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EFFECTION

Master of Design Innovation and Technology

MDIT / RMIT

an immersive biofeedback experience

in collaboration with ***The HeartMath Institute***

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Bachelor of Design / Interior Design / 2018
United World Institute of Design / India

Diploma in Collaborative Design
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ACKNOWLEDGMENTS

I would like to thank Prof. Ross McLeod and Prof. Jeff Hannam for the opportunity to complete my major project under their supervision.
Thank you for all inputs, your feedbacks and your constant guidance throughout the last few months.

Special thanks to Dr. Rollin McRaty and Annette Deyhle of HeartMath Institute for their continual support and effort in making this collaboration a possibility. You have introduced me to a new concept and a new way of life. Thank you.

I would also like to express my deepest gratitude towards my parents for their unconditional love and support throughout this journey. Thank you for dealing with my ups and downs and thank you for always being my rock. Love you both.

Lastly, I would like to thank all my friends and colleagues at MDIT. We have been through a challenging year, but today we stand tall with our “limitations defining our possibilities.”
Keep creating and keep inspiring!

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01

ABSTRACT

Stress, anxiety, overwhelm, frustration have become a part of our everyday life now, especially in the growing competitive world that we live in. Most of these emotions arise due to the change that is happening, and our bodies do not like change.

We are not physiologically equipped to deal with unexpected change.

Scientific research has demonstrated that different emotions give rise to different patterns of the heart activity which in turn have distinct effects on the cognitive and emotional functions of our body. These effects not only influence our emotional processing but also higher cognitive faculties such as how we perceive, think, feel, and perform. Our physiological system is always responding to our emotional system and vice versa. The more ordered and stable pattern of the heart's input to the brain during continued positive emotional states such as appreciation, joy, awe, facilitates cognitive function and reinforces positive feelings to transition the body into a specific harmonious and coherent state, scientifically recognized as a state of coherence.

Effection is a sensorial experience that utilizes a biofeedback loop to highlight the simple yet complex interconnections between our heart, our breath and our emotions.

The installation, situated in the Mind and Body Gallery at Melbourne Museum, uses light and sound mediums to bring involuntary, unconscious bodily processes into consciousness. The design utilizes Inner Balance sensor technology developed by the HeartMath Institute as an input data stream that interacts with a sound and light system. The resulting multi-sensory spatial experience prompts audiences to become aware of the interconnections inside and outside of their body and to recognize a state of coherence in which mind and body is in harmony.

“When you text a heart emoticon to a deserving party, it means more than just your devotion to another. The heart’s evolution and endurance has enabled people to communicate their feelings effectively since the beginning.

There’s a deeper connection than you may realize.”

-Danny Groner

02
RESEARCH OVERVIEW

Background

Our heart is central to our survival, pumping blood and helping circulate oxygen throughout our body. The heart symbol is central to popular culture, seen everywhere from classic artwork to movies to social media.

But how did we get from one to the other?
Why does the bloody organ in the center of our chests symbolize everything we feel about love?

The human heart is the center of physical and spiritual being and represents the central wisdom of feeling as opposed to the head-wisdom of reason (Cooper, 1978). It is compassion and understanding, life-giving and complex.

Most of us have been taught that the heart is constantly responding to orders sent by the brain in the form of neural signals. However, recent studies have proven that the heart sends more signals to the brain than the brain sends to the heart. These heart signals have a significant effect on brain function – influencing emotional processing as well as higher cognitive faculties such as attention, perception, memory, and problem-solving.

Not only does the heart respond to the brain, but the brain continuously responds to the heart.

Our body is a web of interconnections.

*"The human heart is the center of physical and spiritual being and represents the central wisdom of feeling as opposed to the head-wisdom of reason.
It is compassion and understanding, life-giving and complex"*

J.C. Cooper

Motivation

As designers we are all guided by reason to redefine an idea or a concept. I see myself emerging as a spatial designer to convey stories through a sensorial play of elements that result in some form of an emotive response towards a systemic positive change.

My why of design is to present an open space for people to look at the holistic and interconnected nature of reality and existence and question it from an introspective perspective.

Over the years I have developed keen interest in using light and time as a medium to alter the self-established constraints of reality, to evoke an awareness towards the unconscious dynamics of our bodies and to present that relationship as an abstract, subjective piece of art.

Research aim

My aim is to create an experience that is open to interpretation but in some ways prompts subjective contemplation towards the internal dynamics of the human system, thereby creating a to more conscious and self-aware life system.

Instead of using images or text to evoke those experiences, my aim is to use pure light and sound as abstract mediums that in some way cause a network of causes and effects.

Introduction

This compendium aims to explore the series of effects that compose the entire human system. It begins by exploring the central organ of our body- the heart, and how it is essentially the core of our existence - subconsciously controlling not just our emotions but also our perception and our other cognitive faculties.

The research then looks at how different emotions affect the heart differently and how the heart affects different parts of the body differently, all those links together creating an interconnected web of biofeedback.

This brings us to HeartMath Institute's vast compendium of research about the heart, and about a new psychophysiological state of being - coherence.

The second part of the research deals with how other external factors affect the human body. It looks at how light and sound affect not just our physiological systems, but also our emotional and psychological systems.

The next part of the report combines all the previous research to create a dynamic set of cause and effect relations between the heart, emotions, light, sound and other physiological systems in order to determine the structure of the feedback loop for the design proposal.

The fifth part explores the different design strategies involved in creating the design. It investigates different light and sound phenomenons that I have incorporated in my design and also briefly touches on a few design precedents that have informed my design in some way or the other.

The past part of the compendium in detail breaks down each elements associated with my design.
It explores the context, the experience the feedback loop and the structural elements of the space in order to achieve the set results.
I have also briefly discussed some low fidelity prototyping undertaken and how my project fits in The Covid 19 context.

Lastly, the report ends with an appendix or timeline of sorts that details my design journey in the last few months and positions my proposal in today's context.

I hope you enjoy reading it.

03
YOUR APPRECIATIVE HEART

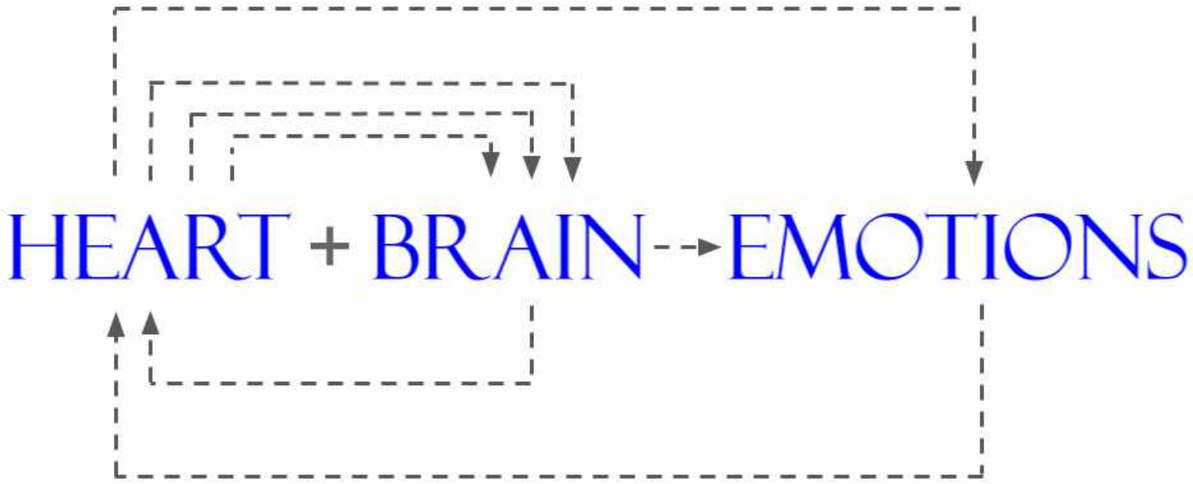


Figure 1. *Emotions arise with the heart and brain acting in unison*

Throughout history and across diverse cultures, religions, and spiritual traditions, the heart has been associated with spiritual influx, wisdom, and emotional experience, particularly with regard to other-centered positive emotions such as love, care, compassion, and appreciation. (McRaty, 2002).

Recent work in the relatively new field of neurocardiology has firmly established that the heart is a sensory organ and a sophisticated information encoding and processing center with an extensive intrinsic nervous system sufficiently sophisticated to qualify as a "heart brain." The patterns of the signals from the heart to the brain not only affect autonomic regulatory sensors, but also higher cognitive facilities such as perception and emotional processing. Emotions are thus a product of the brain, heart, and body acting in unison.

One tool that has proven valuable in examining heart-brain interactions is heart rate variability analysis (HRV).
Rather than being monotonously regular, the rhythm of a healthy heart-even under resting conditions – is actually surprisingly irregular, with the time interval between consecutive heartbeats constantly changing. This natural beat to beat variation is known as HRV. The normal variability in the heart rate is due to the coordinated action of the two branches of the autonomic nervous system - the sympathetic nerves which act to accelerate heart rate, while the parasympathetic (vagus) nerves which slow it down. These nerves are continually interacting to maintain cardiovascular activity in its optimal range and to permit appropriate reactions to changing external and internal conditions. The analysis of HRV therefore serves as an indicator of the function and balance of the autonomic nervous system. It serves as a marker of physiological resilience and behavioral flexibility, it reflects our ability to adapt effectively to stress and environmental demands (The Science of HeartMath, n.d.).

