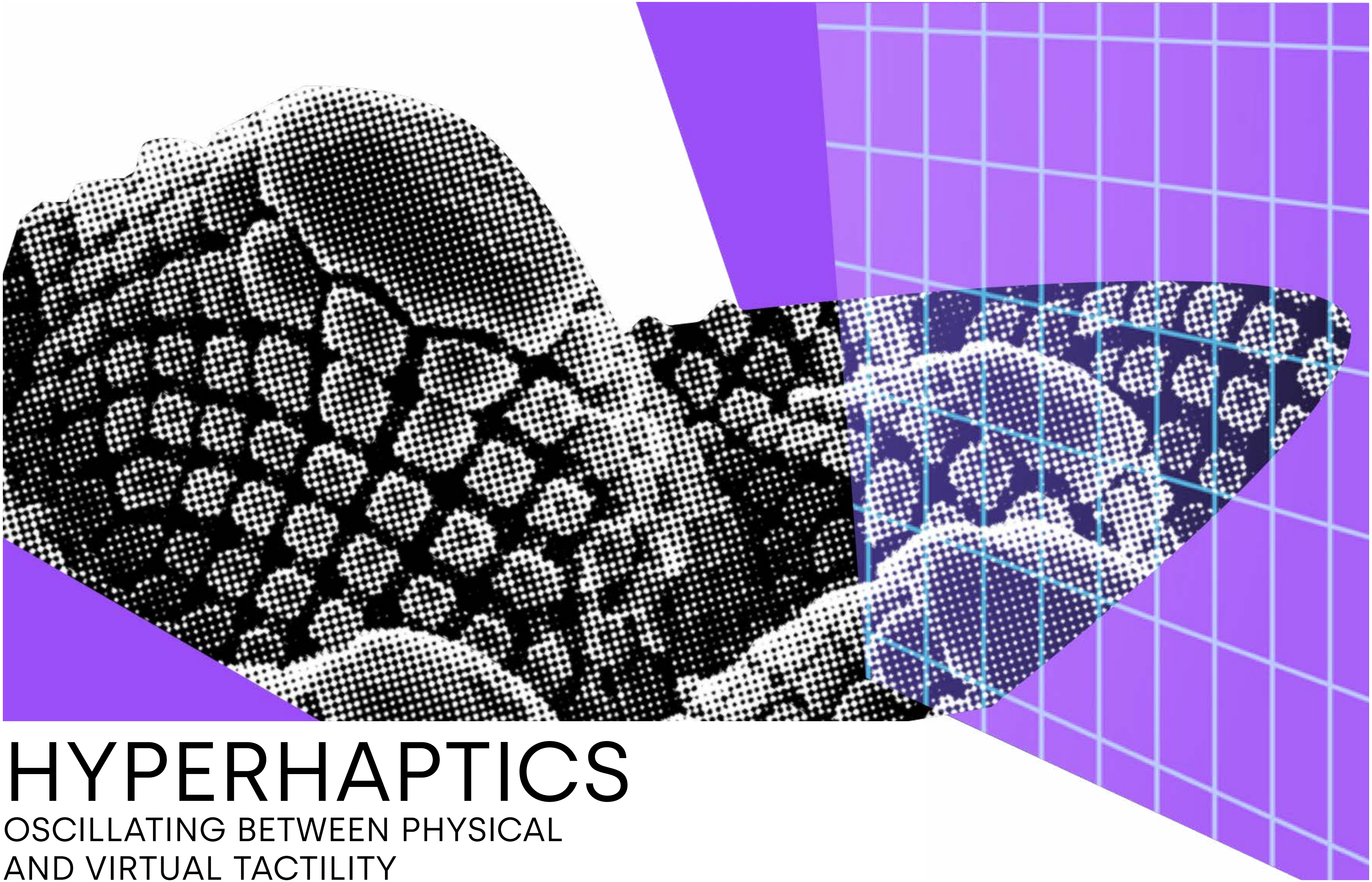


HYPERHAPTICS

OSCILLATING BETWEEN PHYSICAL AND VIRTUAL TACTILITY

↘
The introduction of the concept of „the ultimate display" by Ivan Sutherland is regarded as the birth of Virtual Reality, or VR for short. The technological developments of the last 50 years have since then produced increasingly realistic experiences that reproduce sensations associated with the physical world. (1)
However, these systems primarily address only two of the human senses; our sight and hearing. In comparison, our skin and with it our sense of touch is a little-explored sensory interface for VR and AR (Augmented Realities) technologies. The skin forms the basis of all our physical interactions with the outside world. Tactile sensations generate the deepest and most emotional kind of contact between individuals and are therefore essential for immersive virtual experiences. (2)
We understand 'virtual reality' not only as a collective term for dedicated technologies, but also as the digital enrichment of physical spaces and objects with multi-sensual levels of information. The aim of the project is to explore the extent to which virtual realities can generate not only equivalent but completely new 'hyper-realistic' experiences by means of synaesthetic stimuli.

How can haptics and materiality be transported into the virtual? How can senses be meaningfully coupled to complement and expand physical reality? How can the imagination of users be stimulated while they mentally construct imaginary virtual worlds beyond spatial and temporal boundaries?
If experiences are basically multi-sensory data, they can be manipulated in the end. „We are interested in whether and how learned patterns of experience can be changed and how we can recondition our perception," says curator Mike Meiré. Areas of application in which the wonderful perceptual abilities of humans can be expanded are numerous and range from education, communication and entertainment to medicine and rehabilitation. Part of the project will therefore be to identify meaningful applications and to design suitable solutions.
The project is based on the research work of the 'Cutting' project at the Cluster of Excellence 'Matters of Activity', which deals with the cultural practices of 'cutting' and understands them as a process of dividing as well as composing, ultimately deciding.

(1)
Dangxiao Wang et al., Haptic display for virtual reality: progress and challenges, in: Virtual Reality & Intelligent Hardware, Volume1, Issue 2, Pages 136-162, 2019

(2)
Yu, X., Xie, Z., Yu, Y. et al. Skin-integrated wireless haptic interfaces for virtual and augmented reality. Nature 575, 473–479, 2019

HYPERHAPTICS
OSCILLATING BETWEEN PHYSICAL AND VIRTUAL TACTILITY

COLLABORATION

with eLAB (lead by Felix Groll) • Dr. Olivier Bau (Computer Science) • Paula van Brummelen (Textil- and Surfacedesign) • Dr. Maxime le Calvé (Anthropology) • Christoph Volbers (Product-Design)

supported by the Cluster of Excellence »MATTERS OF ACTIVITY«

SUPERVISION PROF. CAROLA ZWICK • JUDITH GLASER • FELIX RASEHORN

↘
A 4 — 29
Micro Motions (19.10. – 06.11.)
Technological Focus:
Shape memory alloys (SMA) and physical computing
Workshop supervised by •
Paula van Brummelen, Judith Glaser

→
The 1st sprint investigates the richness of motions on a micro-level, reaching from ASMR via tropism to the pupillary light reflex and its potential to augment our perception. The medium of choice for creating these subtle yet strong responses are shape memory alloys (SMA).

↘
B 30 — 57
Haptic Vision (09.11. – 27.11.)
Technological Focus:
Augmented Reality (AR) and Virtual Reality (VR), Unity Engine
Workshop supervised by •
Christoph Holtmann, Felix Rasehorn

→
During the 2nd Sprint we were interested in the recombination of senses to model richer experiences, including multiple senses. How can technology be used to generate patterns or experiences that can be reinterpreted through other senses? The students were asked to develope concepts to augment human sight with the support of AR technologies.

↘
C 58 — 83
Pseudo Haptics (30.11. – 18.12.)
Technological Focus:
Augmented Reality (AR), physical computing and Processing
Workshop supervised by •
Dr. Olivier Bau

→
The 3rd sprint focused on the mutual relation between visual and haptic perception to investigate haptic illusions. These were used as inspirational concepts for the exploration of physical-virtual storytelling. The students were asked to experiment and come up with short interactive stories that combine physical objects, actuators, vision-based object tracking, and computer graphics.

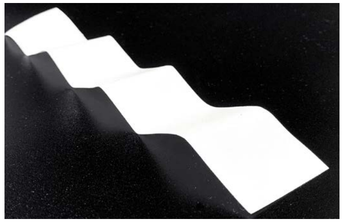
↘
D 84 — 111
Deep Dive (30.11. – 18.12.)
Technological Focus:
free of choice

Workshop supervised by •
Judith Glaser, Felix Rasehorn

→
In the final sprint, the students had time to work on concepts, ideas or questions that arose from previous sprints. They were free to further develop their experimental series' on a more exploratory level or to work on specific products and experiences.

↘

A 4 — 29
Micro Motions (19.10. – 06.11.)
Technological Focus:
Shape memory alloys (SMA) and
physical computing
Workshop supervised by •
Paula van Brummelen, Judith Glaser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1


2

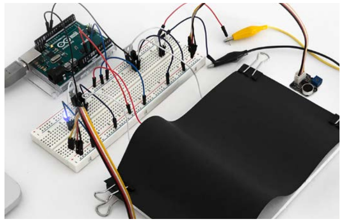

5

DESIGN STUDENTS

1. Netta GIGI &
   Maria SORAVITO DE FRANCESCHI
2. Aminata CISSE
3. Johannes SCHMIDT
4. Tillmann KAYSER & Felix HENßLER
5. Ran ZHANG
6. Minseong KIM
7. Alexandra RUPPERT
8. Tal SZNICER

MICRO MOTIONS

19 OCT— 6 NOV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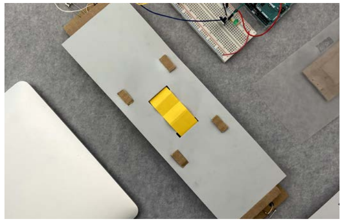
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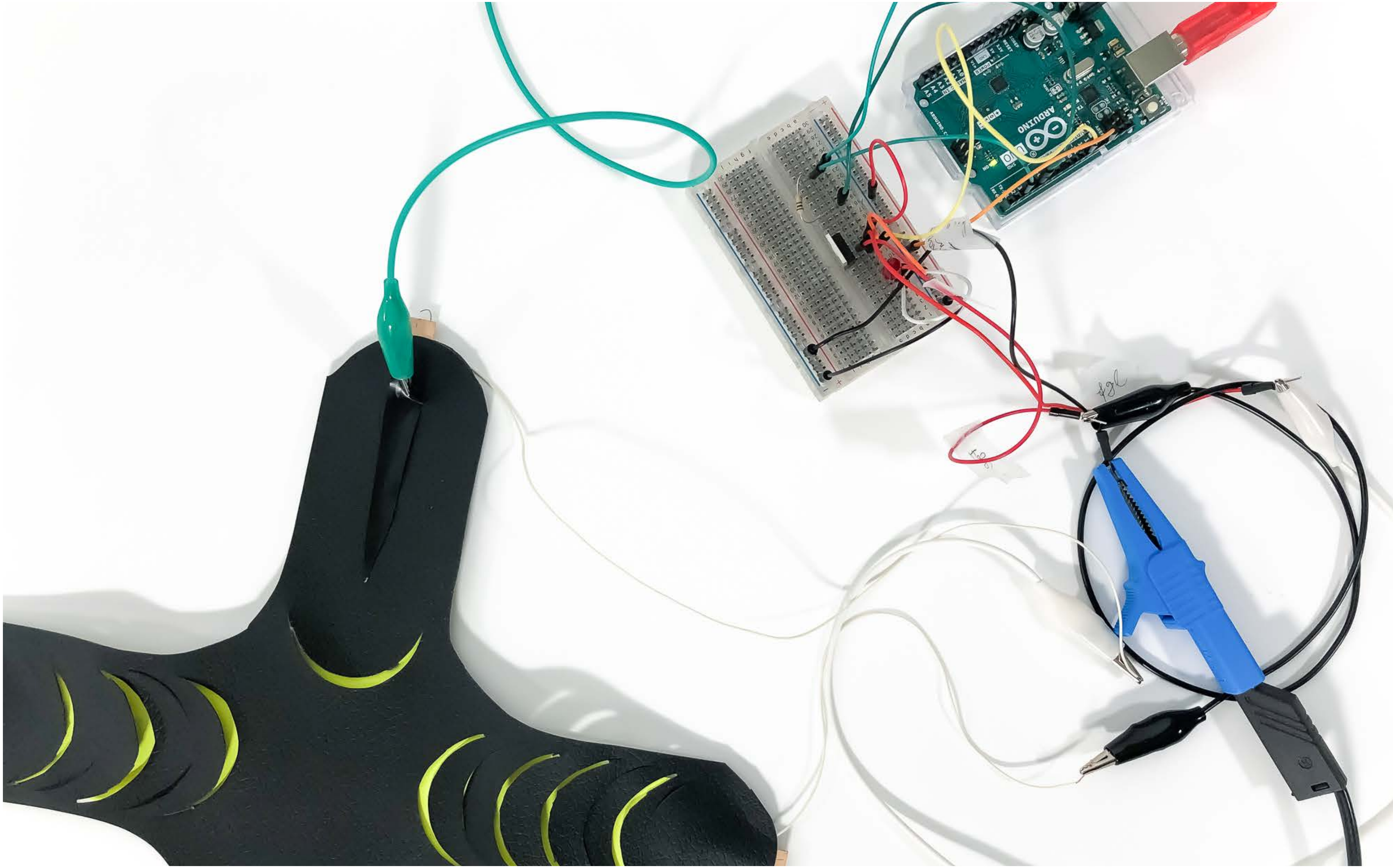
↘
On a daily basis, a range of subtle yet strong sensations enrich the perception of our physical surroundings. The pilomotor reflex, more commonly known as goosebumps, can occur due to various stimuli. It can be caused by a drop in temperature to re-balance the surface of our skin; by an intense emotional response such as stress, or by music that moves us. Brain structures like the amygdala and prefrontal cortex are activated, parts which typically trigger feelings of pleasure and reward. A related phenomena is Autonomous Sensory Meridian Response, ASMR for short, which refers to the experience of a tingling, pleasantly felt sensation on the skin. Mostly associated with relaxation, reassurance, and well-being, again triggers can be diverse – a slight touch on the head; whispering voices; the crackling of foil. This sprint investigates the richness of motions on a micro-level, reaching from ASMR via tropism to the pupillary light reflex and its potential to augment our perception..
The medium of choice for creating these subtle yet strong responses are shape memory alloys (SMA). In contrast to conventional motors such as stepper motors, SMAs move tenderly, gently, and silently. Employing physical prototyping technologies, SMA wires can be addressed and controlled, thus reactions of individual elements as well as entire surfaces can be designed.
Gestaltung as well as technology is understood to be liberated from the burden of copying as it does not imitate nature as it is but mimics its principle of production (3). Particular importance is given to matter as an ›active agent‹ in the design process. Respecting that in Design problems and solutions co-evolve (4).
Under the title ›Figures of Speech. Tactile Onomatopoeia.‹ the students were asked to translate an onomatopoeic phrase, drawn at random, into a responsive surface. Onomatopoeia refers to words that phonetically imitate, resemble, or suggest the sound that they describe. The challenge was to grasp the acoustic quality of the phrase and transform it into a multi-sensual experience. In the course of the sprint, the exploration of this initial task became ever broader.

(3)
Winkler, H. (2002) 'Über das mimetische Vermögen, seine Zukunft und seine Maschinen.', Kinoschriften, 5, pp. 227–239

(4)
Dorst, K. and Cross, N. (2001) 'Creativity in the design process: co-evolution of problem–solution.', Design Studies, 22(5), pp. 425–437

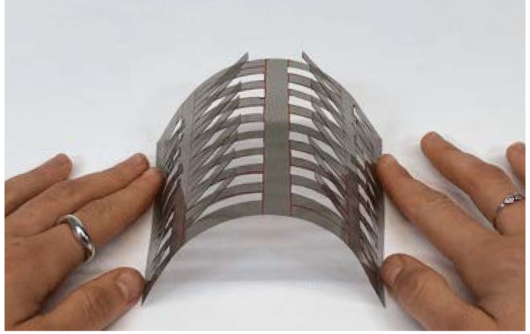
MICRO MOTIONS
19 OCT— 6 NOV

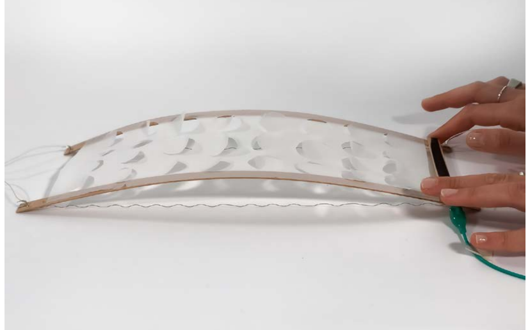
TEXT BY JUDITH GLASER



↘
RESEARCH QUESTION / INVESTIGATION
How might one create a gesture of »impossible touch«, so that two individuals can feel one another without touching?
↘
METHODOLOGY
First a prototype for a flexible surface was created using thin strips of wood and shape memory alloys attached to a power source via Arduino. The strips' flexibility allowed them to raise and bend when the shape memory alloy was activated.
The way in which the surface is activated is key to the concept. It was important to trigger the motion with a sensitive, varied, human touch like a stroke - not just by pressing a button. As a sensor or trigger we used a kind of synthetic textile.
For the surface materials, PVC, silicone but also a kind of artificial leather or thin drawing paper was used. Different patterns were cut out of the materials to experiment with their characteristics, to see what effect prongs or organic shapes have on the resulting motion.

↘
PARAMETERS
The ampere intensity was the parameter used for the wire - this affected how much the SMA contracted. The wood material and its flexibility also had an influence. If the wood strips were thicker and less flexible, the motion would be less pronounced.





↘

FINDINGS

The intensity of the movement changed depending on the materiality and pattern we used for our series of experiments. Working with the memory shape alloy was also not always predictable. Every now and then the wire did not return back into its »trained« shape. The »stroke« trigger however was very reliable. The way the movement of the surface is triggered was the main focus, successfully creating a more rewarding, human interaction.

↘
RESEARCH QUESTION / INVESTIGATION

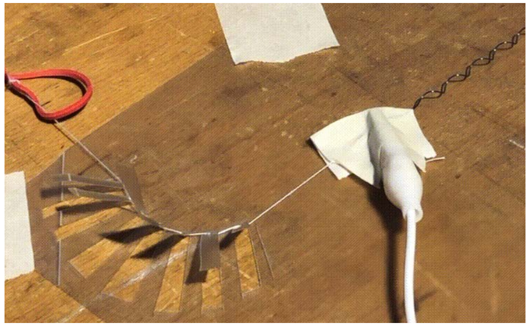
Is it possible to simulate an organic movement with non-organic materials? Aiming to visualize the sound of »bees buzzing busily from flower to flower«, an experiment was designed with the aid of *shape memory alloys*.

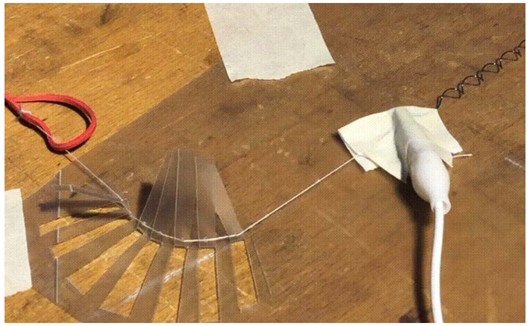
↘
METHODOLOGY

Wing and flower shapes were cut from paper and plastic and shape memory alloys integrated to make them move and buzz. The material was connected to *Arduino* and an energy source to control the movements. Insulation foil, foam, a wooden plate and thread were later used to make a more refined prototype.

↘
PARAMETERS

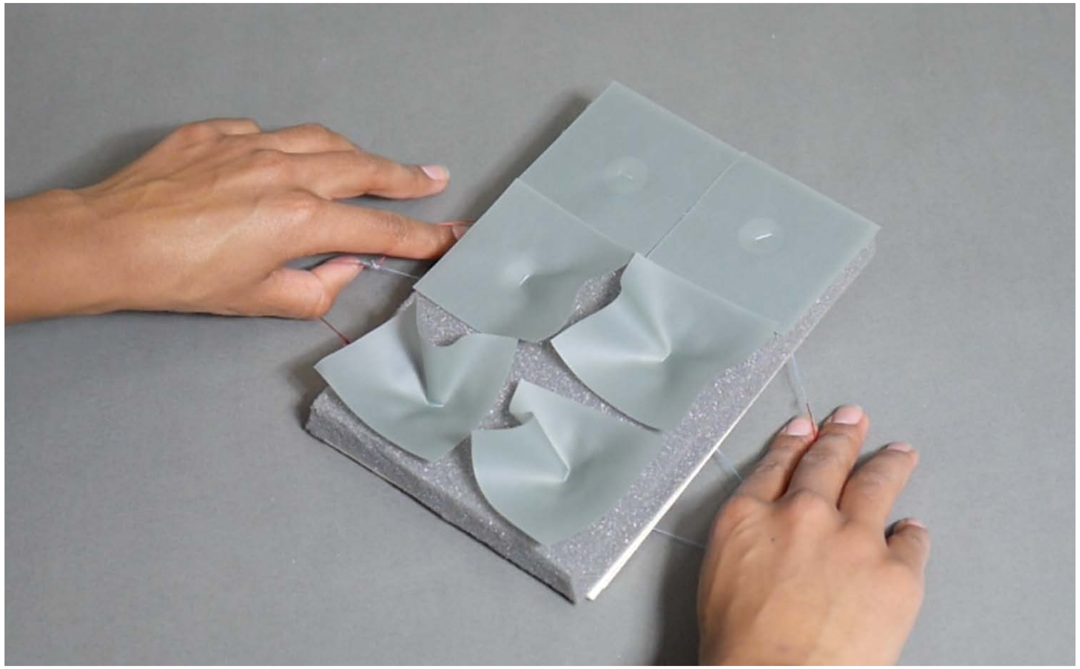
As the *shape memory alloy* and its power level was constant, the only parameters which could be changed were the shape, size and type of materials used to visualize the motion.

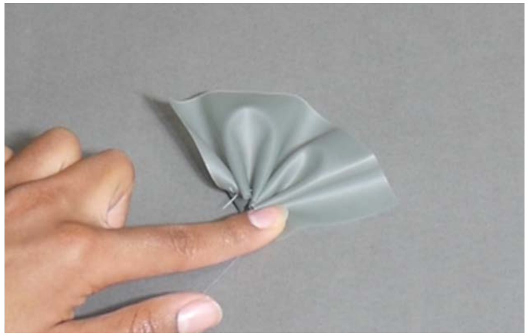


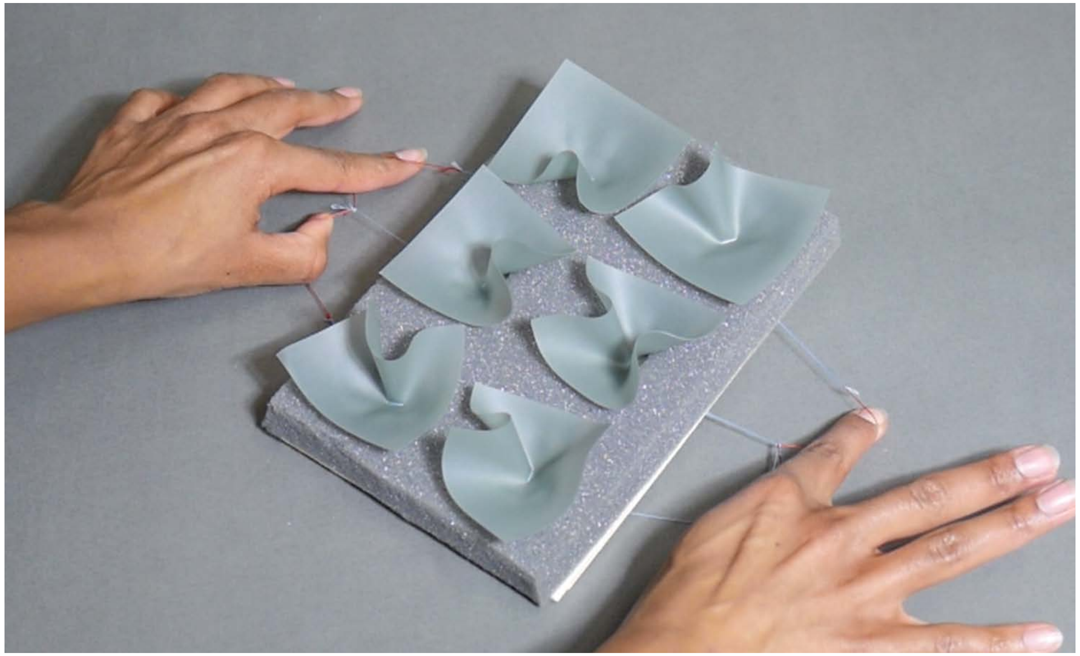


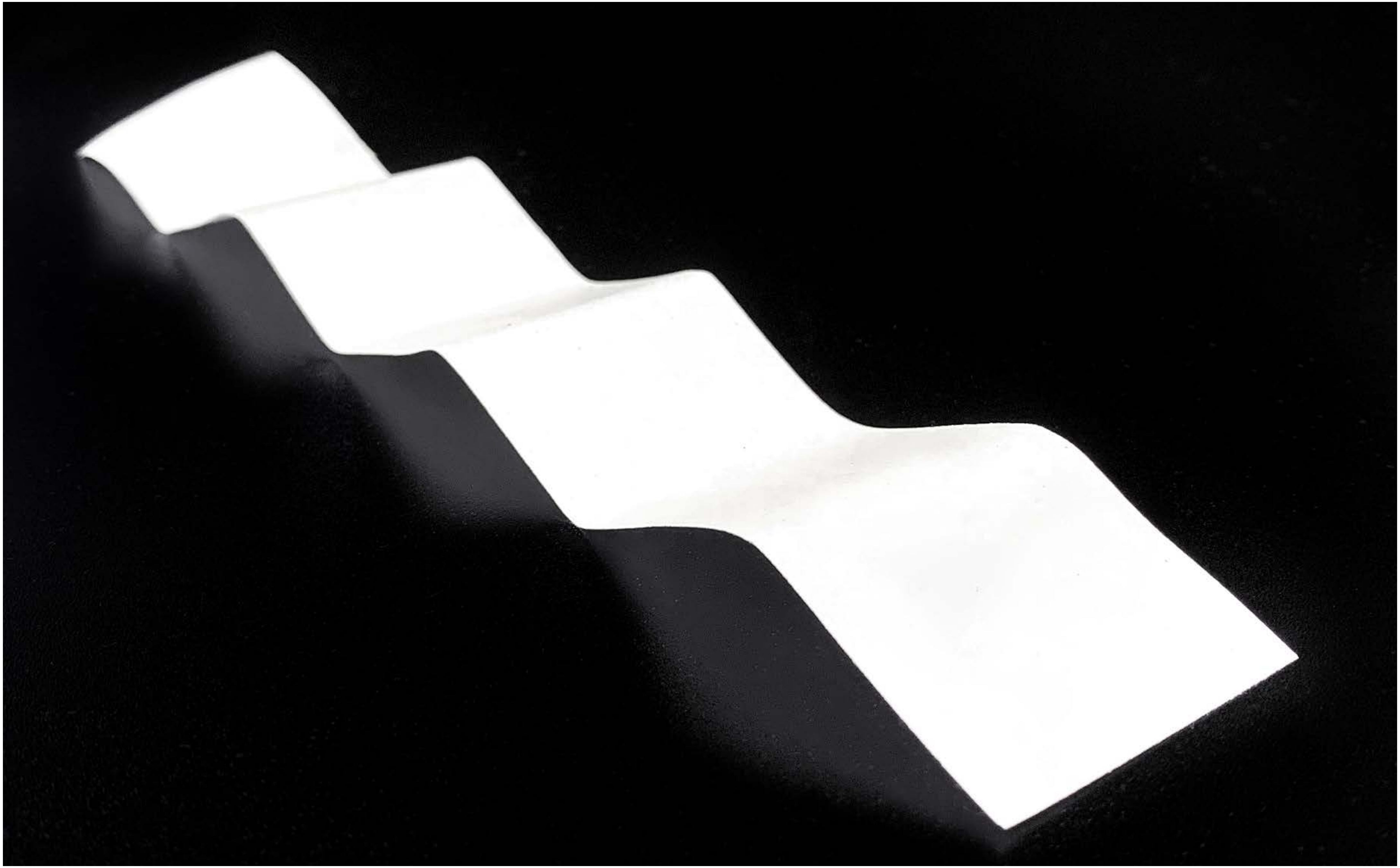
↘
FINDINGS

It wasn't possible to create a buzzing motion as the movements generated by the *SMA* were too slow, with no vibration. The focus shifted to replicating the natural, gentle motion of a flower opening and closing its petals, which lent itself much better to visualising the small energy input of the *SMA*.
The last prototype worked well and resulted in a responsive surface design. The surface was divided into squares which each had a separate flexible plastic membrane. When activated, each square membrane is pulled backwards from a central point, causing its edges to lift and contract inward. Gravity smoothly and efficiently returns the surface to its flat, inactive state.





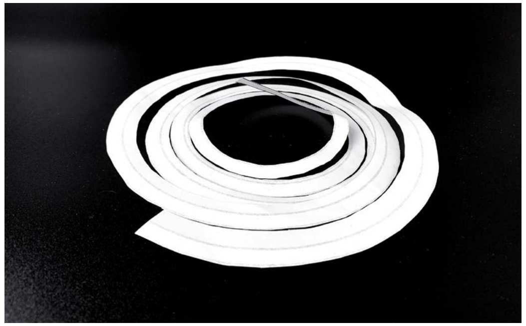


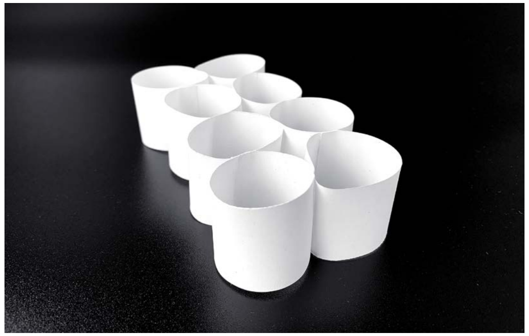


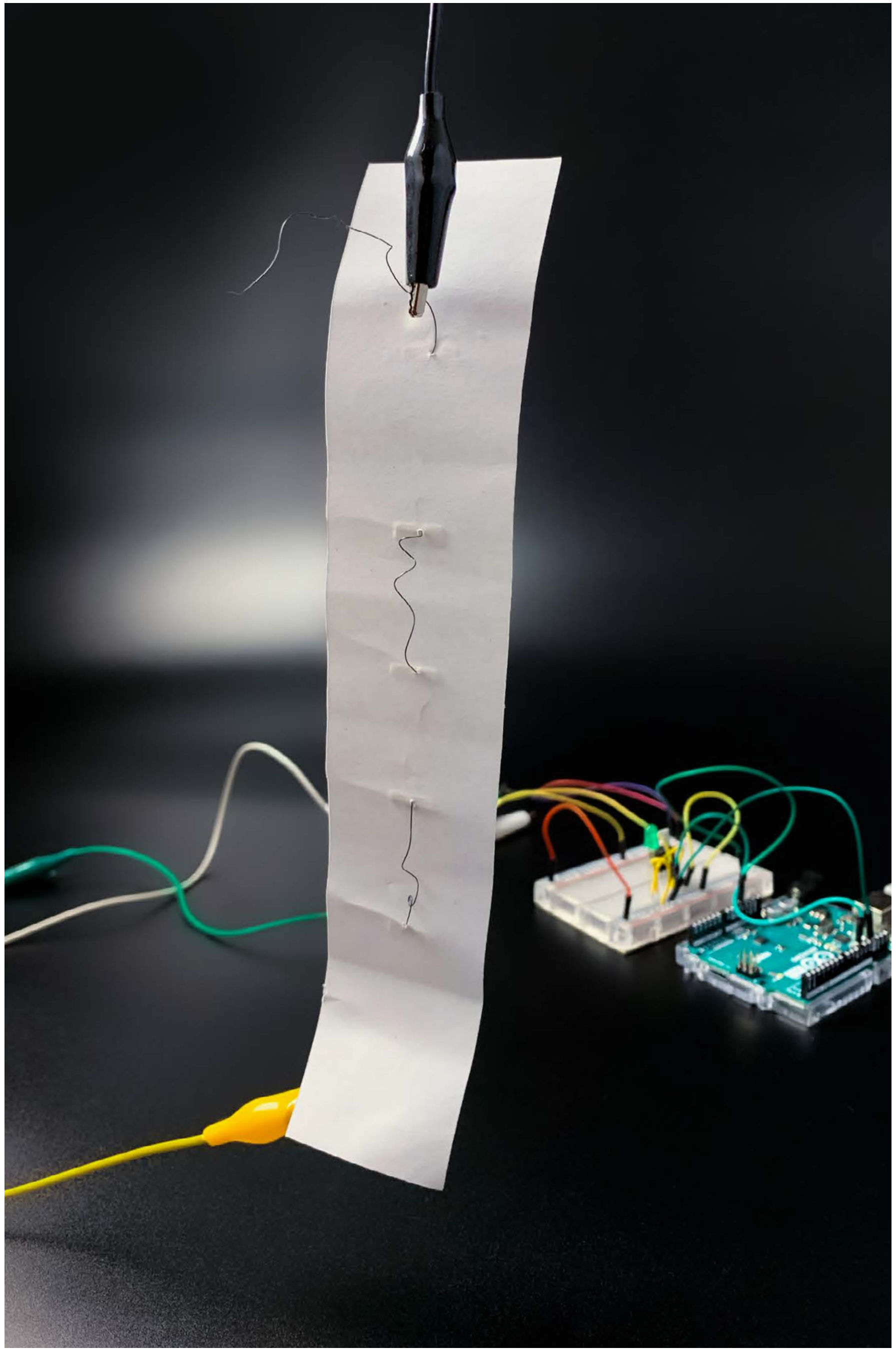
↘
RESEARCH QUESTION / INVESTIGATION
What defines the character of a certain motion? And how can it be imitated? During this design sprint I dived into the micro dimension of motions aspired to represent a specific motion. I used the onomatopoeia »Snakes slither through the leaves« as a pictorial inspiration to translate it into a responsive surface.

↘
METHODOLOGY
As a starting point for my work, I analysed the slithering motion of a snake in detail and split it into smaller elements. I created numerous – mainly paper – prototypes and experimented with folding, cutting and assembling techniques. To approach a characteristic motion I worked with Shape Memory alloy which I attached to my prototypes to bring them »to life«.

↘
PARAMETERS
I worked with different strengths of paper, carton and PVC foil to build prototypes in order to find the right level of tension that worked well with the *SMA*. I also variegated the complexity of the prototypes for each construction idea. At some point, I even rotated dimensions by hanging the prototype and installing a weight on it to balance out the *SMA's* strength.





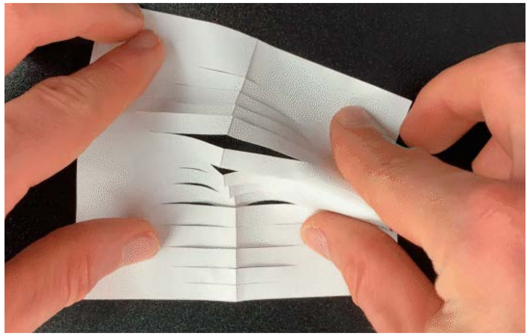


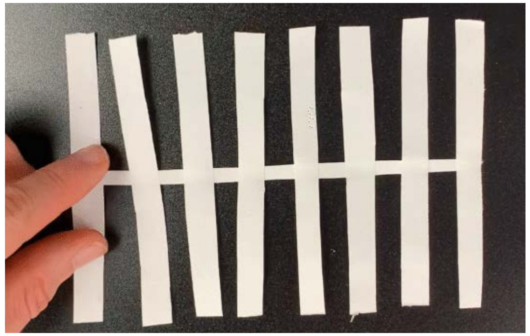
↘ FINDINGS

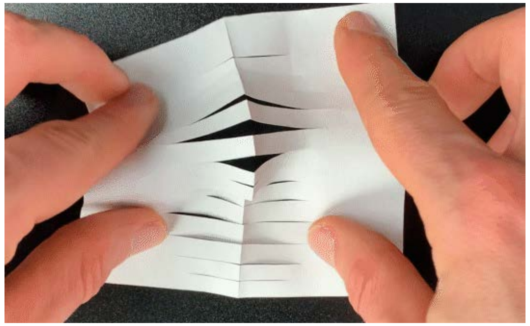
With increasing strength of the paper or material of the prototype the scale of the motion became smaller and slower as well. Eventually, basic paper as prototype material turned out to be the best option for my needs, because it allowed me to create quickly and precisely many prototypes in different sizes. The right tension of the folded construction turned out to be a fine line.

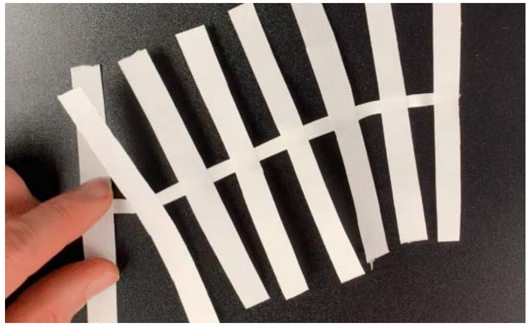
The right tension of the folded construction turned out to be a fine line. Most prototypes worked in terms of their motion potential, but were either too complex, too weak or too strong to be powered by the *SMA*.

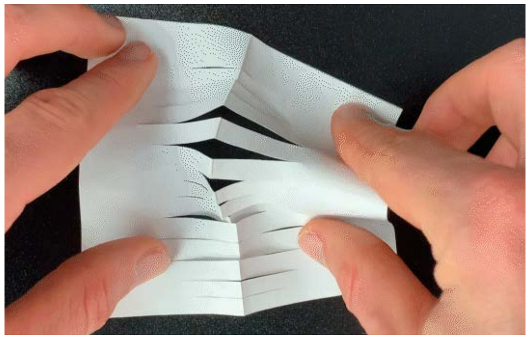
My approach to split a complex motion into smaller elements worked out well and helped me to explore motions on a micro level. After creating prototypes for single elements of the motion, I was able to combine the functional again into more complex prototypes to achieve a higher quality of a responsive surface.

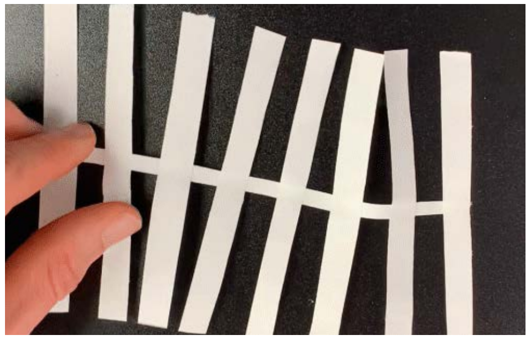


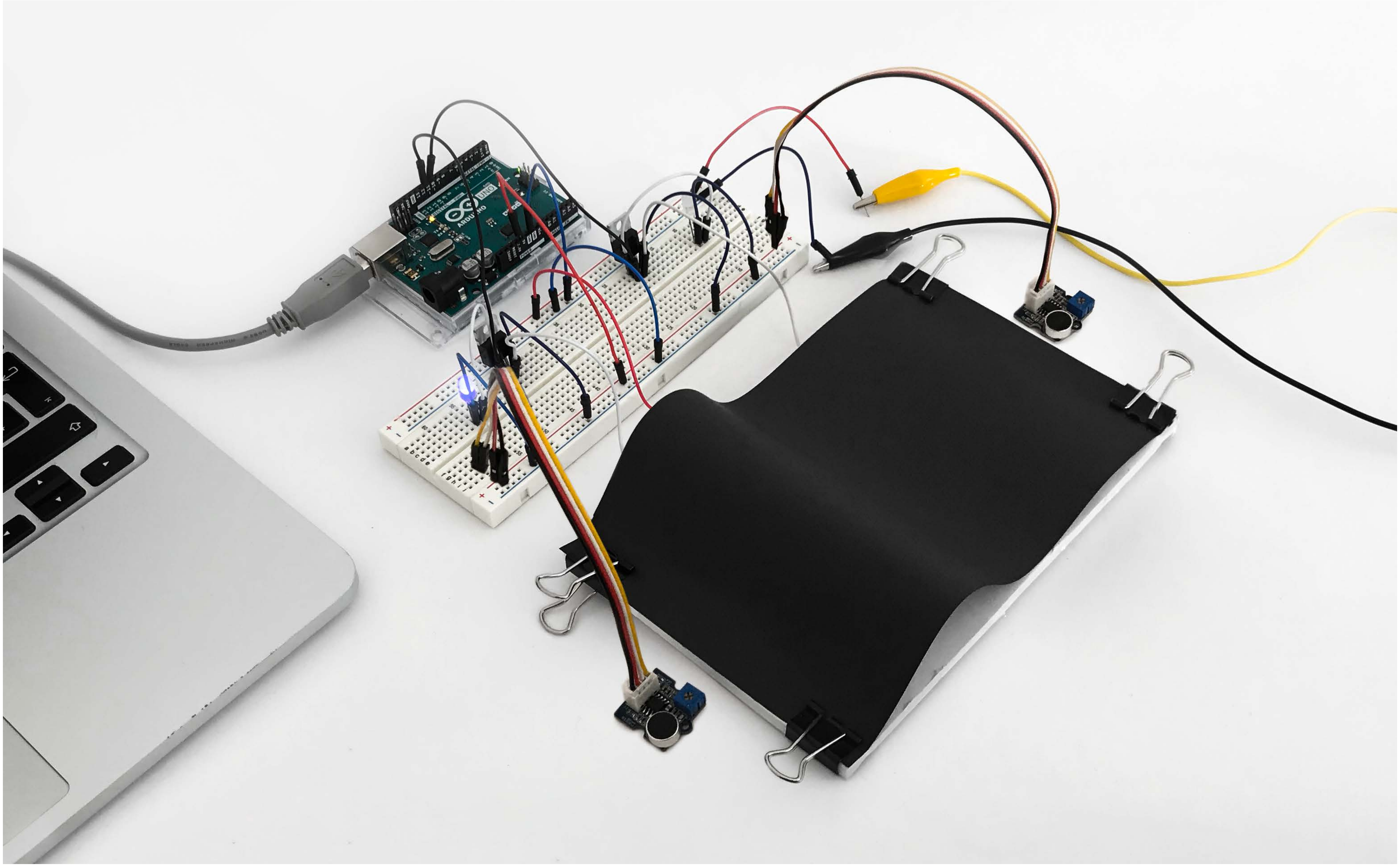








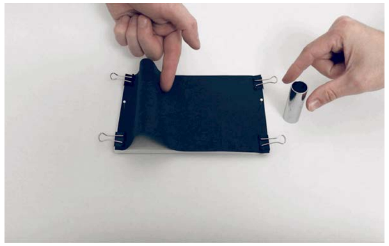
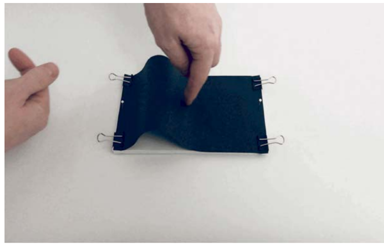
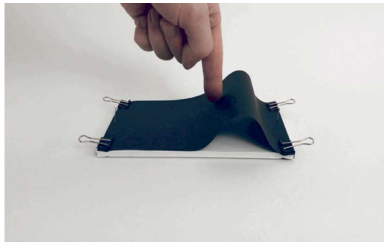
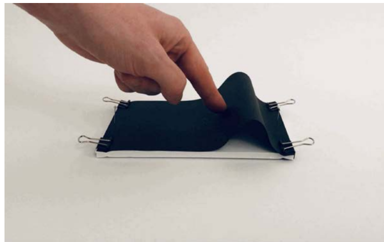
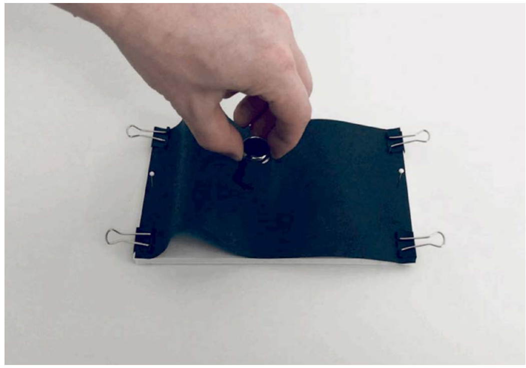
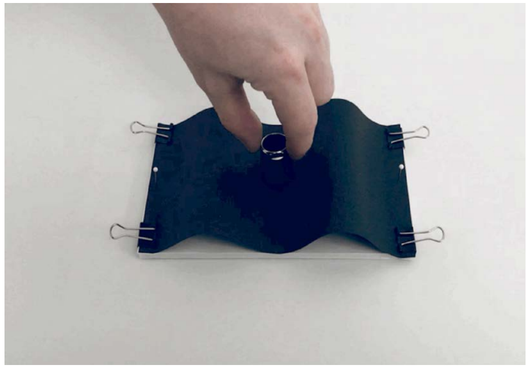
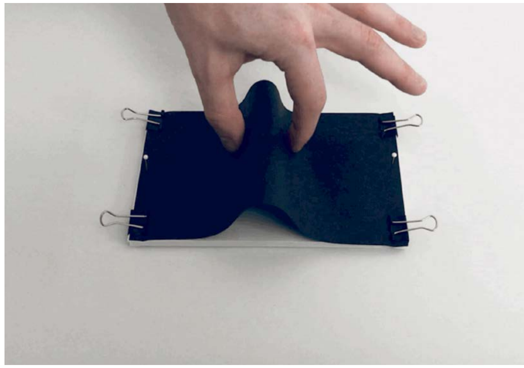




↘
RESEARCH QUESTION / INVESTIGATION
Interaction represents a relationship between an object and a user. What action could cause a plausible reaction in an otherwise »simple« arched paper surface?

