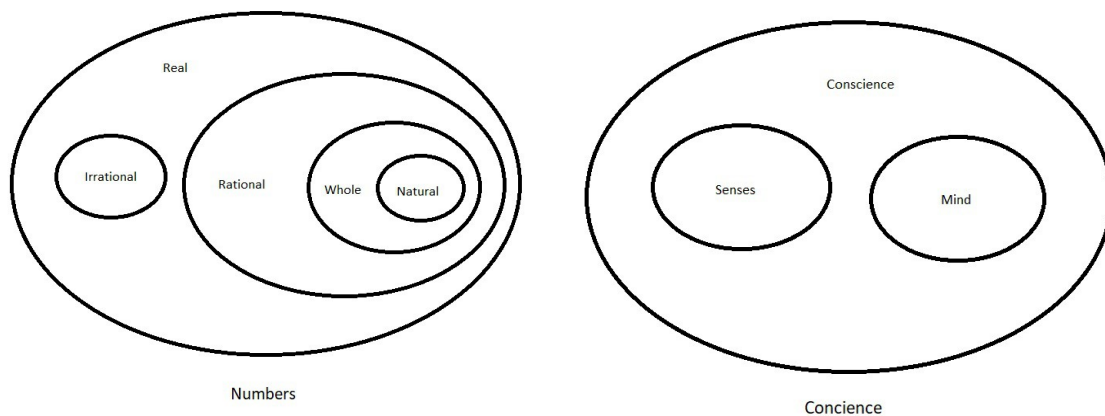
social and the scientific component, produce a multidirectional knowledge. In most of these projects there is an intrinsic pedagogical purpose to raise awareness. Therefore, this kind of collaborations usually occur in an institutional and cultural context, which takes away the burden and the need to sell as a final objective.

In a conversation I had with the Bogotá born biologist Gabriel Peinado, he mentioned something that still resonates strongly in me; we spoke about works of bioart and the complexity that a creation between two different disciplines entails. While I told him about my worries on how to create something interesting and understandable for people, he interrupted me. He said that, generally, when encountering this type of work, although attractive, he did not find them interesting from a scientific standpoint. This was materialized in a challenge that I impose on myself when developing a piece. How can I suscite enjoyment and admiration from a biologist's specialized and scrutinous glance at a creation of art and science? That is where I consider a project to reach a middle ground between the two disciplines, when it can be appreciated from different fields of knowledge, thus contributing in various ways and opening a crevice on the conventional form of conceiving said knowledge. Such a piece places itself on a misty field where it is validated by not being easily catalogued or named.

Society in general is not involved with scientific thinking and the newly produced knowledge therein goes unnoticed for the most part. Only the most important breakthroughs reach people's ears, even amongst members from different fields of science, news is hard to come by. Of course, there's a lot of us on the planet and such a state of disinformation is natural, but considering human being's irresponsibility with the great forces revealed by science, society should improve on its level of scientific awareness.

For that reason, I believe these projects, containing several fields of knowledge combined, could be very efficient at penetrating the human experience in multiple forms. *Curiosity* and *surprise* are key components in learning effortlessly in a sensitive or multisensory experience. To explain this, I must refer briefly to what I learned in a satsang about Zen Buddhism and human perception. As a metaphor I will use the Venn diagram that describes the organization of numbers. First comes the field of real numbers that embraces everything. Within this universe are rational and irrational numbers. Within rational numbers are whole numbers and within whole numbers, are natural numbers. Now we step into the human field and my understanding of it according to Zen Buddhism. Before the mind, which is in charge of naming, grouping and

linking, are our senses, passively collecting information without any effort. This empty and infinite field, that acts as a sort of background where space and time don't exist and where the information perceived by the senses goes, is known as our conscience. This conscience plays the same role as the space determined by real numbers. Within the field of consciousness we find sense perception and mind.



10. Visualization of the examples, Marthin Rozo Castaño, 2021

Continuing down this philosophical path, the mind is a tool that can be used consciously to solve problems. This is the point where things get more complicated, since throughout a typical western upbringing, we are not taught to understand the mind and how to use it. It's not about knowing how to subtract or multiply but about knowing how to live in the present in a light and agile way without allowing the mind to constantly think up and undo possible futures or impossible pasts.

The efficacy of a state of constant curiosity and wonder, that carries toward exploring and being amazed, consists of the perception level a person is in at any given moment. These two attributes are part of a previous moment in which the senses are avidly perceiving and the mind has not yet taken full control in trying to name what it comes across. That is why, in this line of thought, a piece of art and science is so powerful. There is the sensory component that activates within the spectator this potent state of curiosity and simultaneously the scientific component penetrates in the form of a lived experience as opposed to a somewhat ethereal theory. What I mean by a somewhat ethereal theory is the way in which science is usually taught, through books and blackboards. Perhaps this kind of hybrid that implicates more than

one area of knowledge at once are the key to reaching people in an unexpected and therefore insightful way.

## 6. CONCLUDING REMARKS

In the text *what it feels to be a bat?*, said question, according to Nagel, its author, would be impossible to answer (Nagel 1974, 435-450). The philosophical essay enters the complexity of perceptive understanding from a non-human standpoint. We are completely conditioned by the subjectivity of our sensory tools, and to be able to understand another being's point of view would imply the capability of analyzing the way they see the world purely objectively, which proves impossible. Nevertheless, this project seeks precisely such an approximation, and said conclusion does not discourage but rather provides a certain tranquillity to pursue a project that is merely a playful experiment to try and recreate the animal's experience.

Since before coming across Nagel's essay, we knew that the objective would not be achieved one hundred percent. Still, we believe that just by achieving a glimpse, the experience will be enough to bring us closer to them and away from our own perspective. The aim is to tell about and share that particular way of feeling the world around us through sound, to generate a bit of empathy between species.

It seems to me that spaces and experiences like these are lacking in society. Nowadays technology is advancing too fast and on a social level we are very involved in our own economic system and we are neither ethically nor philosophically prepared to use responsibly many of the new technologies that surround us. We lack spaces in which we can see the world around us from a different perspective. To be aware that the planet is not just a field for cultivation or a space to extract resources for the exclusive benefit of the human species. It is also a complex, ancient space full of relationships between different beings who live in constant equilibrium.

“Can art be a form of social pollination?”  
(Alejandro Tamayo 2021)

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10. Visualization of the examples, Marthin Rozo