HEART RATE VARIABILITY

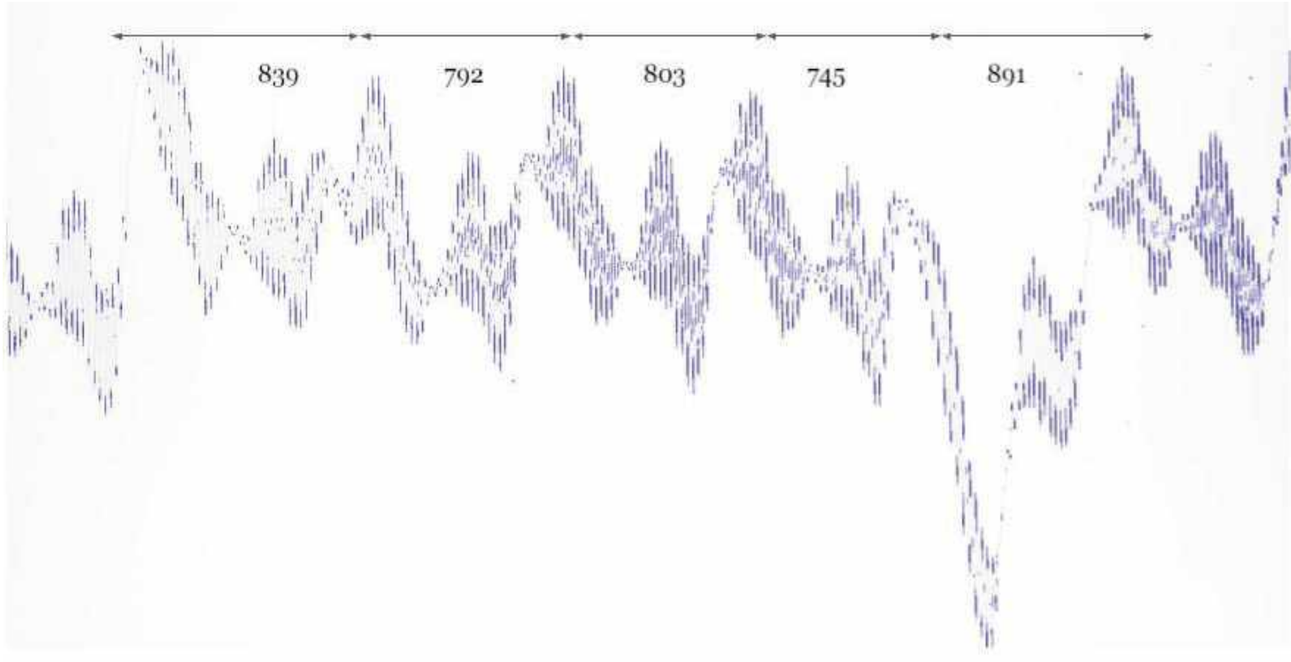


Figure 2. *The time interval between each heart beat is called Heart Rate Variability or HRV*

EFFECT OF EMOTIONS OF THE HEART

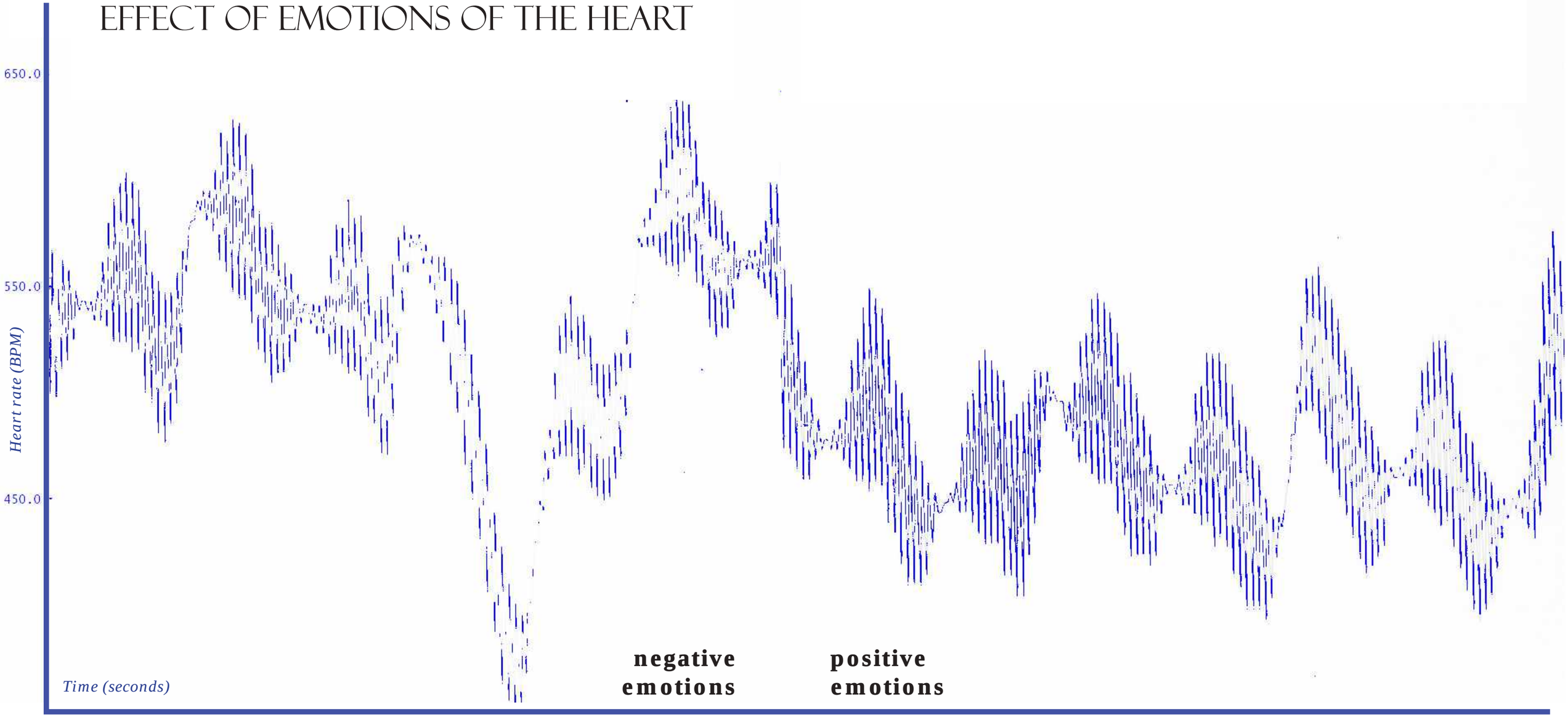


Figure 3. *Disordered heart rhythm patterns during stress and negative emotions*

Figure 4. *Ordered heart rhythm patterns during positive emotions*

During stress and negative emotions such as anger, frustration, heart rhythms become more erratic and disordered, indicating less synchronization between the parasympathetic and sympathetic branches of the nervous system. The corresponding pattern of neural signals traveling from the heart to the brain inhibits higher cognitive functions, thus limiting our ability to think clearly, remember, learn, reason, and make effective decisions, also serving as a reinforcement to the emotional experience of stress.

Many studies have found that people who experience stress, irritation, anger and frustration have high risks of developing heart problems. Stress, anger and frustration causes a chain reaction in the body thus causing blood pressure to rise and weakens the immune system. If this happens more often, this would cause our heart to strain and eventually lead to serious health issues (Medilife Blogger, 2018).

In contrast, while experiencing positive emotions such as appreciation, joy, love, heart rhythm pattern becomes highly ordered, looking like a smooth, harmonious wave, reflecting greater synchronization between the two branches of the ANS, and a shift in autonomic balance toward increased parasympathetic activity.

Recent research has found a link between an upbeat mental state and improved health, including lower blood pressure, reduced risk for heart disease, healthier weight, better blood sugar levels, and longer life (Positive emotions and Health, 2015).

Figure 5. *A comparative graphical representation of heart beat patterns during negative emotional states*

Figure 5. *A comparative graphical representation of heart beat patterns during positive emotional states*

THE STATE OF COHERENCE

Research at the *HeartMath Institute* has shown that generating continued positive emotions transitions a body-wide shift to a specific, scientifically measurable state called psychophysiological coherence, because it is characterized by increased order and harmony in both our psychological (mental and emotional) and physiological (bodily) processes. The heart rhythm patterns generated in this state, often known as heart coherence rhythm are represented by a smooth, uniform pattern in the heart rate variability trace. Whilst being in this coherent heart state, the two branches of the ANS synchronize together, different bodily systems such as the respiratory rhythm and the blood pressure rhythm also synchronize with the heart rhythm patterns, and there is increased harmony between the heart and the brain. This state of physiological entrainment represents a harmonious functioning of the human system.

The role of breathing has been proven as a useful intervention to initiate a shift towards a coherent state. The normal respiration rate for an adult is around 12-20 breaths a minute. This rate can often vary based on the situation we're in. Research has proven that a rhythmic breathing of 6 breaths a minute can serve as a helpful transition into coherence. However, The *HeartMath Institute* focuses on an intentional generation of a heartfelt positive emotional state coupled with rhythmic breathing in order to excite the system at its natural resonant frequency and thus enable coherence to emerge and to be maintained naturally, without conscious mental focus on one's breathing rhythm (The Science of HeartMath, n.d.). This series of cause and effect not only helps reinforce the state of coherence, but also confers a much wider range of benefits such as deeper perceptual and emotional changes, increased access to intuition and creativity and cognitive and performance improvements.

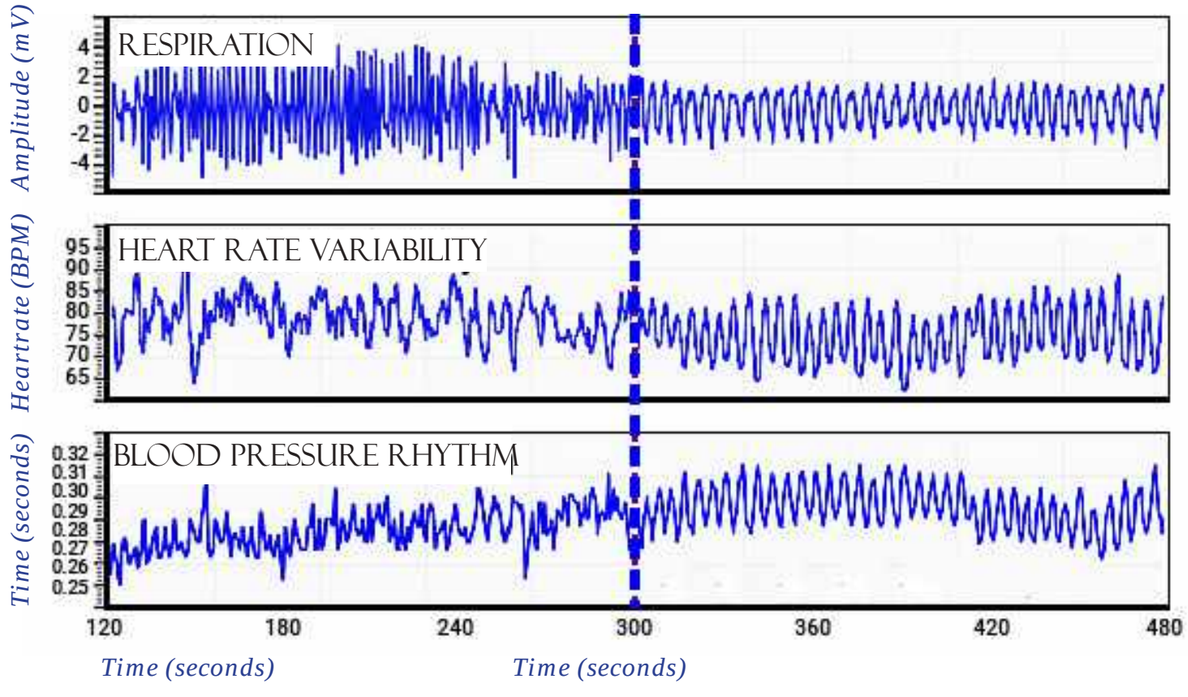


Figure 6. *Physiological entrainment during the state of coherence* **©The HeartMath Institute**

Several tools and technologies have been devised by *HeartMath* to help transition into a state of coherence.