↘
METHODOLOGY
In order to experiment quickly, the experiment was set up in an analog way. For this, a simple piece of paper was interacted with by hand, in order to be able to record the potential interaction styles and quickly find the most promising gesture to match the reacting motion. This piece of paper was attached with clips to a shorter piece of card, resulting in the upper layer of paper forming a curved convex arc, the apex of which could move back and forth flexibly across the length of the paper.

↘
PARAMETERS
The interaction was varied and tested comparing opposing pairs of gestures: the paper arc was pinched up and pushed down; the arc moved in sync with the gesture, or asynchronously. The speed of the interaction was changed, as well as the direction, the height and the type of trigger. The initial tests varied the stimulus - initially used the gesturing hand itself to move the arc, then a separate hand, then a sound sensor and finally a distance sensor.

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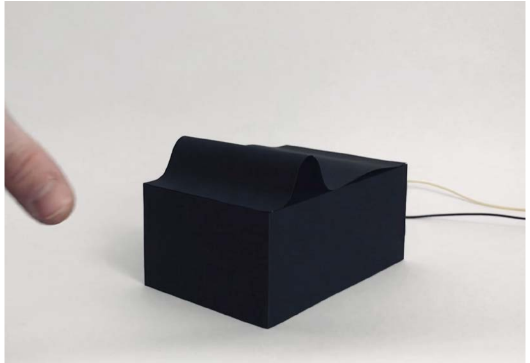
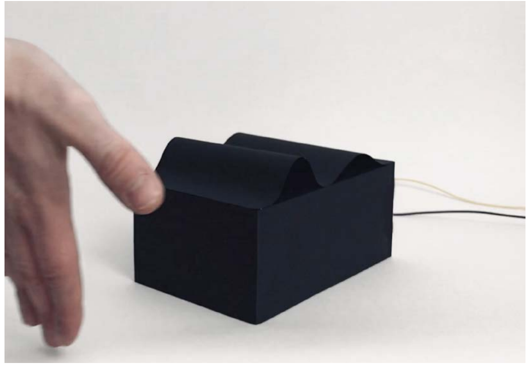
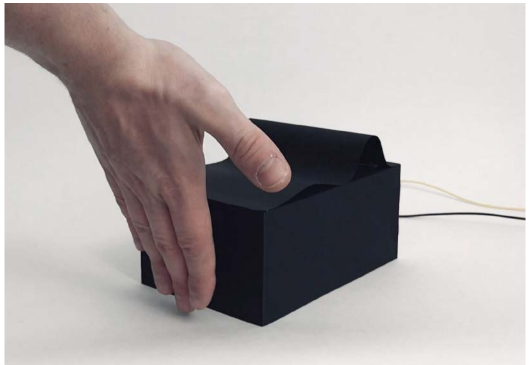
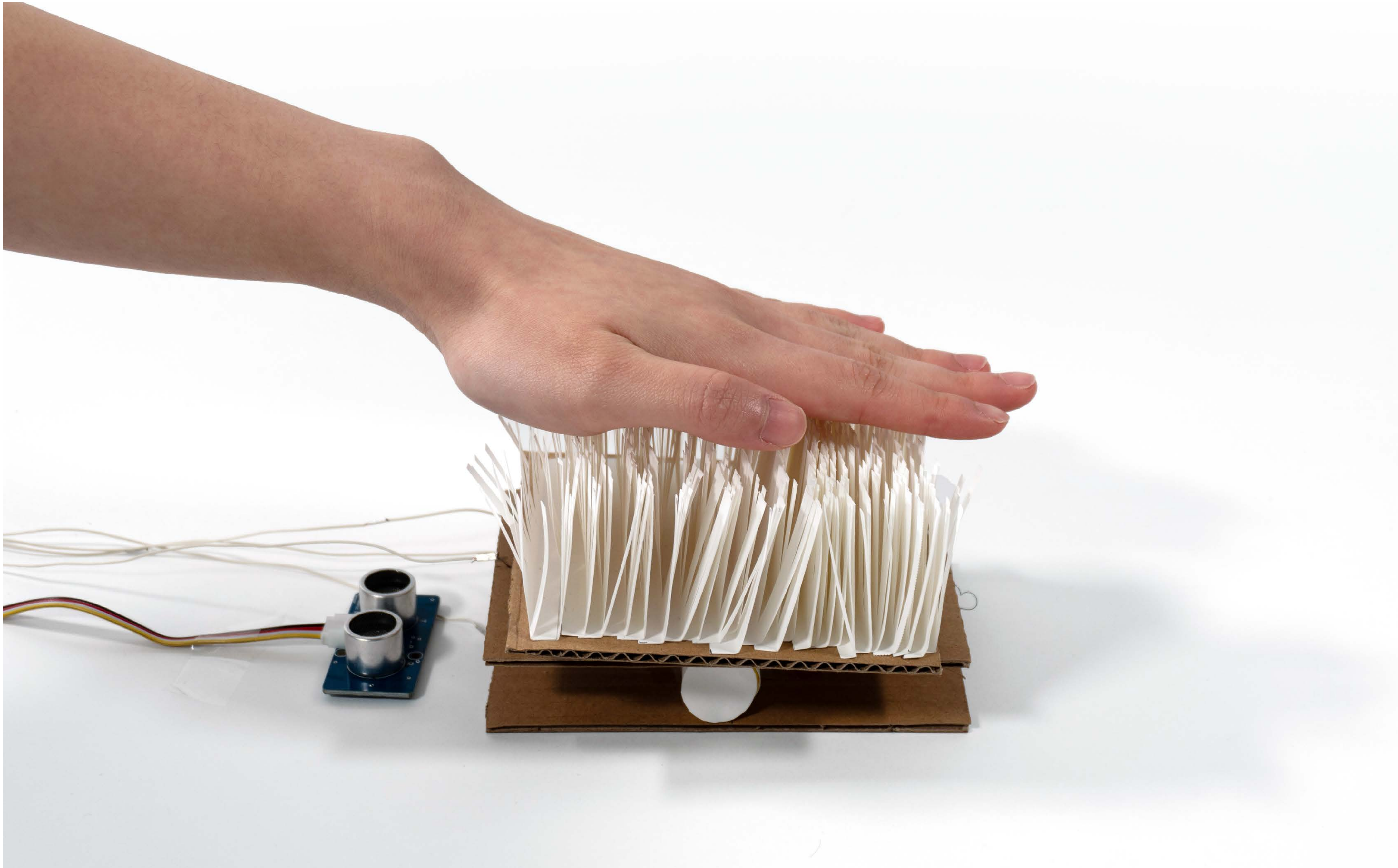
FINDINGS

In the end, an expressive result was achieved with a combination of gestures that »call forth« and »scare away« the arc of the paper surface. As the user comes closer to the object, the arc moves back, and as the user moves their hand away, the arc moves closer as the paper surface comes to life.









↘
RESEARCH QUESTION / INVESTIGATION
How can surface motion allow us to experience a tactile sensation from a different perspective? Instead of us touching an object, can an object actively touch us?

↘
METHODOLOGY
The experiment began by translating the sound of »rustling« into surface motion, working with shape memory alloys and paper. When activated, the *SMA* shook the paper strips and caused them to rub against each other. In a further iteration, many paper strips were layered so that they had more weight. The paper strips were set to be pulled up when triggered and then fall thanks to gravity's additional force, creating a more defined motion. An ultrasonic distance sensor was used to trigger the surface movement. When one places one's hand over the prototype, it starts swaying as if it were touching one's hand.

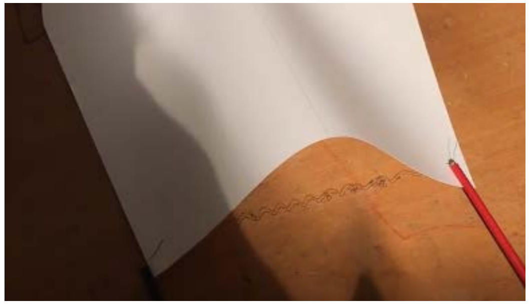
↘
PARAMETERS
Different external forces were tested to reverse the *shape memory alloy* to its initial position, such as elastic energy, gravity, and the force of another shape memory alloy. By controlling the time of power on and off as well as the voltage, the speed of movement can be changed to give a stronger or softer sensory effect.

↘
FINDINGS
Because of the soft movement of the *SMA*, the hand can hardly feel the surface movement and the materials. It is therefore important to find a stronger source to enable the hand to feel the »touch« of the object.

↘
RESEARCH QUESTION / INVESTIGATION
When people play in the water, they swing their arms wide to make waves. Could this familiar gesture be translated into a micromotion that allows people to indirectly experience the energy of waves?

↘
METHODOLOGY
To replicate the wave motion, shape memory alloys were combined with paper, a material chosen to express the softness and power of waves and their constituent water. The *SMA* is activated through a gesture sensor via *Arduino*. When people swing their arms over the sensor, the *SMA* is activated, moving the paper model to form a »wave«.

↘
PARAMETERS
The gesture sensor can detect 4 directions: left, right, up and down, within a range of ca. 30cm. Depending on the direction of the detected gesture, the *Arduino* can send or stop the current to the *SMA*. When people swing their arms to the right or upwards, the *SMA* is activated to create waves. Conversely, if the arm is swung left or downward, the *SMA* will stop working and the paper model will return to its original position.



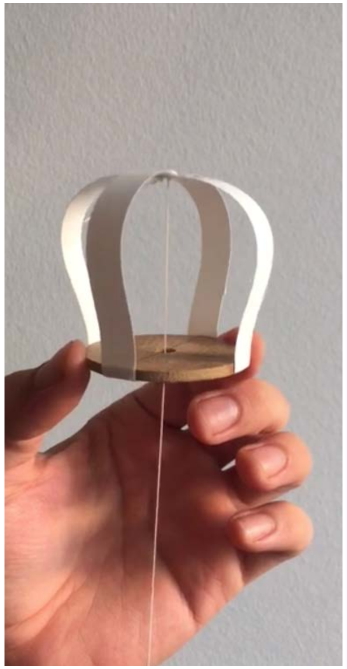
↘
FINDINGS

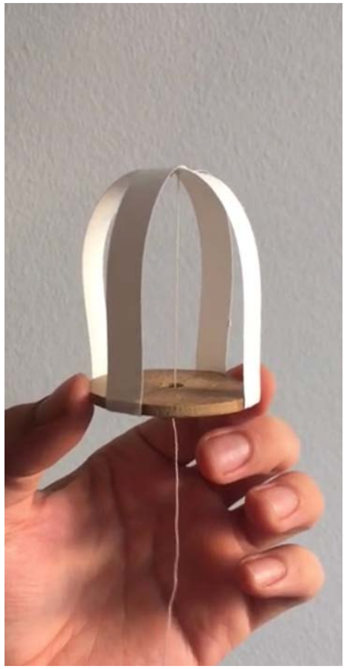
The opposing directions of the activation gestures made the device easy for users to understand. Paper worked well to visualize the small amount of force exerted by the *SMA*, as it is a lightweight material with moderate elasticity and tension. Although it is possible to form a wave with the minimal power of *SMA*, it was necessary to use another mechanism to return it to its original position. In this case, a rubber band was hung on the other side of the *SMA* to capture enough energy to reverse the motion.

↘
RESEARCH QUESTION / INVESTIGATION
The motion generated by a shape memory alloy appears almost organic. Could it be used to make an unusual object come to life?

↘
METHODOLOGY
Domes were made to »breathe« by attaching a *SMA* in their center that could move their external membrane up and down. The domes were built with bending PVC strips and covered with nylon fabric.

↘
PARAMETERS
Different paper weights and textile types were experimented with in order to find the good balance between lightness and strength to move the *SMA* organically.

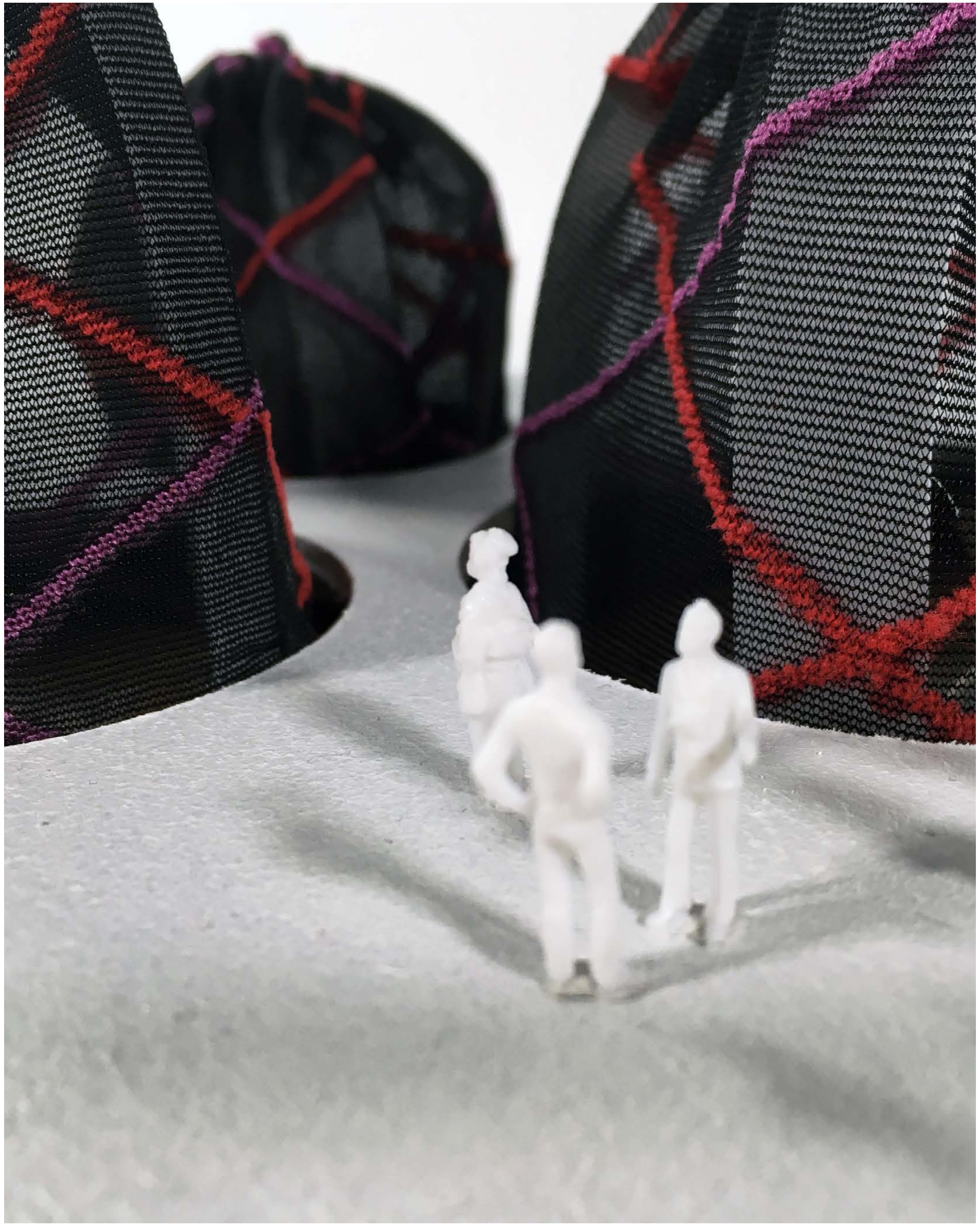


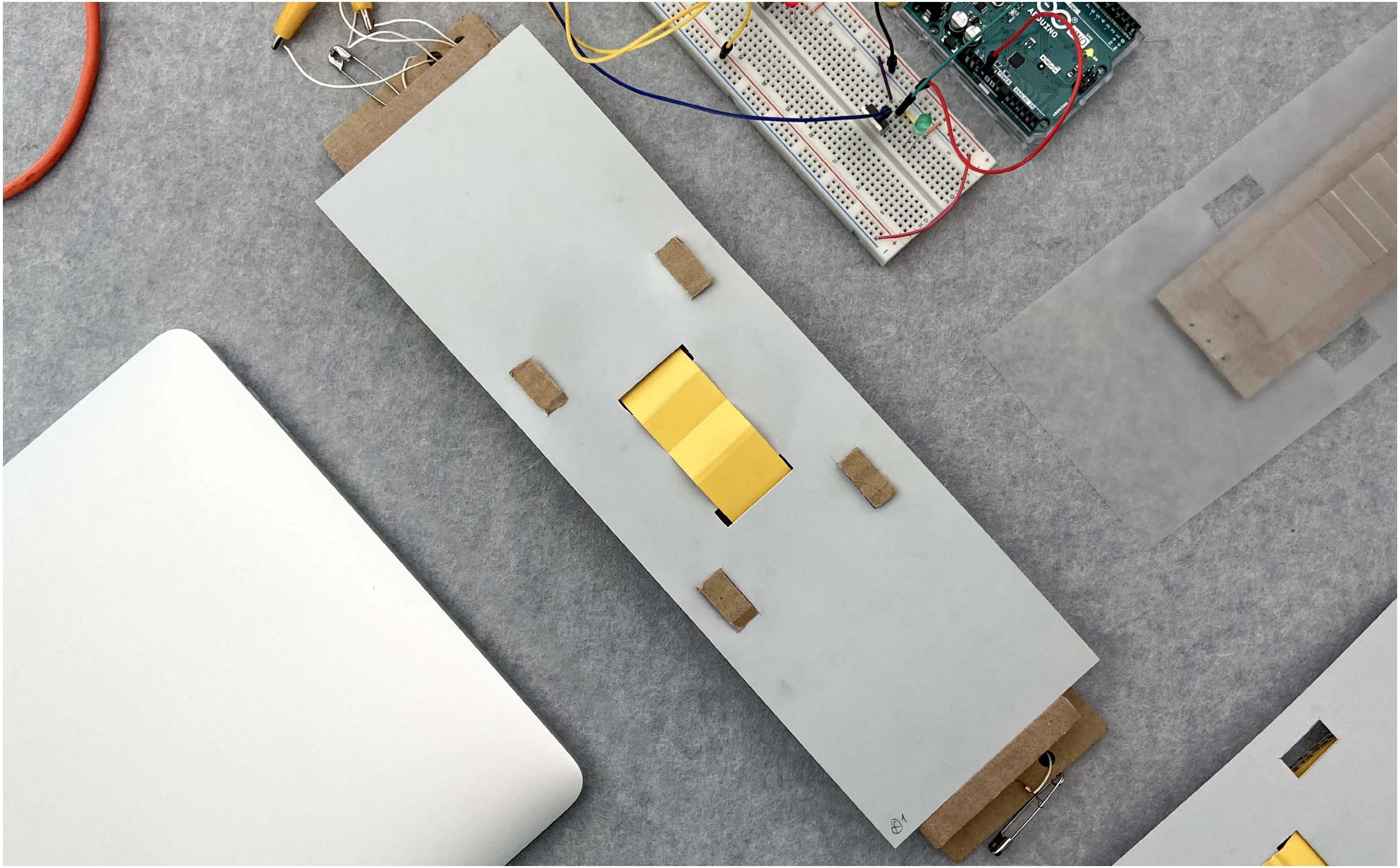


↘

FINDINGS

Early experiments demonstrated how sensitively the SMA reacted towards small changes. Whenever one parameter was modified, the whole construction was affected, which narrowed down the selection of materials.
In order to increase the visual effect of a breathing movement, I played with the perception of scale: by adding miniature model figures to the dome platform, the »breathing« domes took on a larger scale, so the observer could imagine themselves in the model.

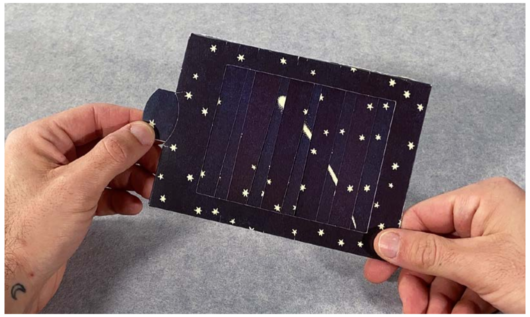


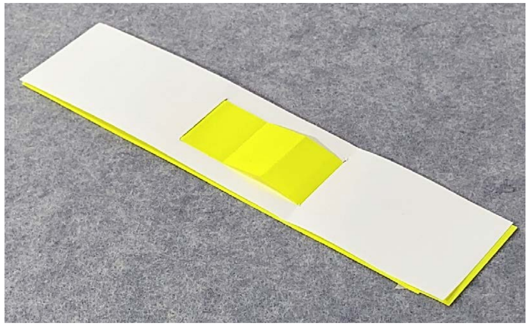


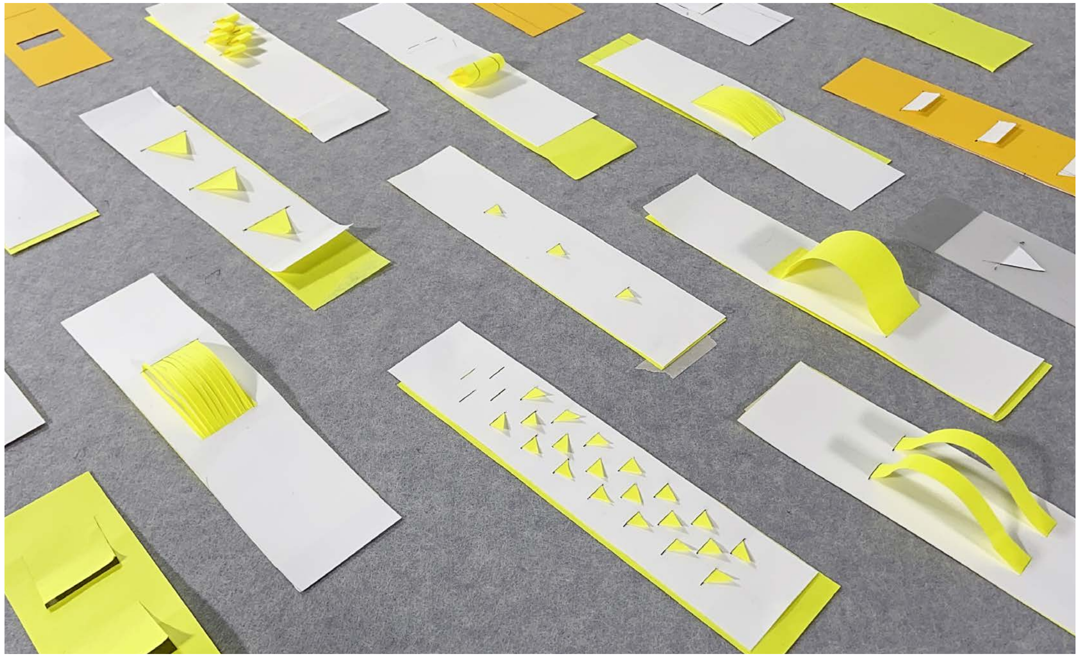
↘
RESEARCH QUESTION / INVESTIGATION
Third-party cookies exist exclusively in digital spaces, and they have no physical presence. This fact makes them so easily accepted without thinking about the implications of that action. A »rumbling« sound is a warning that something is about to happen nearby - e.g. an earthquake. In »Rumbling Cookie«, I wanted to examine how to add a haptic dimension to make users more aware of a digital activity that lacks a physical presence, yet is not without consequence.

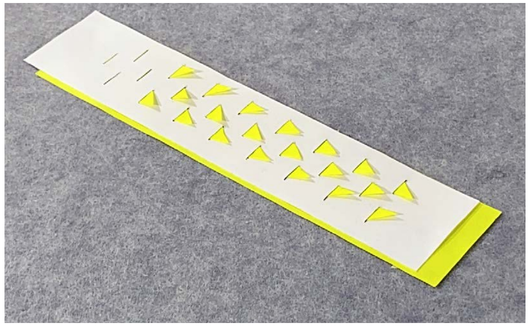
↘
METHODOLOGY
I searched for visual semantics in different words, alternating shapes, foldings, materials, and colors to fit the rumbling surface. I tested different cuttings and structures, multiplying and varying in size.

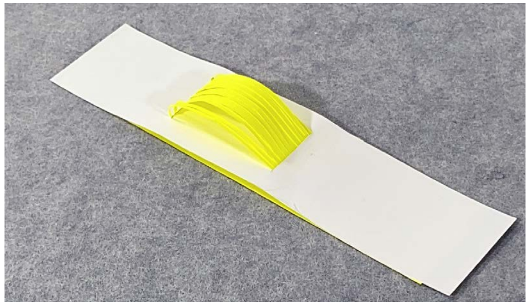
↘
PARAMETERS
I alternated between different materials (paper cardboard and PVC) and explored different colors.
The stronger the material, the stronger the sense of alertness was achieved. Also, more folding of the material created a stronger alert.



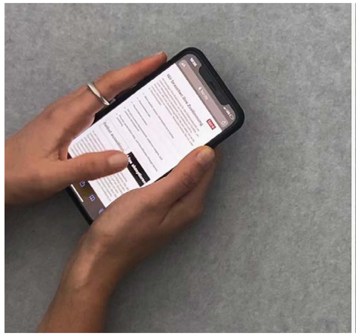


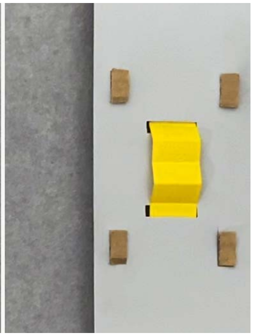


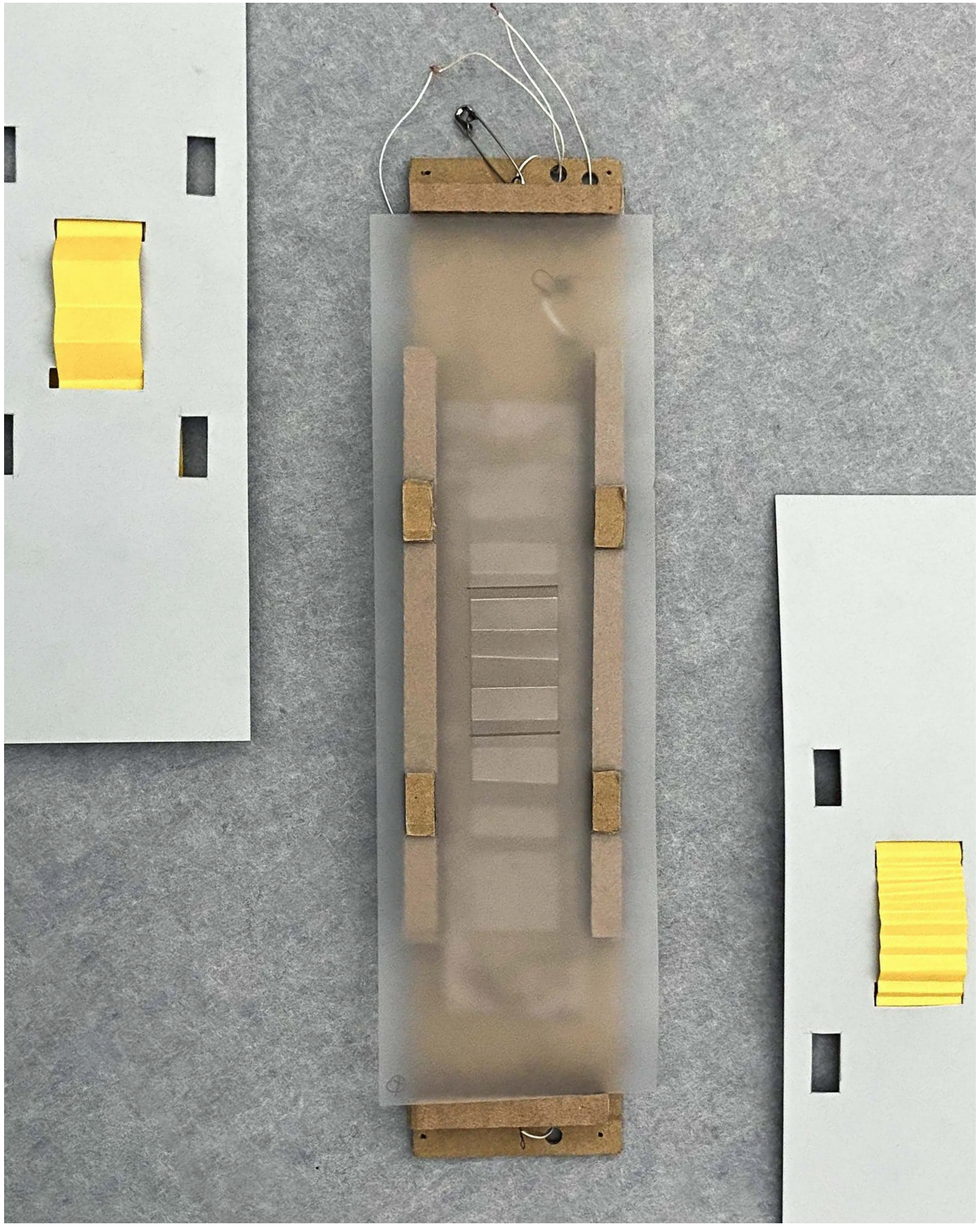




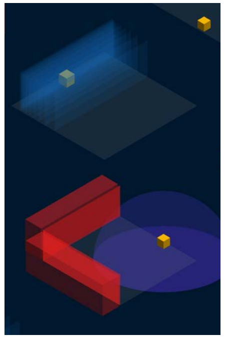
↘
FINDINGS
The motion of my prototype didn't have the desired effect. The reason was that the actuator required more length to be able to move the structure. I found out that PVC material better communicates a sense of alertness compared to paper due to its qualities. PVC has a sturdy surface - a quality that better served me in communicating a »rumbling« effect.







↘
B 30 — 57
Haptic Vision (09.11. – 27.11.)
Technological Focus: Augmented Reality (AR) and Virtual Reality (VR), Unity Engine
Workshop supervised by •
Christoph Holtmann, Felix Rasehorn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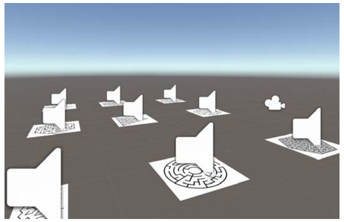
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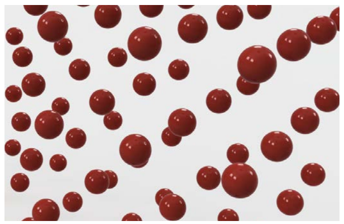
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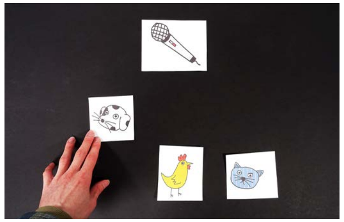
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5


8

DESIGN STUDENTS
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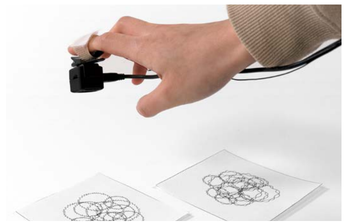
2. Tal SZNICER
3. Johannes SCHMIDT
4. Aminata CISSE & Felix HENẞLER
5. Minseong KIM
6. Netta GIGI &
   Maria SORAVITO DE FRANCESCHI
7. Yoorie KWON
8. Tillmann KAYSER
9. Ran ZHANG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HAPTIC VISION
9 NOV—27 NOV

↘

Touching, seeing, smelling, hearing, tasting: our bodies are naturally equipped to perceive subtle sensory impressions from our environment. The sensitivity of the human finger for instance goes far beyond its mechanical function of grasping. The fingertip is able to differentiate between surface patterns up to 13 nanometers in amplitude. Which means if your finger was the size of the Earth, you could feel the difference between houses and cars. The interaction of the finger with the surface is detected by mechanoreceptors embedded at various depths in the skin, some of which are sensitive to deformation (''slow adapting receptors'' for static touch) and others are sensitive to vibrations arising from movement (''fast adapting receptors'' for dynamic touch). (5)

During the 2nd Sprint HAPTIC VISION we were interested in the recombination of senses to model richer experiences, including and recombining multiple senses. David Eagleman describes the human brain as a general-purpose computing device, able to recognize patterns and interpret these usefully. (6) Other concepts, such as the conceptual metaphor theory, postulate that mental concepts are linked to sensorimotor representations of bodily states and experiences via the process of metaphor. (7)

How can technology be used to generate patterns or experiences that can be reinterpreted through other senses? The first design task AUGMENTED POT HITTING asked the students to come up with concepts to augment human sight with the support of AR technologies. The technical focus of the sprint was on the potentials of AR and VR, and the implementation of image and object tracking in Unity Engine. We concentrated on auditive and haptic augmentation strategies. Conceptual metaphors and sensory substitutions for embodied interactions were explored, designed and technically prototyped.

(5)
Lisa Skedung and others, 'Feeling Small: Exploring the Tactile Perception Limits', Scientific Reports, 3.1 (2013)

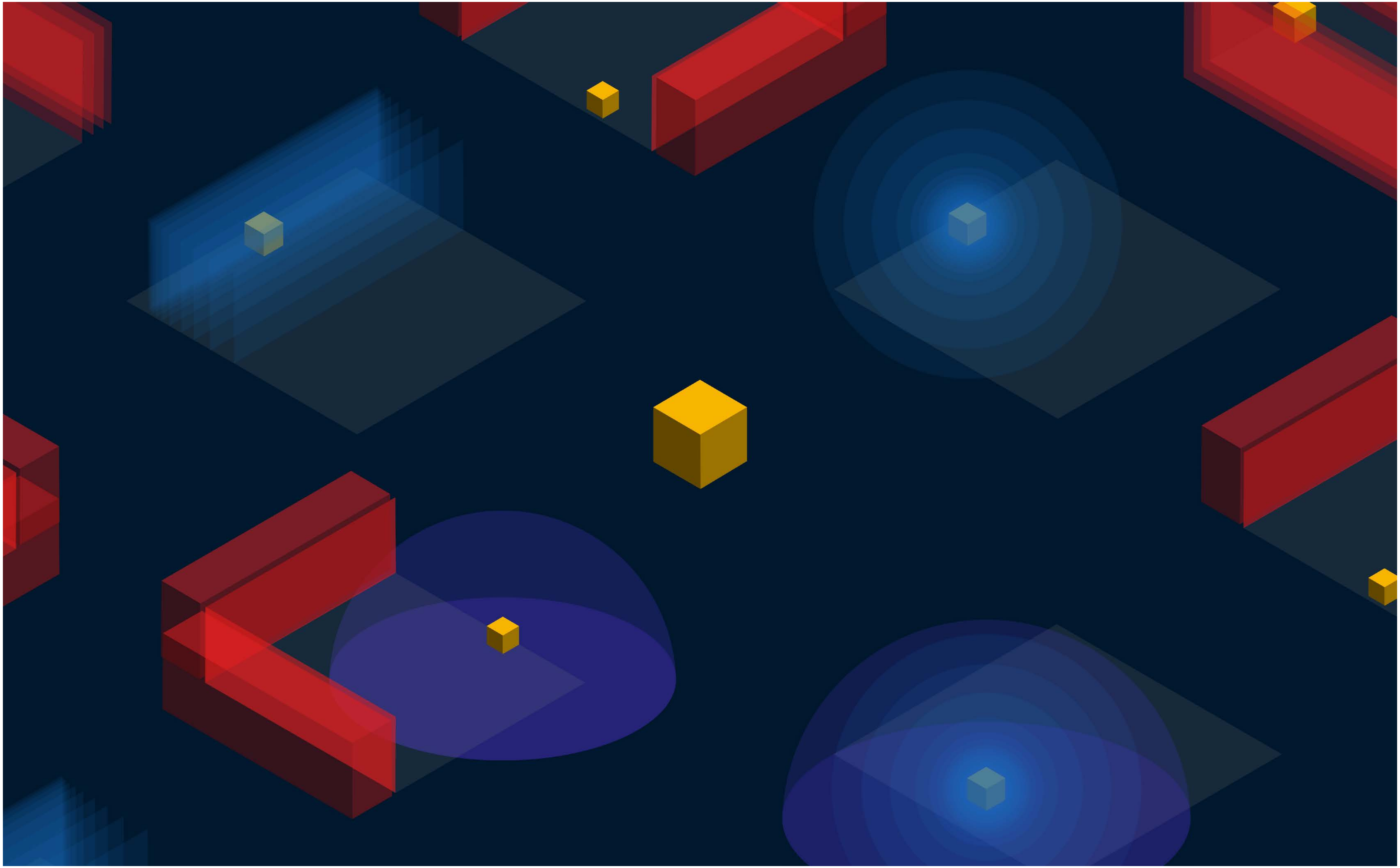
(6)
David Eagelman, 'Can we create new senses for humans? ', TED15 (2015)

(7)
Diana Löffler and others, 'Substituting Color for Haptic Attributes in Conceptual Metaphors for Tangible Interaction Design', (presented at the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction, Eindhoven Netherlands: ACM, 2016), pp. 118–25

HAPTIC VISION

9 NOV—27 NOV

TEXT BY FELIX RASEHORN

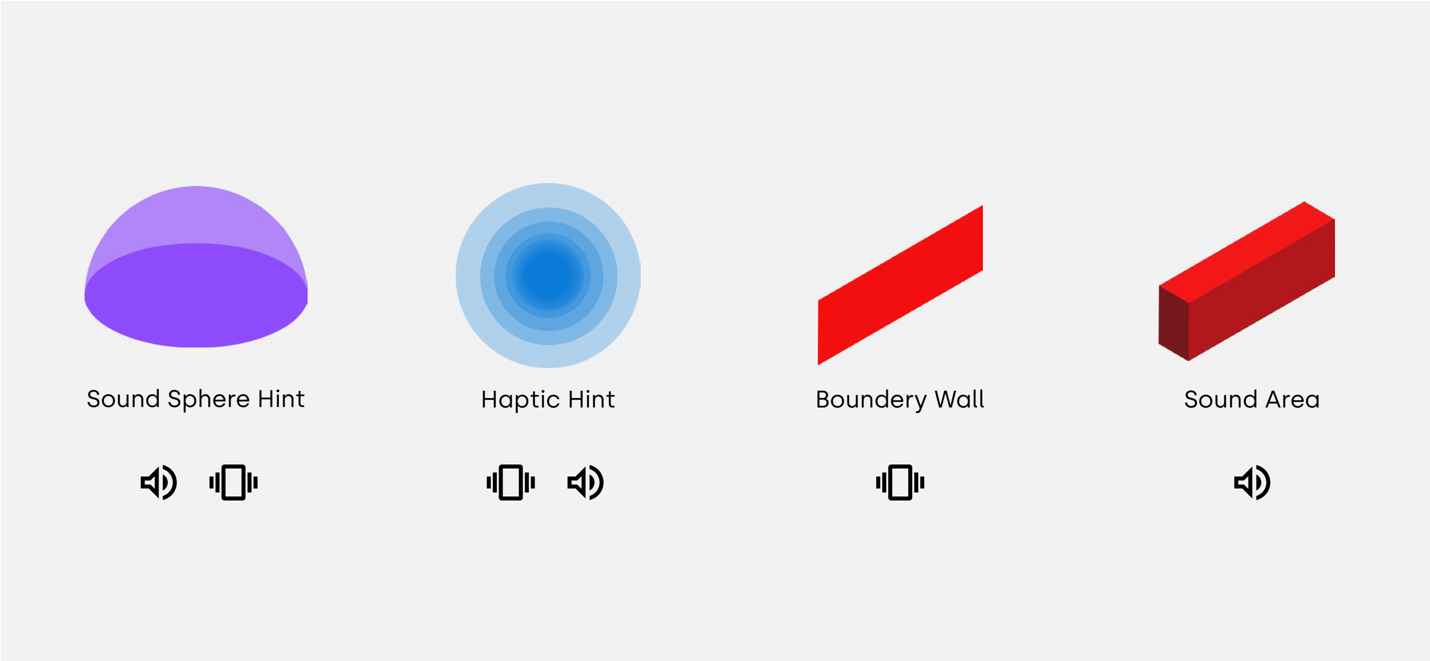


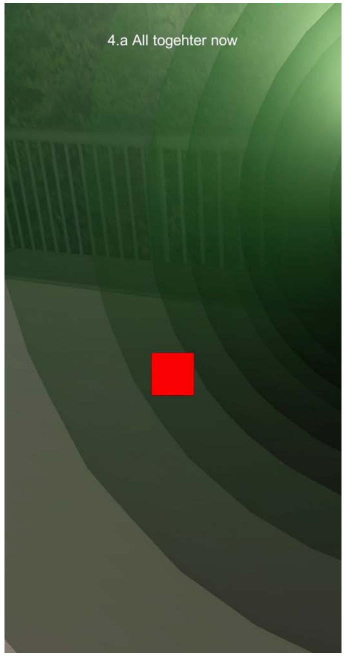
↘
RESEARCH QUESTION / INVESTIGATION
How can one navigate in an AR environment using only auditory and tactile perceptions? I argue that if I could successfully make someone navigate using only those two senses, this skill would later serve as an excellent complement to vision navigation.

↘
METHODOLOGY
I created various navigation elements based on stereo sound, vibration, or both. I conducted experiments on test subjects experiencing the environments.

↘
PARAMETERS
I tuned and alternated parameters in the following objects:
Haptic hint - placement of the hint frequencies (linear/exponential) - cm.
Sound sphere hint - range and volume - cm and decibels.
Boundary wall - haptic feedback - Pulse-width modulation (PWM).
Sound area - different sounds - sound files.

The effects of changing these parameters were:
Haptic hint - exponential spread + spreading of the haptic hint on three axes = better performance locating the target object.
Sound sphere hint - higher range + linear spread of the volume = better orientation in the space.
Boundary wall - a distinct variation of PWM = better symbolic recognition of the vibration.

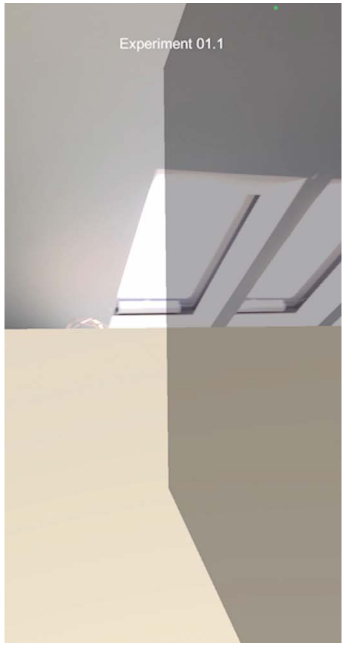


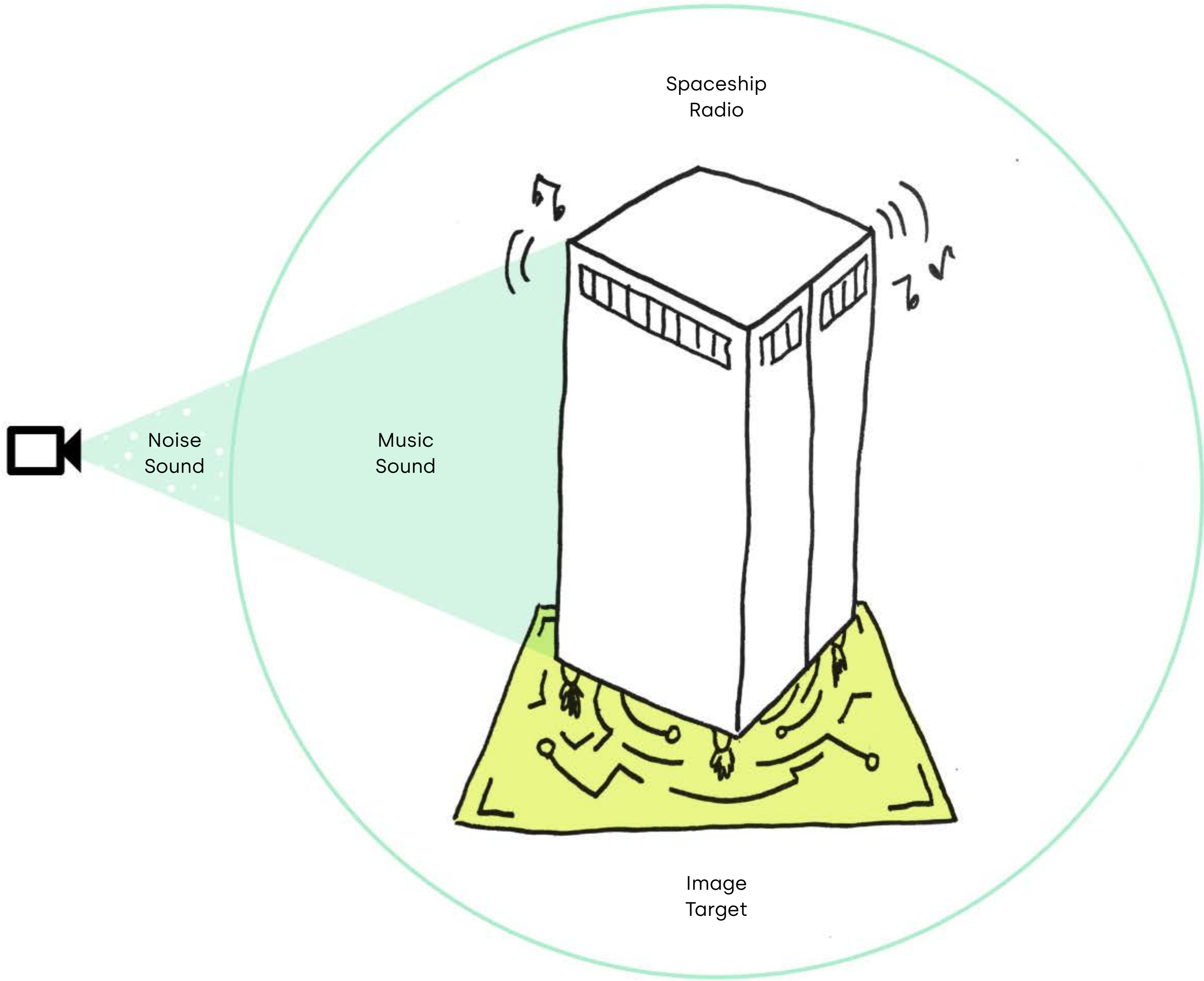


↘

FINDINGS

I found out that using vibration as a navigation tool didn't work as expected. Participants had different interpretations of the same vibrations.
It is easier for the test subjects to navigate using the auditory systems than the haptic system because of their greater ability to sense subtleties in the location by sound rather than the subtleties of the vibration types. Having said that, sounds were better in aiding the participants in large-scale navigation, where vibrations were better in aiding accuracy on a small scale.

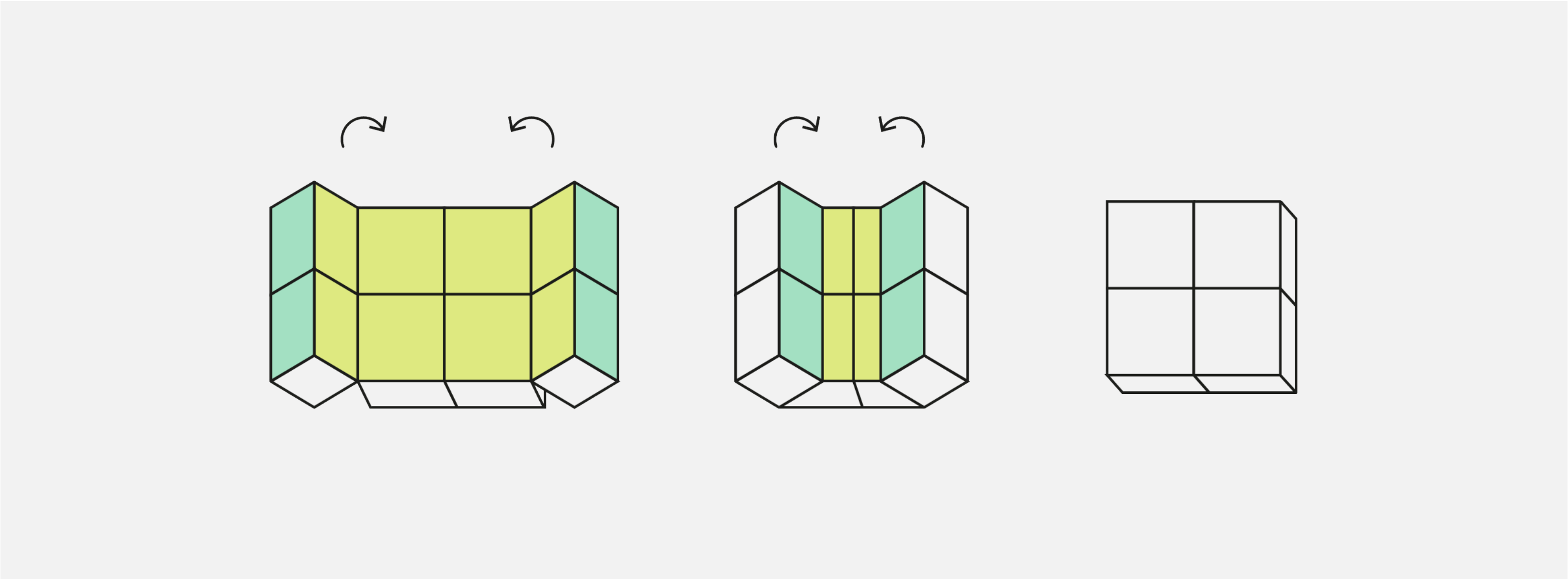


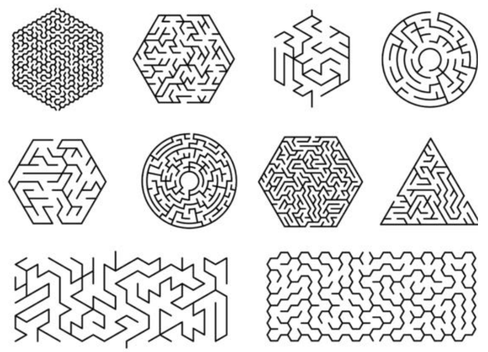

Spaceship
Radio
Noise
Sound
Music
Sound
Image
Target

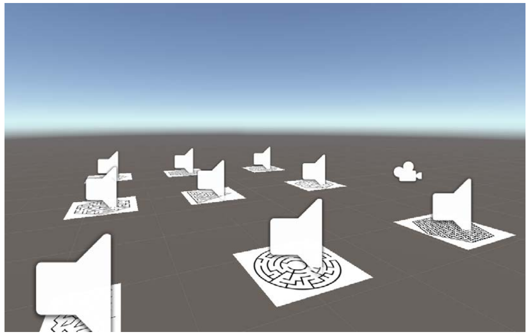
↘
RESEARCH QUESTION / INVESTIGATION
What could be the possibilities of augmenting our reality in a way that it gives us access to other worlds that would usually be out of reach? I wanted to explore the approach towards an unfamiliar object that triggers curiosity by the music that comes from it.

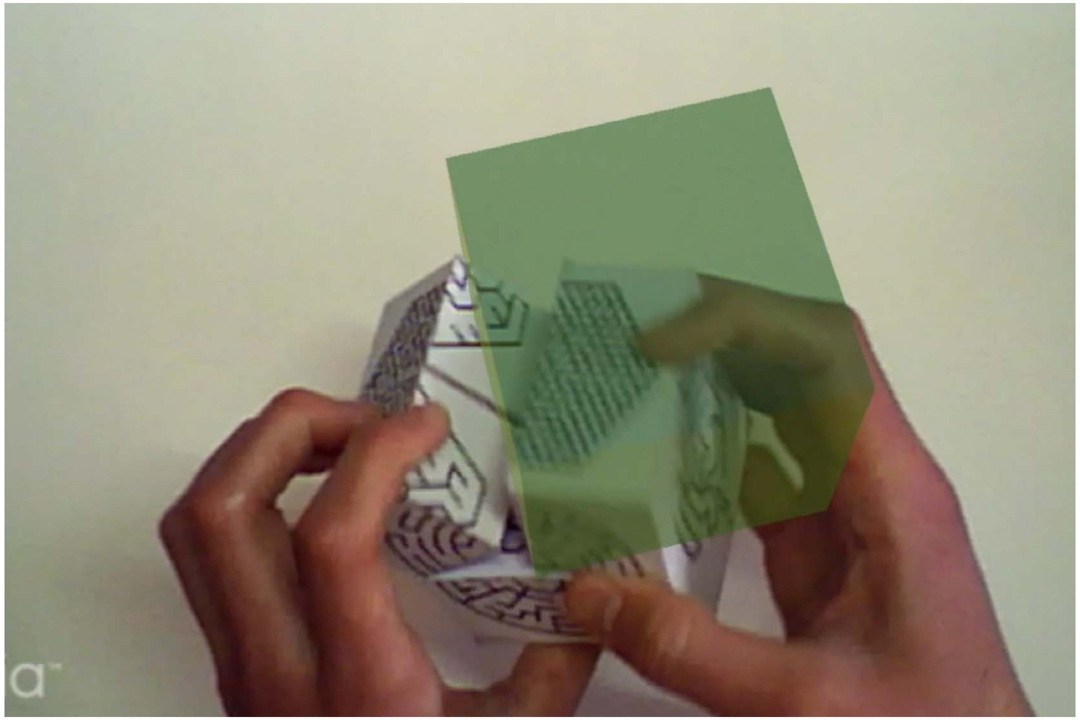
↘
METHODOLOGY
In the working process I switched from approaching a virtual to a physical object. I focused on a haptic experience, using a wooden cube as the object carrying ten different image targets. Each target is connected to a specific variation of a song that starts playing once the AR camera approaches the image target.

↘
PARAMETERS
The distance between the camera and the image targets played the most important role. It was about finding the right threshold of the sound-switch by moving within millimeters.



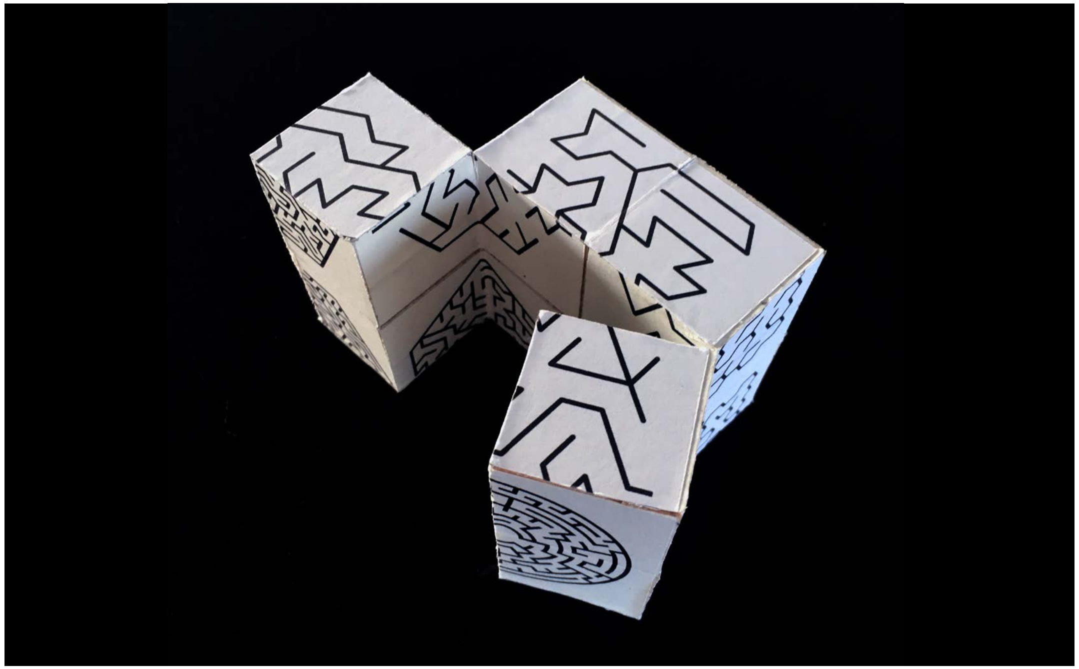


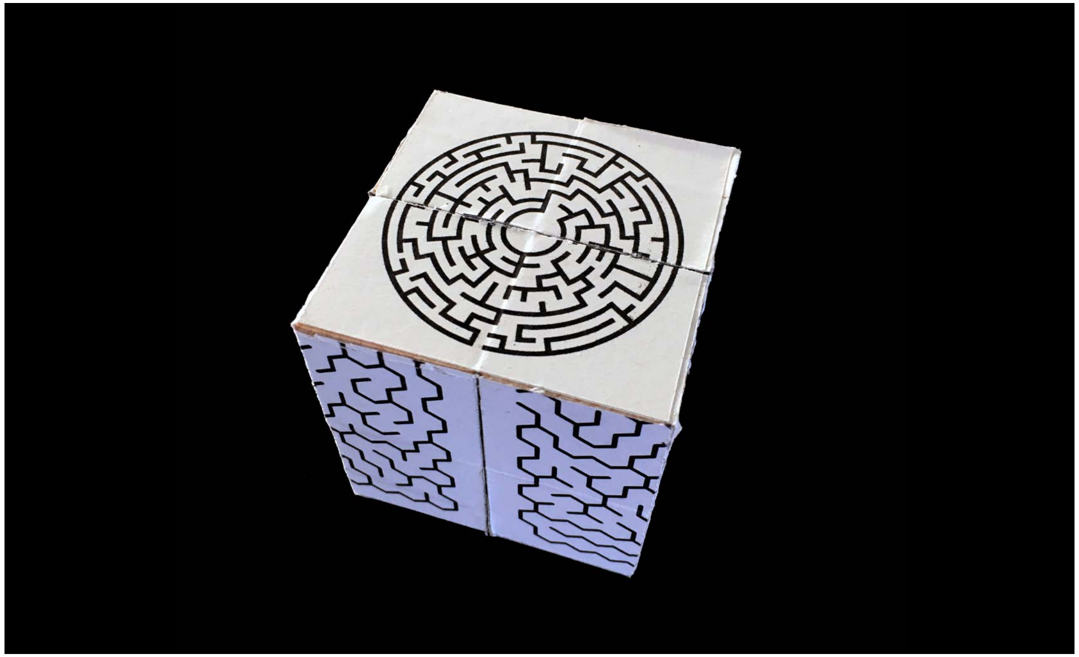


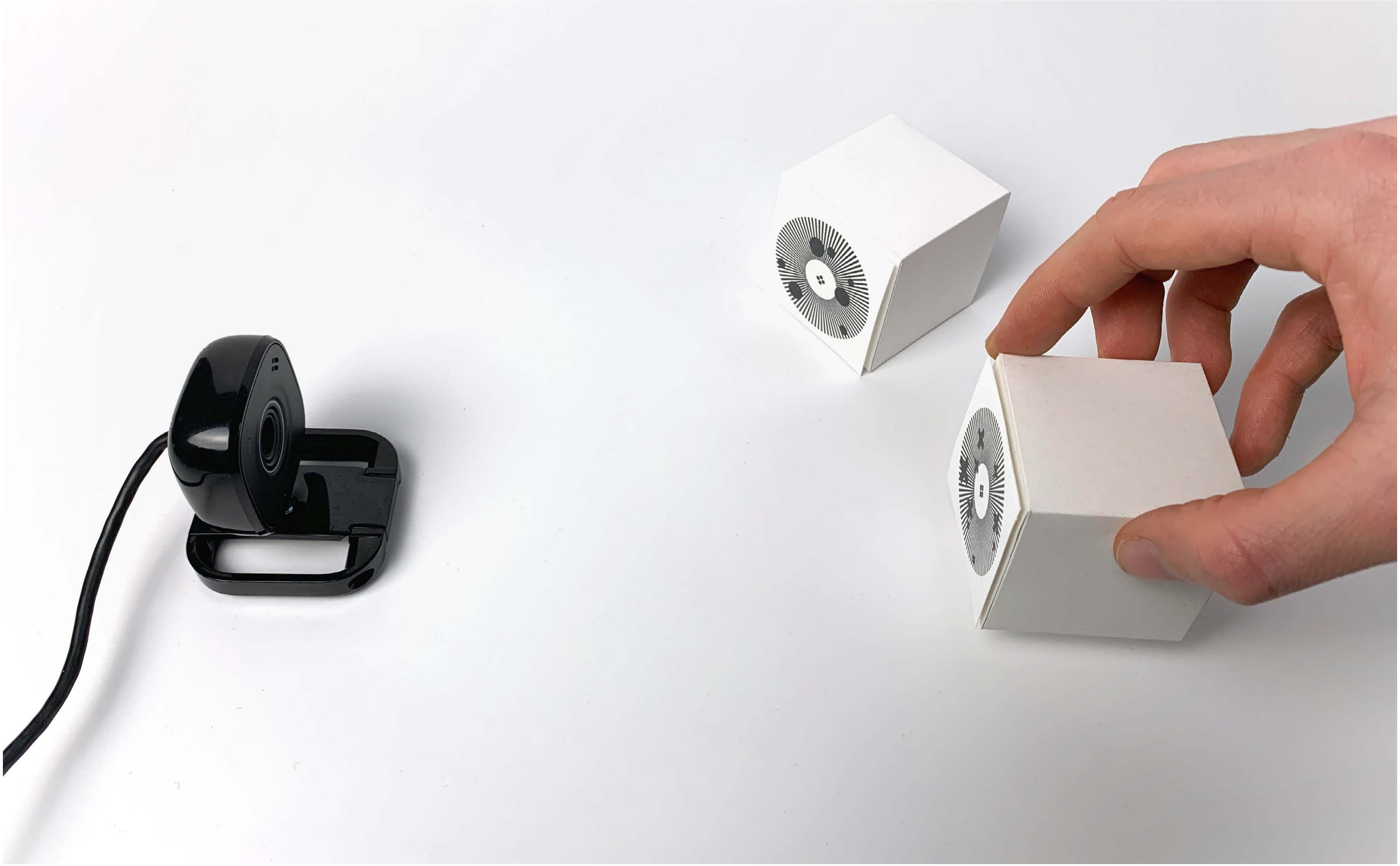


↘
FINDINGS

The technical setup of the *Unity* software needed to be modified to allow the ten different sounds to play one at a time and not overlap each other. The used image targets of geometric mazes were easy for the camera to be recognized and wrapped up the narrative in a visual way: they symbolize the »unknown« that we want to explore.



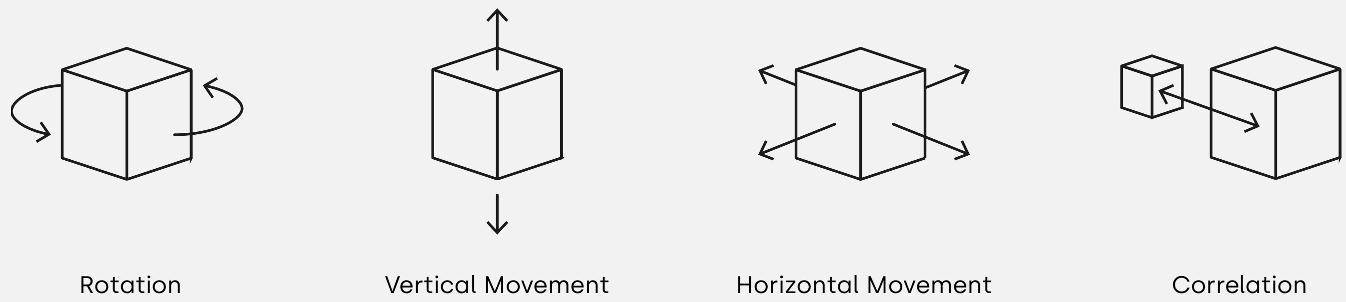




↘
RESEARCH QUESTION / INVESTIGATION
Digital technology often wants to convince with a high level of accuracy. But why do for instance traditional (analog) instruments have so much more charme stay competitive in comparison to digital music software? In this sprint, I want to explore different ways to interact with sound at the intersection of a digital, an analog and an augmented reality environment.

↘
METHODOLOGY
I created a selection of sounds and some paper cubes with different visual targets attached. By using the gaming / AR engine *Unity* and *Vuforia* and an external camera I set up a program that would connect them with the target cubes. Once the camera would detect a target the associated sound be played. To indicate the successful detection an augmented colorful sphere would be visual in front of the targets on the screen.

↘
PARAMETERS
I upgraded the basic setup by adding parameters that would enhance the quality of the sound on different levels such as volume, pitch and stereo pan. Next I connected these parameters to the position of the paper cubes. This allowed me to explore different interactions – rotating, lifting up and down, back and forth, correlation of several cubes – and evaluate their quality in relation to the perceived sound.

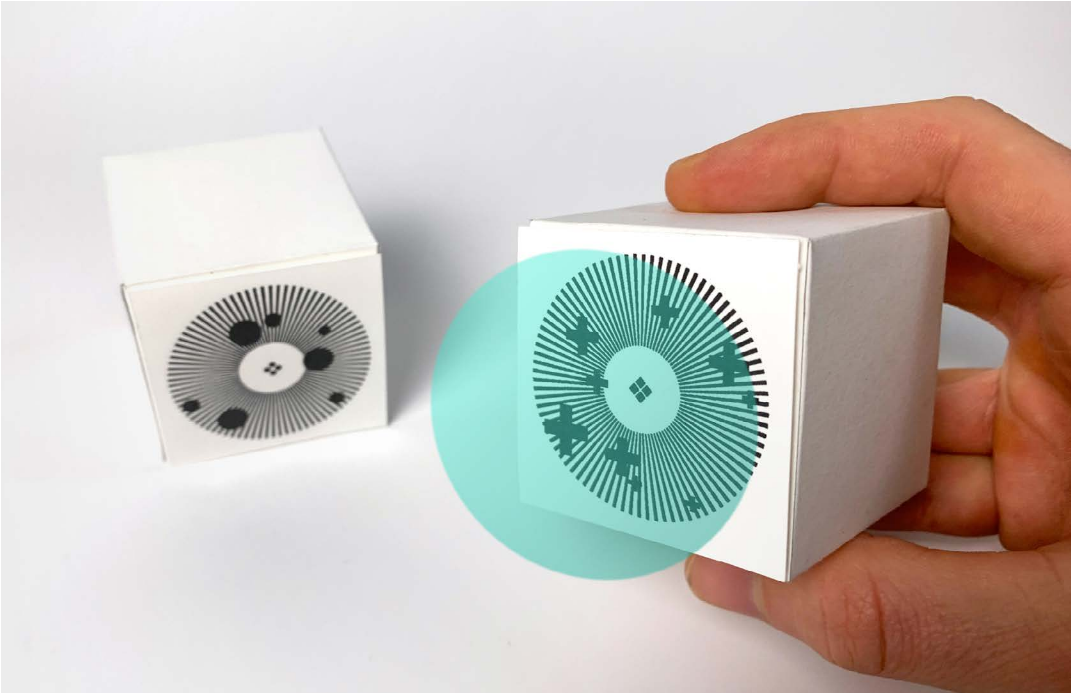


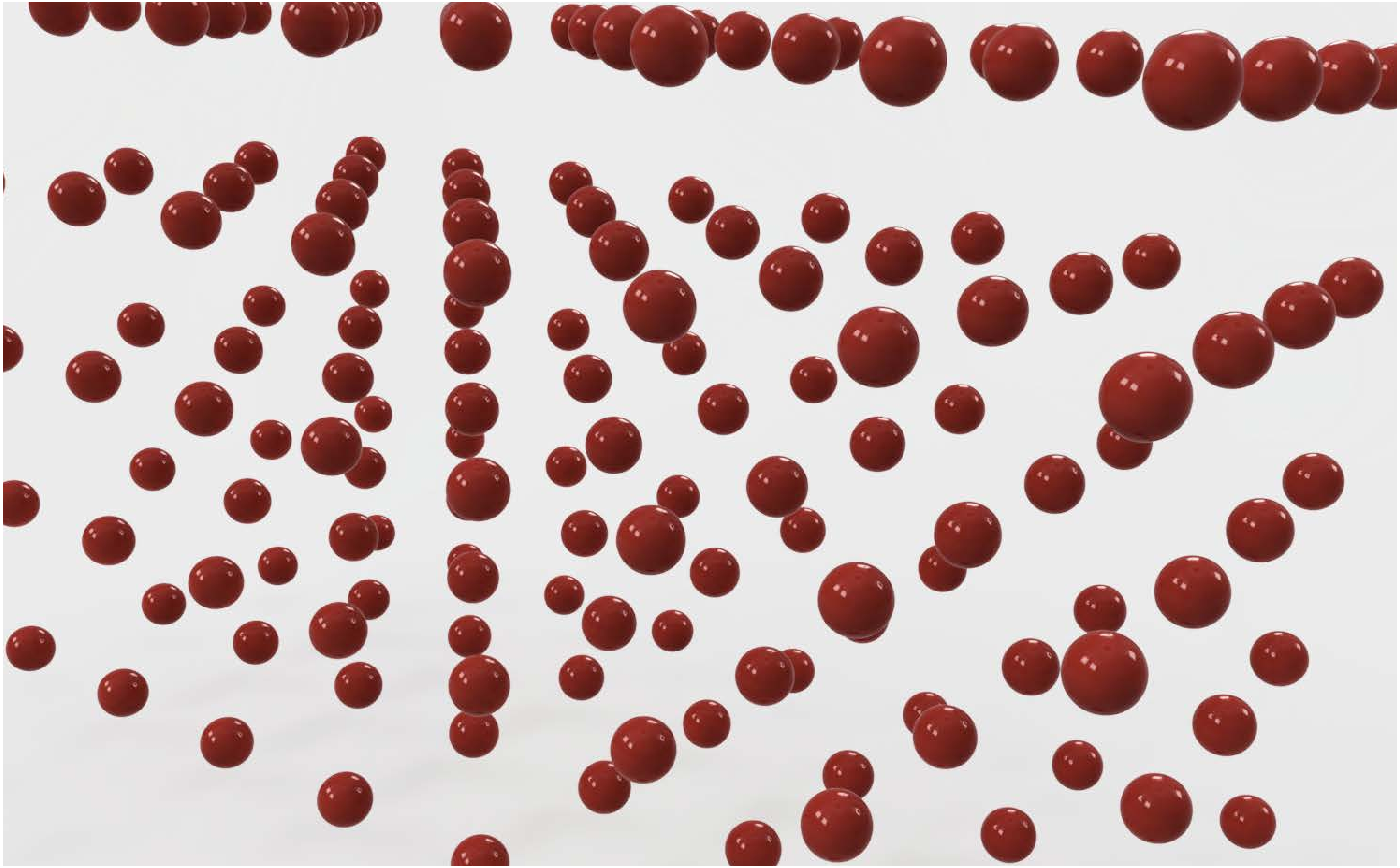
↘
FINDINGS

Eventually, I would end up with a setup where I paired the distance between the cube and the camera with the volume parameter. The closer the cube would be to the camera the louder its sound would play. I also tested the same with the interaction of lifting the cube (the higher the louder) or their correlation to other cubes (the closer the louder). By rotating the cube the stereo pan would be tweaked. Rotating the cube to the right caused the sound to move more to the right within a stereo sound system and the other way round.

The correlation of several cubes turned out to be not the best way to adjust the parameters of multiple sounds because the correlation provided only one value (distance) which was not practical to tweak several sounds. Also, the lifting up and down interaction was not really practical because it limited the setup to two cubes (one for each hand of the user) and their position could not be fixed.

Although the correlation of cubes didn't work in terms of sound, there was still a visual constellation of the cubes within the setup that would allow the user after some practice to »read« the sound out of the cubes' positions. Pairing the distance between the camera and the cubes to tweak the volume worked the best and allowed an intuitive interaction. Also, the overall experience had a playful and inviting character to interact and discover sound.





↘ RESEARCH QUESTION / INVESTIGATION

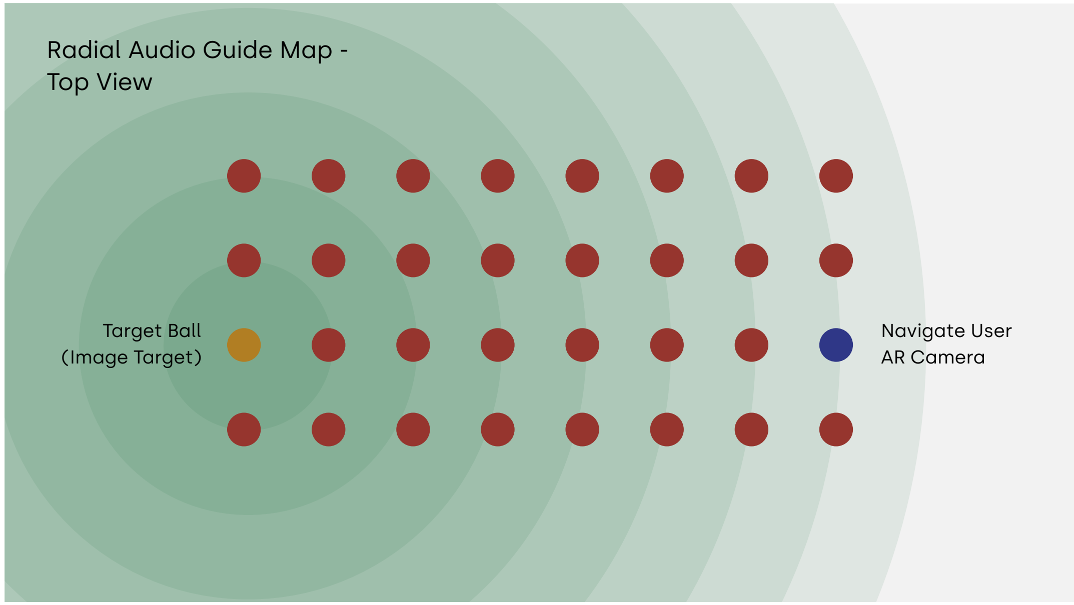
Map services such as Google Maps navigate the users, often in a bird's eye view, through a two-dimensional space. The research question of this sprint was: Is it possible to experience and navigate through the whole volume of a room?

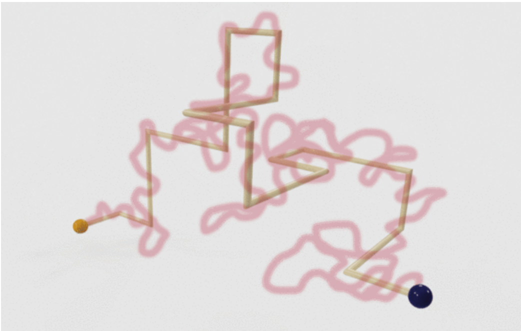
↘ METHODOLOGY

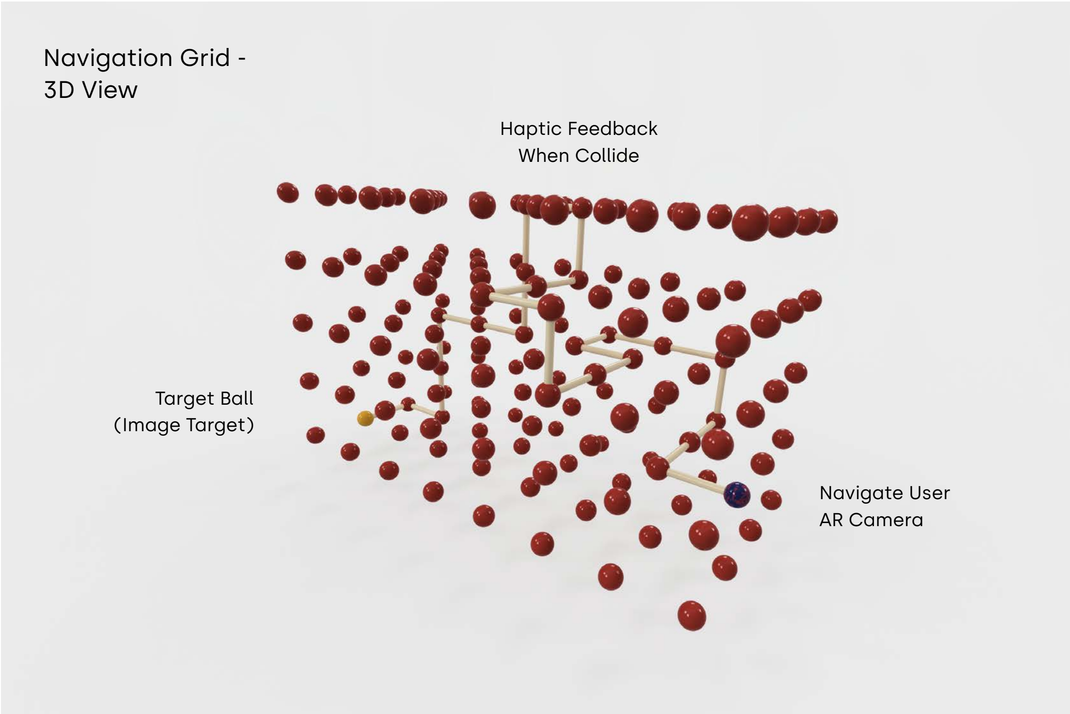
To make a model of 3D space a three dimensional grid of small red balls was created in *Unity*. The balls were all equally spaced and at right angles to each other. Each ball represented a point in space. The grid enabled users to move into all six directions from each ball. A target marker made it possible to move through the grid by using an AR Camera. To make the navigation work, one ball had to be defined as the starting point, one as the target (with a hidden golden ball inside) and several balls to create a path. All balls gave a haptic feedback when they were touched by the AR Camera.

↘ PARAMETERS

Different speeds and strengths were tried, to show the viewer that he or she is on the right path to the target. When the user got off the path, the haptic feedback was triggered. A radial audio guide was also used. The sound got louder as the user got closer to the ball. The audio and haptic feedback had a meditative effect on the AR environment. This made it easier to concentrate and follow the directions. After the first tests the size of the balls and the space between the balls were changed. This helped to make the feedback and the navigation more precise.

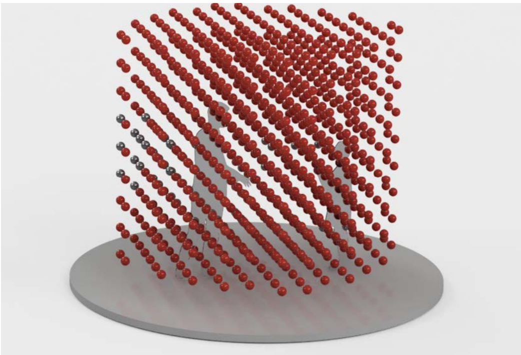


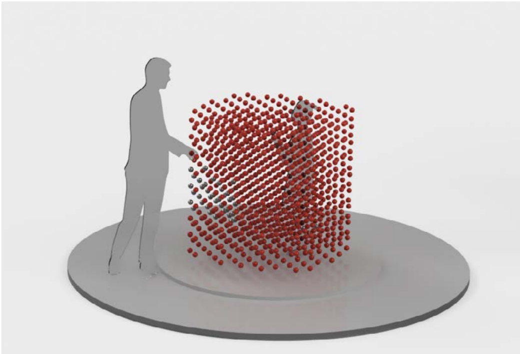


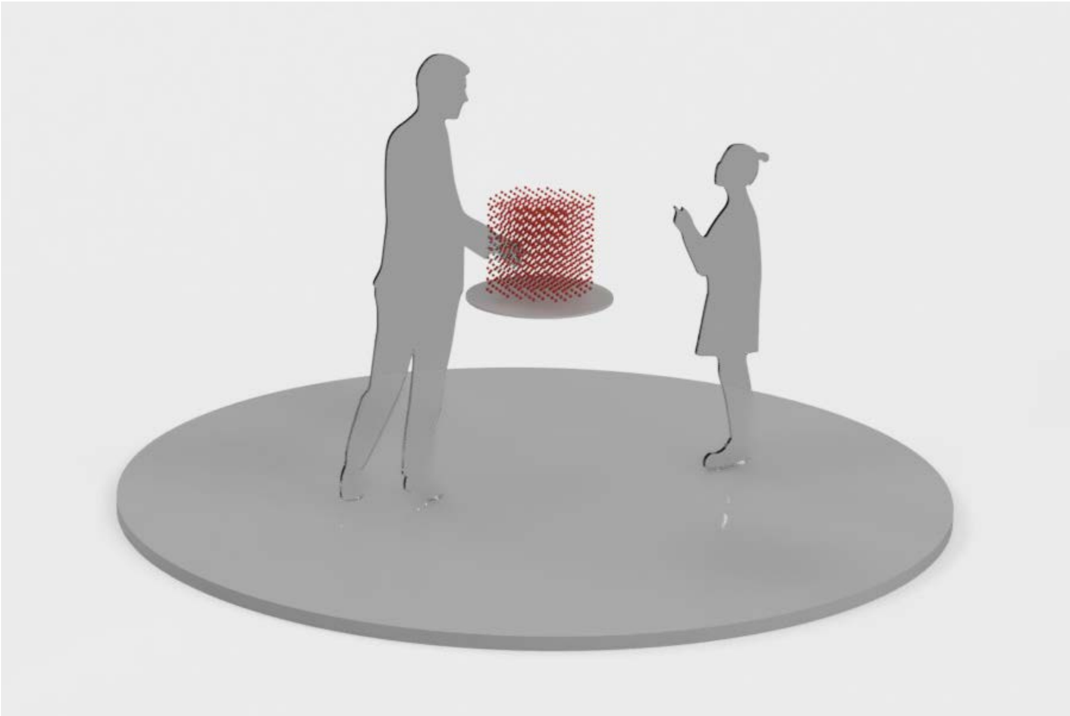


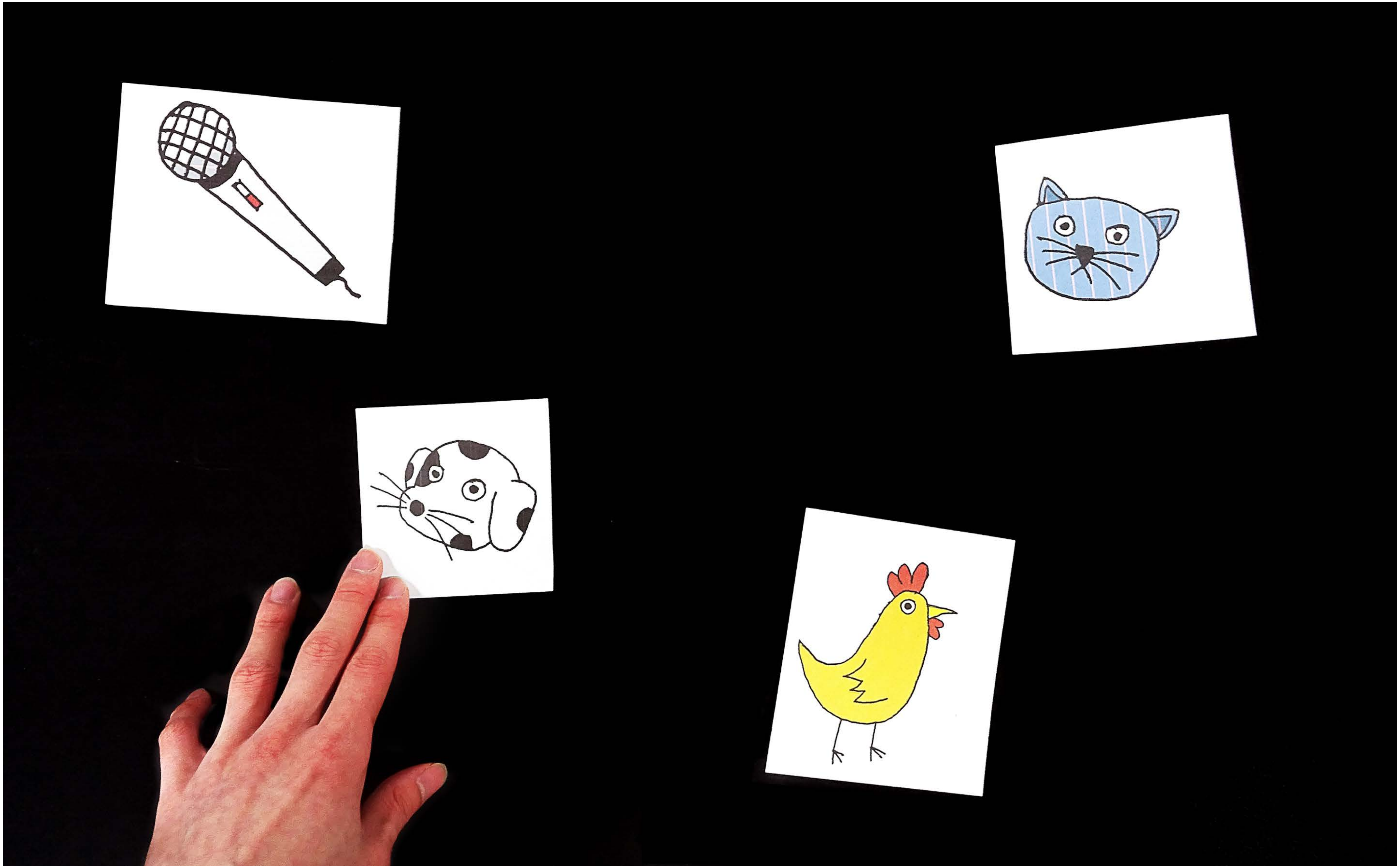
↘
FINDINGS

The original setup did not work. The goal was to create a space where you could move in all directions, but the program (*Unity*) always needs to have the marker on the ground in view. This means that users can never look up. An unexpected gain was the scale of the 3D space, which could be changed depending on the size of the target marker. This way a small 3D map could be magnified to make the navigation in a small environment easier.
The audio feedback worked better than the haptic feedback in the prototype. The haptic feedback on the balls didn't lead a way but rather confirmed the steps already taken. The audio feedback was much more intuitive to follow. The decision was made to apply haptic feedback only when the user left the path - something like a warning signal when hitting road marking on a street.









↘
RESEARCH QUESTION / INVESTIGATION
The location of images becomes a reference point for interacting with sound. How to map movement to sound using outputs according to a combination of detected images?

↘
METHODOLOGY
By drawing pictures directly and uploading them to Unity, the program can recognize them as image targets. Each image was uploaded to Viforia for image detection, a specific sound is set for each image. Once the software recognizes an image the corresponding sound is played. The intensity of the sound varies according to the distance between images and a set target. When two or more images are detected, they affect each other by adding sound effects to the audio output.

↘
PARAMETERS
The sound is produced according to the recognized image, and the sound changes according to the distance and shape between images.

↘
FINDINGS
For seamless image detection, simplified animal drawings were used to connect audio and visual sense corresponding animal sounds played. Through moving images next to another orchestral sounds could be produced, intuitively mapping complex sound settings to movement.

↘
RESEARCH QUESTION / INVESTIGATION

For the first task in the second sprint Haptic Visions, we focused on unreachable situations / moments.