The Inner Balance technology analyses and displays heart rhythm, measured by Heart Rate Variability (HRV), which indicates how emotional states are affecting our nervous system.
The Inner Balance App and Sensor is an innovative way to improve performance and well-being through real time, precision feedback and training. The App shows your heart-rhythm pattern (HRV), as a breathing pacer with built-in coach guides you into a more aligned inner state. The App works exclusively with the, one-of-a-kind, *HeartMath* Sensor that attaches to your earlobe and sends data into the app via a Bluetooth sensor.
The core idea of the technology is to generate sustained positive emotions and rhythmically altering the breathing pattern to shift into a reinforced state of coherence.

INNER BALANCE TECHNOLOGY

Figure 7. *The Inner Balance Technology by HeartMath* **©The HeartMath Institute**

04
COLOR, LIGHT, SOUND & THE HUMAN BODY

EFFECT OF COLOR ON THE HUMAN BODY

Colors are known to influence behavior and emotions of people. Every color has a different effect on the human mind (Azeemi, S. T., Raza, S. M, 2005). Some colors make you feel anxious and irritable, while other colors induce a feeling of calm and relaxation. On a psychological level, color responses are very personal and embedded in our own personal experience and culture. However, set colors are said to have a common effect on the physiological systems of the body.

Color Therapy or Chromo Therapy is the use of color in various forms for the purpose of creating balance and health in the human system, which not only refers to the physical body, but also the emotional and mental aspects of it (Litscher et al., 2013).

The use of different colors for its healing properties in regards to its physiological effects has been discussed on the next page. (Healing Power of Colors, 2014):

Violet
These are colors of transformation.
They heal melancholy, hysteria, delusions and alcohol addiction and bring spiritual insights and renewal.
These colors slow down an over-active heart.

Purple
Magenta strengthens contact with your life purpose.
Stimulates adrenaline and heart activity.

Indigo
Indigo is a great purifier of the bloodstream and also benefits mental problems.
It is a freeing and purifying agent. Indigo combines the deep blue of devotion with a trace of stabilizing and objective red.

Blue
Blue cools down inflammations, fever, high blood pressure, stops bleedings, reliefs headaches, calms strong emotions like anger, aggression or hysteria.
Blue brings peace and tranquility.

Green
Green is the color of Nature and the earth. It is balance and harmony in essence and possesses a soothing influence upon both mind and body. It is neither relaxing nor astringent in its impact.
Green brings psychological and emotional harmony and balance

Yellow
Yellow helps strengthen the nerves and the mind. It helps awaken mental inspiration and stimulates higher mentality. It is an excellent color for nervous or nerve-related conditions or ailments.
It also energizes the muscles.

Orange
Orange is warm,cheering, and non-constricting.
Orange has a freeing action upon the body and mind, relieving repressions.
Orange shows new possibilities and other options in life.
Stimulates creative thinking and enthusiasm.

Red
Red brings warmth, energy and stimulation.
Good for energy, fatigue, colds, chilly and passive people. Red energizes heart and blood circulation, it builds up the blood and heightens a low blood pressure. Energizes all organs and senses.

White
White is the perfect color; for it is all colors, in perfect balance and harmony. It is the color of the awakened Spirit; the light of perfection; the light of the Cosmic Consciousness, the Divine Light.

Figure 8. *The effect of color on the human body*

EFFECT OF LIGHT ON THE HUMAN BODY

"We re all Heliotropic beings.
We respond to light."
- James Turrell

Human beings are very sensitive to light exposure, and changes of light intensity can shift many physiological parameters like melatonin, alertness, body temperature, heart rate, and heart rate variability

In a recent study conducted over healthy participants, physiological parameters were tested after a 10 minute exposure to blue and red LED light.
Constant exposure to blue light was proven to significantly decrease body temperature whereas exposure to red light lead to a slight increase. Significant stimulation to blue light has also proven to decrease heart rate and simultaneously increase heart rate variability, hinting at a body-wide shift into the parasympathetic mode. On the other hand, exposure to bright, red light over time has been proven to slightly increase heart rate (Litscher et al., 2013).

In another study, the effects of hue and brightness was tested on heart rates. Not only did the heart rates increase during vivid red and vivid yellow conditions, but those colors also increased alertness. Pale blue colors on the other hand were proven to increase relaxation and calmness (Ayash et al., 2015). The emotion ratings showed that the hues also had a significant effect on arousal, which increased from blue to green to red.
Other authors report that red light activates avoidance, whereas blue light enhances approach and comfort (Mehta et al., 2009).

There has been no one standard system of color and their effects on the human body, but it is safe to say that unsaturated and pale colors specifically of shorter wavelengths such as blue induce a feeling of calm, whereas saturated and bright colors specifically of longer wavelengths such as red and yellow increase stimulation.

EFFECTION : A LIGHT EXPERIMENT

Based on the research findings previously discussed, I conducted a make shift experiment to test the immediate response of on colored lights from different people.

Methodology:
I asked the participants to sit in a dark room while I projected a set series of colors over a zoom call that served as a makeshift light. The idea was to test the immediate emotional response from them based on not only the hue, but also the brightness and the sequence of colors.
Through the experiment, I guided them through an intentional shift in focus in the ambiance of the space as opposed to just staring at the colored screen and asked them to reflect back on it after the experiment was done.

Observations and discussions:
Based on the data collected from 10 participants, most of them felt an instant arousal while looking at red light. However, when subjected to a combination of consequent red, purple and blue light, most reported feeling pleasant and happy.

Dark blue light triggered an alert response from people, whereas light blue and pastel shades of blue triggered a feeling of calm and relaxation.

When subjected a series of contrasting lights such as red and green, most people reported perceiving the colors as more intense than they truly are. This pinpoints to the adaptive nature of the eye where the retina of the eye tries to adjust to various levels of light as quickly as possible.

White light on the other hand did not seem to have a distinctive effect on people. Nevertheless, they did report feeling neutral and settled.

However, when subjected to a series of flashing white light with varying on and off time intervals, the results have been interesting. Almost all participants felt disoriented and dizzy, but most participants also reported feeling overly focused and alert and equally calm and at peace.

Results:
Through the experiment makeshift conducted and the research undertaken, it is safe to say that pastel shades of color result in feelings of calm and peace whereas brighter and warm colors result in feelings of excitement and slow changing colors no matter what hue evoke relaxation and comfort. .