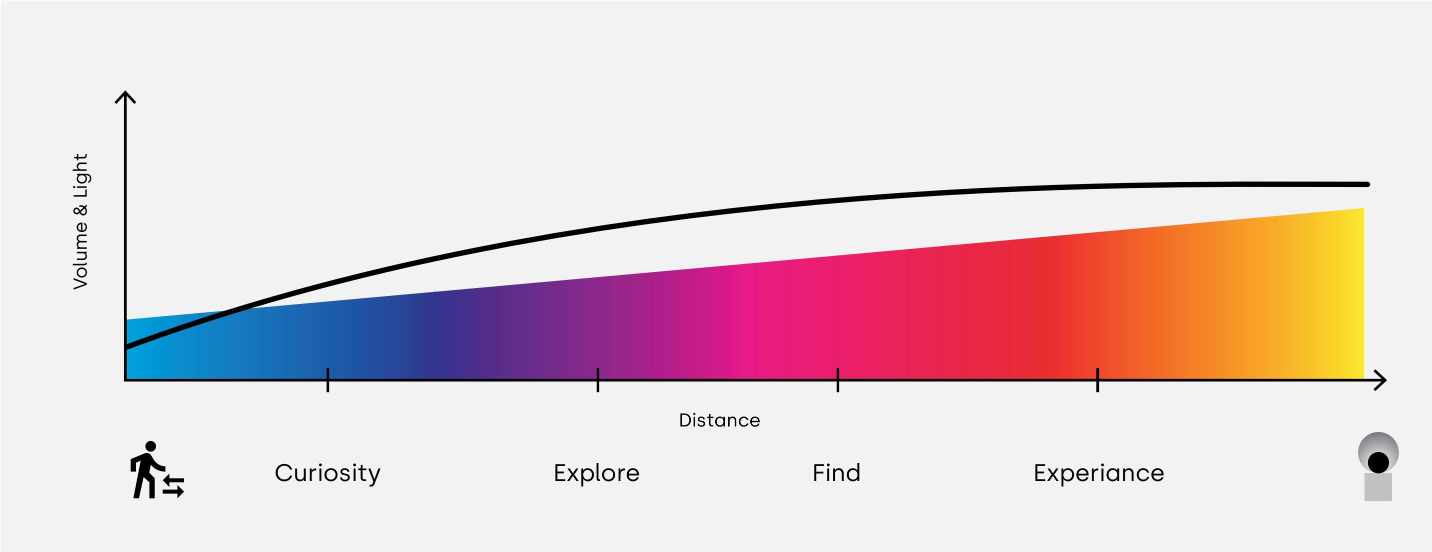
We wanted to give a feeling of an approach that seems easy but in reality isn't so. We want to create an illusion that visualises something the user cannot touch. As if they were observing a rainbow, they must observe it from a certain distance to get the best viewpoint.

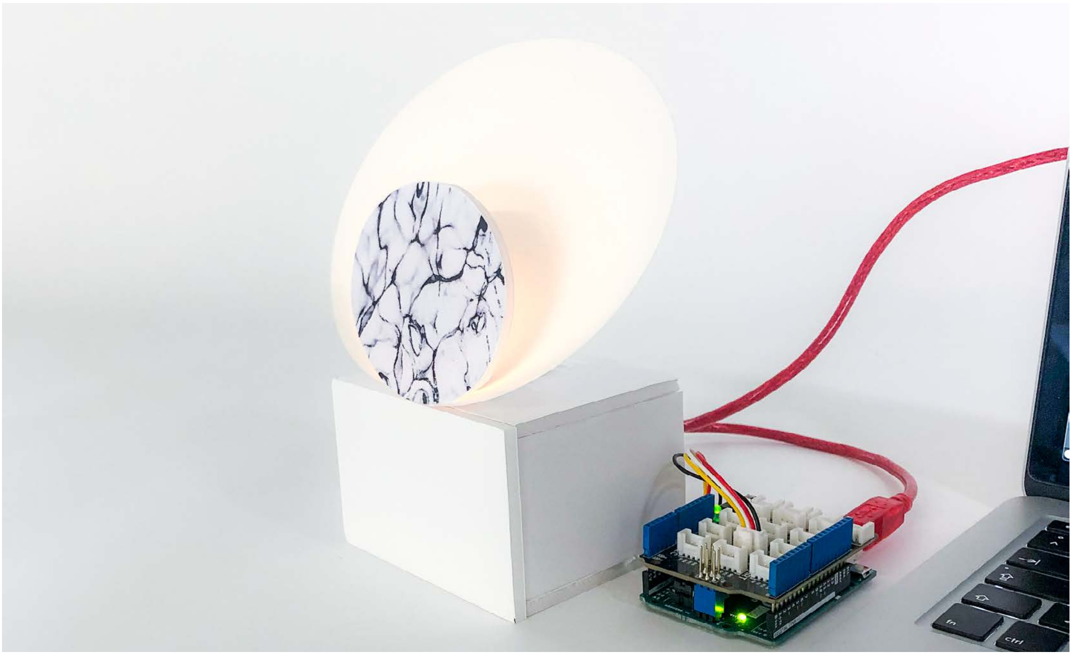
↘
METHODOLOGY

We concentrated on the aspects of feedback via sound and light related to distance. We used the Unity software program in combination with a physical prototype that contained our own »image target« which refers to marble texture or a reflection. LEDs were used to create coloured responsive light feedback and sound for a multisensory experience.

↘
PARAMETERS

To get interesting results we changed the parameters a few times to check the reach points of the best experience the user can have. We actually wanted to make the user find the ideal spot by themselves by walking back and forth. For the first trial we designed the parameters so as you get closer to the image target (the prototype - with camera attached), the sound increases and the light changes from yellow to blue.





↘ FINDINGS

We quickly realised that the reach point should be somewhere in the middle. We wished the sound could change more smoothly and softly so it's a less radical transition when the user experiences the change. It would have made sense to experiment with more tests for different kinds of sound related to each color. We were surprised to find out how creating a moment that combines the relationships between sound, vision and color can generate a much stronger haptic experience without even touching an object; our brain can observe and translate this experience just by listening and seeing the output.

↘
RESEARCH QUESTION / INVESTIGATION

How far can we trick our brain into bodyownership illusion by giving the right feedbacks?

↘
METHODOLOGY

From the findings of the »rubber hand illusion« we know that we can trick our brain into a body ownership illusion.
How could we use it for the virtual world?

↘
PARAMETERS

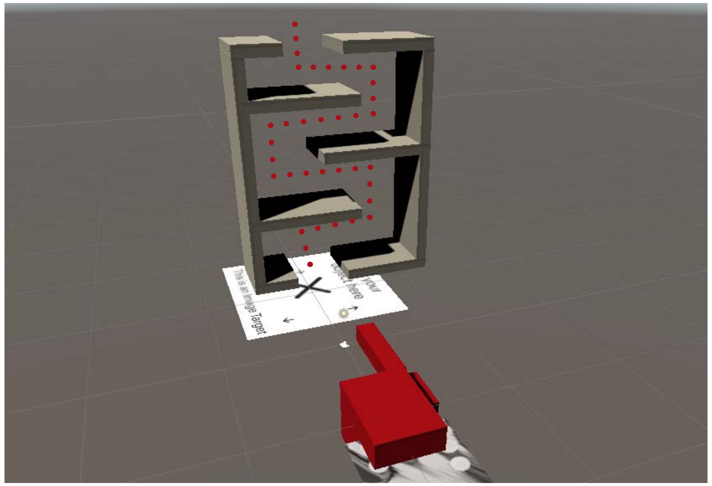
We have a virtual maze in AR where you have to navigate through with your additional body part which is stuck to your hand by a target tracker.

A haptic feedback on ur fingertip is guiding you through. The motor is on the fingertip because of highly tactical sensations we have there.

↘
FINDINGS

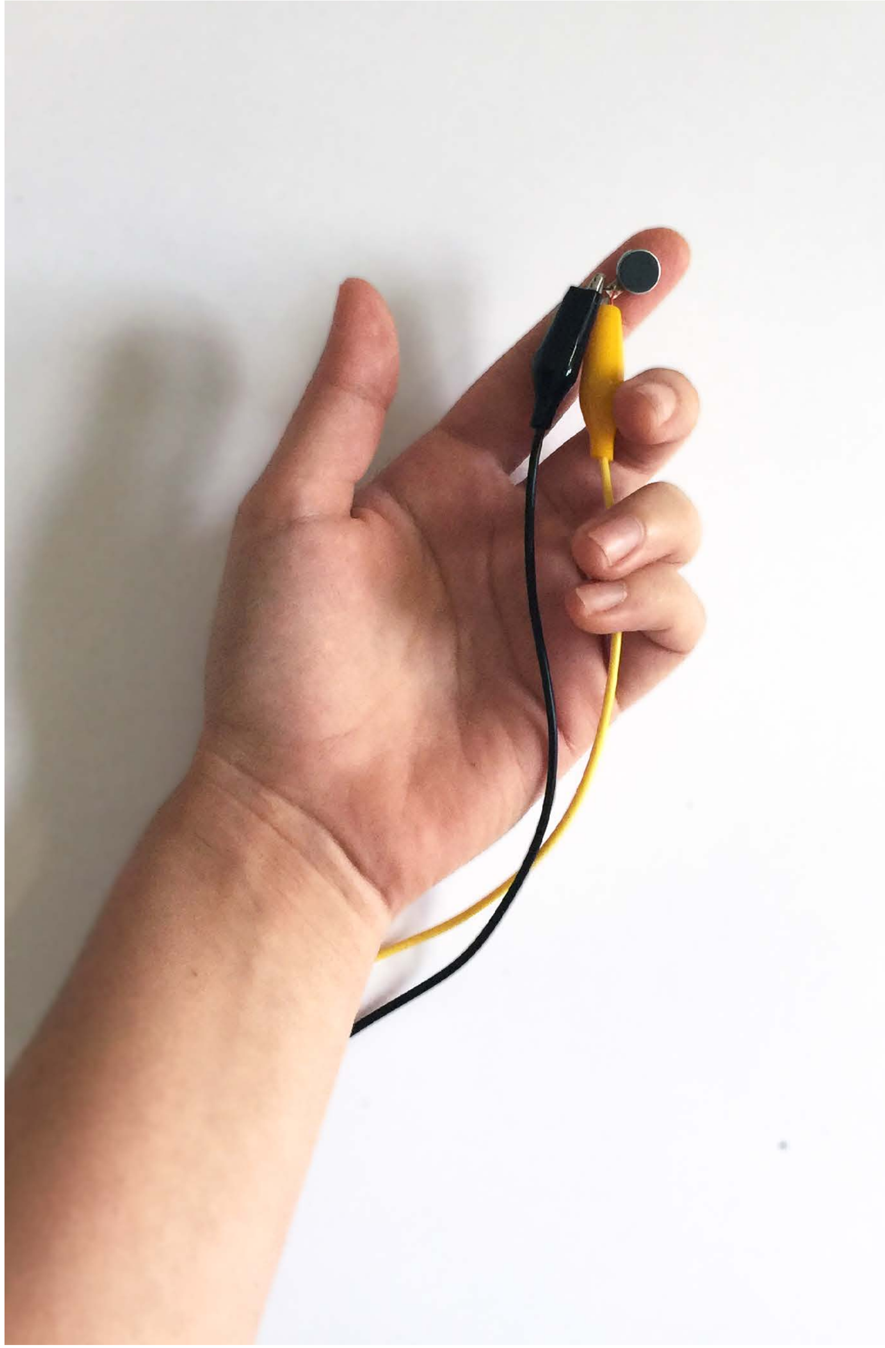
It became clear that our minds can be shaped by our virtual experiences, and not just our real ones. In VR it's easy to manipulate our vision, but by also giving our body the right feedback, we can make our brain believe its real. Through virtual interactions, we gain a feeling of ownership over this virtual body.

It could find usage in rehabilation of temporal paralysis.



Haptic Vibration
No Collision

Haptic Vibration
When Colide



↘
RESEARCH QUESTION / INVESTIGATION

How to create a legitimate AR portal experience?

↘
METHODOLOGY

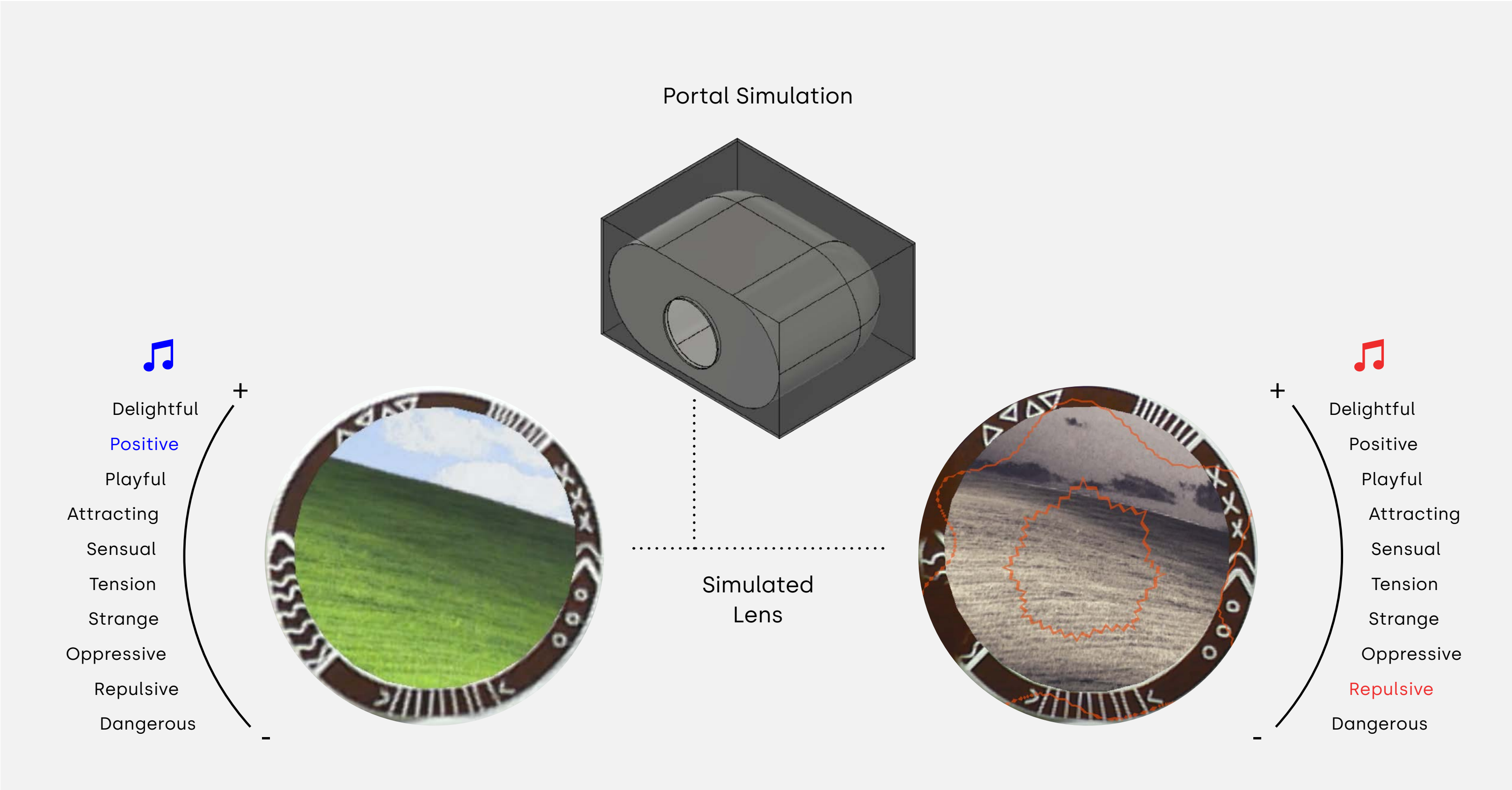
For my experimental setup I used the following tools: The game engine *Unity*, a 3D modeling program, as well as an image tracker created by myself. The latter should also be the physical placeholder for the portal experience.

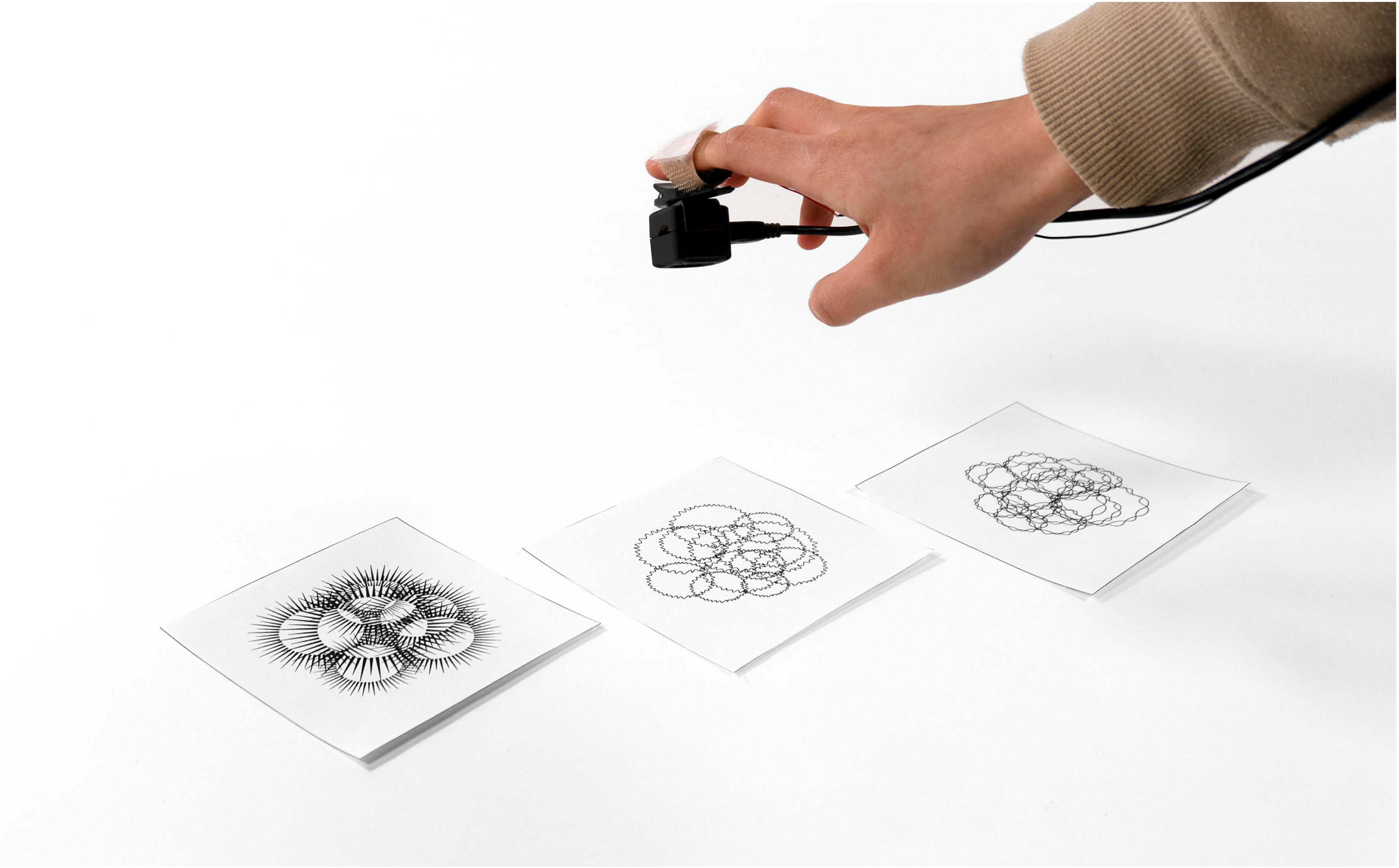
↘
PARAMETERS

For the setup, I changed the parameters of both the physical objects and the digital ones (like size, distance). By changing the size, I could vary the immersion level of the experience. A small hole promised a curious peephole, whereas a larger portal stood for a mutually immersive experience.

↘
FINDINGS

What was surprising was how quickly the illusion of an expanded space could be achieved. Only the flickering of the image target spoiled this illusion. For another experiment, I would continue to work on this requirement. It was a good idea to make the image target round - this increased the effectiveness of the illusion enormously.





↘
RESEARCH QUESTION / INVESTIGATION

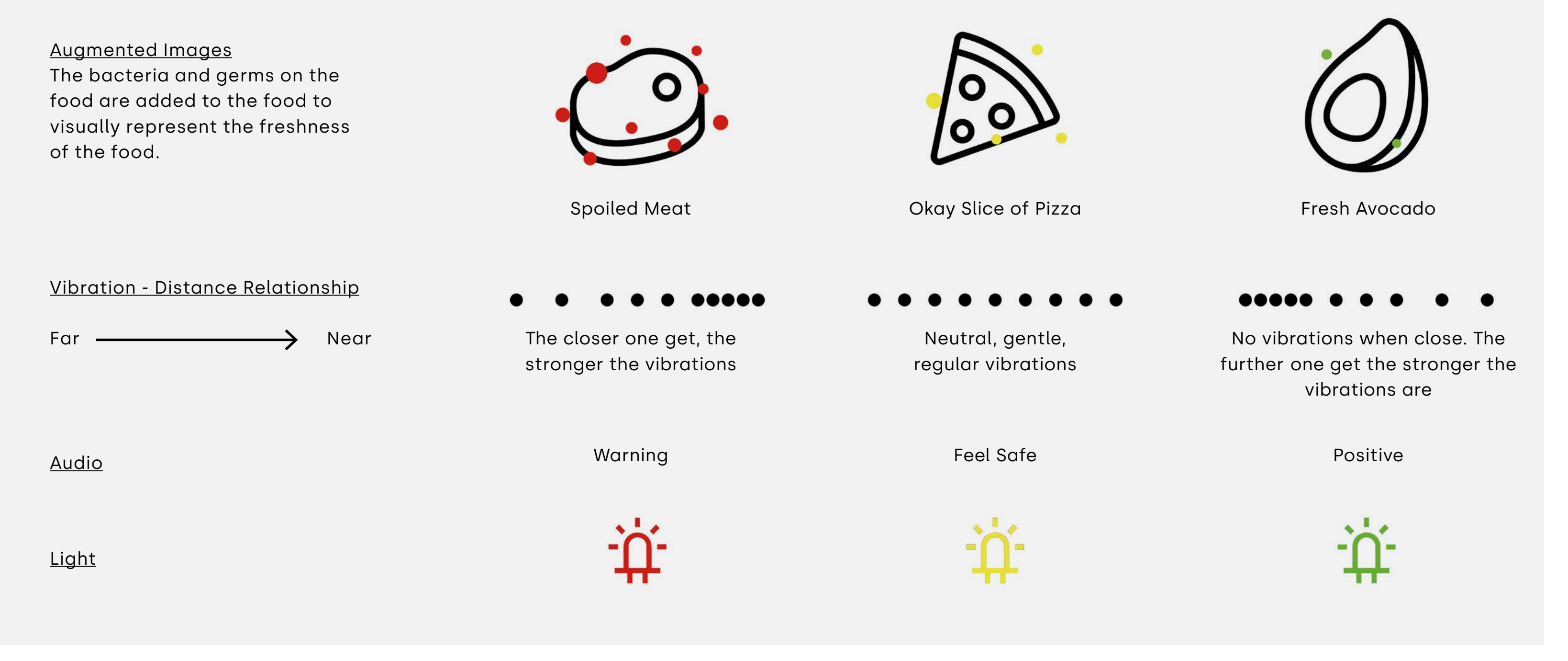
Combining virtual vision with realistic haptics, I tried to build a haptic device that could »visualise« invisible data to people through their sense of touch and give them relevant feedback when needed.

↘
METHODOLOGY

I chose the scenario of »food freshness« just to get started. So I created three image targets on paper to represent real food in three different states. Based on these, I experimented with different forms of feedback such as light (LED), visual (in *Unity*), vibration, audio, and different combinations. Later in the process, I turned it more specifically into making a haptic device.

↘
PARAMETERS

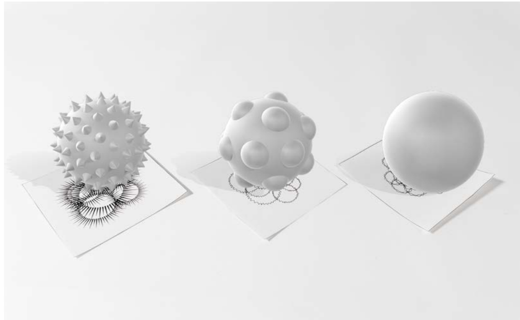
The distance of the portable device (camera) from different objects (image targets) is an important factor. When a person gets within a certain distance (depending on the size of the virtual object), feedback is triggered. The distance also influences the frequency of vibration; the volume of a sound or the intensity of a colour. Furthermore, different objects also correspond to different types of feedback. My goal was to define that the objects (image targets) represent different qualities which correspond to different feedback. For example, when a person approaches, the vibration becomes stronger or weaker to show a sense of rejection or attraction, or sends a warning signal through high-frequency vibration and expresses safe signal through low-frequency vibration.

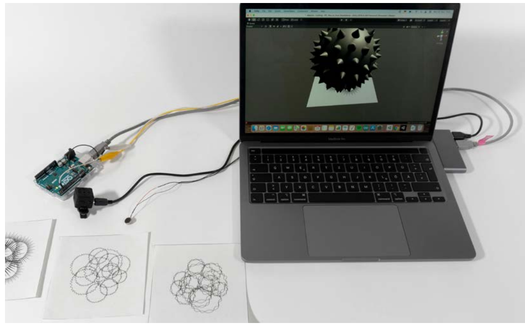


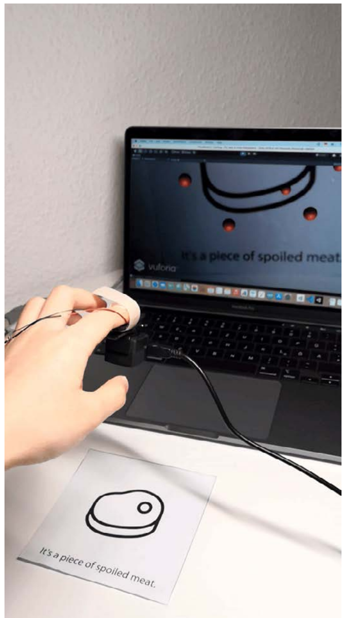
↘

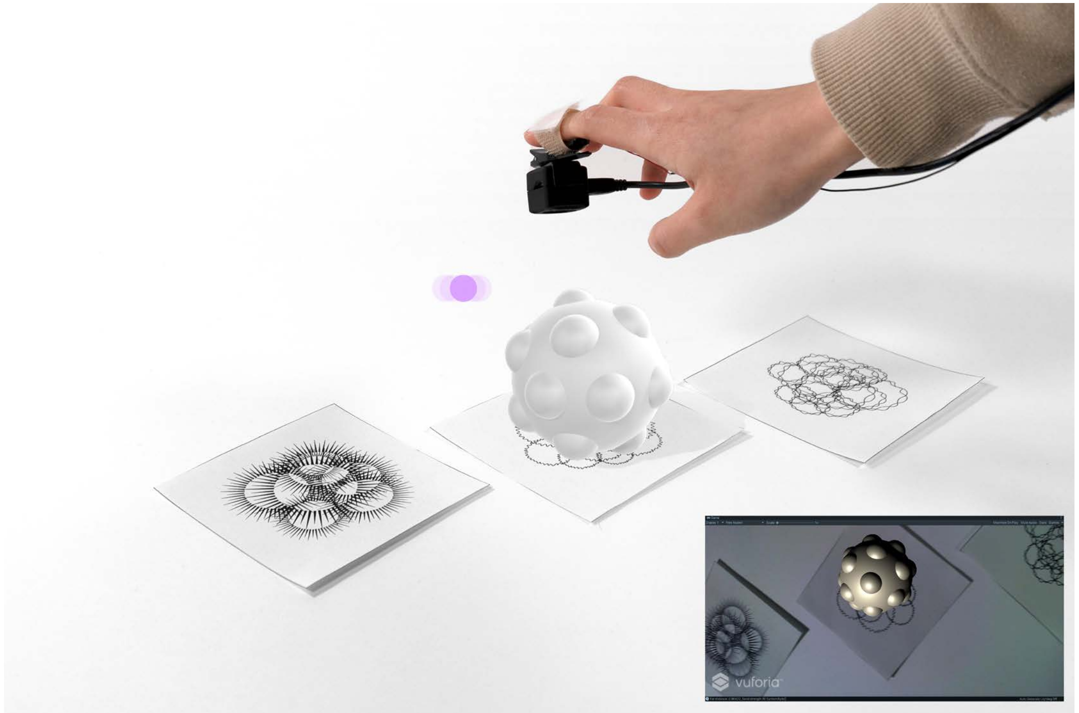
FINDINGS

At the beginning I put the motor on the camera device, so that when you hold the camera you can feel the vibration and get direct feedback. Thus the hand is holding the device it is occupied and a user limited in the usage of his/her hand. To avoid that and to increase the experience I combined the camera directly with the hand.
I tested different positions at the hand to apply vibration to. The fingertip feedback is great for the scene of touching something on the surface. So I was wondering if I could use vibrational feedback to make it seem like I was touching something virtual. What led me to my final attempt. And it worked well to represent different materials or/and shapes by means of different vibration patterns, strengths, and frequencies.

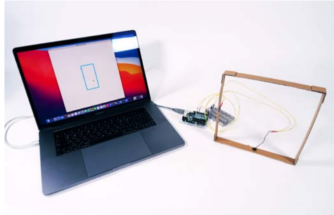








↘
C 58 — 20
Pseudo Haptics (30.11. – 18.12.)
Technological Focus: Augmented Reality (AR), physical computing and Processing
Workshop supervised by •
Dr. Olivier Bau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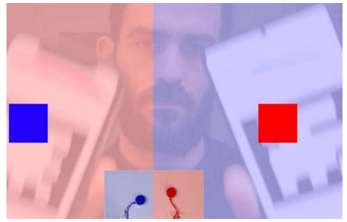
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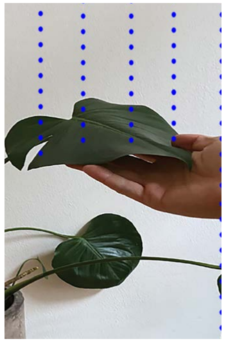
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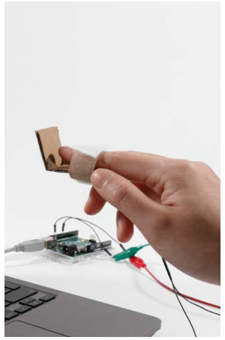
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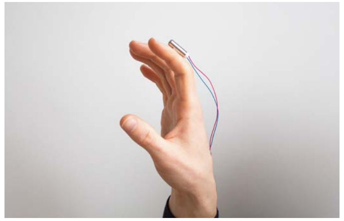
2

DESIGN STUDENTS
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5. Ran ZHANG
6. Minseong KIM
7. Tal SZNICER
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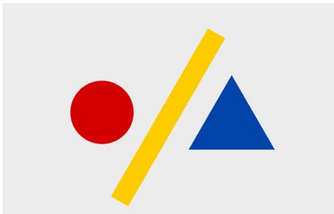
9. Maria SORAVITO DE FRANCESCHI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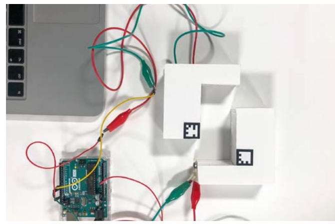
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PSEUDO HAPTICS
30 NOV—18 DEC

↘
Our brain combines information from each sense to provide us with our perception of the environment. Each sense, however, is not a siloed, isolated source of information , but our senses are rather "permeable" to each other: what we see influences what we taste, what we feel influences what we see. Sensory substitutions illustrate this more complex processing our brain does of various sensory data: tactile information, for instance, can be a partial substitute for sight (8), or stimulate the auditory cortex and help the hearing-impaired. (9) Other manifestations of this permeability across senses include synaesthesia where the stimulation of one sense results in a sensation perceived in another sensory pathway, or sensory illusions where reality as represented by our senses is "misrepresented". These phenomena are studied and used to enhance one's experience of the world, from helping the impaired with assistive devices, to storytelling: for instance, the immersive nature of movies, simple series of discrete images over time, is the result of illusions and the interplay of senses.

One field of research in particular, PseudoHaptics (10), investigates the relationship between vision and haptics, in which visual information plays a role in what we feel, and what we feel complements visual information. This sprint uses PseudoHaptics as an inspirational concept for the exploration of physical/virtual storytelling. Students were asked to experiment and come up with short interactive stories that combine physical objects, actuators, vision-based object tracking, and computer graphics. This setup allowed for experimentation exploring the relationship between physical tactility and appearance of objects, and their virtual counterparts, i.e. computer generated tactile sensations and graphics.

(8)
https://www.newyorker.com/magazine/2017/05/15/seeing-with-your-tongue

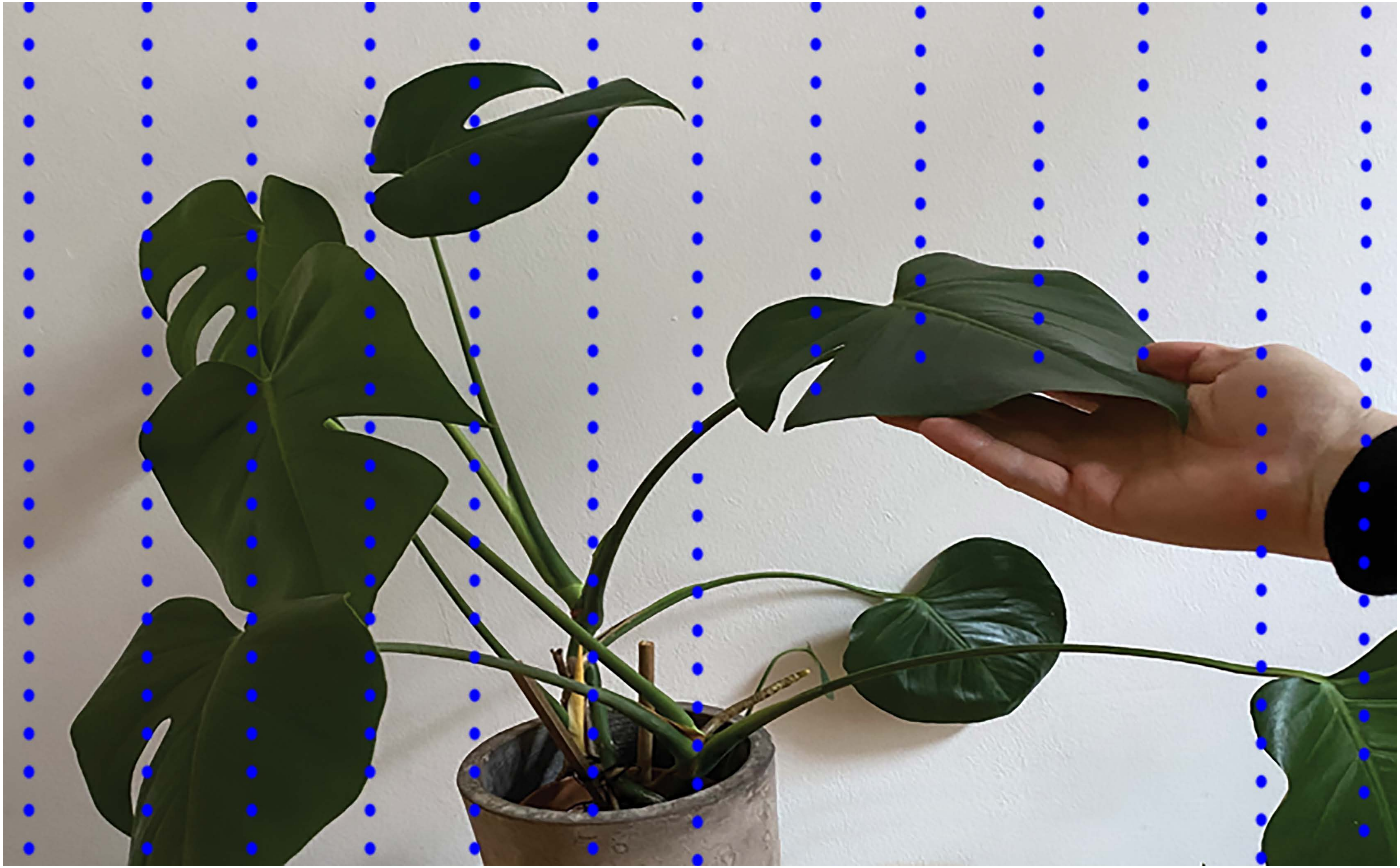
(9)
Schurmann M, Caetano G, Hlushchuk Y, Jousmaki V, Hari R (2006). "Touch activates human auditory cortex". NeuroImage. 30 (4): 1325–1331

(10)
Andreas Pusch, Anatole Lécuyer (2011). "Pseudo-haptics: from the theoretical foundations to practical system design guidelines" Proceedings of the 13th international conference on multimodal interfaces

PSEUDO HAPTICS

30 NOV—18 DEC

TEXT BY DR OLIVIER BAU



↘
RESEARCH QUESTION / INVESTIGATION

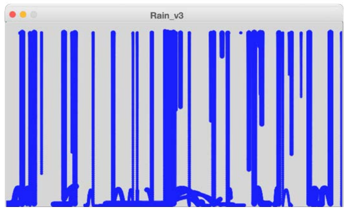
How can I map digital content in an analog form?

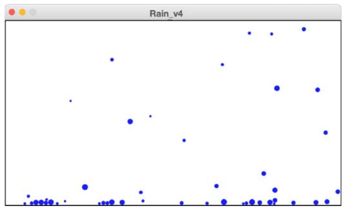
↘
METHODOLOGY

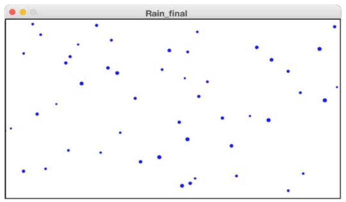
For my story I used my Monstera plant, which should be affected by »digital rain«». The virtual rain should hit the plant’s leaves, more or less, as the leaves are tilted and turned. The user should experience that »rain« in the form of haptic feedback.

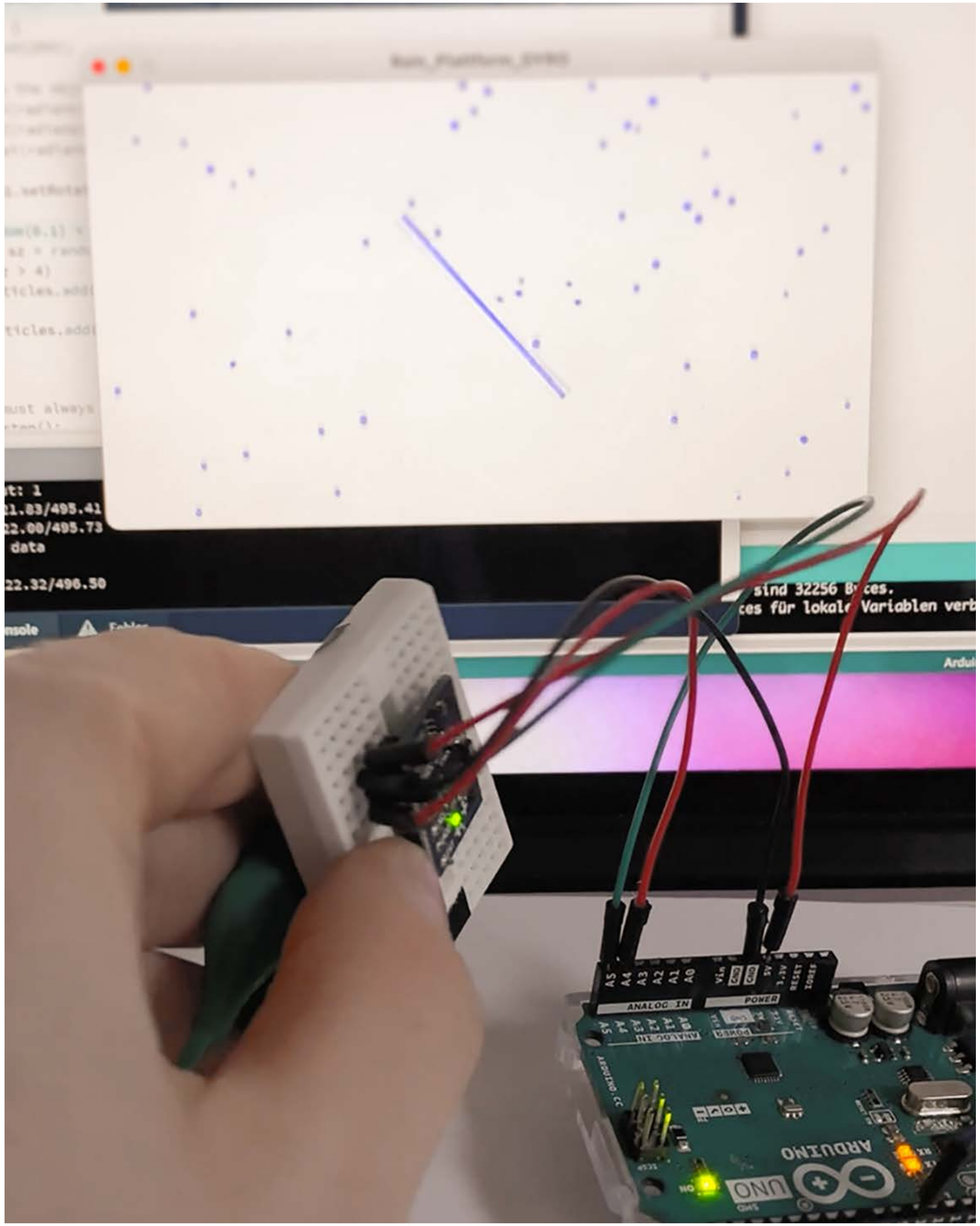
↘
PARAMETERS

I changed mainly digital parameters such as the strength and length of the actuators’ output. In addition, I added variations with the digital rain. Especially the impact on a reactive surface, which should finally address the actuators, kept me busy.



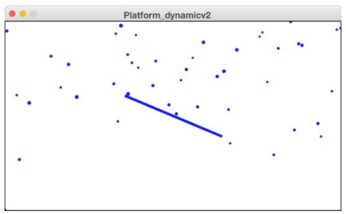


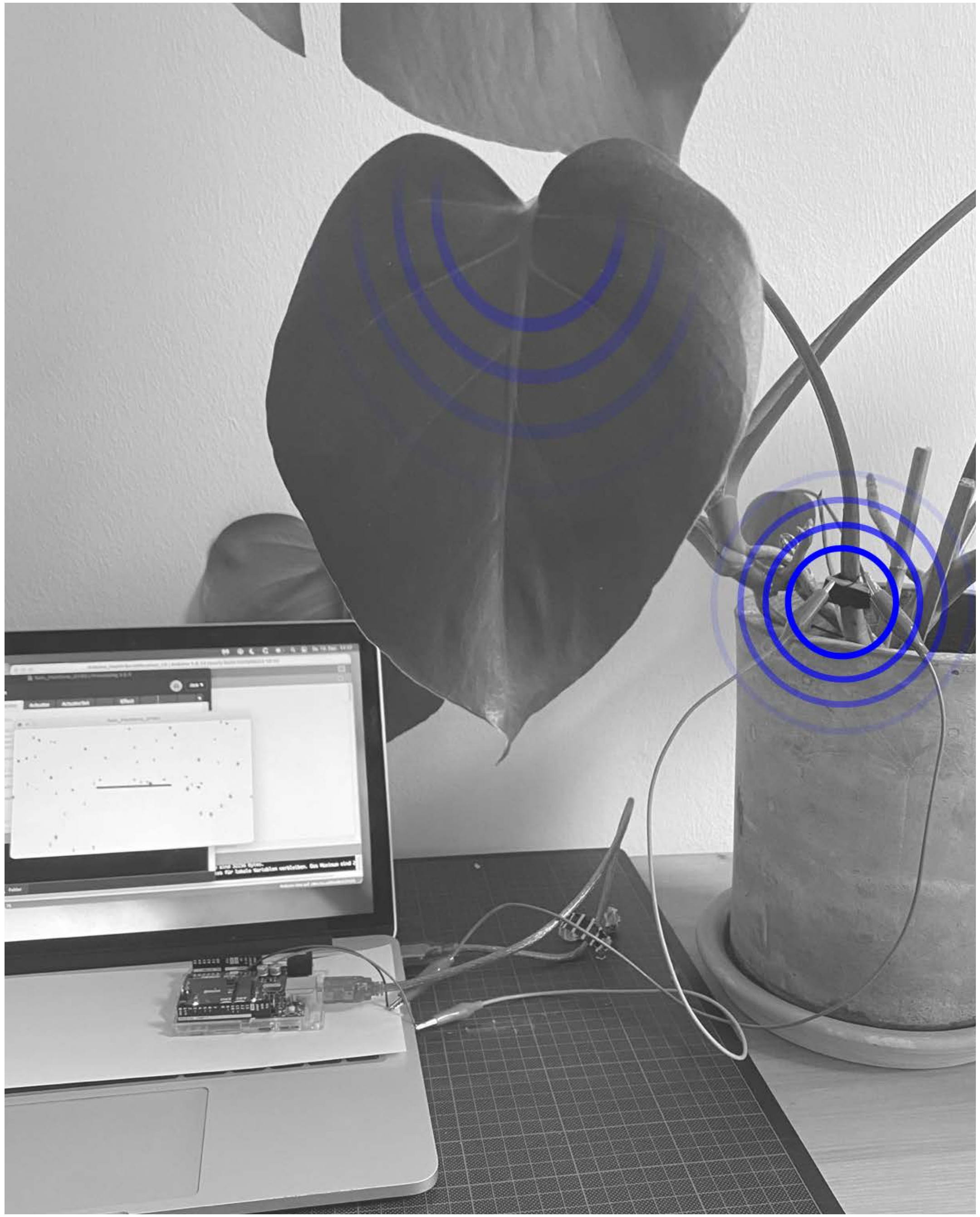


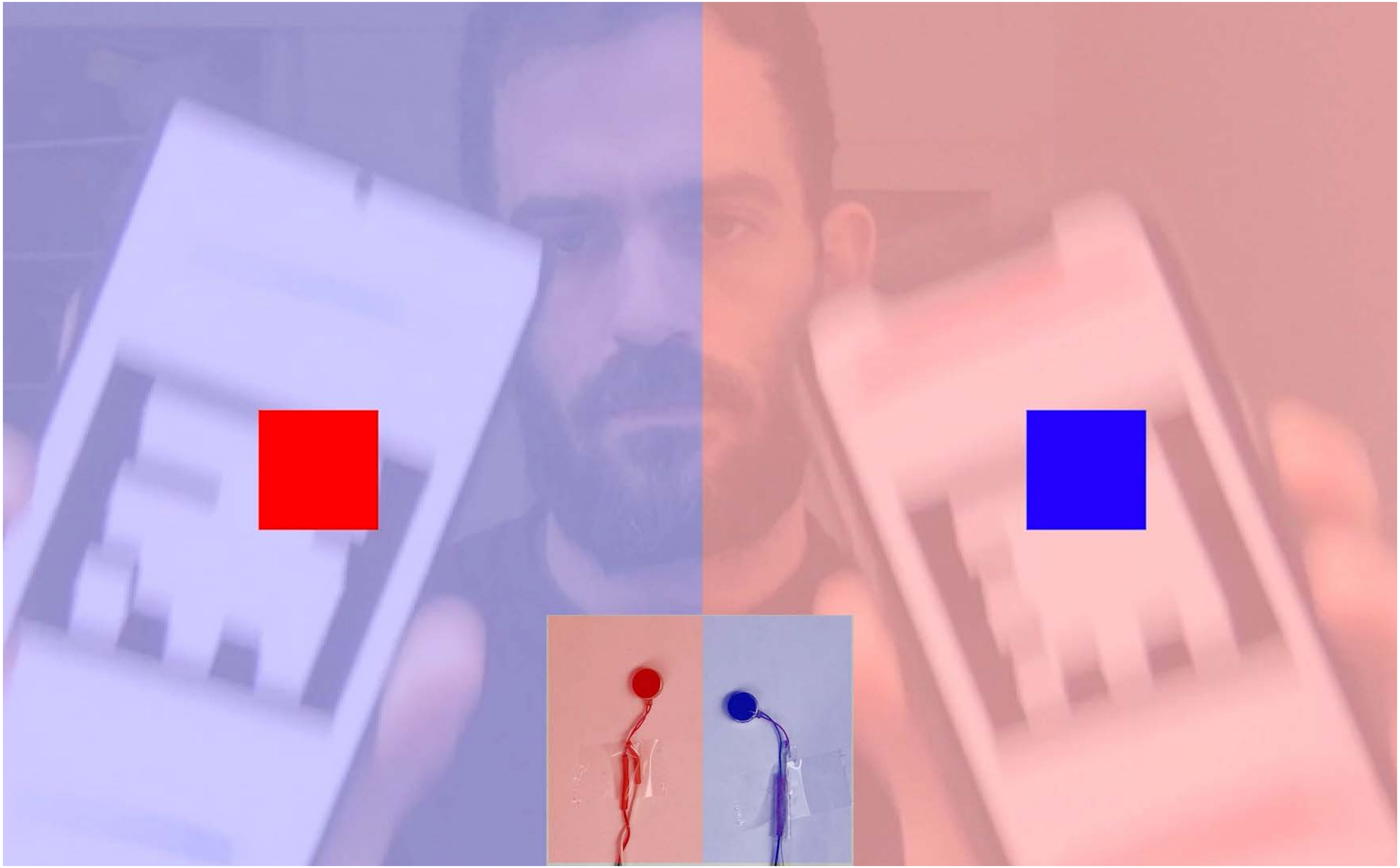


↘
FINDINGS

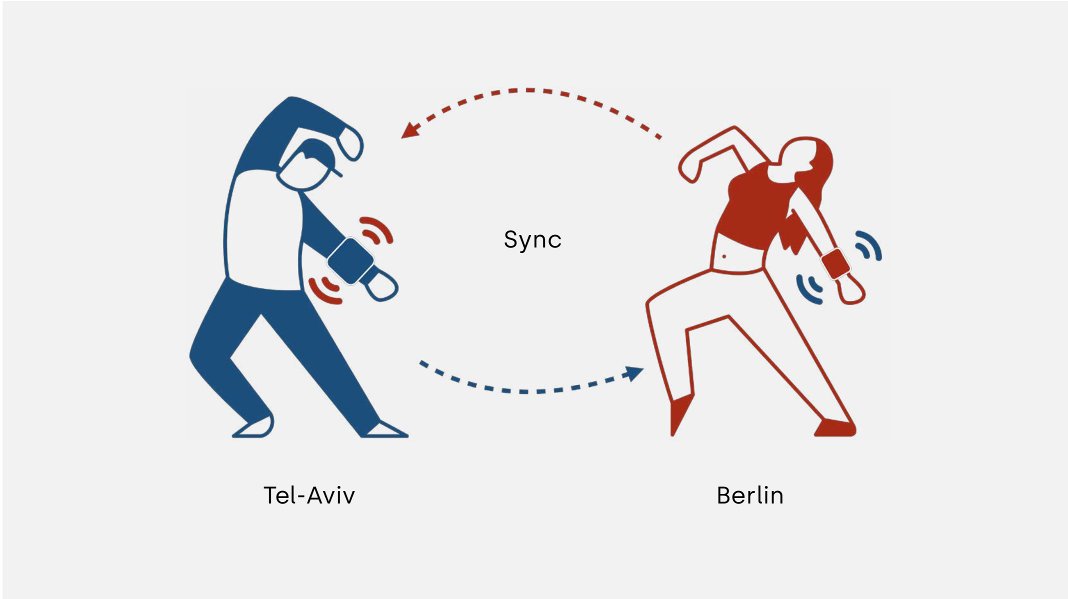
Too high a number of particles caused the actuators output to receive a persistent signal, so that the vibration effect could not be differentiated. I also realized that a greater number of actuators would not necessarily improve the effect.
It was nice to see the vibration transferred to my Monstera plant. It functioned similarly to a sound body. This gave the vibrations a new quality that I, as a user, could associate with the displayed rain animation.

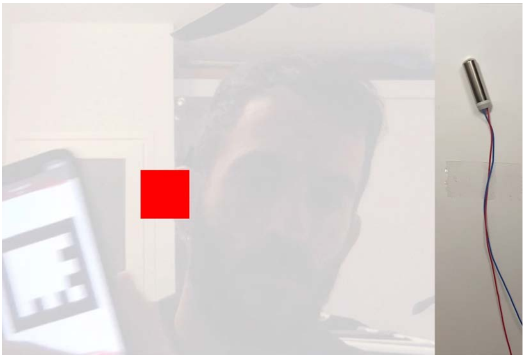


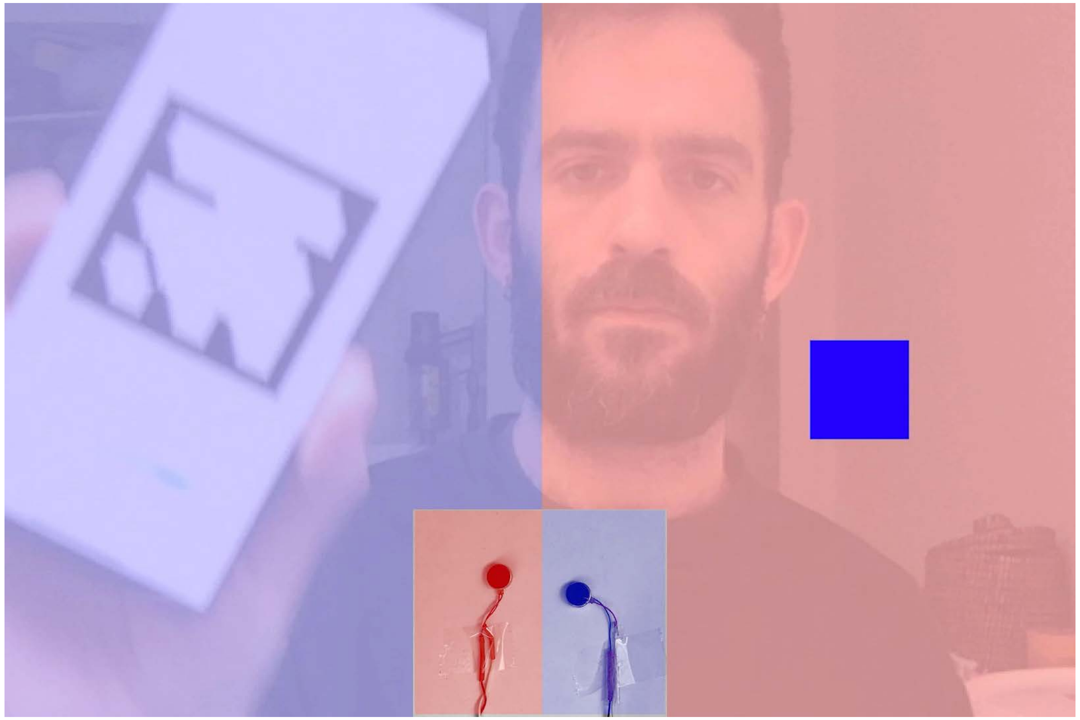




↘
RESEARCH QUESTION / INVESTIGATION
In "Dance with Somebody," I explored ways to enrich remote “togetherness” in times of social isolation. In other words: how to make a digital dance experience more immersive?
↘
METHODOLOGY
I focused only on the sync aspect of the dance experience. I conducted three experiments using image target recognition and haptic vibration motors.
↘
PARAMETERS
To identify a dance movement, I changed the acceleration sensitivity alternating delay in milliseconds. I also changed the vibrator frequencies by altering their PWM.

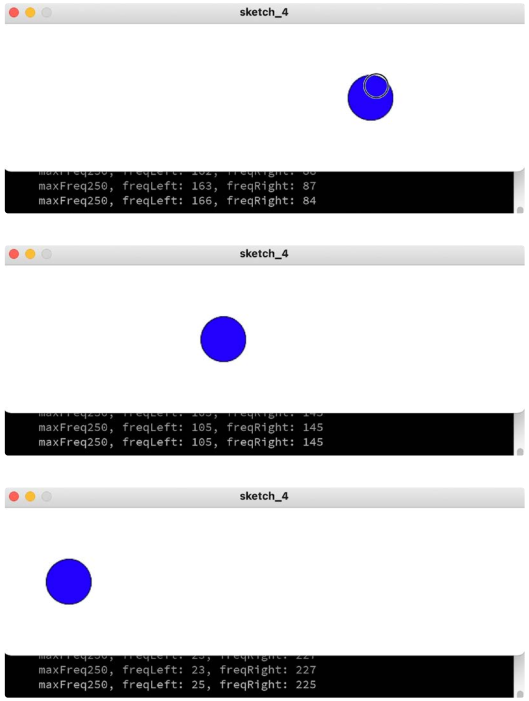


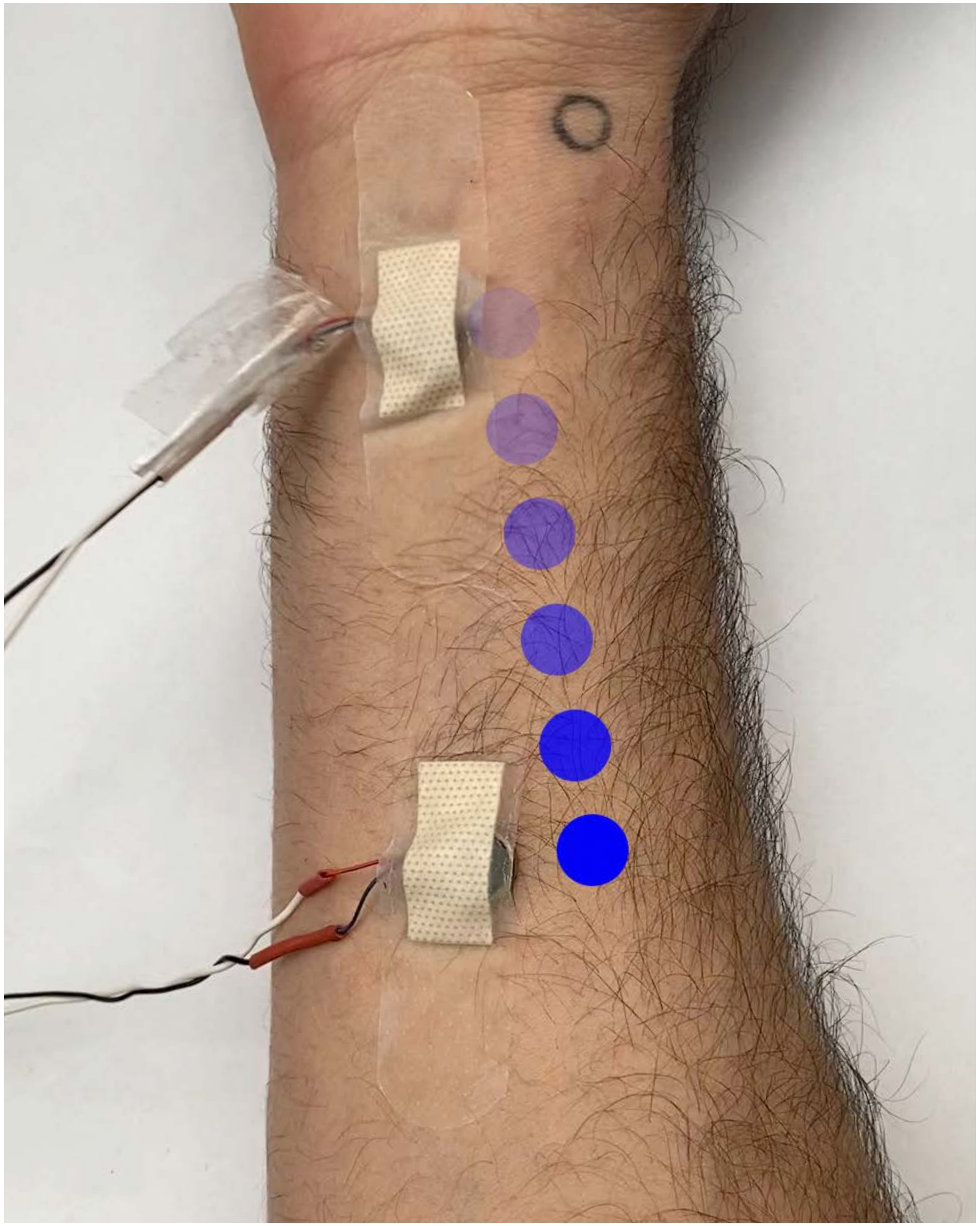


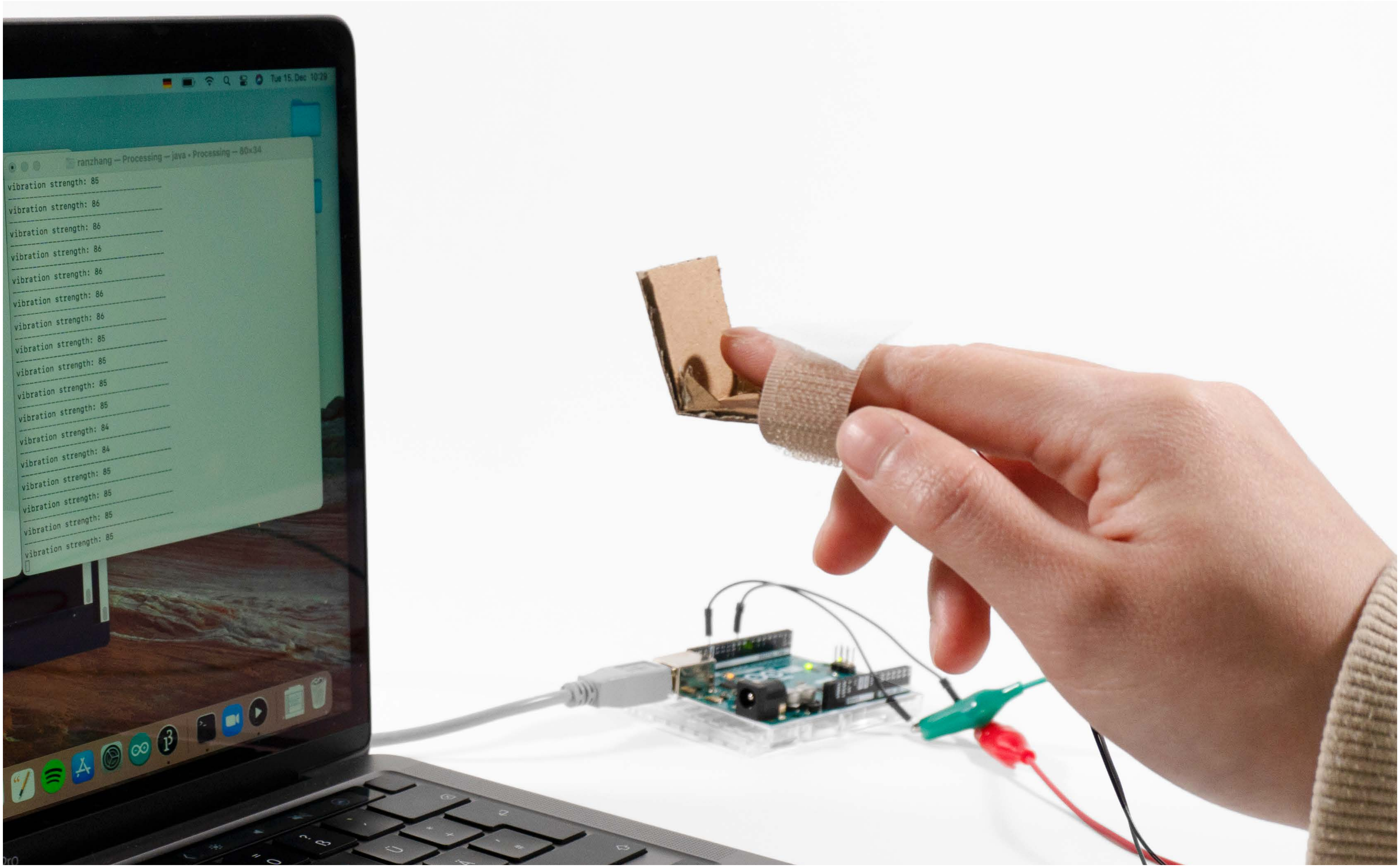


*
»Dancer« icons by Benjamin Bours, from the thenounproject.com

↘
FINDINGS
I discovered that the vibration motors are too subtle for a dancing scenario. I successfully extracted only the end of the dance movement. I found that for different BPM there is a suitable range of delay milliseconds to best capture a dance move.



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↘
RESEARCH QUESTION / INVESTIGATION

In this sprint, I explored the possibility of feeling virtual surface textures. If we zoom in on a surface texture, it can basically be a regular or irregular pattern. What I wanted to simulate was a means of »feeling« the virtual magnified texture by way of vibration.

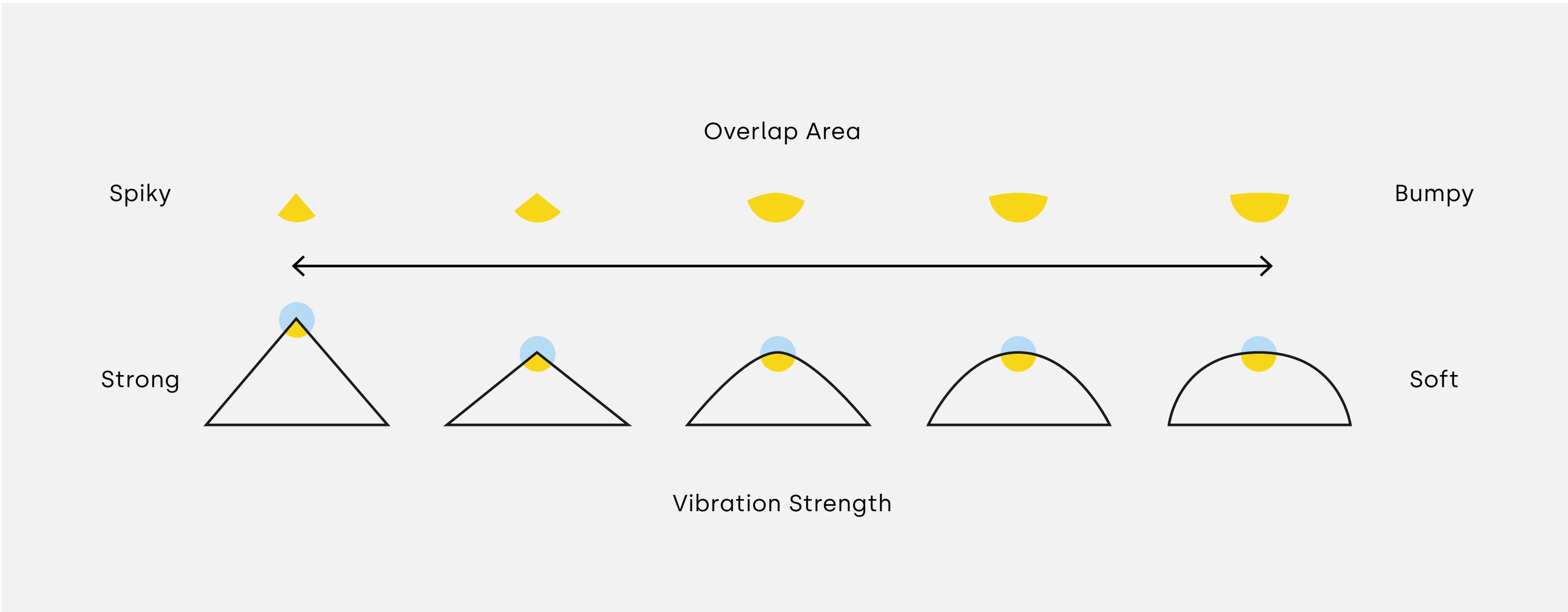
↘
METHODOLOGY

With the use of a marker, a blue circle moves on the screen in real-time, corresponding to the movement of the hand. The virtual texture is displayed on the screen as a graphic. When the blue circle interacts with the virtual texture, the motor vibrates in different patterns to indicate the roughness of the texture.

↘
PARAMETERS

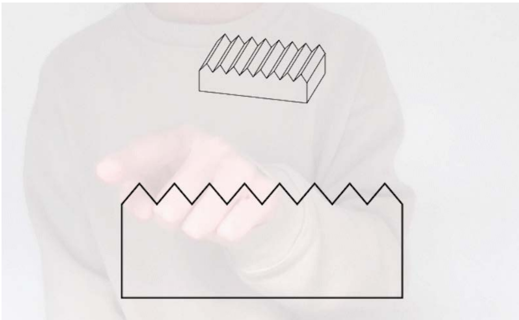
The vibration strength varies with the roughness of the surface, which is achieved in two different ways. The first one depends on the overlapping area of the circle and the texture. The second way is to establish the relationship between the tangent angle of the texture curve and the vibration strength.

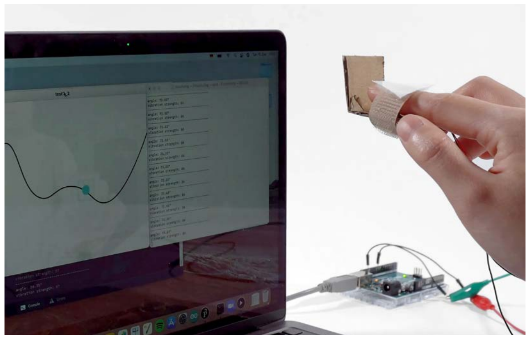
For the overlapping area: the smaller the area, the stronger the vibration, just like the difference between touching the spiky and bumpy surface. For the tangent angle: the larger the angle indicates the greater the tilt of the curve, the greater the change in texture, and therefore the greater the vibration strength.

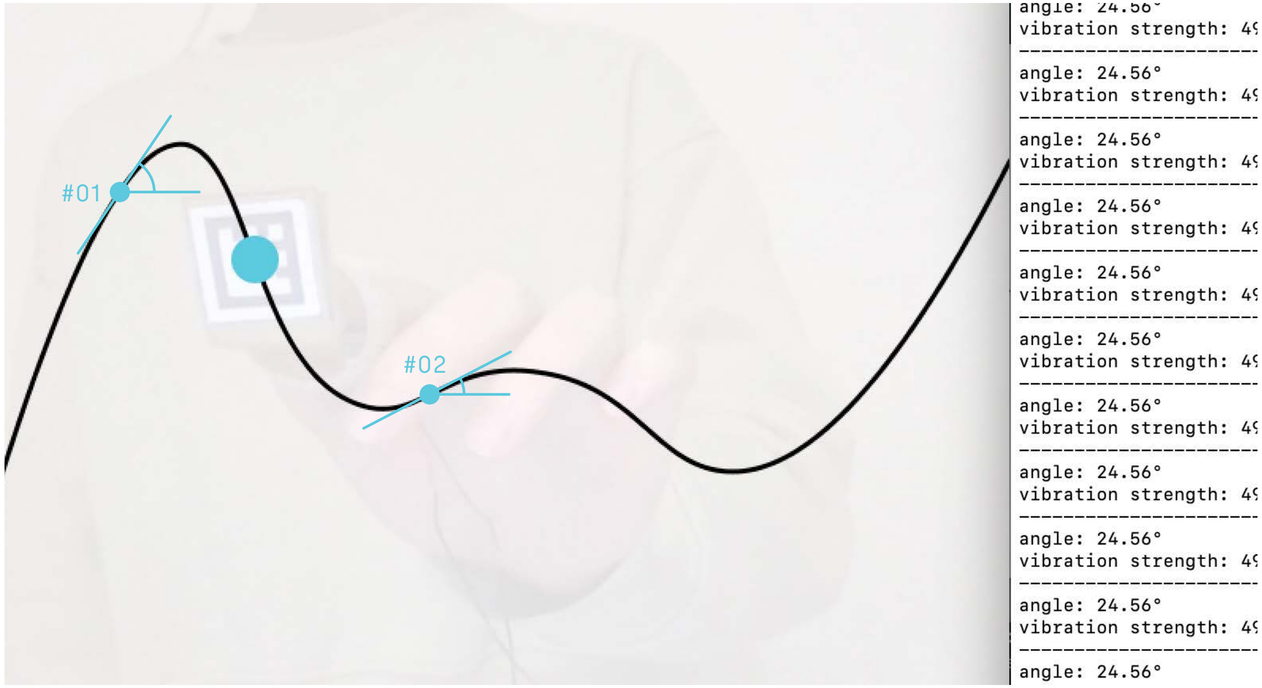


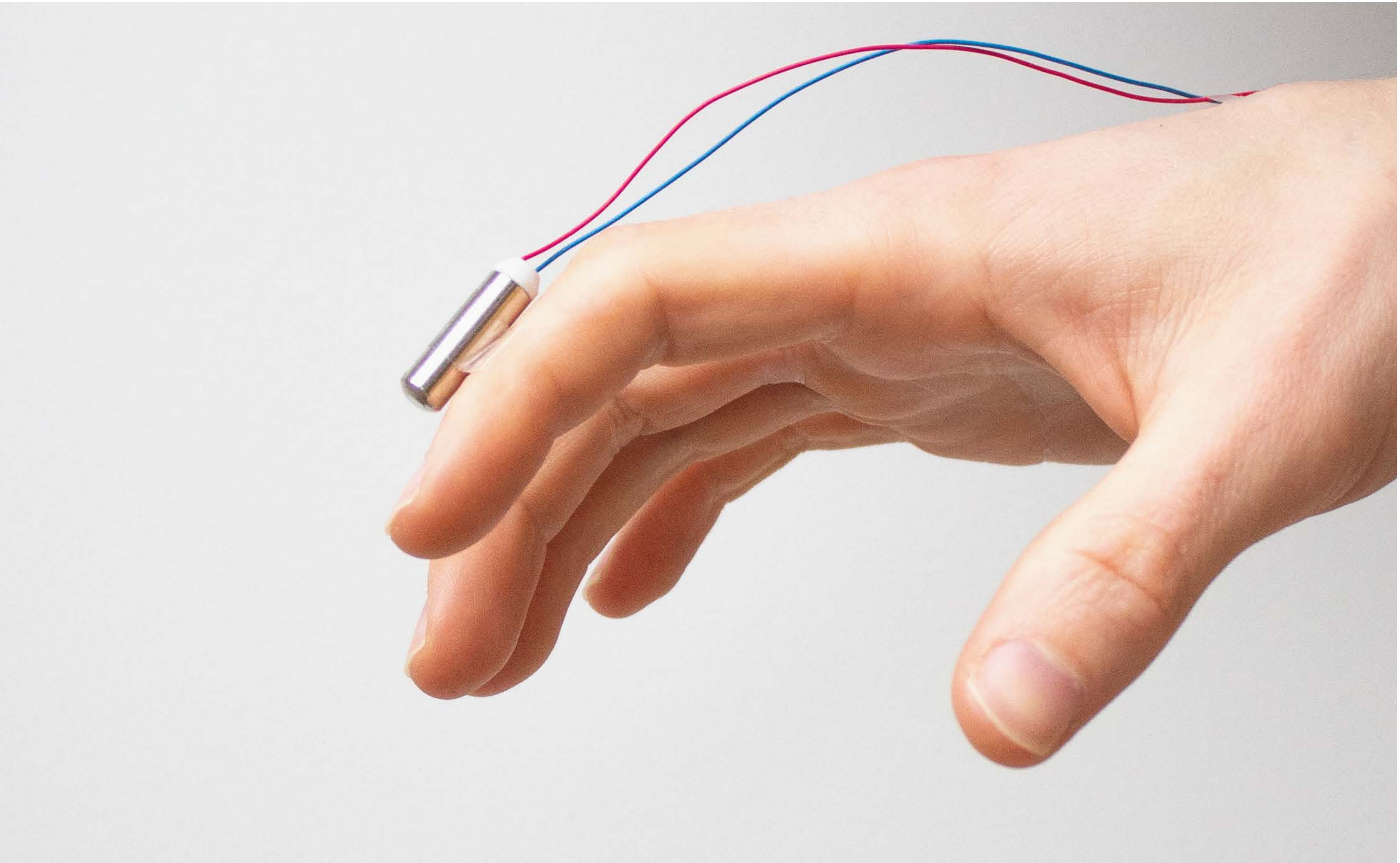
↘ FINDINGS

While the marker works well for the task, it requires some manual precision to follow the curve, especially now that textures have been »zoomed in« on, making it more difficult to identify if the texture is more subtle. Moreover keeping the arm elevated is tiring.
When I set up the relationship between the vibration strength and other factors, they can be correlated automatically. Then surface texture does not need to be limited to regular patterns but can become more free. The surface texture can be freely defined and be automatically transformed into a vibration pattern.









↘
RESEARCH QUESTION / INVESTIGATION

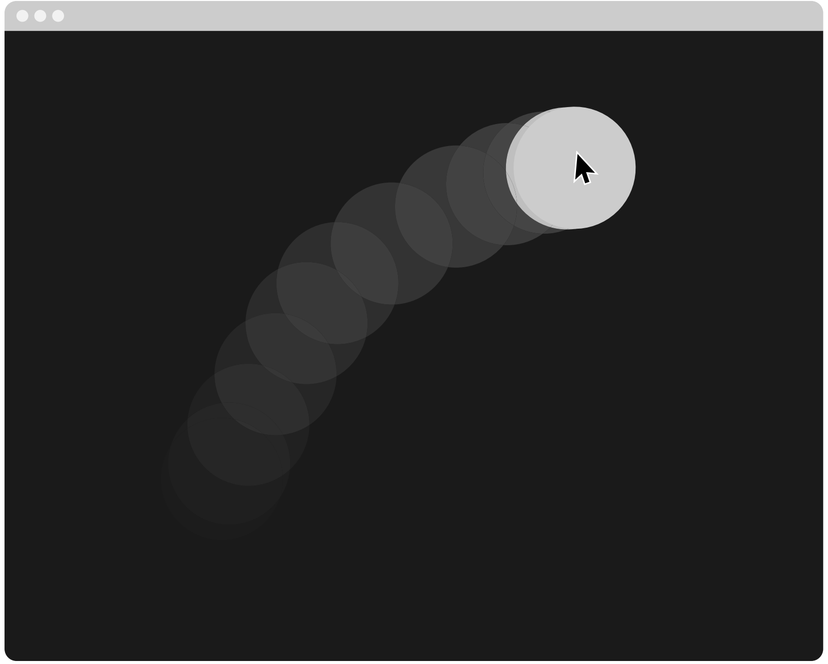
The interaction with screens and augmented reality became part of our everyday life – however they mostly target our visual and auditory perception. In this sprint I wanted to investigate how such interactions can be enhanced to create a richer experience that triggers our haptic sense – for example in cyber sports where visual and auditory feedback is frequently not enough.

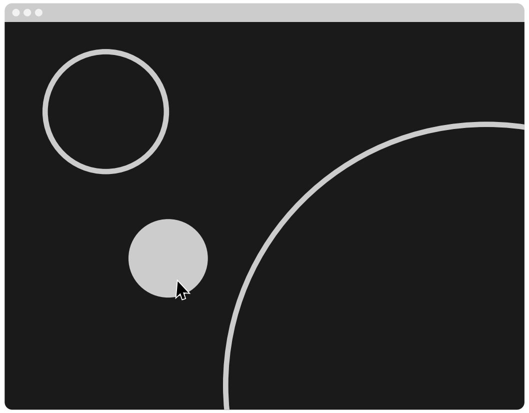
↘
METHODOLOGY

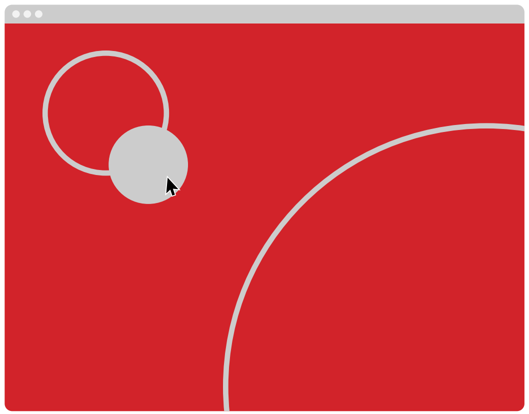
I used the scenario of virtual fitness as a starting point and focused on two main aspects: the coordination / guidance of certain movements and the feeling of weight. I designed small experimental programs with *Processing* and *Arduino* that would communicate the idea of coordination and weight visually and connected them with a vibration motor as an output of the interaction that would be attached on my index finger.

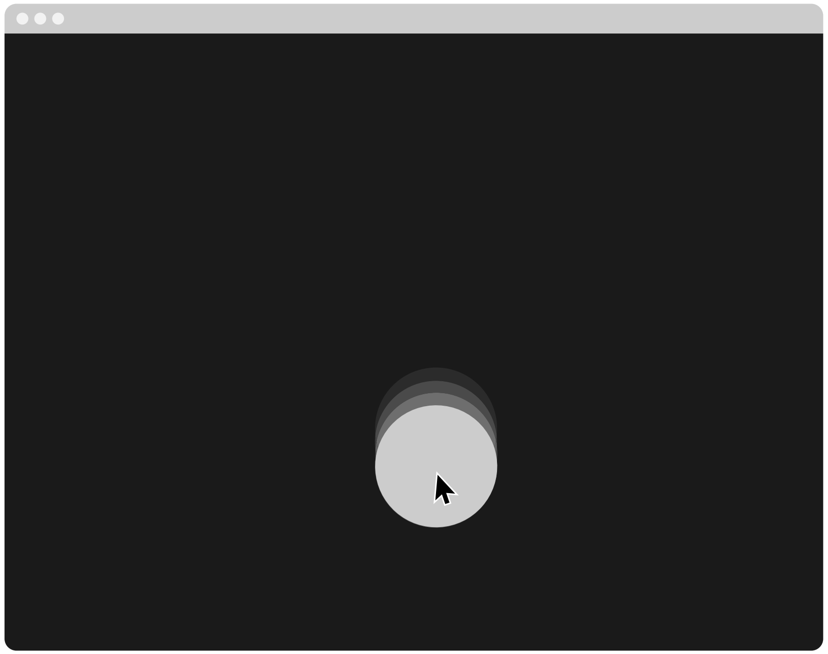
↘
PARAMETERS

To approach the aspect of coordination, I started with a simple one-dimensional vibration stimulus (ca. 0.5s vibration signal on a consistent intensity level) that would be triggered by clicking the mouse, moving in a certain direction, moving with a certain speed hinting a visual obstacle. Next I added variety to the vibration output by defining patterns like fade-outs and fade-ins or connecting the position or moving speed of the mouse with the intensity of the vibration feedback.









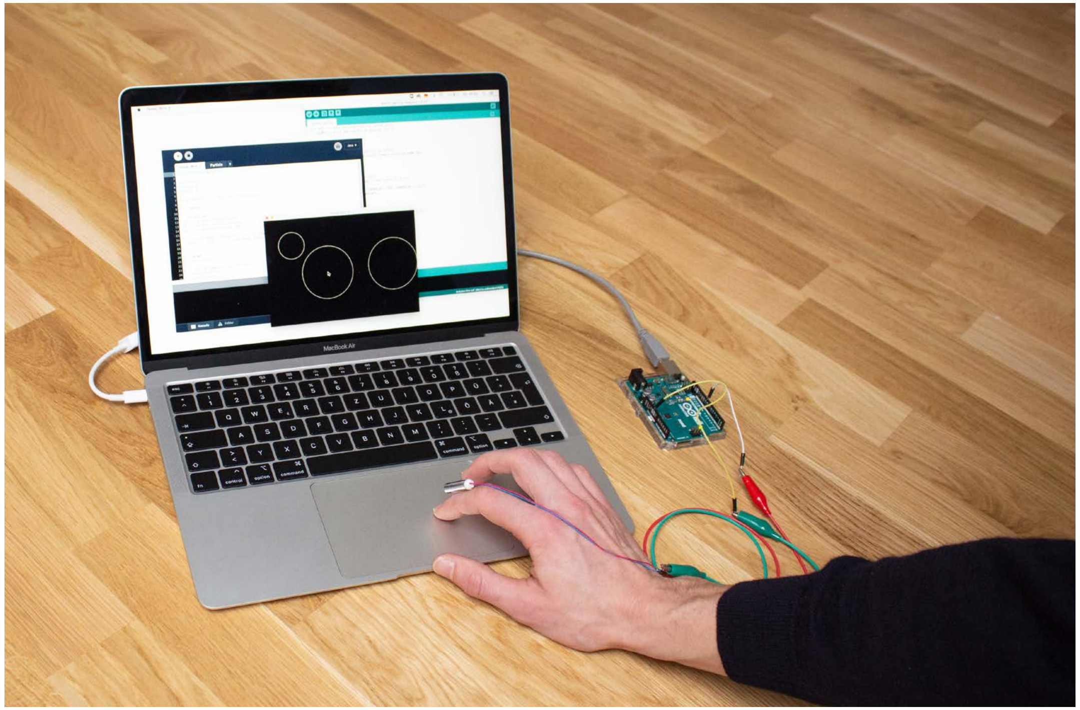
To approach the feeling of weight, I explored visual delays of moving objects on the screen in the sense of gravity and translated those into matching delayed vibration feedback. Moving an object up would cause a visual delay and also a delayed vibration feedback that would fade in. Moving the object down would result in no delay to create a physical experience (since it's easier to move an object down than up due to gravity).

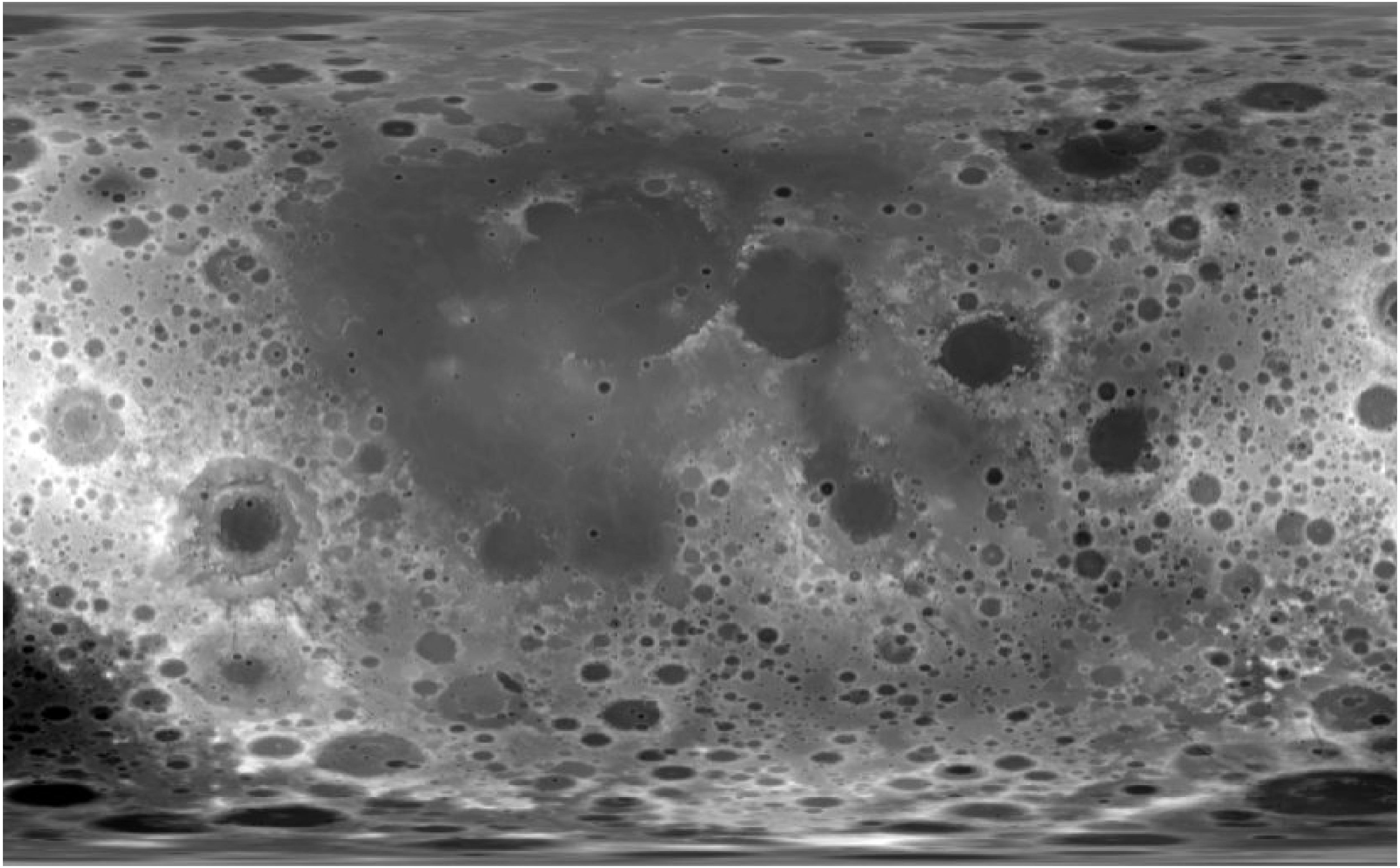
↘

FINDINGS

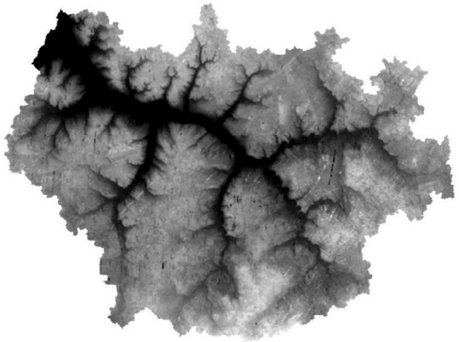
During the process, I noticed that the usage of a mouse and a screen is such an established interaction and works so fast that it was hard to integrate a haptic element in it and actually »wait for it«. Therefore I had to slow down some of the experiments. Also, it was quite difficult to communicate a message / information with the vibration feedback when combined with the actual movement of the mouse.