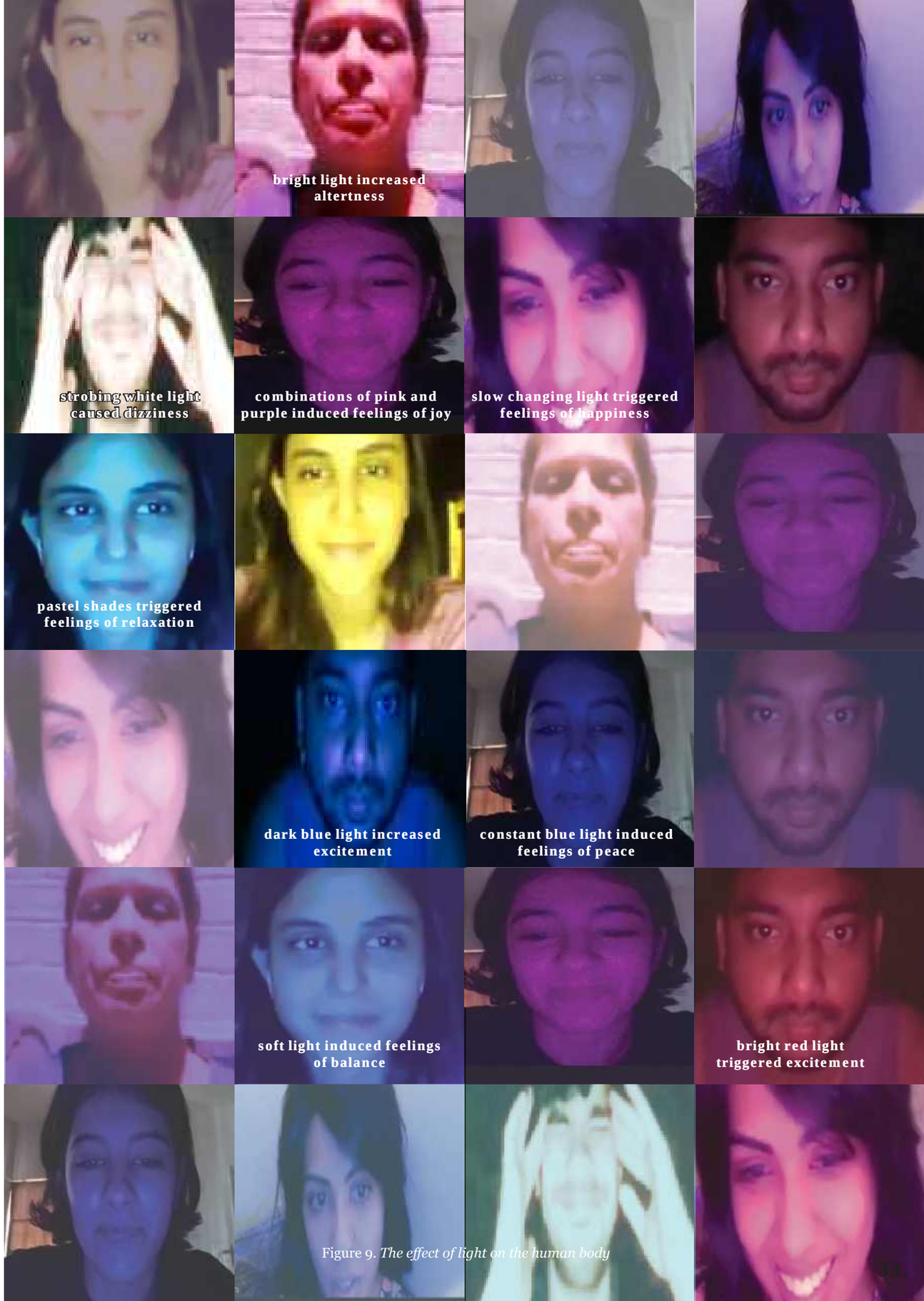


Figure 9. *The effect of light on the human body*

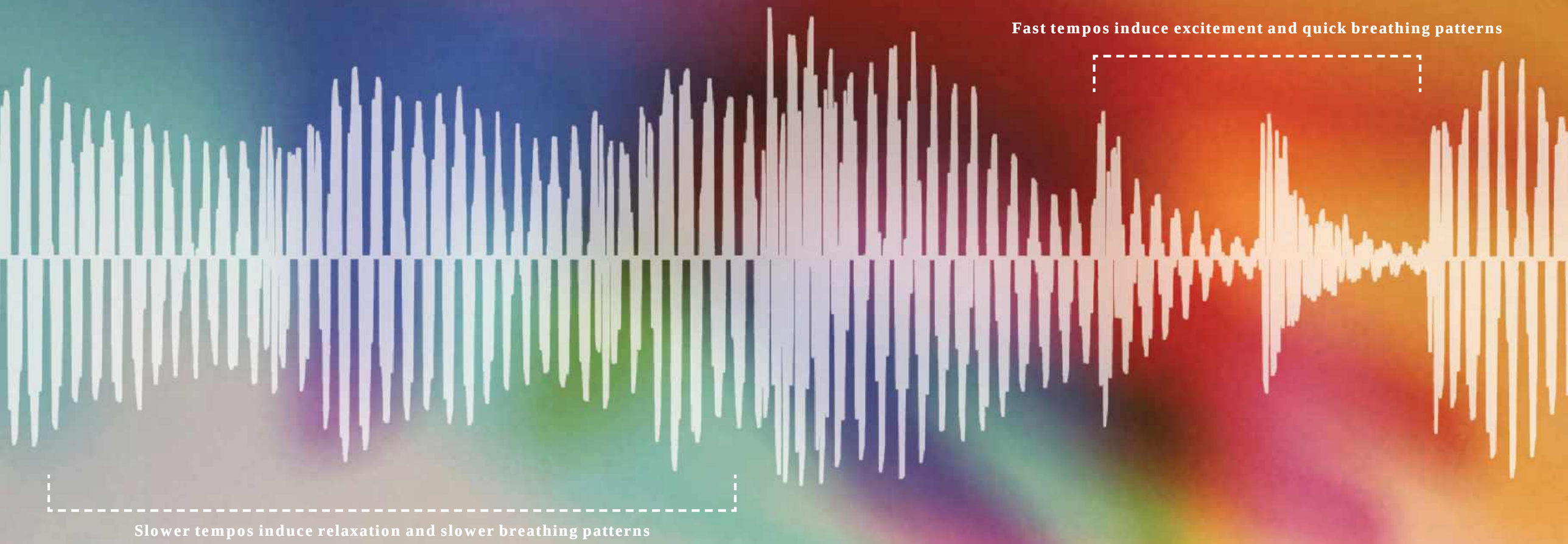
EFFECT OF SOUND ON THE HUMAN BODY

"We all respond to music. Research has proven that music engages not only our auditory system but many other parts of our brain as well, including areas responsible for movement, language, attention, memory, and emotion."
-Tuning in 2018

Processing of sound begins in the brainstem, the part of our body that controls our heart rate, respiration rate and blood pressure, thus producing an entrainment of respiratory timing and heart rate (Larsen et al., 2006). The biological oscillators in our body always synchronize with external inputs and hence there is a constant connection of cause and effect, internally and externally.

More so than anything, recent research in sound stimuli has proven that is not the key of the music but the underlying tempo of the music that significantly alters the physiological responses to it. The breathing frequency is increased by musical inputs, and this increase is proportional to the tempo of the music: the slower the music, the slower the breathing rate and vice versa. In the same study, they found that respiratory frequency, heart rate, and blood pressure all decreased to below baseline levels when the music stopped. This points to the theory that any form of music or sound causes some level of arousal and intrinsically our bodies fully relax under silence (Larsen et al., 2006).

According to the American Music Therapy Association, music "provokes responses due to the familiarity, predictability, and feelings of security associated with it." On a more affective level, listening to music can trigger the release of dopamine, a brain chemical that is responsible for positive feelings and emotions. This is why most of us have our own personal choice of music and that choice is also significantly based on what activity we are conducting while listening to that music.



EFFECTION : A SOUND EXPERIMENT

Based on the research previously discussed, I conducted another experiment to test the relation between sounds, lights, emotions and physiological responses.

Methodology:
I first asked the participants to sit in a dark room while I projected a series of ranging pastel colors over a zoom call that served as a makeshift light. I asked them to use headphones while I played a sequence of sounds to test the transitional emotional response from them based on not only the soundtrack, but also the color hues. Through the experiment, I prompted them to focus on the shift in their emotional state and their breathing patterns. After the experiment, I asked them to reflect on the transition from the start to the end.

Observations and discussions:
Almost everyone reported having felt a surge of anxiety and frustration while I played a heavy metal song, even though the color on the screen was as relaxing as white. Interestingly, everyone recounted feeling even more anxious when the screen was black against the same sound.
On the other hand, everyone felt pleased and peaceful when listening to a series of waves crashing against a blue color. While I played the same sounds against a black color most reported having felt the same levels of pleasantness.

The sounds of the waves slowly transitioned into sounds of a human heart beating against a white screen. Almost all participants reported having felt even more relaxed and calm. An interesting remark during this phase was someone saying, “I felt more human then.”
I then slowly decreased the volume of the heartbeats and added in a soundtrack of a deep, heavy breathing rhythm them said. All participants said they instantly felt connected and 80% of them said that they subconsciously ended up syncing their breaths with the breathing rhythms.
Over time as the breathing soundscape got quick and heavier, most participants recounted feeling nervous and uneasy as they also tried syncing their breaths with the soundscape.
As the soundscape returned to deep and heavy rhythms, everyone reported having felt much calmer than before.
The experiment ended with the sounds going off, leaving only a plain white screen in front of them. 50% of the participants described feeling balanced and peaceful and more conscious of their internal systems.

Results:
Based on the research undertaken and the simultaneous experiments conducted, it is evident that our physiological systems are always responding to external stimuli and our bodies are more receptive to sound when the visual field is plain and uniform.

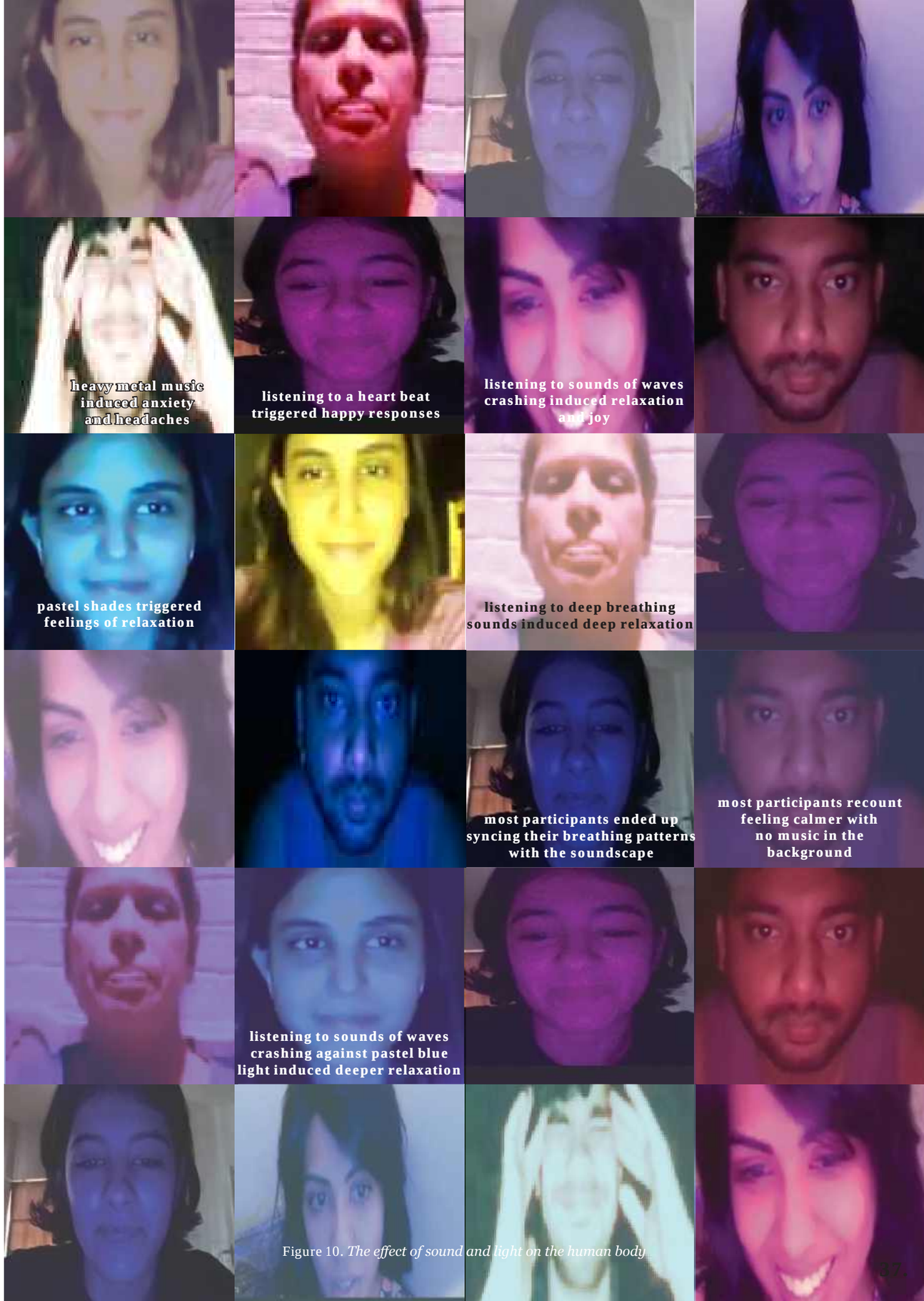


Figure 10. *The effect of sound and light on the human body*

05

DESIGN STRATEGY

SLOW DESIGN

In order to listen to our inner systems, we need to consciously bring that awareness towards it.

We need to pause and reflect;

We need to slow down.

"Slow Design is a democratic and holistic design approach for creating appropriately tailored solutions for the long-term well being of people and the planet. To this end, Slow Design seeks out positive synergies between the elements in a system, celebrates diversity and regionalism, and cultivates meaningful relationships that add richness to life."

Slowness doesn't refer to how long it takes to design or do something. Rather, it describes an expanded state of awareness, accountability for daily actions, and the potential for a richer spectrum of experience for individuals and communities (Strauss et al., n.d.).

Slow design acts as a catalyst of individual, socio-cultural and environmental well-being by bringing in certain principles and guidelines that have not only guided my thinking but also my design qualities and structure as described on the next page.