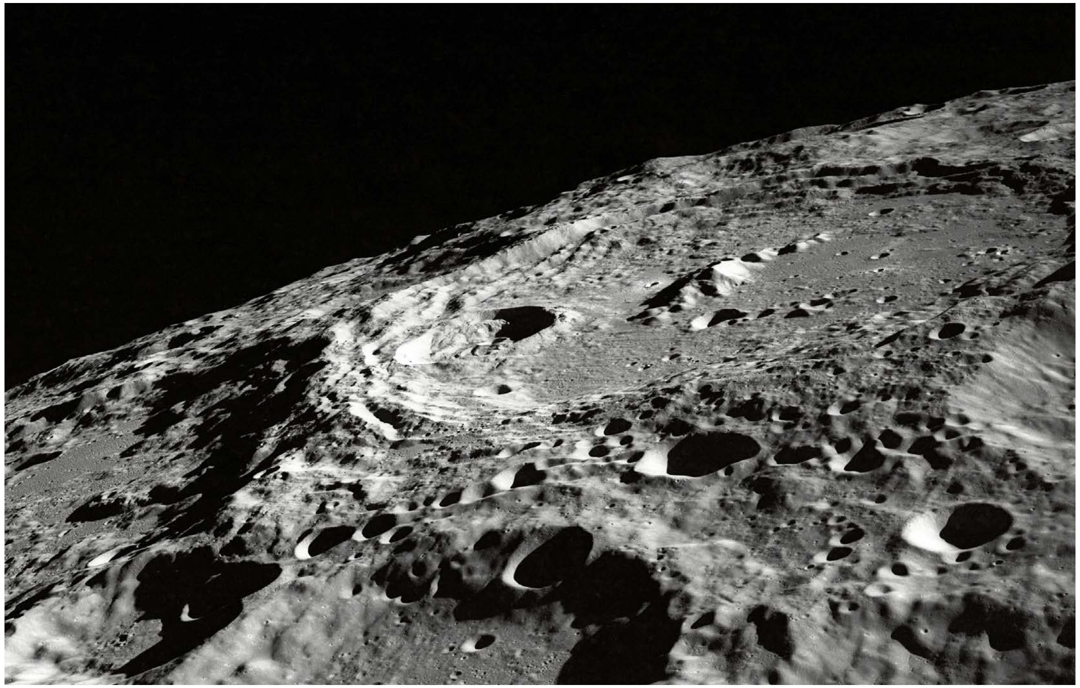
The setup worked out well to connect and interchange all parameters and tweak them accurately. Giving coordinated guidance through haptic feedback turned out to be a well working practice. The pseudo haptic effect created through a delayed visual and vibration feedback was also convincing and has a high potential for more investigation.





↘
RESEARCH QUESTION / INVESTIGATION
Can we explore otherworldly terrain, like the surface of the moon, physically?
↘
METHODOLOGY
Black and white topographic maps show depth through the level of brightness. Hovering over black and white images, I made the mouse cursor react upon the level of brightness through the *Processing* software, sending feedback to a vibration motor attached to the computer mouse.
↘
PARAMETERS
I experimented with black and white gradients, as well as the force and the positioning of the vibration feedback. The brighter the pixels of an image, the stronger the vibration feedback.



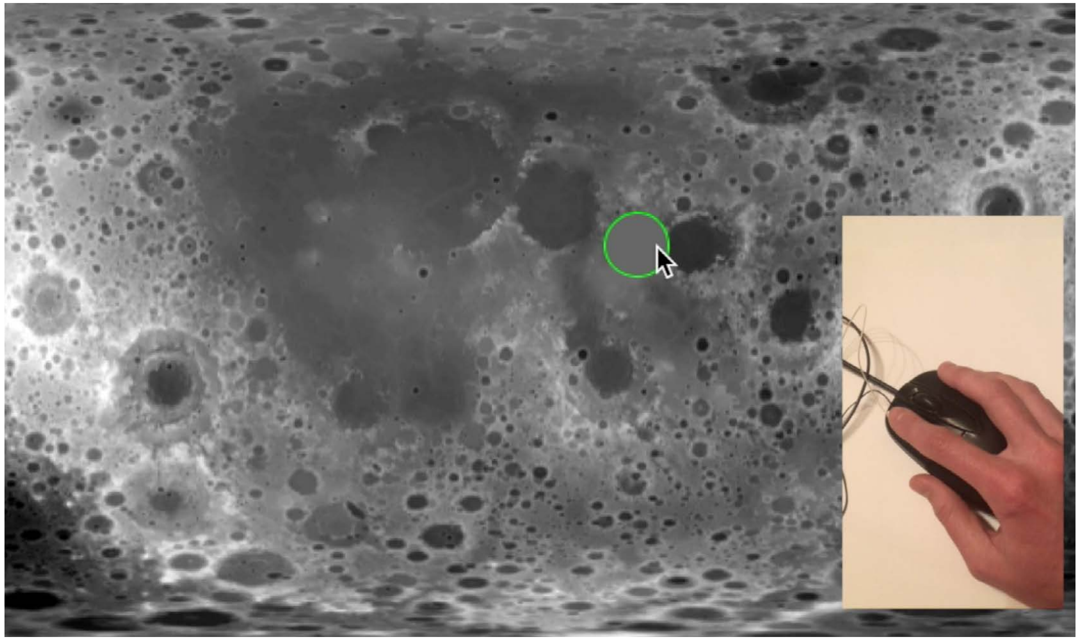


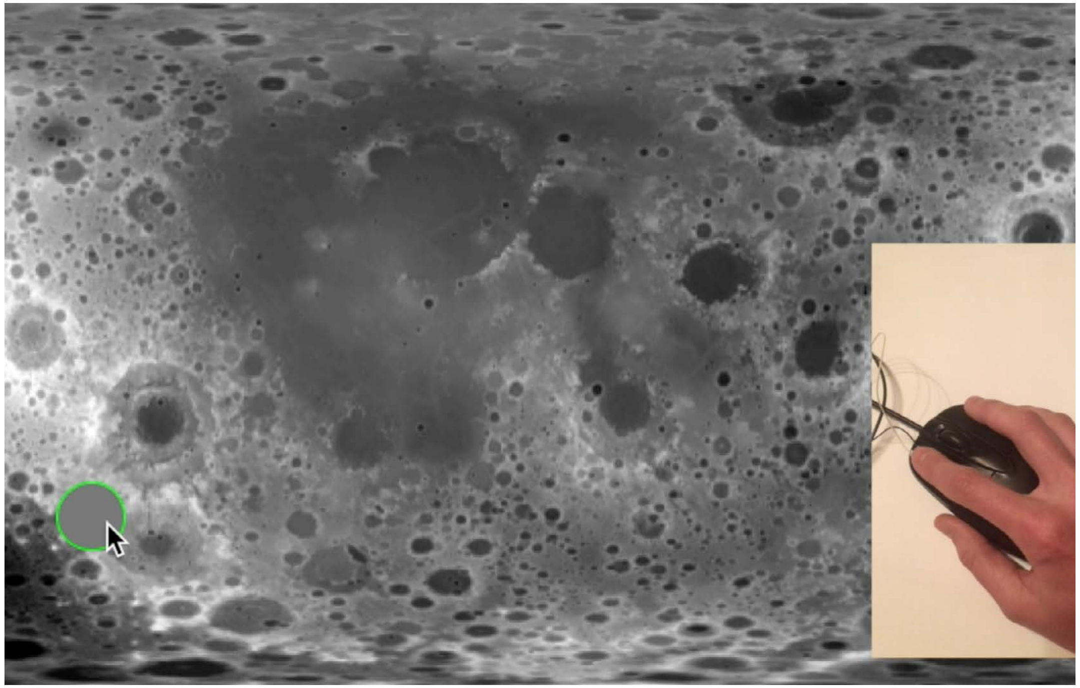
*
Opening image (previous page) by NASA, from astrogeology.usgs.gov

**
Topographic Map by Andrew, from digital-geography.com

↘
FINDINGS

The vibration feedback played out well, but did not quite resemble the haptic sensation I expected. It feels unrelated to the terrain of the map image. Through experiments I got interested in further possibilities of the vibration feedback: Black and white images could be translated through vibration to set sand in motion to create new sand formations or rythmic patterns.

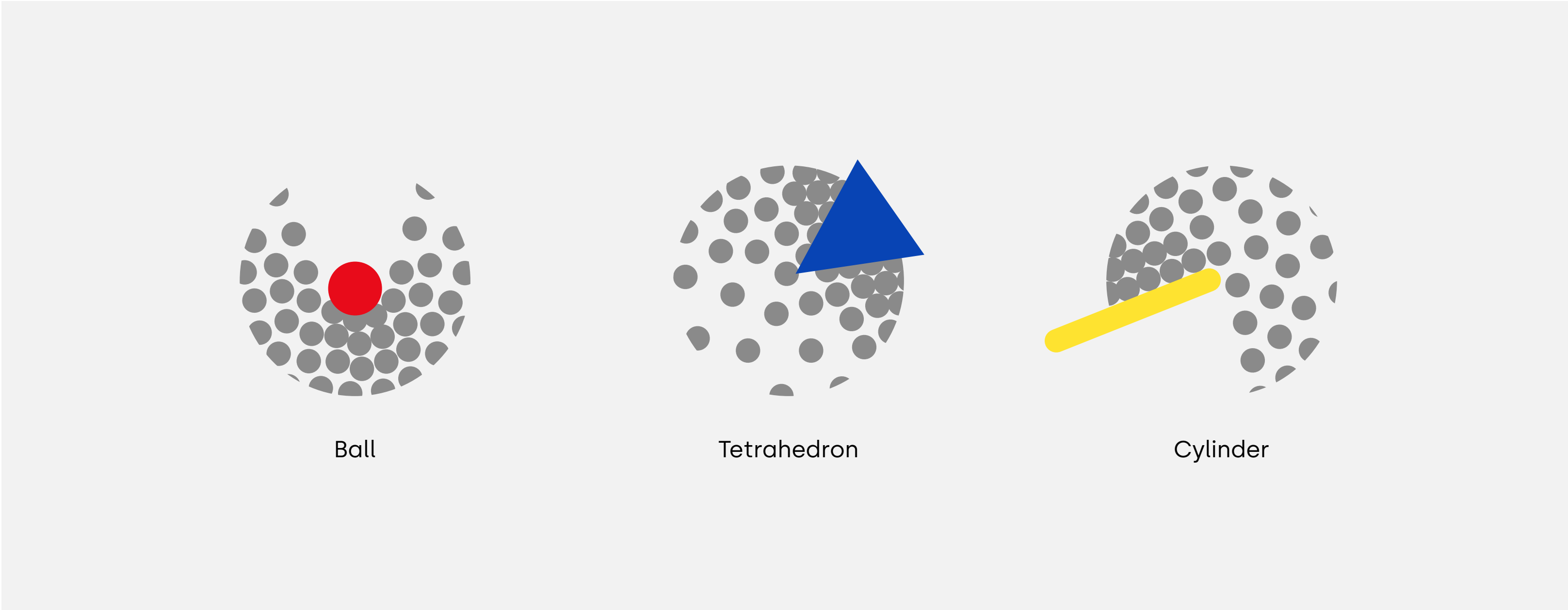




↘
RESEARCH QUESTION / INVESTIGATION
The goal was to link analogue gestures and expressions of humans interacting with physical objects to the digital world.
The users express their feelings with the items and the items can then translate the expressions to give a matching haptic or audio feedback.

↘
METHODOLOGY
In the beginning a collection of gestures was made which were then related to three representative objects. A tetrahedron, a ball and a cylinder. In the next steps the tetrahedron was prototyped by using foam and fabric. It represents the items used in the gestures crumble, squeeze and throw.

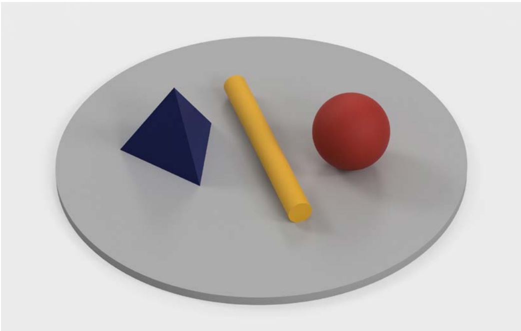
↘
PARAMETERS
The right size of the tetrahedron was chosen by prototyping different sizes of the object. For the digital impression exploding triangles per activation were chosen.

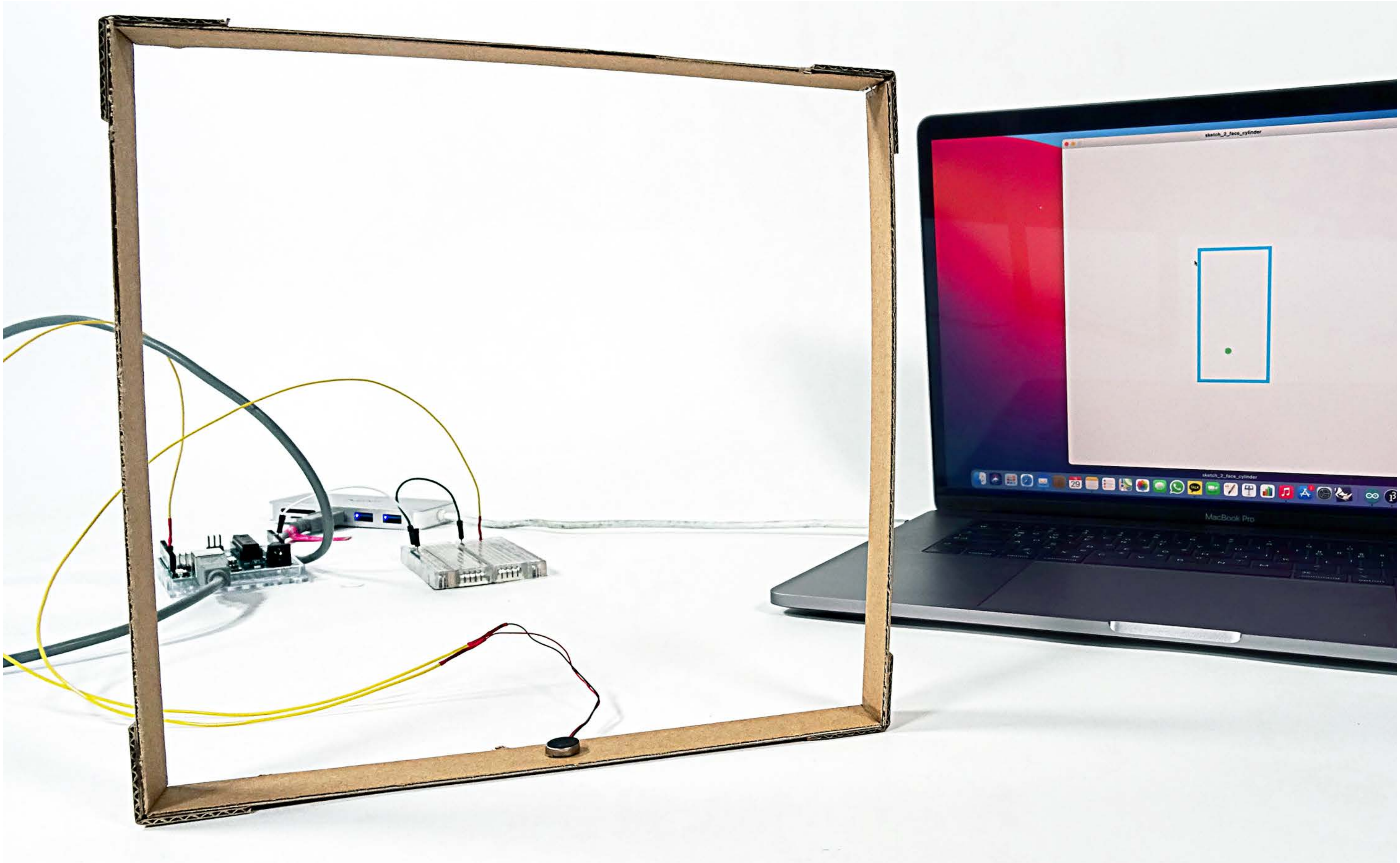


↘

FINDINGS

The fun and the magic feeling of the device exceeded expectations.
The electronics inside the tetrahedron worked out pretty well. The best thing about it was that it was completely silent and didn't make noise or any known feedback that is too similar to a clicking device. It worked because copper strings were sewed inside the foam which close the circuit as soon as they are brought together through crumpling the tetrahedron. This creates the achieved silent »click«.

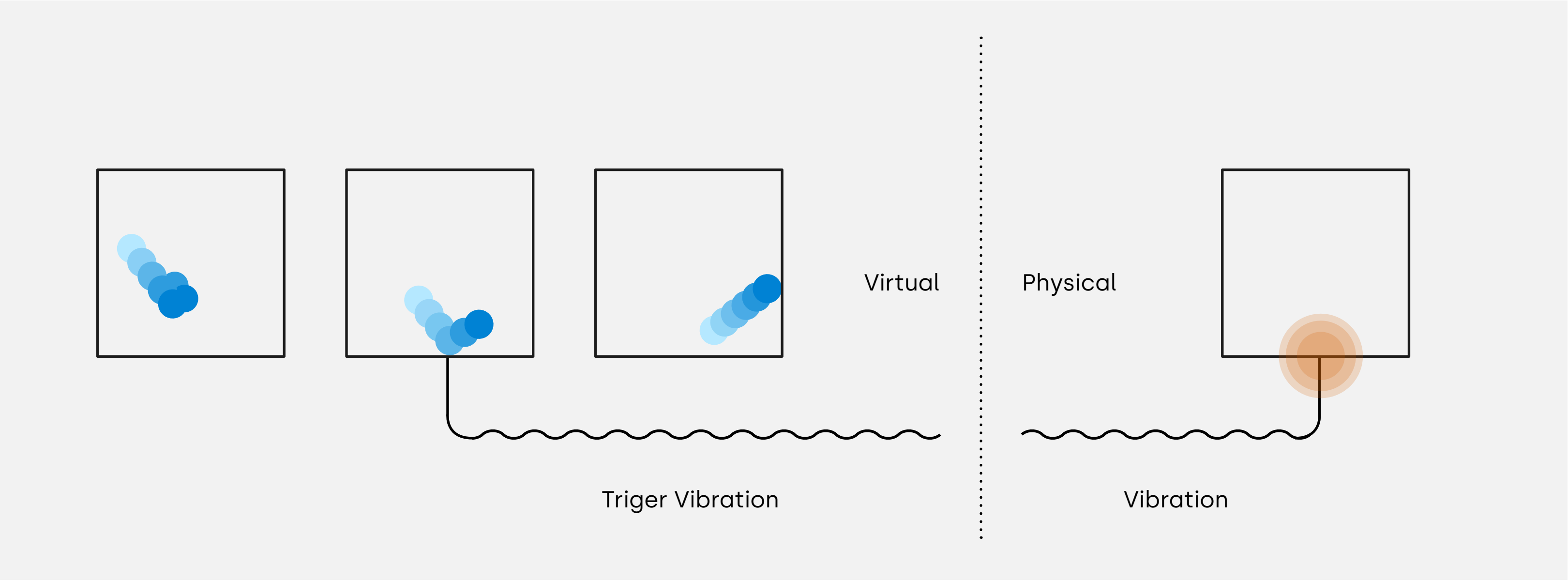



sketch_2_face_cylinder
MacBook Pro

↘
RESEARCH QUESTION / INVESTIGATION
The program's events can run forever as long as the computer has energy. It is also possible to play table tennis forever in the program, because the program can ignore the laws of physics. But the reality is not. No matter how sturdy balls and walls you have, someday they will break. My goal was to synchronize the program and reality so that the laws of physics of what happened in the program would actually happen.

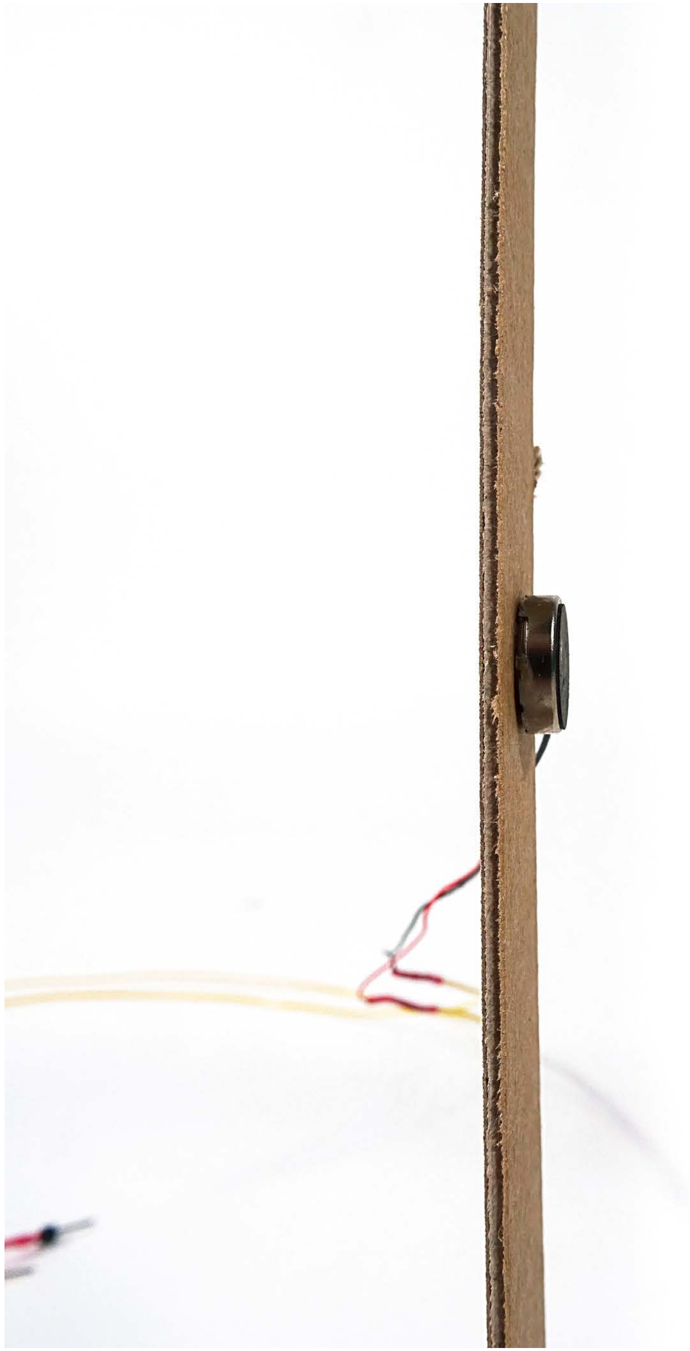
↘
METHODOLOGY
A specific model linked to the real world shows the laws of physics that arise from events in computer programs. To this end, *Processing* and *Arduino* are connected with the program, so whenever the ball hits a square in the program, the square model in the real world reacts instead. Connect the *Arduino* and *Processing* to each other, and when *Processing* sends a signal to the *Arduino*, the output is displayed through the sensor connected to the *Arduino*.

↘
PARAMETERS
Through program coding, when the ball hits a specific wall of the square, it sends a signal to the *Arduino* to activate the vibration sensor for 0.5 seconds. Just as the ball shakes when it hits the square, when the ball hits the square in the program, the vibration sensor attached to the real square model works and the square model shakes.



↘
FINDINGS

The program and the model of reality were interlocked so that we could experience the program closer in the real world. The actual model connected to the program was made of thick paper. A vibration sensor was connected to this paper model and the output was observed. The light weight of the paper was effective in showing the output. Various outputs were derived according to the location of the vibration sensor. If the sensor was installed on the side of the square, the side was shaken, and if the sensor was installed on the floor of the square, the model moved slightly.




cmd
alt
ctrl
fn
UNO
ARDUINO

↘
RESEARCH QUESTION / INVESTIGATION

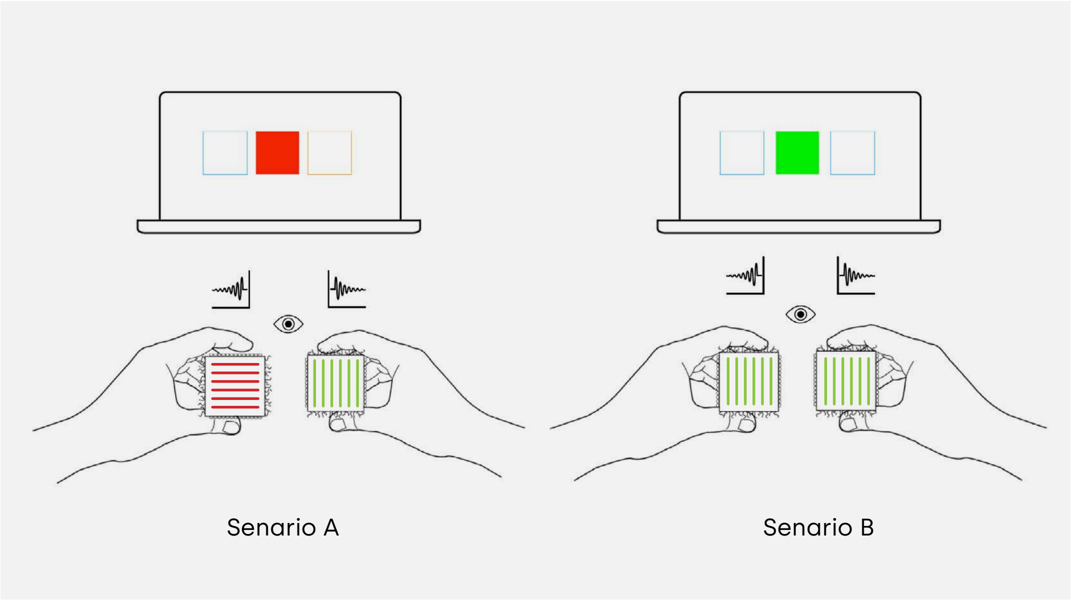
For the first task of the third sprint, we wanted to create a series of experiments that will be focused on the interaction with different colours, as well as exploring the effects haptic feedback (through small vibration motors) has on the interaction between user and object. How and when do we best design a user experience with haptic, tactile elements, but also incorporating visuals and sounds?

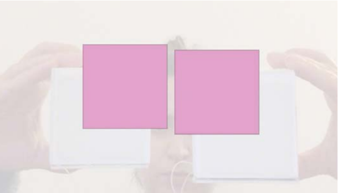
↘
METHODOLOGY

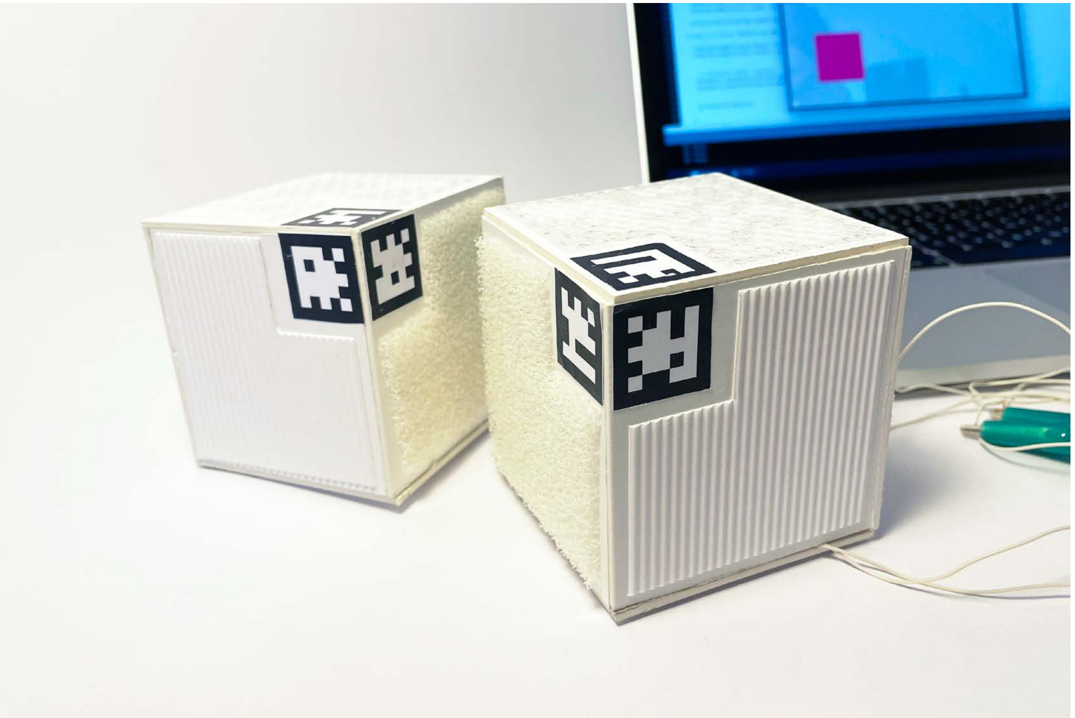
At first we experiment with visual aspects: the users should be attracted by an interaction of colors and gradients. Haptically, both users should be informed by a vibration at the image target that the »puzzle pieces« are approaching. In addition, we wanted the user to feel different materials as they also sense the vibration motors and visual feedback.

↘
PARAMETERS

We made various tests combining distance between the two physical objects, different colours and material. For example as the two physical objects come closer as the user faces the same material (image marker) on the screen the vibration is higher, the color is changing to green (confirmation color) the vibration motor stops working once they're touched. But when two different materials meet, the feedback changes: the vibration keeps on working and the colour is changing to red.
We also created small acoustic tests to check what happens if you combine both material and vibration - can we create a new output of sound?



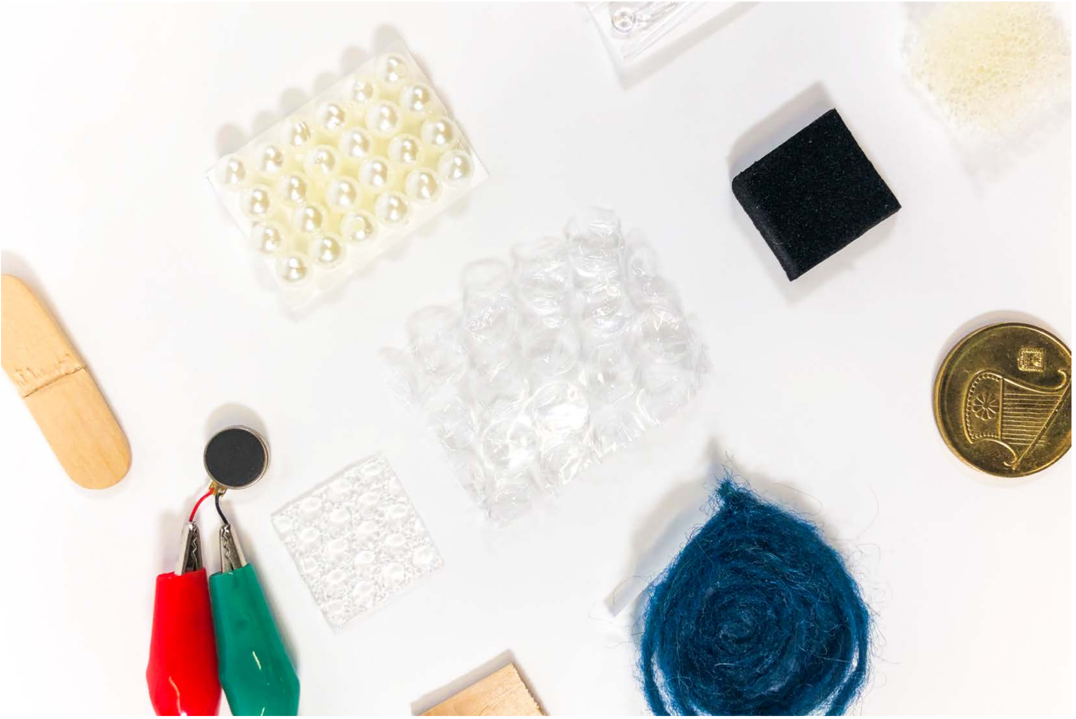




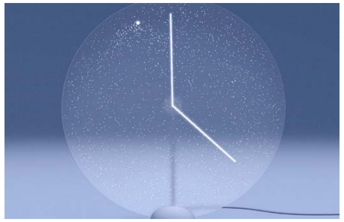
↘
FINDINGS

At the beginning we didn't plan to have a sound as a feedback but we quickly identified its potential and started to run some tests to check what kind of sound feedback we could have with different materials. The results were good and you could really hear the difference between each material.

We managed to create what we wished for, but we realised it actually has more potential then this iteration. We could have added more kinds of visual feedback, for example different patterns that reflect the haptic tactile of the materials, as well as combining more kinds of sound output.



↘
D 01 — 20
Deep Dive (04.01. – 22.01.)
Technological Focus: free of choice
Workshop supervised by •
Judith Glaser, Felix Rasehorn, Prof. Carola Zwick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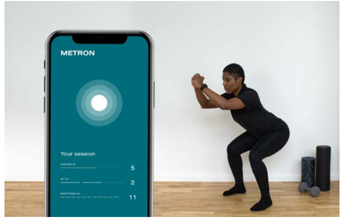

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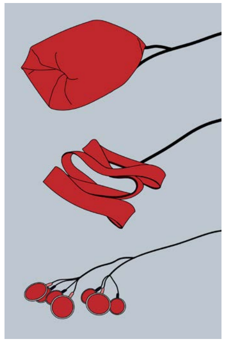
8


6


1


2


5

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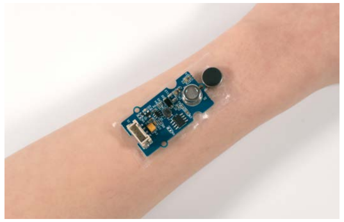
7. Tillmann KAYSER
8. Aminata CISSE & Felix HENẞLER
9. Ran ZHANG

DEEP DIVE

04 JAN —22 JAN


4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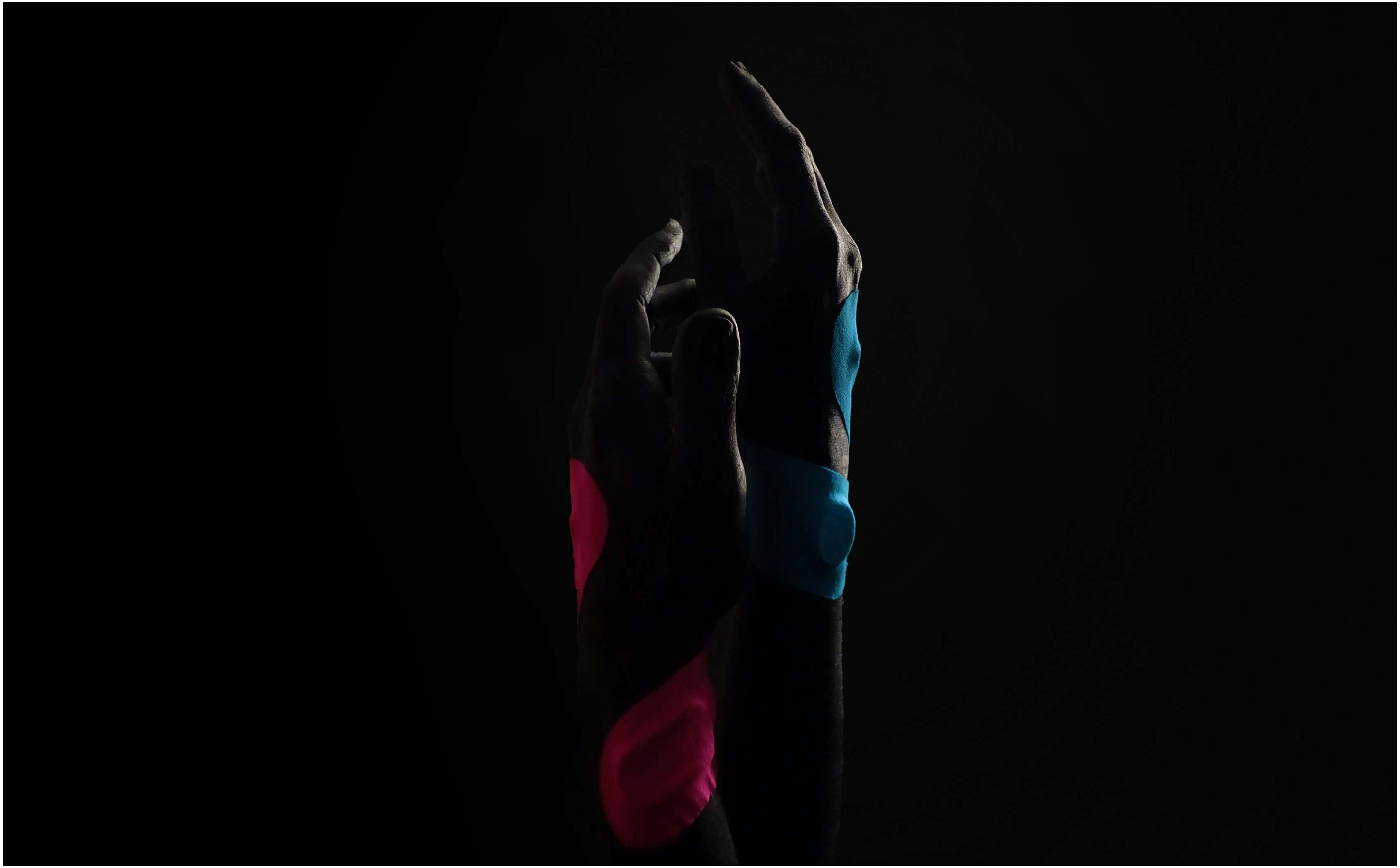
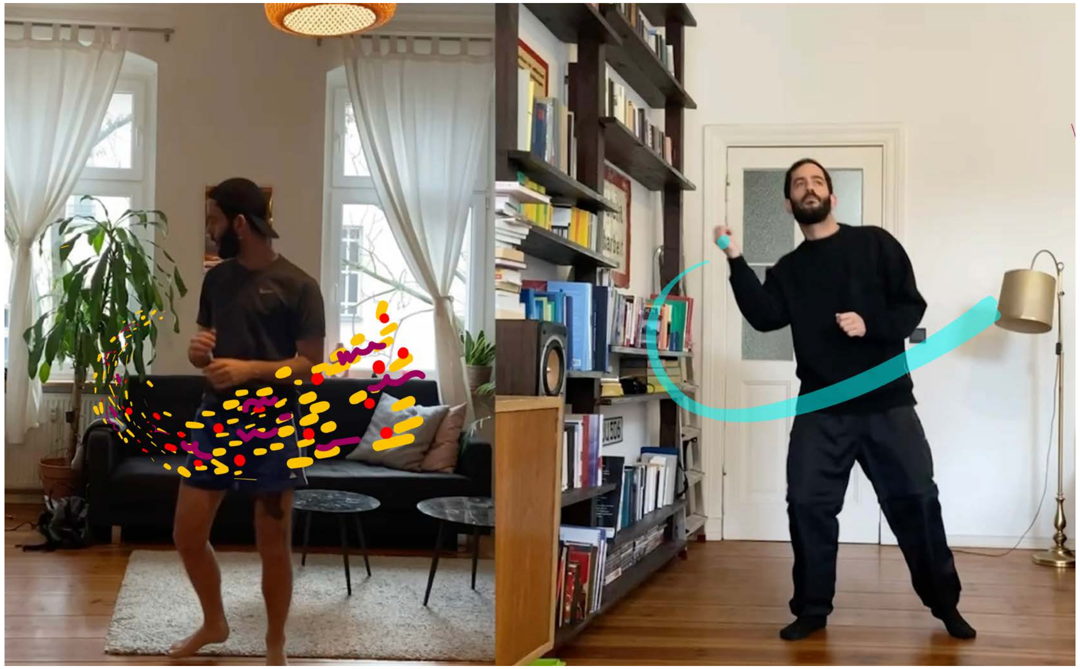


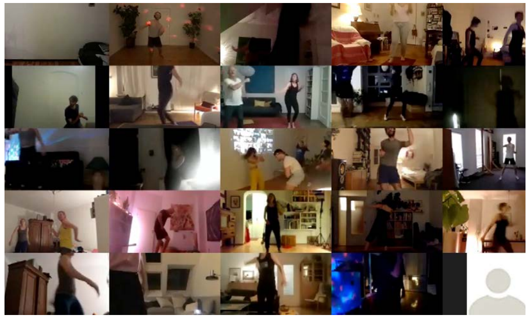
↘
RESEARCH QUESTION / INVESTIGATION

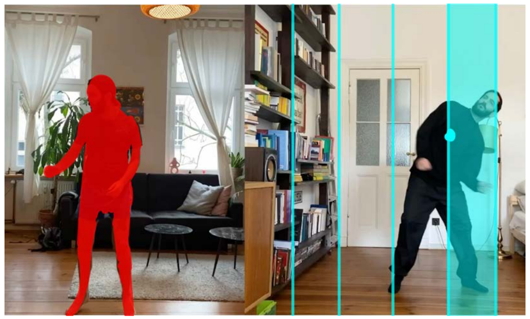
»Letting GO!« is a dance workshop that took place online during the COVID-19 pandemic. In times of social distancing, we yearn for human connection. The project examines how an online dance experience can go beyond the limited and everyday use of audio-visual means by incorporating haptic sensations. Although the screen is a window for communication, it also screens out the delicate nuance that we would perceive with our senses when dancing offline. How can an online experience between dancers become more immersive?

↘
METHODOLOGY

The first goal was to transmit a tactile sensations of a dance move from one dancer to the other. It was necessary to define and filter the »moves« from all the motion data captured. To gather movement data, image targets were used to track the hand movements of dancers. Then, by calculating the acceleration, only the final position of the dance move was extracted. As for the output, the hand proved to be the most appropriate place to receive a »touch« due to its high sensitivity. Vibration motors concealed in a slim band create the feeling of motion on the skin, as if someone is brushing the back of your hand.



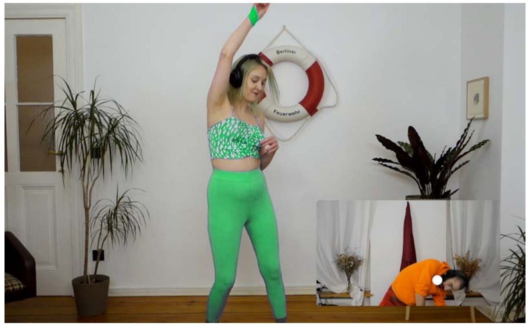


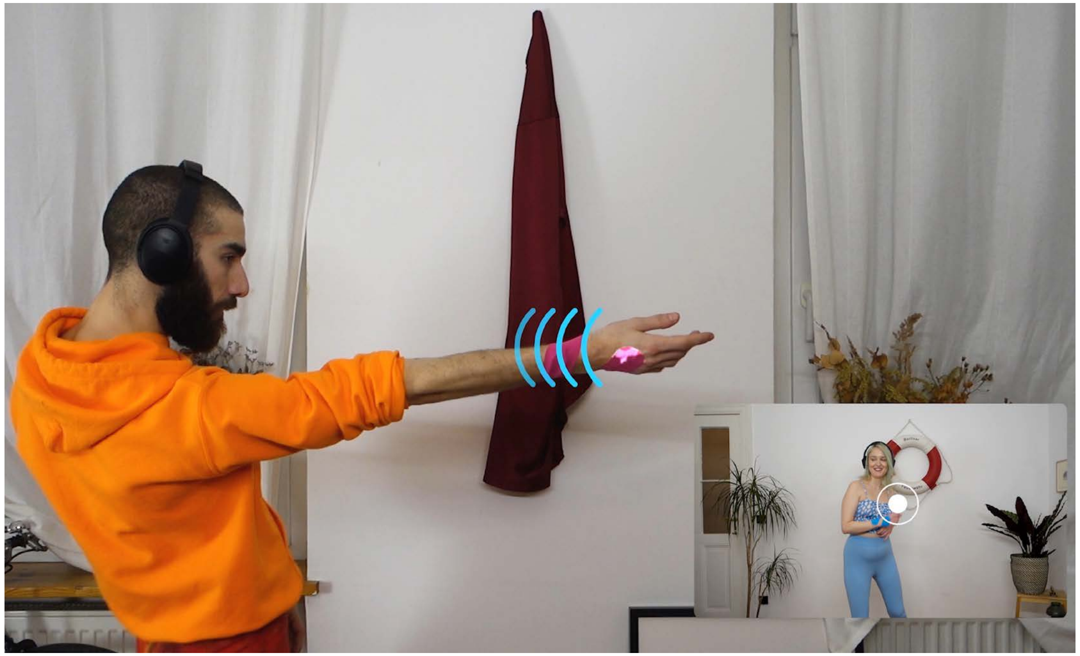


↘

FINDINGS

It seems more relevant than ever to try new means that can help us feel a connection with each other. Especially when communication in the broadest sense is almost completely migrating to digital spaces, yet the physicality of our human bodies is not.





↘

RESEARCH QUESTION / INVESTIGATION

Besides our physical world, there are spaces we can only explore virtually: VR game worlds, the hypnotizing online globe of *GoogleEarth*, or lucid dreams – dreams that you can control while asleep. Nevertheless we humans still like the idea of getting to know these »unreal« places. Can a neo-analog tool help us to more intuitively navigate both physical and virtual spaces?

↘

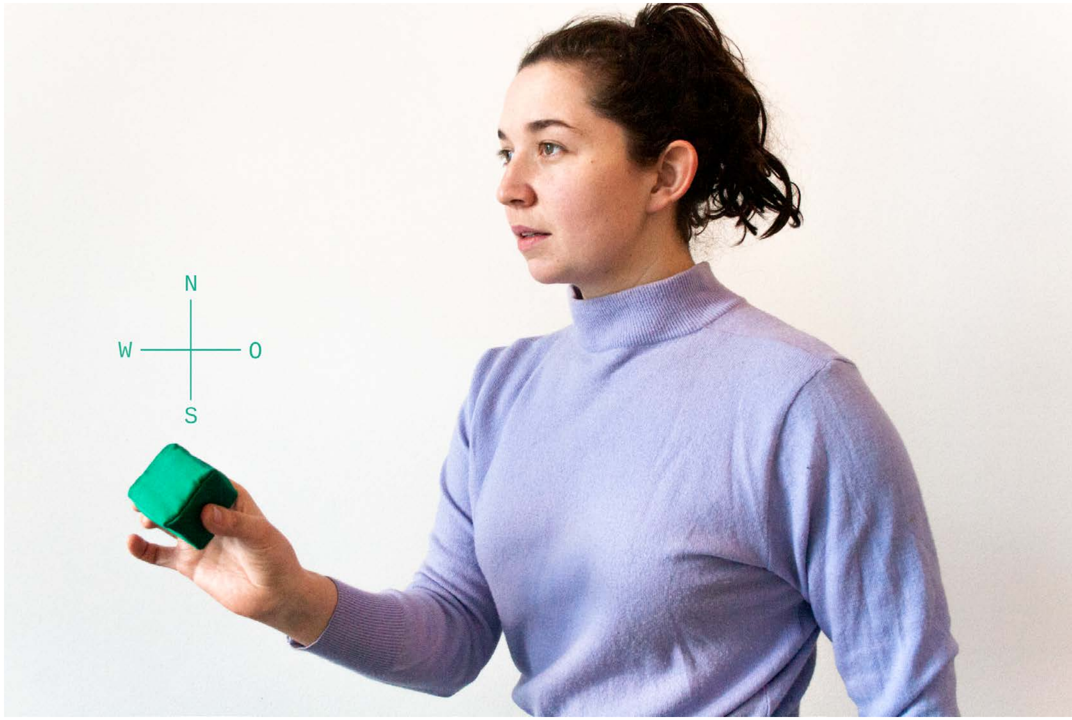
METHODOLOGY

The project aim was to create a handy tool and build up research into navigation and how we orientate ourselves within our world. This research included both human biophysical features that help us with spatial orientation, as well as tools and gadgets that humankind developed since ancient times to help orientate and navigate, such as tracking the positions of sun and stars, the compass or contemporary GPS coordinates.

↘

PARAMETERS

The final prototype, called *Travel Dice*, is a small, handy sponge dice that fits in your hand and pocket. Its attributed navigational features include position, orientation, and »magic transport«. Those features can be explored physically via haptic interactions that build on initial technical experiments: In order to get information about your position, the user holds the *Travel Dice* close to the ear and hears a voice that will name their current location. To be guided into a specific direction, the orientation feature serves as a compass: holding the dice in front

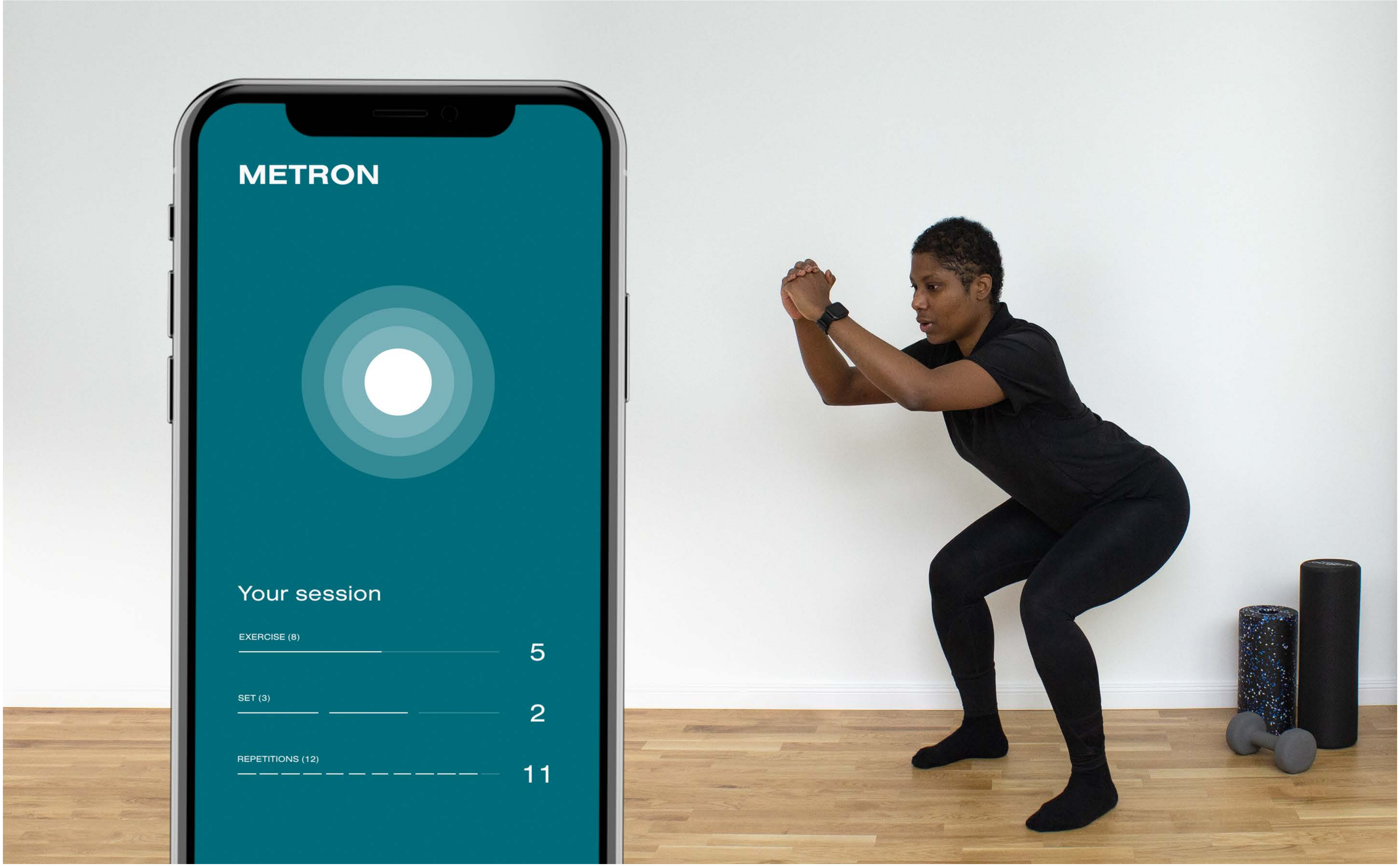


of the body, the strength of vibration will give the user feedback about the right direction. For the »magic transport« feature, the context of *GoogleEarth* serves as a playground: just as the platform's dice button virtually transports you to another random place on Earth, the *Travel Dice* will take you to another place once you squeeze it in your hand.

↘

FINDINGS

Whereas in our physical world, the features of the *Travel Dice* rely on technical possibilities, in lucid dreams its full, unlimited functionality can play out. In lucid dreams, anything seems possible, but references are drawn from the familiar. Carrying around a tool with specific features in the real world will allow users to make use of that tool in a lucid dream. Information about one's position, orientating through the landscape or jumping to another place by a magic transport: the *Travel Dice* will serve many lucid dreamers as the first neo-analog navigation tool.


METRON
Your session
EXERCISE (8)
5
SET (3)
2
REPETITIONS (12)
11

↘
RESEARCH QUESTION / INVESTIGATION

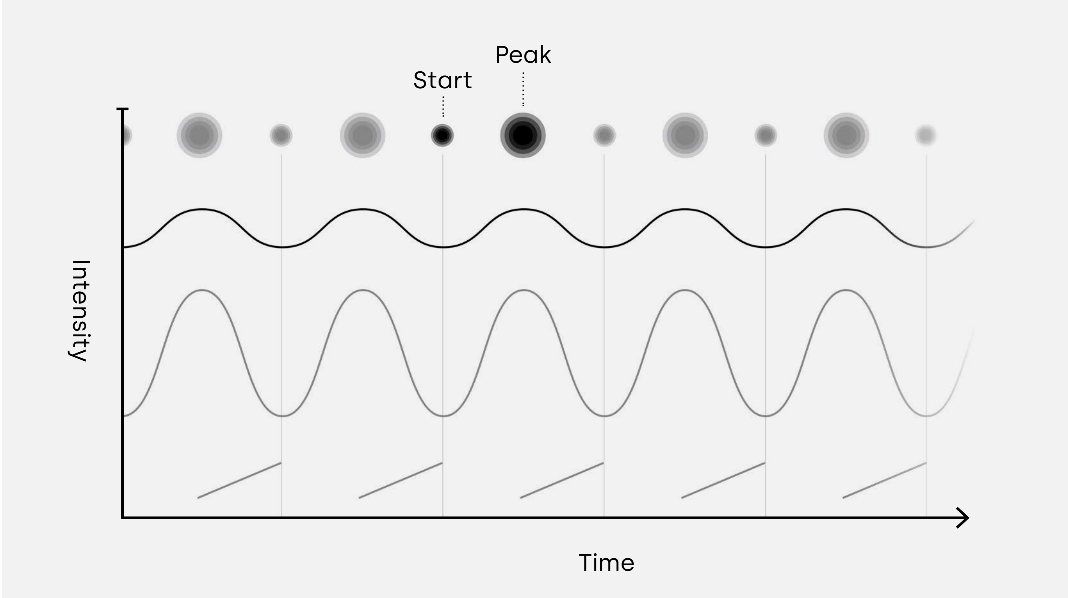
Working out at home has never been so popular. However it still can't compare with exercising in the gym and being coached. Virtual fitness is mostly screen-based, and therefore limited to a visual and auditory interaction. This slimmed down digital trainer is missing some key features: users receive no feedback on whether they carry out an exercise safely and correctly, and not every exercise position allows users to view the screen. Nor would they wish to – exercise should offer a welcome break from screen time.

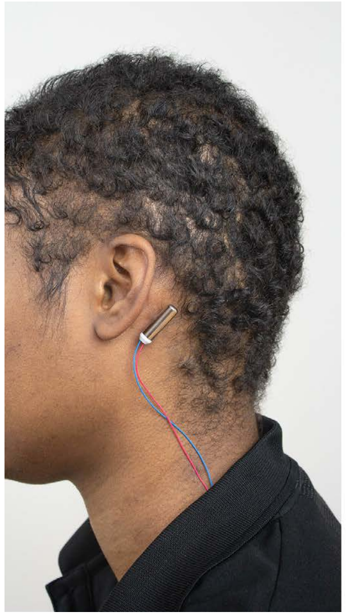
↘
METHODOLOGY

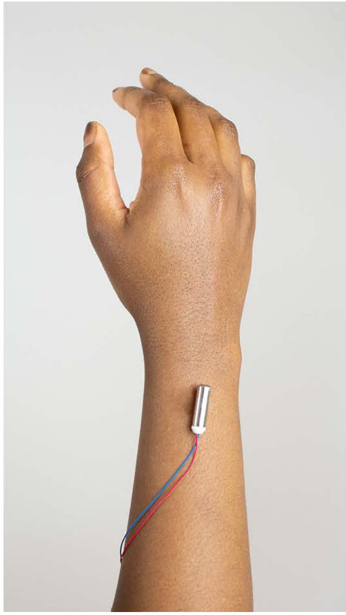
While fitness exercises vary a lot in form and effect, they have one common element that appears on different levels: rhythm. We find rhythm in the individual repetitions and the sets and intervals that contain them. Its impact is significant – the right rhythm serves as a guide for the right intensity and execution in terms of tempo and breathing.

↘
PARAMETERS

In a series of experiments, I explored where a rhythmic impulse could be attached to the body of the user, how the pulse could feel and how it could improve the user experience. Therefore I built a software tool that allowed me to control a vibration motor and apply different patterns of vibration and levels of intensity to it.
I tested to attach the vibration motor at the bone behind the user's ear, at the wrist and I attached it also at the weight itself.





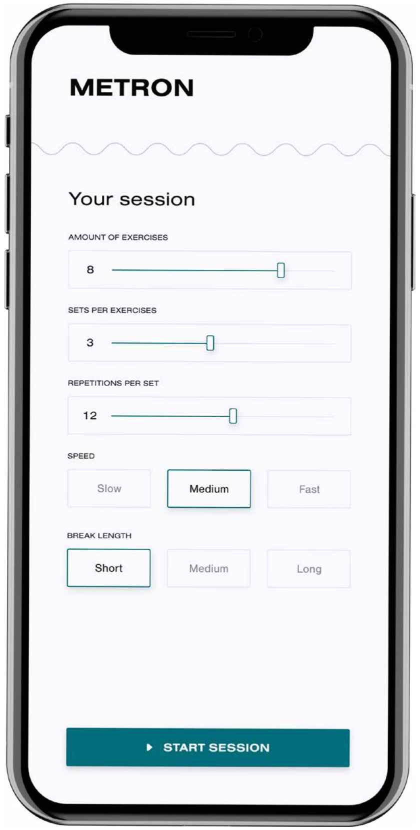


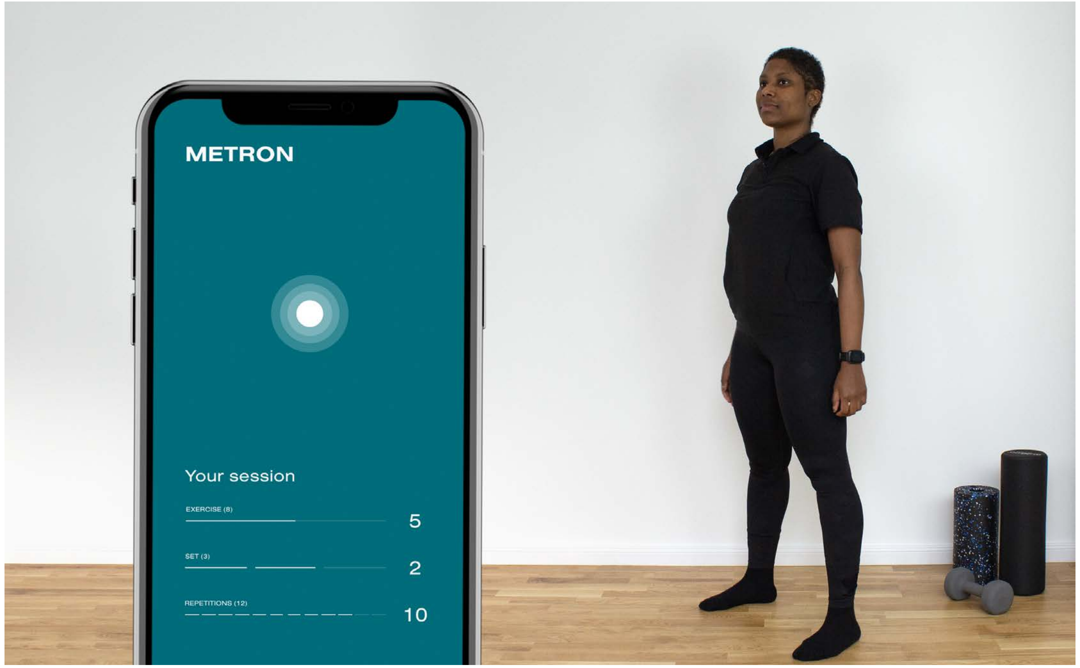
↘
FINDINGS

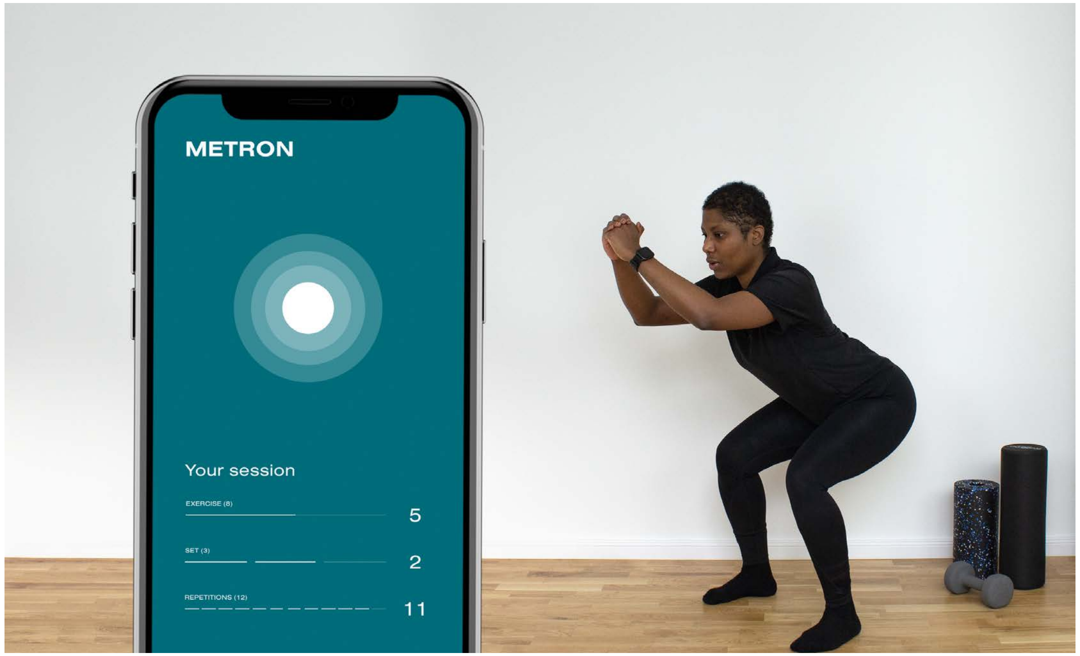
Rhythm is something we feel, therefore the interaction design should be haptic. User tests revealed that the wrist is a pleasant and effective spot to receive haptic feedback. It's a sensitive area where we're already used to reading information – like a watch or testing our pulse. It also allows for freedom of movement.

Following from that, I developed *Metron* – an application concept that guides individual workouts with dynamic haptic feedback. It converts a fitness routine into an oscillating pulse that keeps you in the rhythm. The pulse follows a steady sine wave form: the vibration signal is always on, but its intensity fades in and out analogous to the movement. This flowing, dynamic feedback places emphasis on the highs and lows of the exercise.

Metron works with the hardware embedded in a typical smartwatch. Equipped with a tactile engine that can be programmed, most smartwatches would be capable of transmitting *Metron's* dynamic vibration signal. Once the routine is set up, *Metron* sends the signal to the watch, and the workout can begin.







RESEARCH QUESTION / INVESTIGATION

How could personalised augmented reality affect human relationships?
From the findings of experiments conducted with virtual reality in Sprint 2, it became clear that our minds can be shaped by our virtual experiences, and not just our real ones. In VR it's easy to manipulate our vision, but by also giving our body the right feedback, we can make our brain believe its real. Through virtual interactions, we gain a feeling of ownership over this virtual body. But if this results in a psychological intervention with long term consequences for the human experience, what are the ethical considerations designers must take into account?

↘

PARAMETERS

An experiment was designed to test the premise that individualised augmented reality (AR) experiences can affect human relationships. A couple with different preferences enters the same room, but each partner gains entirely different impressions of the space due to an AR layer which has been customized to their individual preferences. A scale model was built of a room which could be 'entered' using a small camera, allowing the 'room' to be viewed with its personalised AR layer. Only the furniture which participants would interact with physically was included in the scale model, because in this scenario decoration, one element of the person-alised AR layer, would be solely virtual.

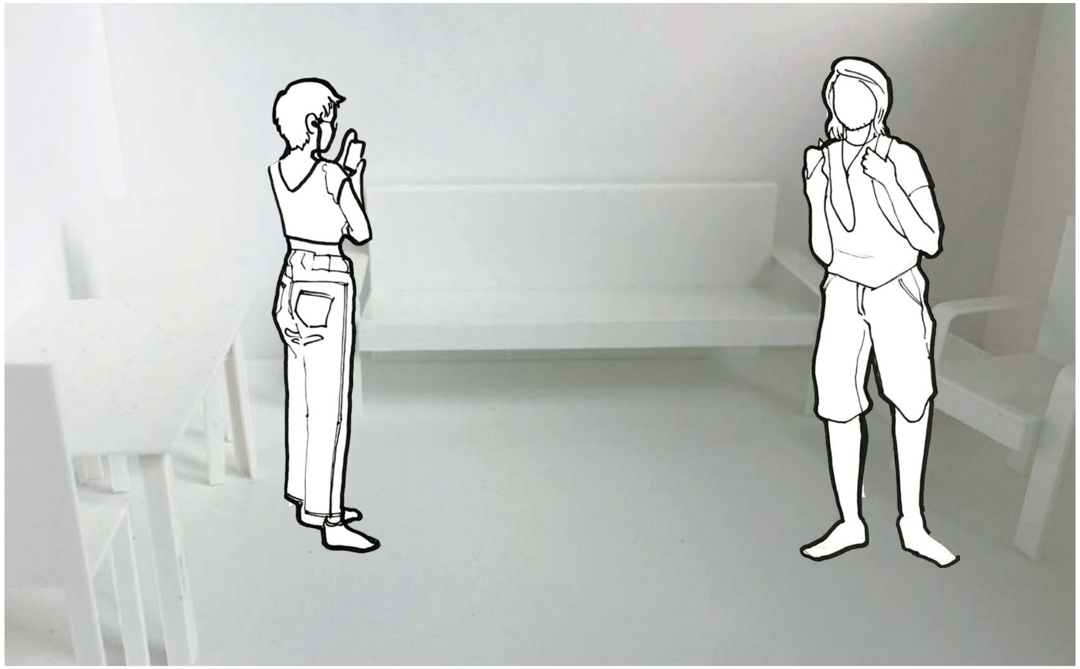
The participants 'enter' the 'room' and begin to describe and compare the different music, decor and lighting of the individual spaces. The question is: despite the different perceptions of the rooms, do the couple still see this as a shared experience?

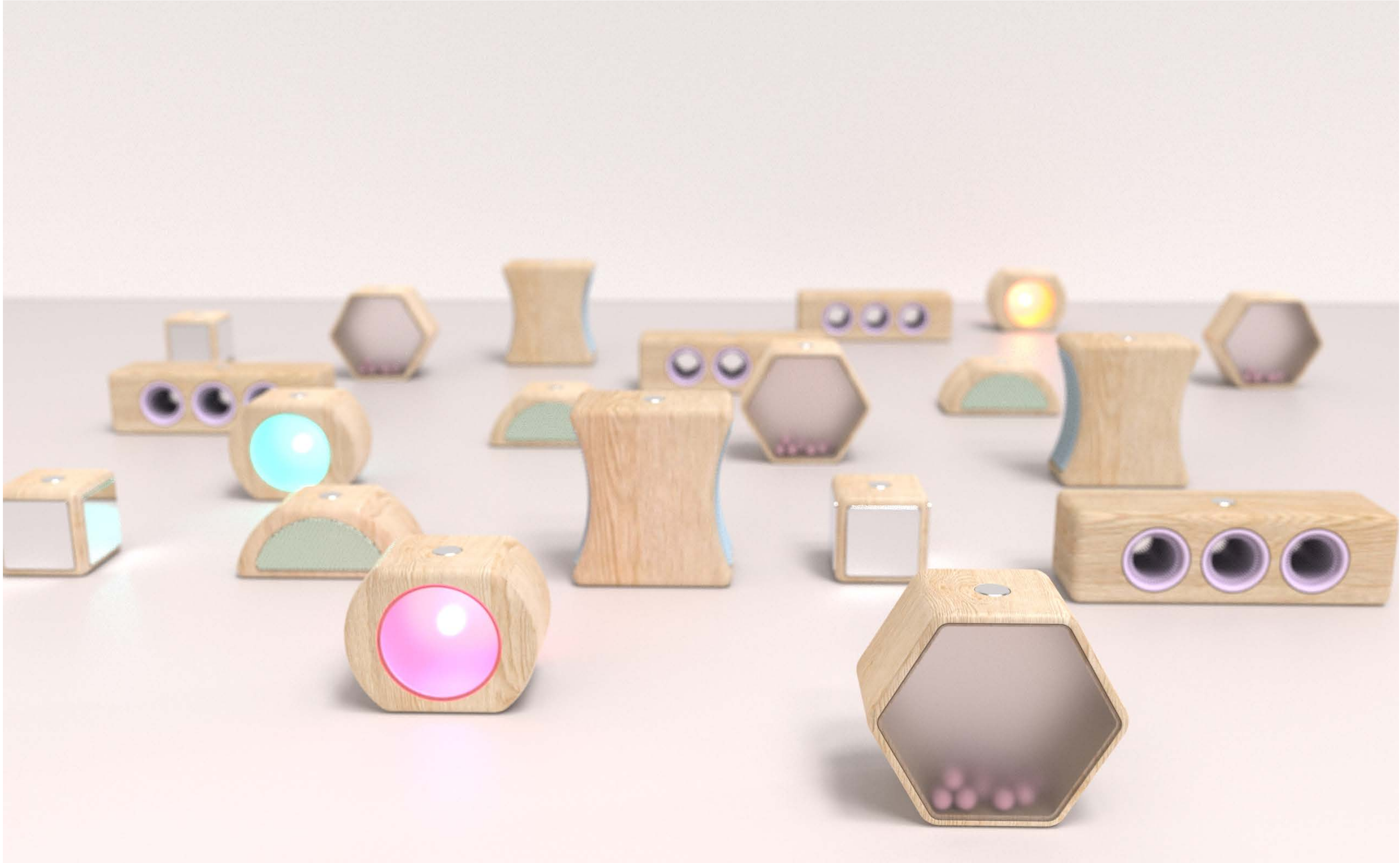
↘

FINDINGS

Based on the findings of this experiment, it remains a shared experience as long each participant communicates their surroundings to the other. Long term, could it affect human relationships? If personalised AR becomes widely used, we may begin to take our individual perspectives for granted and as a result, stop sharing information about this experience with our partner. While each participant enjoyed having 'their own room' tailored to their taste, they expressed the importance of sharing an actual space to maintain their relationship. Sometimes just sitting together without a word and listening to the same music or seeing the same world is enough to create a bond.

This small study highlights the importance of involving psychologists and neuroscientists in more rigorous design research processes for the development of personalised AR, because designers need to seriously consider the consequences of applying any technology that can mould our minds and perceptions.





↘
RESEARCH QUESTION / INVESTIGATION

Very small children explore through touch and taste and this helps their development. Today it can be seen that children are less exposed to tactile and thought-provoking games that combine several senses in parallel. However, there are many long term benefits when children are encouraged to explore and be creative at an early age.

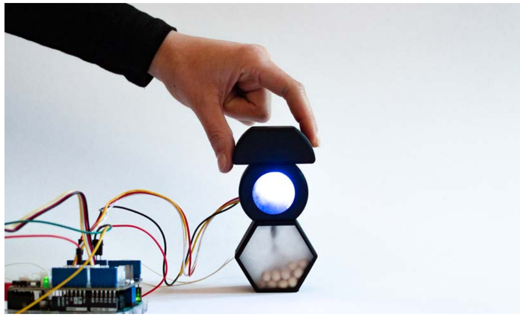
↘
METHODOLOGY

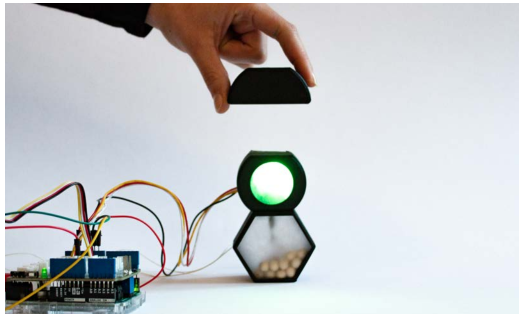
TapTam is a toy for young children that awakens and stimulates their senses as much as possible, and triggers their curiosity and imagination. By creating a game in which there is no right or wrong, children are given the freedom to use their own imagination and approach things differently.

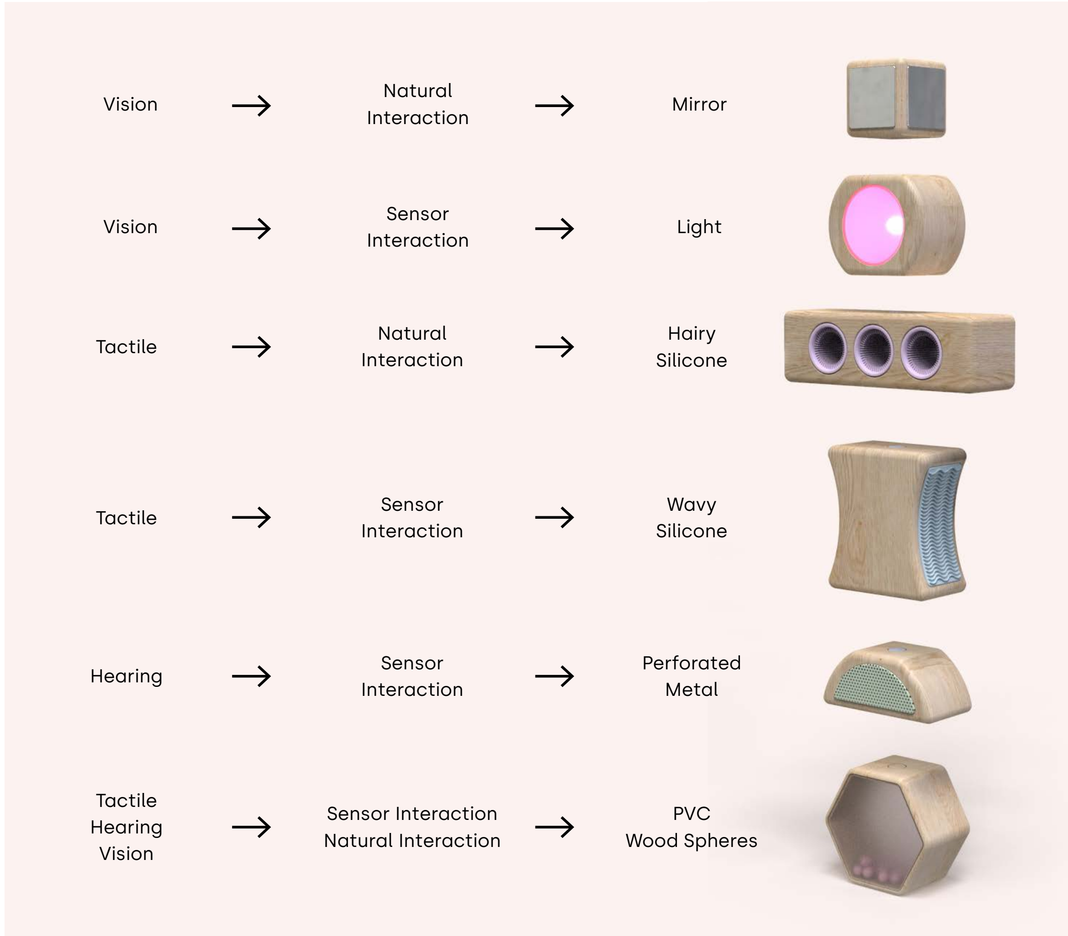
↘
PARAMETERS

Building on knowledge gained from previous experiments with haptic, acoustic and visual feedback, it became apparent that the toy should incorporate all of these sensory stimuli - this time with the addition of more tactile stimuli through varied materials and textures.

TapTam is built in a »Totem-Principle«. Similar to the traditional wooden building blocks that mostly consist of simple geometric shapes with smooth, rounded edges. Each figure represents a specific sensory stimulus, these blocks click together thanks to concealed magnets. The child is rewarded for playing and interacting with the different blocks, as each provides a different, exciting, sensory feedback. Some





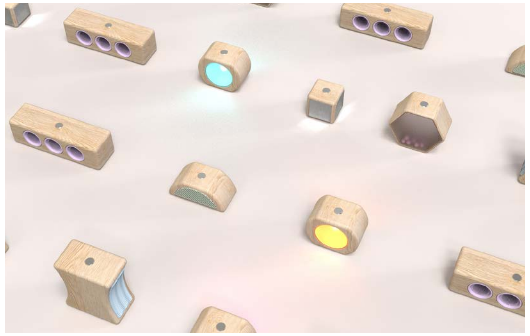


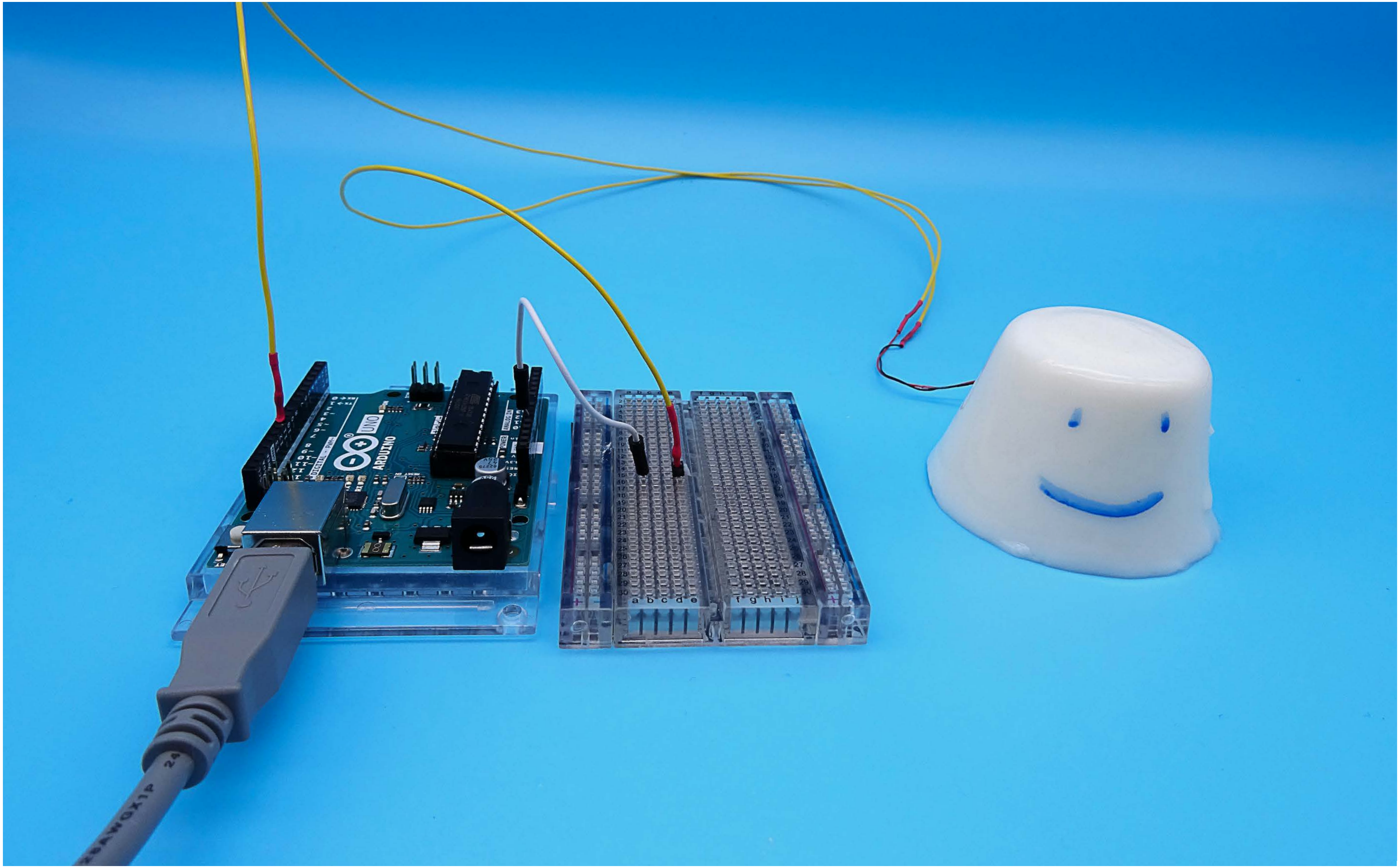
of these are »smart - such as a light module that encourages the child's increasing level of interaction: gradually lighting up when lifted, it becomes a colourful light show when connected to the other blocks. Whereas others are based on analog textural stimuli - such as tunnels lined with silicone »hairs«, perfect for poking little fingers in.

We created 2 models: one is a 3d rendered model simulation, the other one is 3D printed technical model contains our vibration sensors and light work with »Processing« and »Arduino« and shows all technical possibilities, the other one transposes the »look & feel« of selected materials without technical know-how.

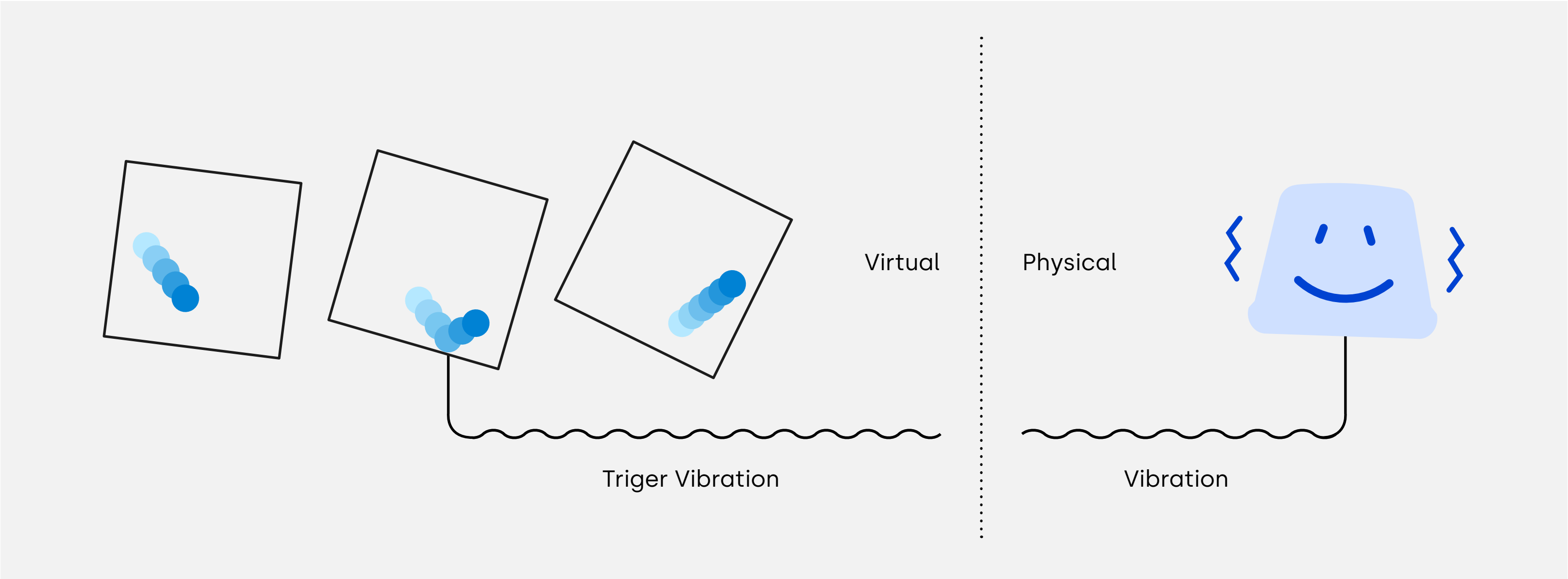
↘
FINDINGS

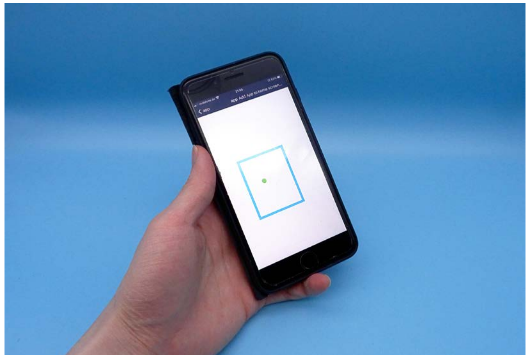
While *TapTam* has been designed as a toy, there is also potential for further development for use in therapeutic applications if adapted with specialist input.