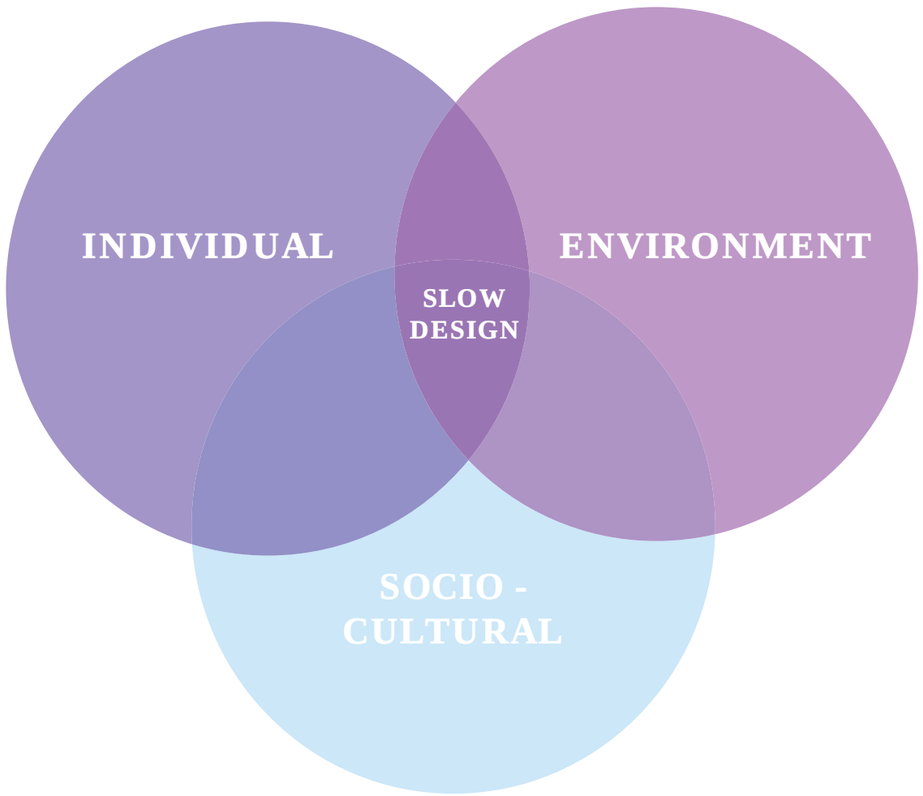


Figure 11. *Slow design acts as a catalyst of individual, socio-cultural and environmental well-being*

Creating new awareness
By probing our attitudes and set beliefs and re positioning them.

Slowing the mind and body
By using time as a medium to facilitate slow movement of the otherwise hyperactive human mind and body.

Revealing forgotten experiences
By using the design to literally bring to light the internal physiological systems that we have almost mistaken as involuntary and uncontrollable.

Immaterializing the design
By playing with materials and presenting them as symbolic layers of meaning as opposed to just structural functions.

Probing contemplation
By creating a space that prompts subjective quiet contemplation and reflection inwards.

THE GANZFELD EFFECT

complete field

In the 1930s, research by psychologist Wolfgang Metzger established that when subjects gazed into a featureless field of vision they consistently hallucinated and their electroencephalograms changed.

The Ganzfeld effect has been reported since ancient times. The adepts of Pythagoras retreated to pitch-black caves to receive wisdom through their visions, known as the prisoner's cinema. Miners trapped by accidents in mines frequently reported hallucinations, visions and seeing ghosts when they were in the pitch dark for days.
Arctic explorers
seeing nothing but featureless landscape of white snow for a long time also reported hallucinations and an altered state of mind.

The Ganzfeld effect is a phenomenon of perception deprivation caused by exposure to a uniform, unobstructed space covering the entire field of vision.

The effect is the result of the brain amplifying neural noise in order to look for the missing visual signals. The noise is interpreted in the higher visual cortex, resulting in loss of vision, creating an apparent 'blackness' or 'nothingness' eliciting a visual and perception deprivation (Metzger, 1930).

Since I wanted my project to be light and to be about light and it's effect on the human body, I was looking at not only the hue or the brightness of the color, but also the spatial context of the light.

This phenomenon has allowed me to use space as a container of light to create the set experiences that highlight the effect of color, not a screen or as a visual, but rather as space , by creating an envelope of colored air.

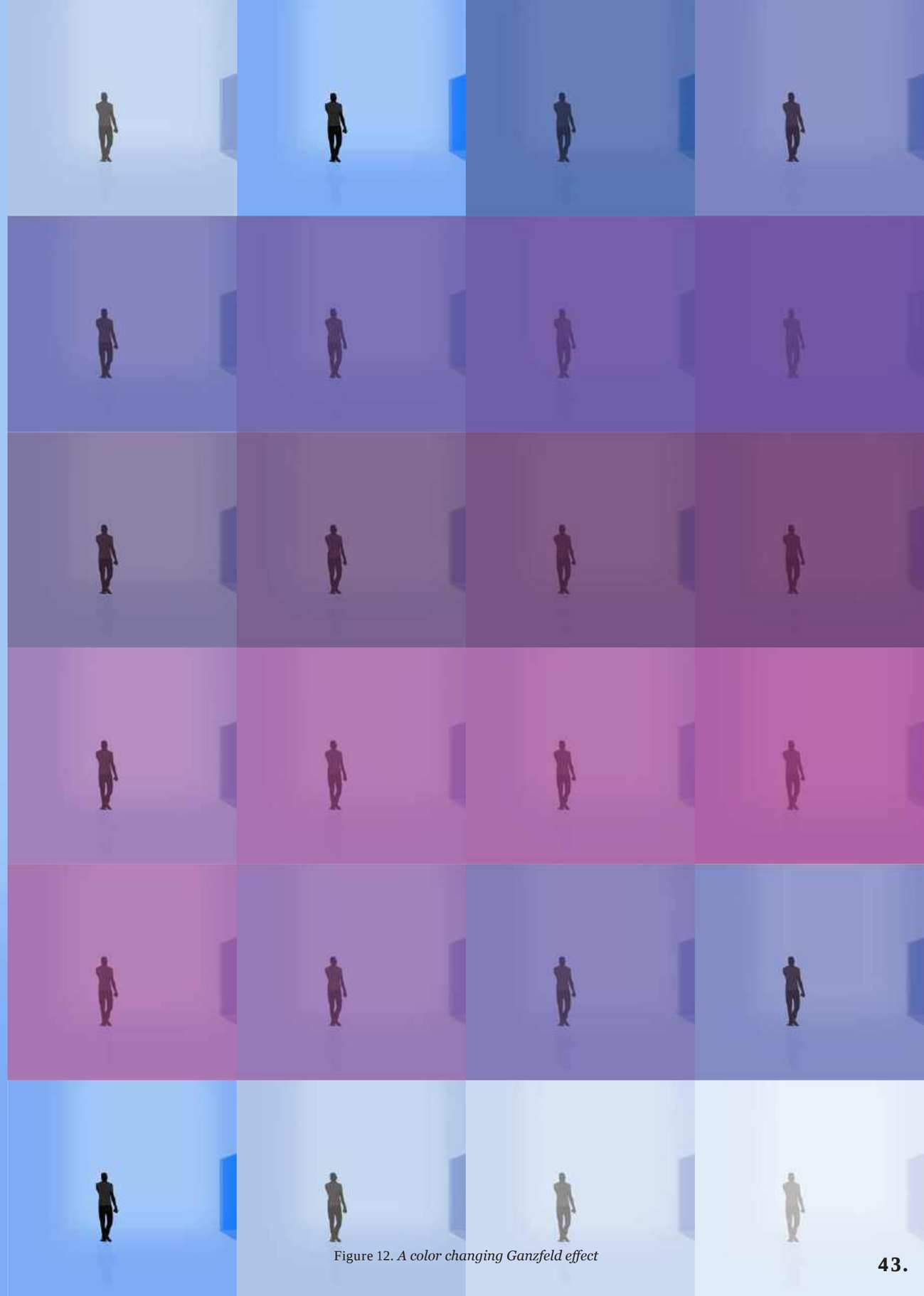


Figure 12. *A color changing Ganzfeld effect*

COLORED SHADOWS

additive color mixing

Light is a continuous spectrum of all of the wavelengths that can be detected by the human eye.
Humans and other species with three such types of color receptors are known as trichromats. The R, G, B cones in our retina are most sensitive to the red, green, and blue wavelengths, respectively.

When red light, blue light, and green light stimulate the three colour receptors on our retinas equally, the signal gets blended in our brain and we see “white” light. Red, green, and blue are therefore called additive primaries of light.

Not all shadows are black (Science World, n.d.).

With these three lights you can make shadows of seven different colors—blue, red, green, black, cyan, magenta, and yellow—by blocking different combinations of lights.

This property of light has allowed me to use the colored shadows as a symbolic representation of the heart’s electromagnetic field and it also serves as a means to induce a sense of joy or amazement during the experience, adding on to my whole idea of the feedback loop.

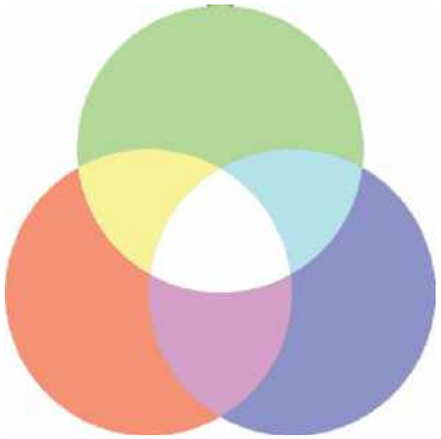
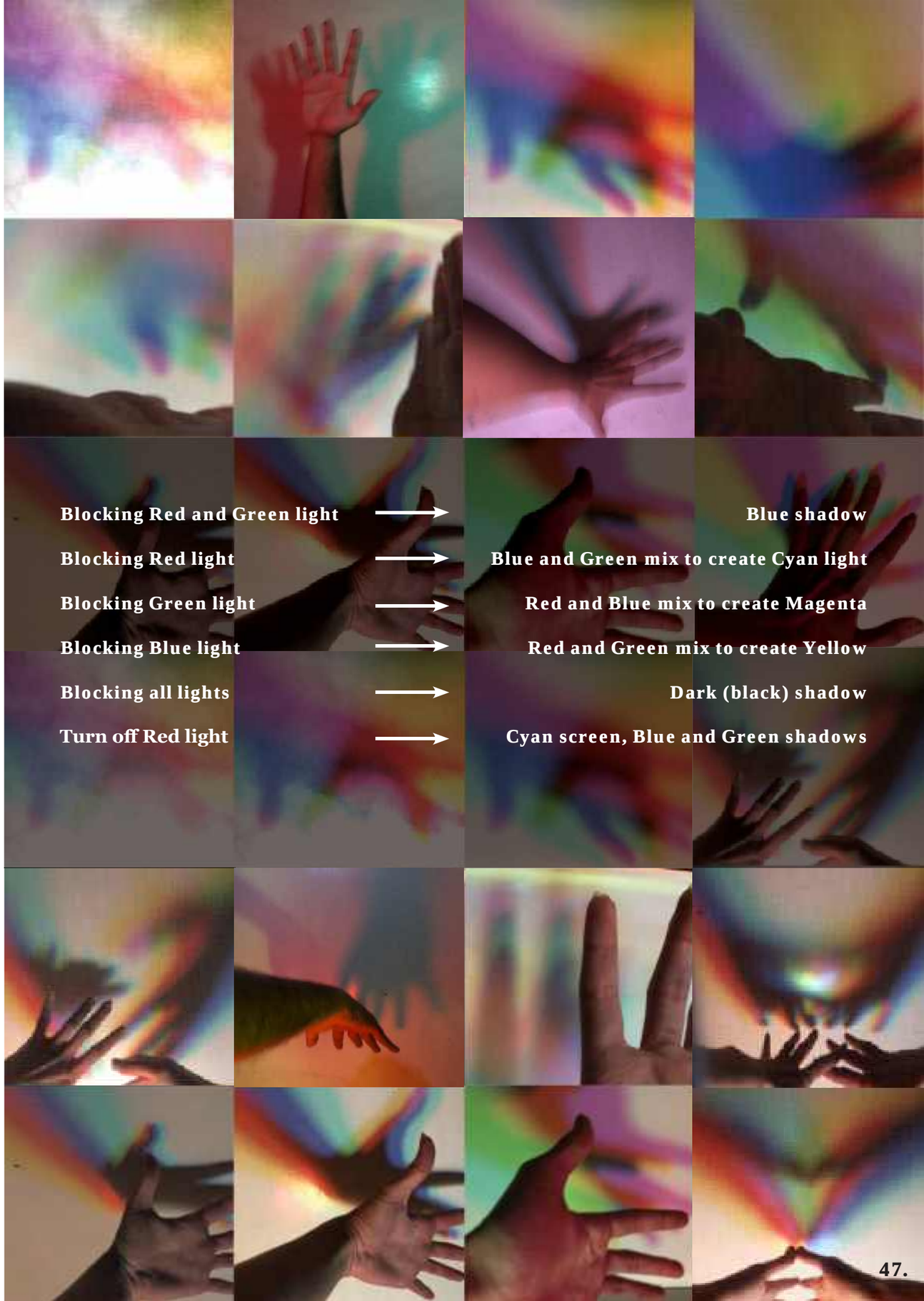
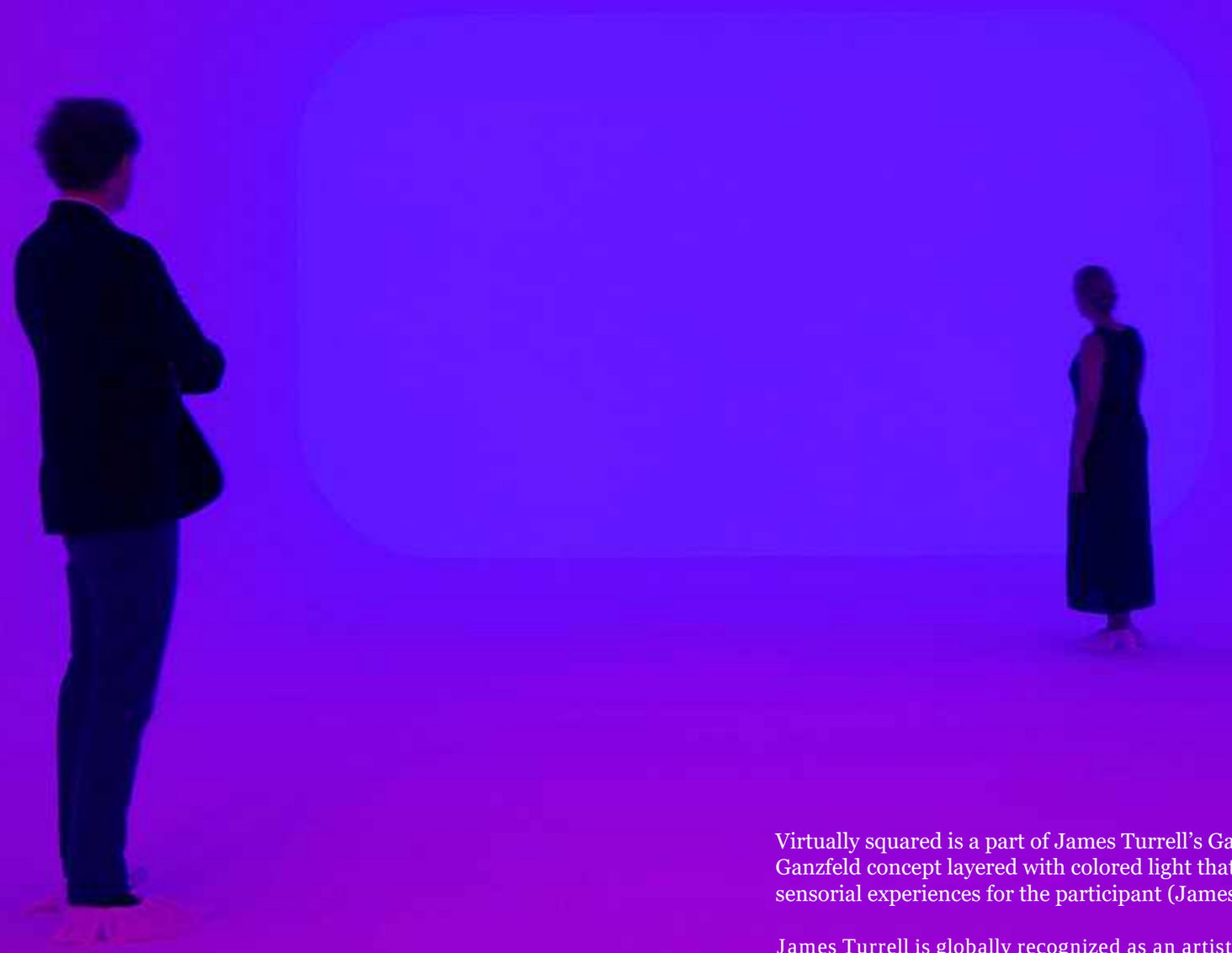


Figure 13. *Additive mixing of light*



1. Virtually squared by *James Turrell*



Technology:
LED lights
Built structure
Self designed software

Virtually squared is a part of James Turrell's Ganzfeld series. These site-specific pieces explore the Ganzfeld concept layered with colored light that goes through a specific cycle to create a variety of sensorial experiences for the participant (James Turrell Retrospective, n.d.)

James Turrell is globally recognized as an artist who uses light mediums to enable participants to see beyond what they generally see. This abstraction and simple use of light has enthralled me for the longest time. His understanding of the physiological effects of light motivated me to understand light not as a source of seeing but more as a source of perceiving and sensing. A deeper study into his style inspired me to layer my design using conventional, minimalistic elements that cohesively puzzle together to form a unique extraordinary environment.

Figure 14. *Virtually Squared by James Turrell* ©jamesturrell.com

DESIGN PRECEDENTS

2. Illumina by *Pablo Gonzalez Vargas*

Illumina is an interactive light and sound sculpture powered by participants' collective heart. During the experience, participants are guided by a visual cue to enter a state of coherence, where the mind, body and emotions are in collective unity, which in turn activates the sculpture's light-show and soundscape. The installation is almost like a mystical experience, highlighting the interconnectivity of our planet and enhances global energy field (Illumina, n.d.).

This precedent really helped guide my design by introducing the idea of a cause and effect interactive sculpture centered around the heart. It also helped me break down the layering of the interaction without it being extremely direct and extremely conventional. This design inspired me to think on a level of scale and sense of control or sense of agency, that glorifies the power vested in the participant in order to emphasize the level of change, thus doubling the impact of the design.

Technology:
HeartMath HRV sensors
MaxMsp
Midi

3. Pulse Room by *Rafael Lozano-Hemmer*

Pulse Room is an interactive installation featuring one to three hundred clear incandescent light bulbs, 300 W each and hung from a cable at a height of three meters. On the side of the room is a sensor that detects the heart rate of the participant which immediately sets off the closest bulb to flash at the exact rhythm of his or her heart. The moment the interface is released all the lights turn off briefly and the flashing sequence advances by one position down the queue, to the next bulb in the grid (Rafael Lozano-Hemmer, 2006).

The most fascinating aspect of this piece is the distinguishable presence of each person. Each participant is fully aware of his personal representation as light. Since this installation relates to the happenings on a very innate and deep level, the idea of showcasing that as a highly noticeable output helped guide my design by allowing that sense of individualized, personal representation in a space full of other participants. This aspect of the design helps the participant tangibly associate with something, thereby deepening the level of connection with the space.

Technology:
incandescent light bulbs
voltage controllers
heart rate sensors

Figure 16. *Pulse Room by Rafael Lozano-Hemmer*

©lozano-hemmer.com

06
EFFECTION

Effection **is a sensorial experience that utilizes a biofeedback loop to highlight the simple yet complex interconnections between our heart, our breath and our emotions.**
The installation, situated in the Mind and Body Gallery at Melbourne Museum, uses light and sound mediums to bring involuntary, unconscious bodily processes into consciousness.

The design utilizes *Inner Balance* sensor technology developed by the *HeartMath Institute* as an input data stream that interacts with a sound and light system. The resulting multi-sensory spatial experience prompts audiences to become aware of the interconnections inside and outside of their body and to recognize a state of coherence in which the mind and body is in harmony.

Mind and Body Gallery - Melbourne Museum

Effection is an immersive spatial experience housed in the Temporary Exhibition Space in the Mind and Body Gallery on the upper level of the Melbourne museum.

This space is reserved for sensorial exhibits that detail the functioning of the human mind and body and provide for contemplation into the workings of your own being.
Since *Effection* is an immersive experience about bringing awareness to the full potential of the human heart, the Mind and Body Gallery works as a perfect context for the design.