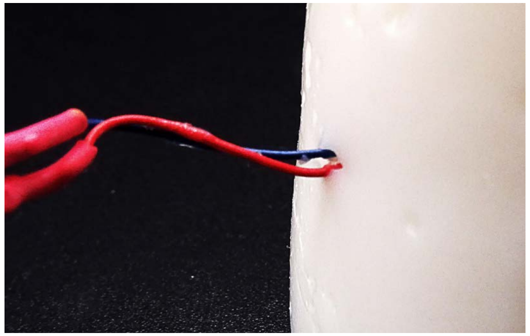


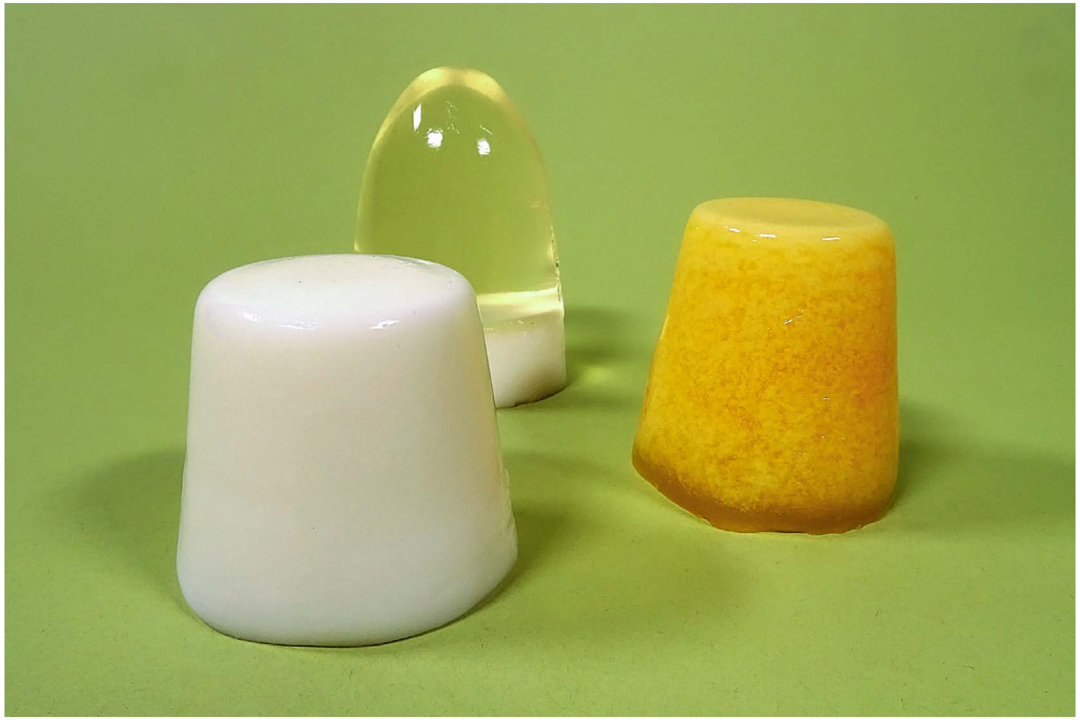

UNO
ARDUINO

↘
RESEARCH QUESTION / INVESTIGATION
If children grow up in a world where the boundaries between virtual reality and physical reality are increasingly blurred, Can we substantiate virtual reality into the physical world so they can experience it more directly?
↘
METHODOLOGY
Whenever a certain action is executed in virtual reality, a vibration sensor is activated through the *Arduino*. The user can control the position of the square, and if the ball hits the wall it will fly in the opposite direction. Whenever this ball hits the bottom of the blue square, the motor is activated.
↘
PARAMETERS
Vibrating motors installed beneath the jelly show the results of actions in virtual reality. *Jelly* has a larger surface area and is fluid, the vibrations diffuse and radiate widely. This physical output allows the user to feel that the jelly and the square that I control are in sync.



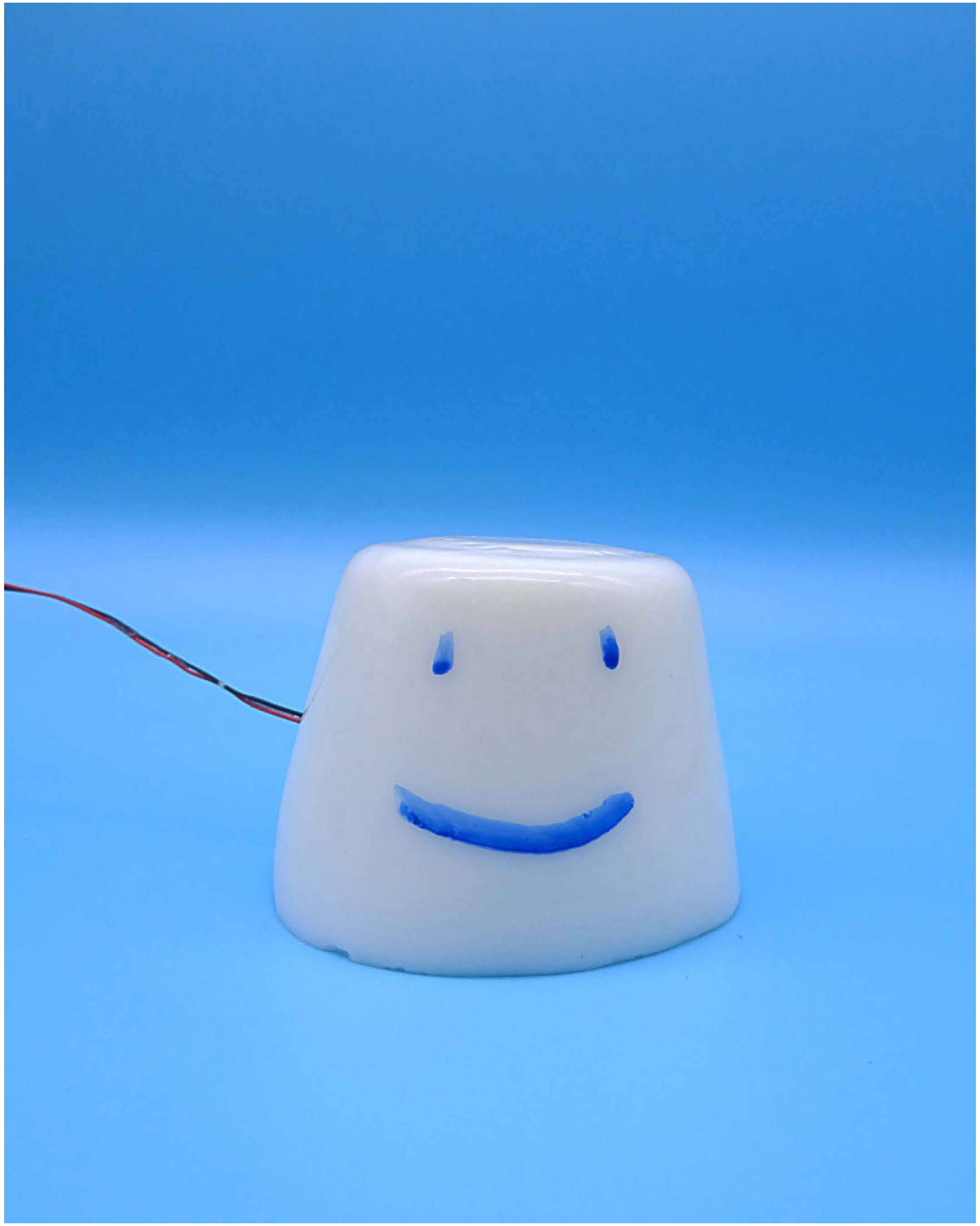


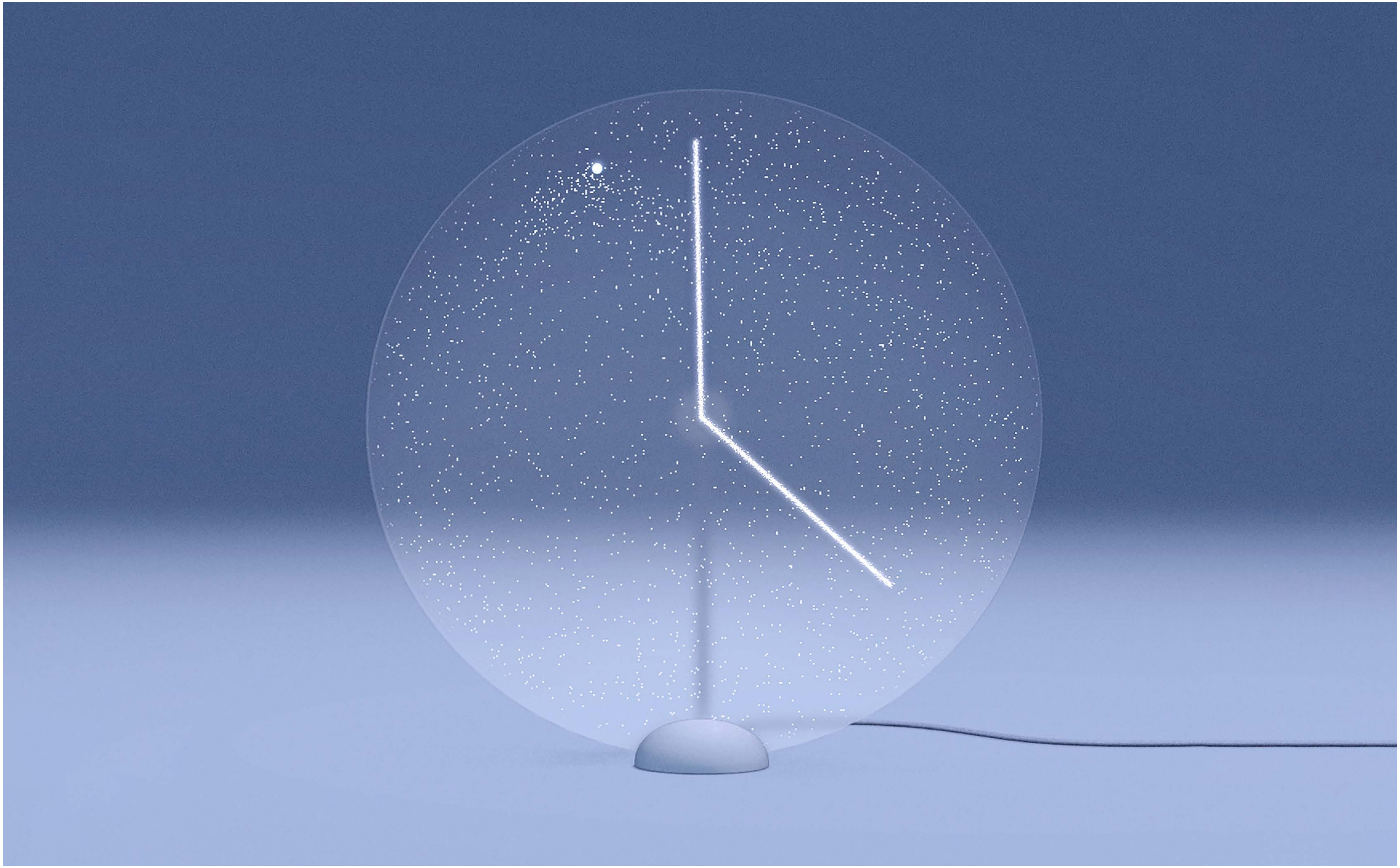




↘
FINDINGS

Jelly is a familiar and safe ingredient for children to play with or consume. It also offers kids the possibility to decorate their own haptic toy. *Jelly* is linked to a smartphone, and children can experience virtual reality being implemented in the physical world through actions in the smartphone. This enhanced jelly can be a way for children to learn about the boundaries and impacts of behavior in a virtual world.





↘
RESEARCH QUESTION / INVESTIGATION

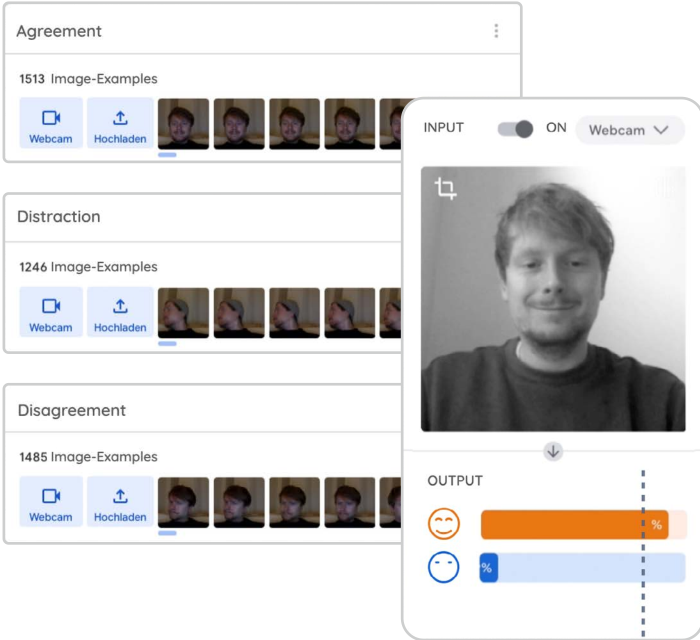
When giving a presentation digitally, it's very hard to »read the room« and assess how your audience is reacting. In these times, when everyone is working from home, speakers face new challenges. A digital barrier is erected between the presenter and the audience - key emotional feedback is lost, making it more difficult for the speaker to respond to the audience.

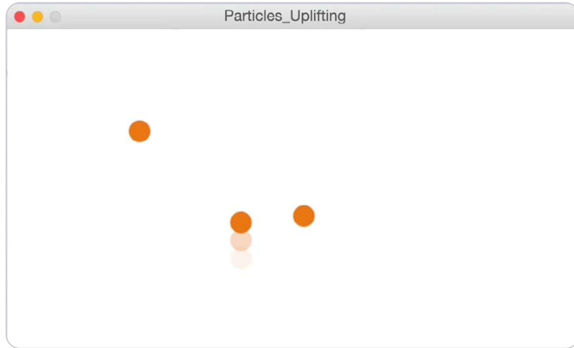
↘
METHODOLOGY

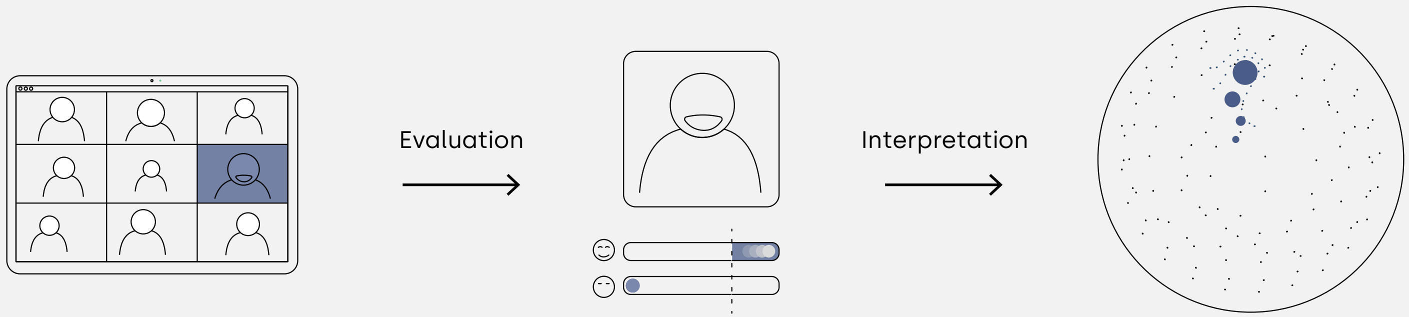
Attempting to convey the most important emotional feedback through the virtual space, it was important to summarize these into the most significant and frequent types of audience response: agitation/quietness, or agreement/disagreement. A camera source serves as an input for machine learning data. This machine learning program would then evaluate the facial expressions and gestures & interpret it into a »room emotion«.

↘
PARAMETERS

Interviews with various users gave important insights that informed the design: all participants agreed that they were insecure without any feedback from the audience, however they would also be distracted if too much feedback was given at the wrong time. Haptic feedback in particular was rejected because of the disturbance, as well as too much »noise«. It became clear that users wish to decide for themselves when and if they want to receive feedback. And if so, the feedback should comfort or encourage the receiver.

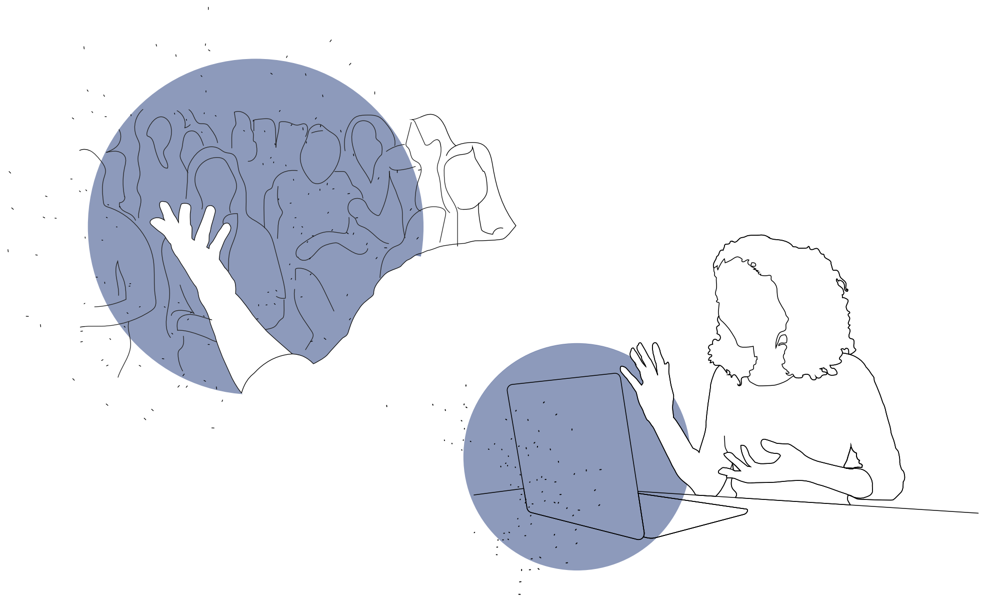


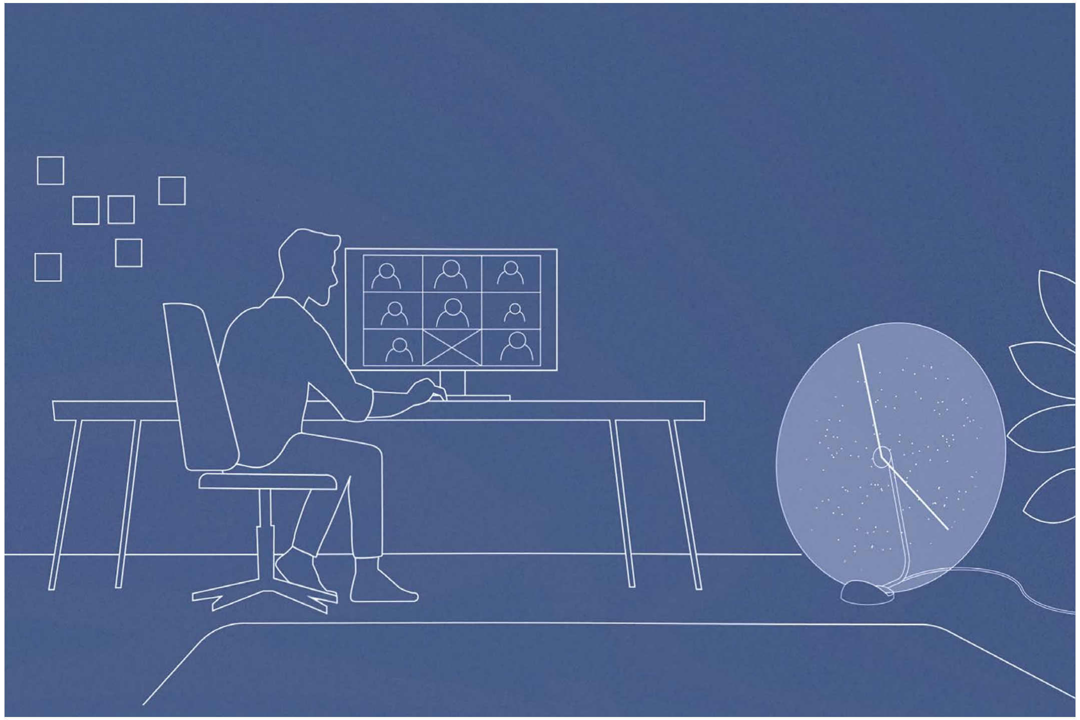


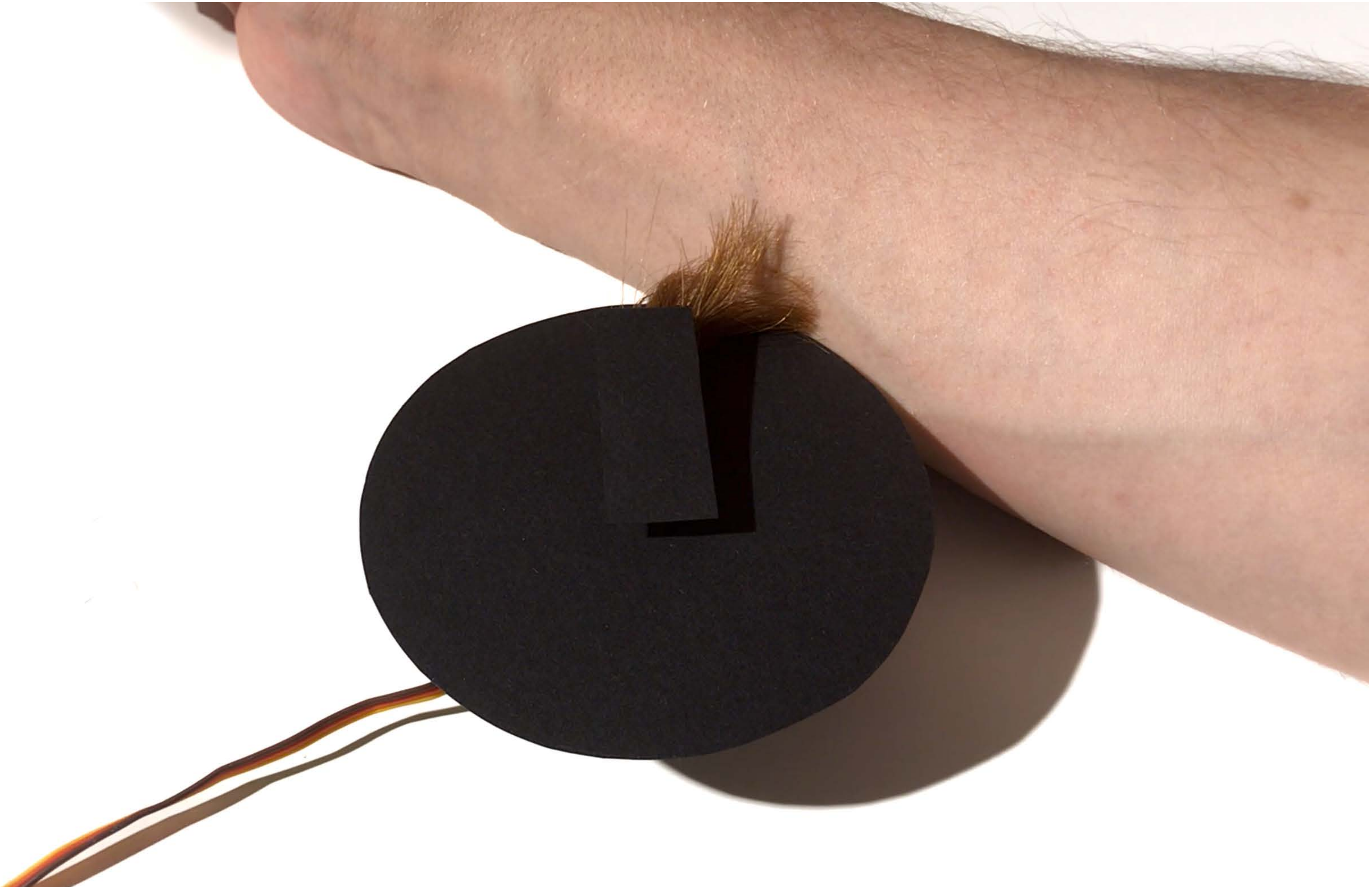


↘ FINDINGS

The final outcome is *OSCILLATE.*
– A speculative concept for a non-intrusive interface for virtual conferences that allows speakers to identify the mood in the audience and better assess how their presentation is received. *OSCILLATE* has at its centre a clock with a dial that is semi-transparent, reminiscent of a dandelion clock. The transparency and subtle design is deliberate, so as not to distract the speaker from their primary focus. The different mood states are displayed as a particle-cloud. Initially broadly dispersed, the particles begin to gravitate towards each meeting participant. The participants' varying moods cause their particles to cluster at different points on the dial, generating cloud formations. The cloud formations are in constant flux, in line with the changing mood of the audience, and the motion of one »cloud« can also influence the other particles.The end result is a nebulous indicator that gives the speaker a sense of the atmosphere in the virtual meeting »room«.







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RESEARCH QUESTION / INVESTIGATION

The inspiration to create wearable tactile feedback modules came from the *Xbox Adaptive Controller*. This tool enables disabled people to create their own customized controller to play games, based on their specific needs. This allows users to design their own way to give their »input«, but how would they receive the »output« in a way that suits them? This inspired the creation of a modular system which can be worn anywhere on the body, that allows users to receive haptic feedback wherever or however they want or need to. The goal was to enrich digital interactions with a variety of new tactile feedbacks that are more complex and interesting than just »vibration«.

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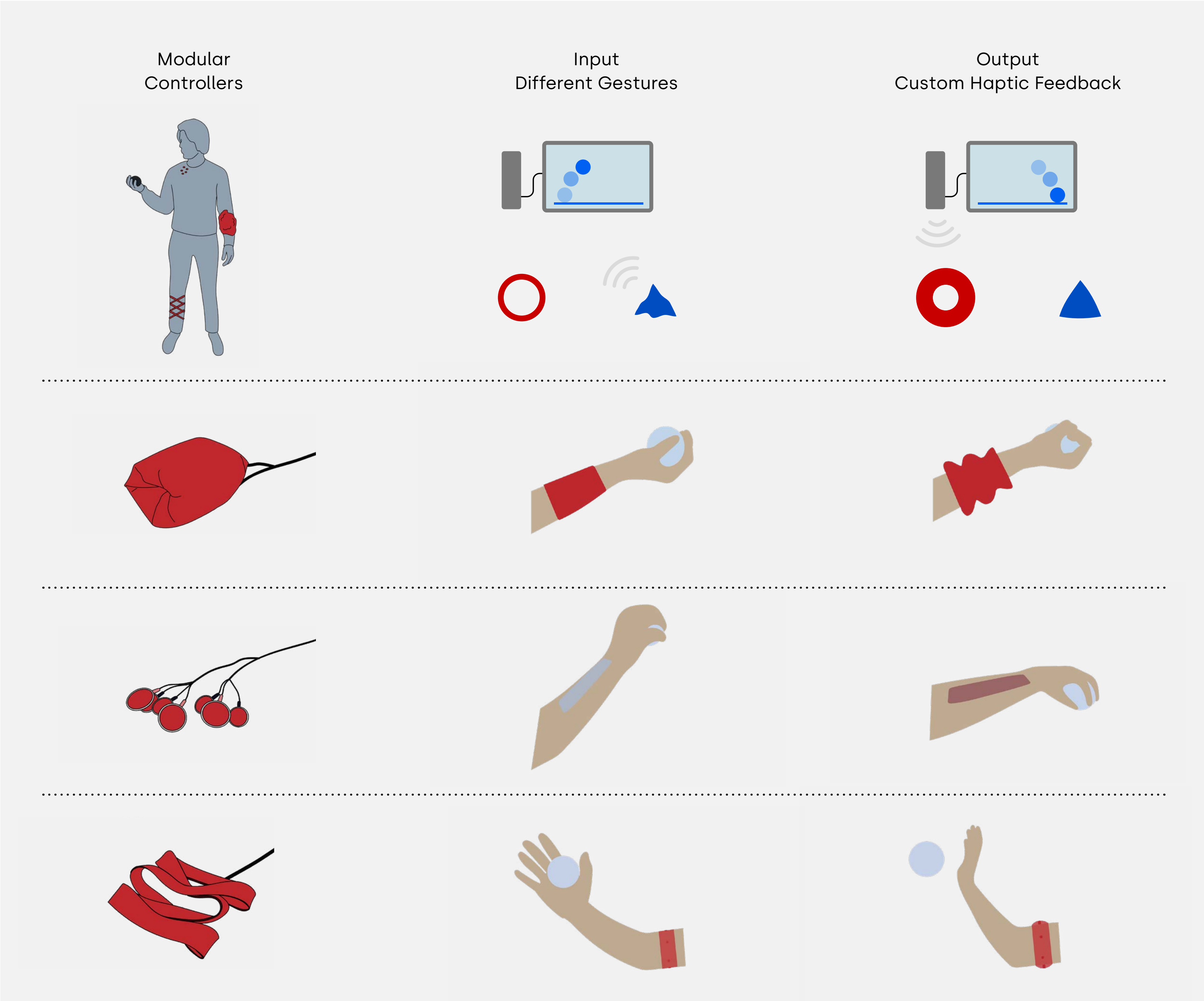
METHODOLOGY

The research began by collecting and comparing different gestures such as clenching, slapping, squeezing, and then pairing these with various haptic feedbacks. Two new feedbacks were designed and prototyped whose effect is not limited to the hands, but can be attached anywhere on the body. One feedback module is based on inflatable tubes which can be inflated in different strengths, speeds and rhythms to constrict and apply pressure to the user's body. The other feedback takes the form of a stroke administered to the user via a motorized, oscillating brush or various, interchangeable textured fabric pads.



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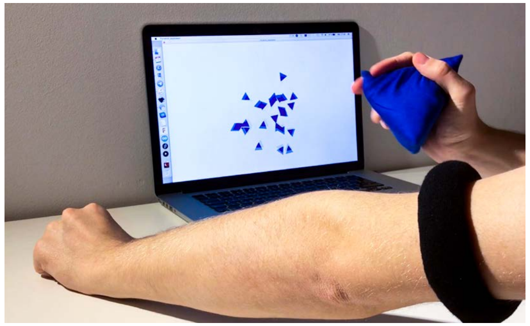
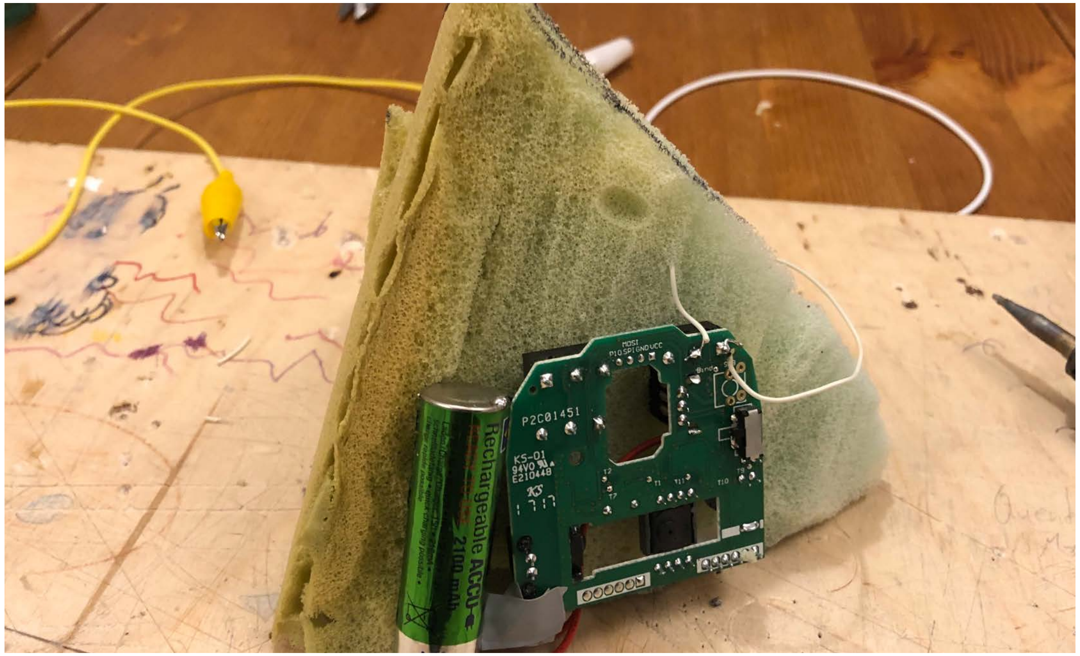
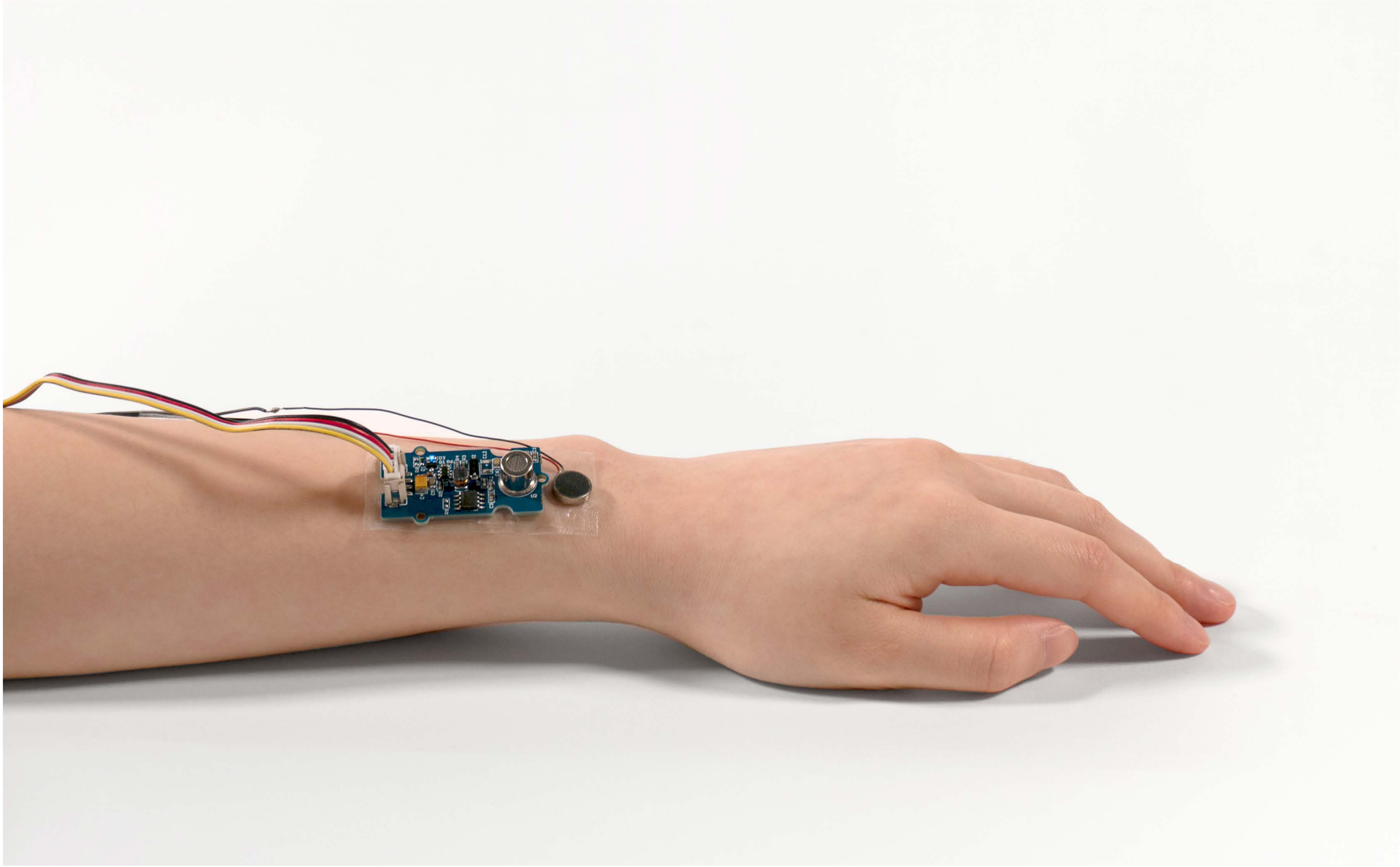
FINDINGS

The modular feedback system could make gaming more inclusive for people with different disabilities.
While the inspiration came from the trend to make gaming more inclusive, it can also enrich the experience for anyone who requires feedback from a digital interface. There could be important applications for »augmented haptics« in other fields such as microsurgery, where it is crucial that the surgeon's hands are not disturbed by any feedback received. It could be used for anyone to experience data they wouldn't usually feel in a way that is different, better or more precise.





*
»Xbox Adaptive Controller« by Microsoft
https://www.pocket-lint.com



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RESEARCH QUESTION / INVESTIGATION

How can we transform invisible data into virtual textures we can perceive?
There is a lot of data in our lives that is invisible but important to us, and we often access it by using tools to turn it into numbers or words. But could we interpret this data as surface textures? We can sense the information we want directly with our skin, no longer relying on cold numbers, but on our sense of touch.
Air quality was selected as an example for the implementation of this principle. Air quality is not visible, not touchable, not smellable. It is difficult for us to perceive it directly under normal circumstances. However, air quality directly impacts our health. Indoors or outdoors, air pollution varies from block to block, hour to hour. Air quality is like the texture of air: if only we could find a way to »feel« it?

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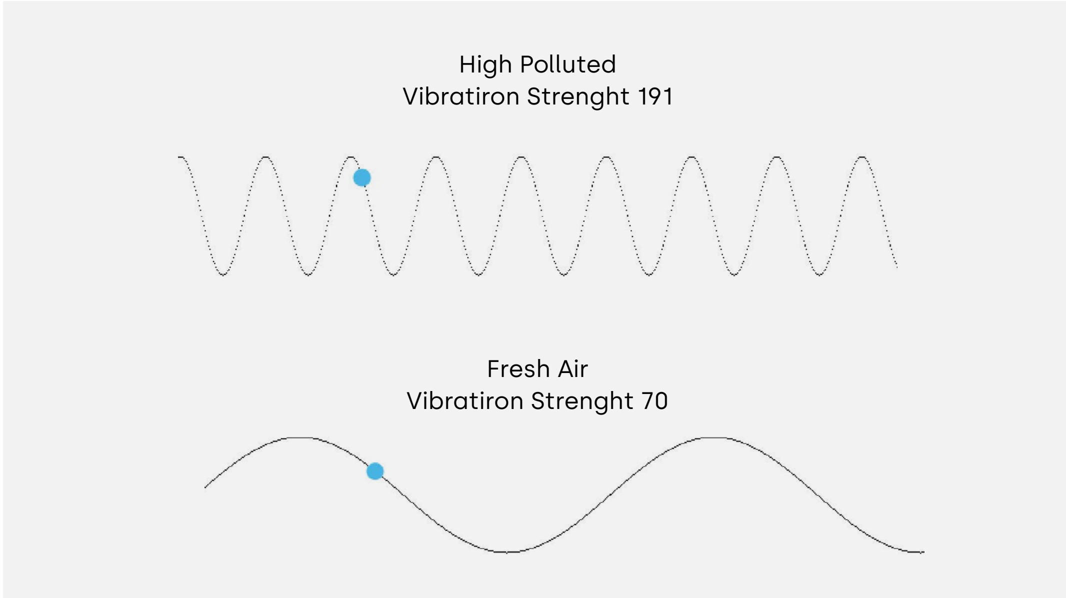
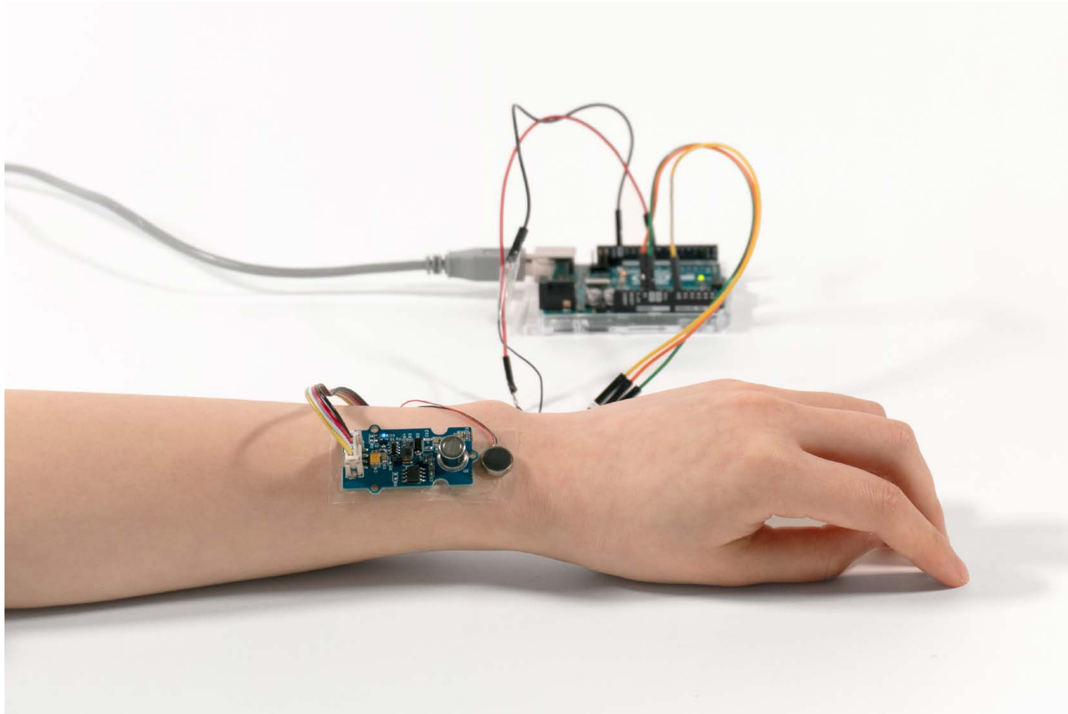
METHODOLOGY

Experiments in Sprint 3 provided the groundwork for turning these »textures« into vibration patterns. The intensity of the vibration varies as graphic patterns are read, for example by the size of the overlap between two shapes, or in the case of the final prototype, by the steepness of a curve.





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PARAMETERS

The air quality is set to different levels, such as fresh air, low pollution, and high pollution, and this data is translated into different curves. These curves are then translated into ripple-like vibrations felt by the user. The worse the air quality, the greater the curvature and the stronger the vibration. When the air is fresh, the user feels a low frequency, slight vibration, which is a reminder to the user that this is a safe state. When the air quality gradually becomes worse, the vibration becomes more intense and high frequency.

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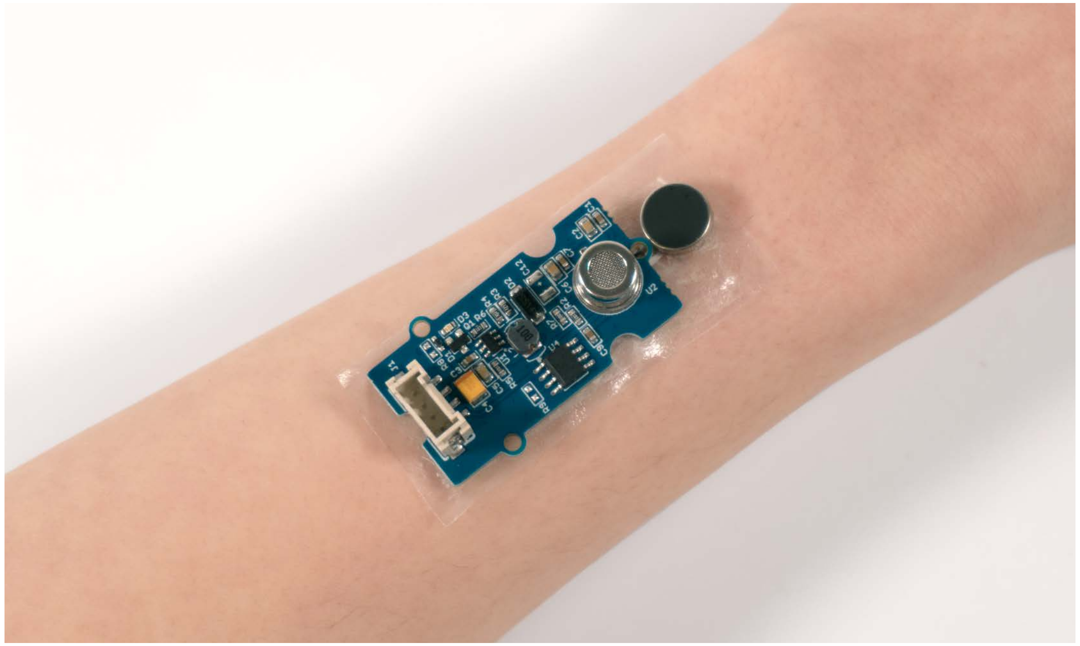
FINDINGS

The outcome is a wearable air quality monitor called *Wair*. It feels the air quality in real time like a new sense.
For testing, I used a marker to pollute the air as it evaporates alcohol and the prototype works well. *Wair* can work like a skin patch or can be implanted into other wearables such as wristbands, masks and so on.



HYPERHAPTICS

OSCILLATING BETWEEN PHYSICAL AND VIRTUAL TACTILITY

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