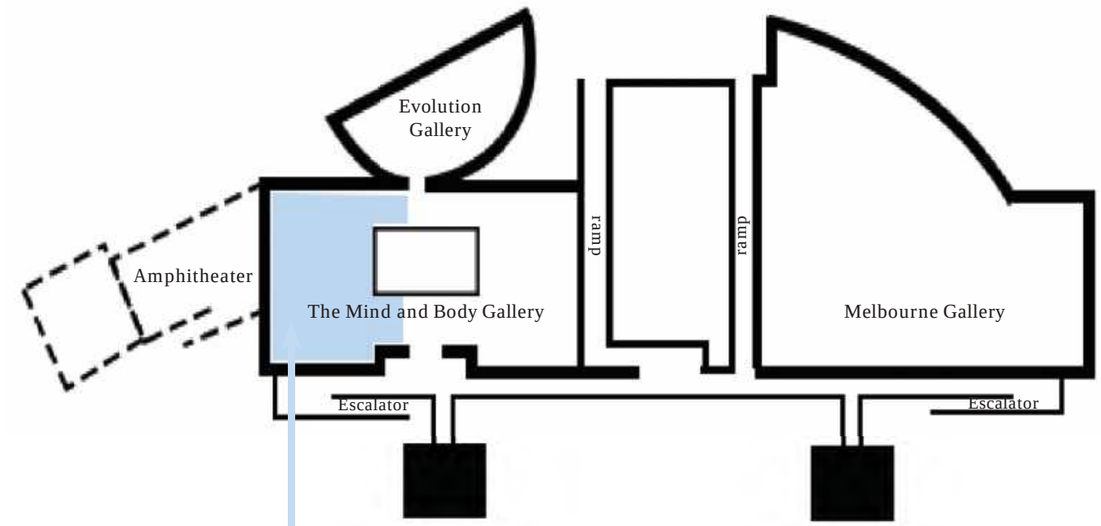


Figure 17. *Plan view of the upper level of Melbourne Museum*

Temporary Exhibition space
Mind and Body Gallery
Melbourne Museum

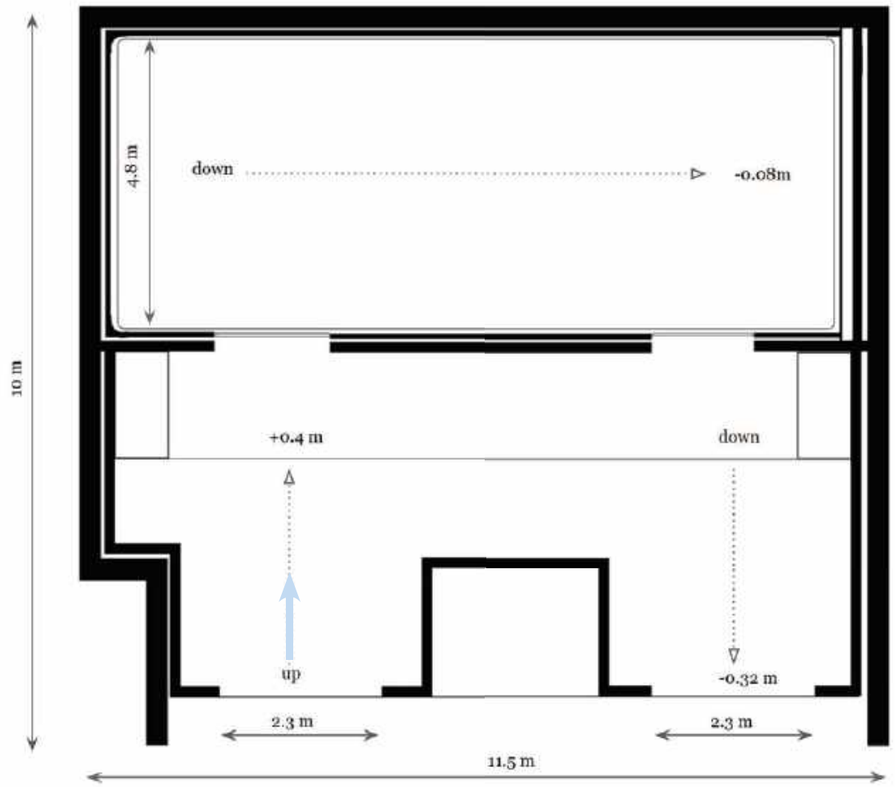


Figure 18. *Plan view of built structure for Effection*

THE EXPERIENCE

Booking Online

The experience is a single person time-based experience with the need to book online before entering. The booking page can be accessed via the Melbourne Museum's website where necessary details about the experience are fully listed.

Since the experience is highly light and sound centered a participant discretion is advised before continuing with the booking.

1. Booking Online

pre - experience

2. Walking in

3. Waiting area

experience

4. The main experience

post - experience

5. Walking out

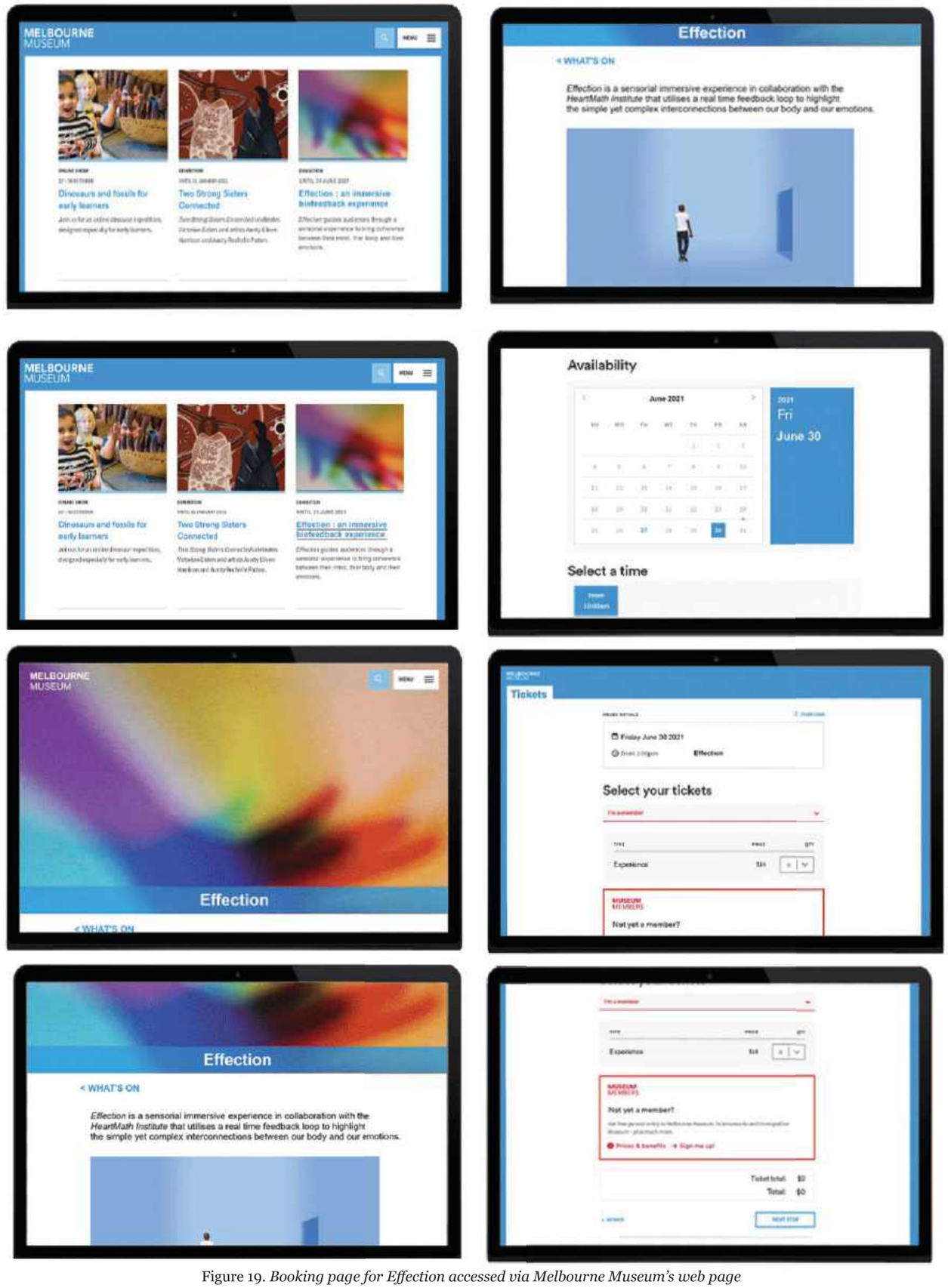
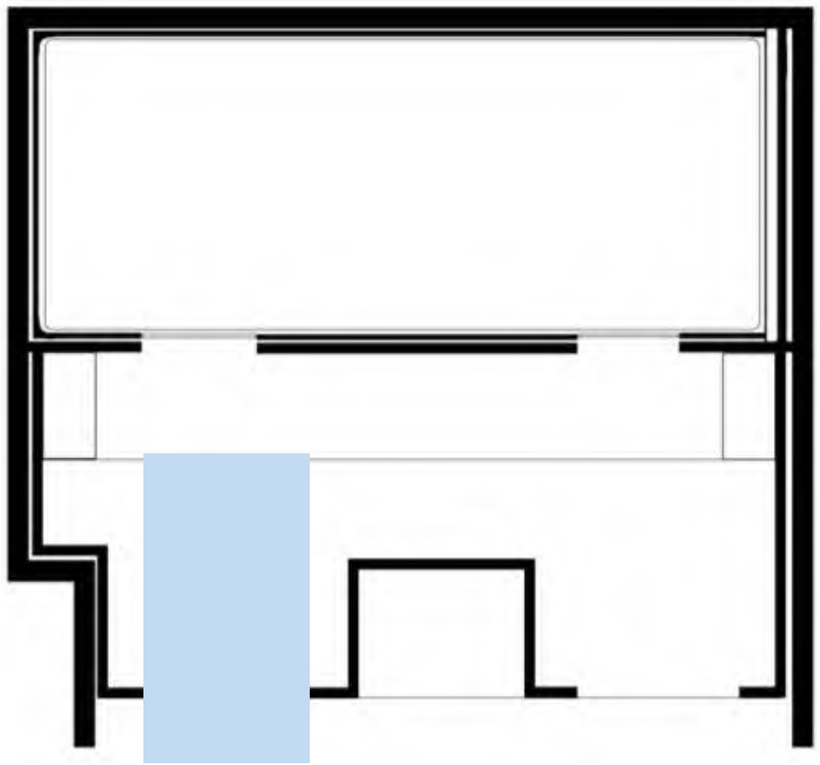
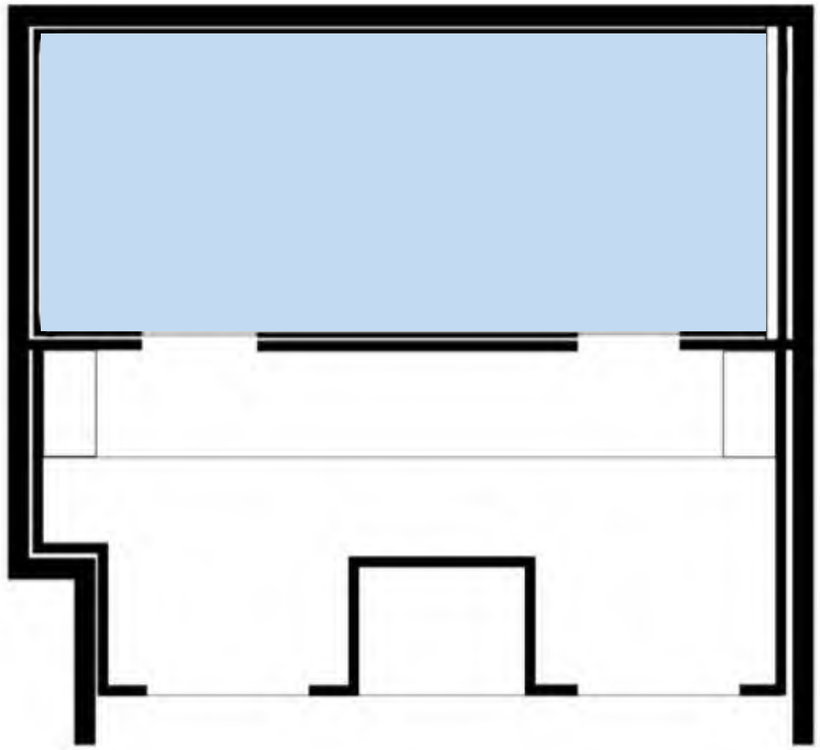


Figure 19. *Booking page for Effection accessed via Melbourne Museum's web page*

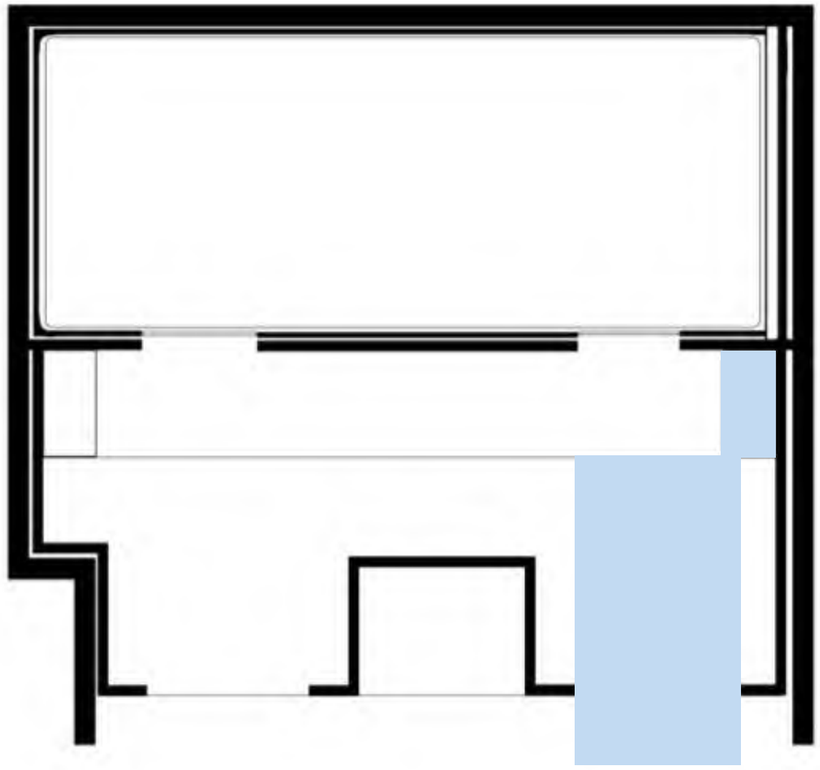


2. Walking in

3. Waiting area

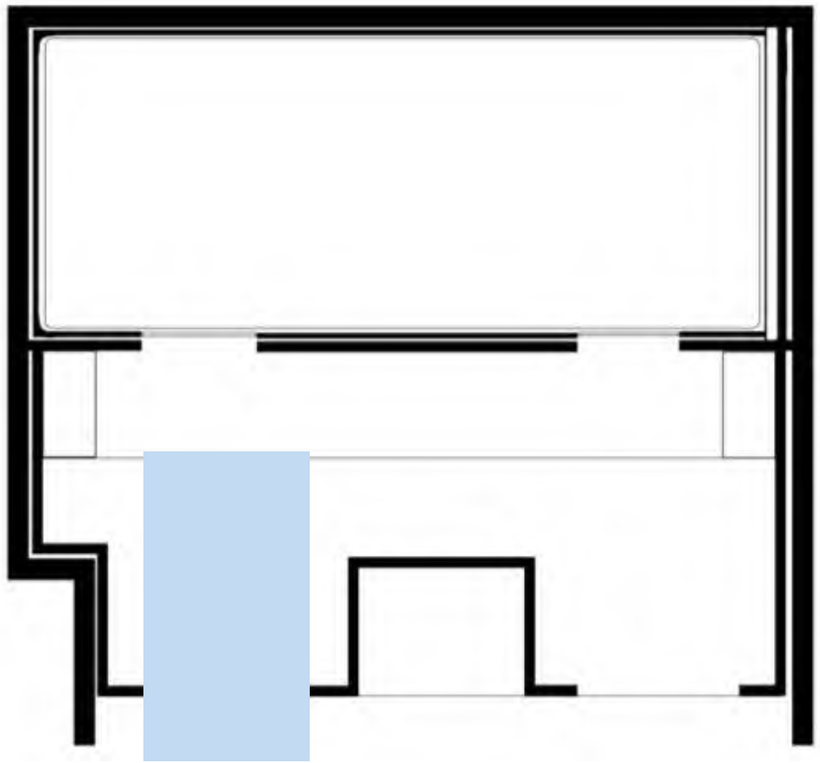


4. The main experience



5. Walking out

Figure 20. *Plan view showing circulation pattern during the pre and post experience*



2. Walking in

3. Waiting area

Figure 21. *Plan view of the pre experience*

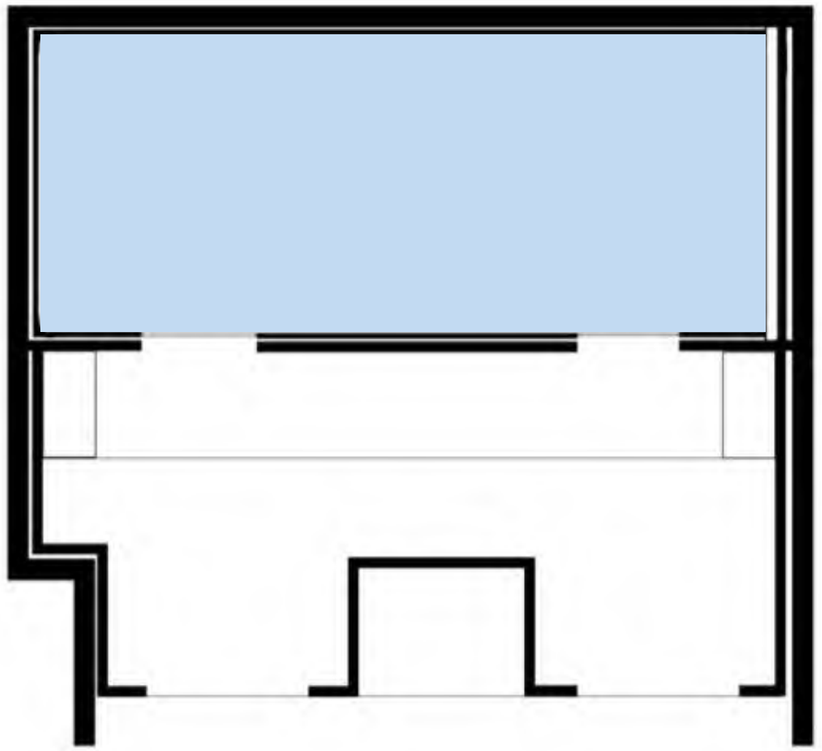
THE EXPERIENCE

Walking in & Waiting area

Participants are advised to enter the space at least 15 minutes prior to their booking time. This is an intentional part of the experience to allow for semi relaxation before their experience.

Upon entering, a low ramp leads participants up to a waiting area where they are asked to scan a QR code and enter their details. They are also advised to turn their digital devices off to allow for complete relaxation during the experience.

The space around them begins to reverberate in a heart beating rhythm while a constant uniform field of white light begins to fill the space. After the set 15 minutes they are handed an *Inner Balance Sensor* by *HeartMath* that they are asked to plug into their ear and enter the space as automatic doors open for them.



4. The main experience

Figure 20. *Plan view of the experience*

The main experience

Upon walking through the door, the room begins to reverberate through a transducer according to the participant's heart rhythm. 15 seconds after their heart rhythm is also projected as a soundscape and soon after the light begins to pulsate in a similar rhythm in a blue and white color order. The tactile vibrations, the soundscape and the lights combine to create an experience that would slow the participants heart rate. This is the first part of the experience that gives the participant a sense of control over the space and introduces the idea of awareness towards the heart.

After establishing the idea of this being a real time responsive experience and after giving the participant a sense of agency over the space, the light then slowly transitions into a series of slow changing colors from blue to purple to pink accompanied by a heavy, deep breathing soundscape which gets slower over time that resonates with the change in the color pattern. This transition occurs when the participant's heart rate has reached a beats per minute value of 65 or under. This combination of light and sound serves as a means for the participant to synchronize his breathing pattern with the light and soundscape, thus introducing the idea of bringing awareness to the breath. This is the second part of the experience where the light and sound mediums affect the physiological and emotional systems of the participant.

This experience continues for 6 minutes where the last 3 minutes of the soundscape shift into a deep breathing pattern of 6 breaths a minute. This change in breathing pattern automatically induces a change in the participant's breathing pattern to 6 breaths a minute which has been proven as a very successful means of reaching a state of coherence. This unintentional shift in breathing accompanied by the pleasing light scape generates feelings of awe and joy in the participant, thus serving as a reinforcement to create higher coherence.

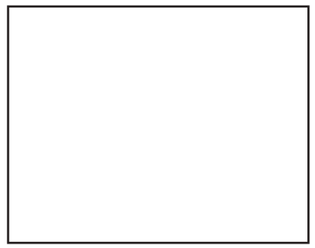
Once the two physiological systems of the body are introduced, the light shifts into a plain white light that slowly increases in brightness, almost serving as a standstill and a space of quiet contemplation. The soundscape fades off here leaving a room of complete silence. However, because the breathing soundscape continued for a long time before, the participant's breathing rhythm has most likely synced to about 6 breaths a minute. As discussed earlier most physiological systems go into a state of complete relaxation during pure silence, giving the participant a chance to completely let go, almost like a deep meditative space.

After 2 minutes, the sound slowly fades into a blissful harmonic music and reveals a sense of change, adding on to the feelings of positivity and calm. Once the body has adjusted to this environment, a series of RGBW LED's flushed in the back wall begin to increase in brightness, thus resulting in rainbow colored shadows being projected on the front wall, representing a blissful state of coherence and symbolically signifying the heart's electromagnetic field or heart's aura.

Amazed at the transition, this change reinforces feelings of positivity and joy while the body remains in a state of pure calm, thus deepening feelings of coherence. This last part of the experience is a physical representation of the participant affecting the space and a metaphorical representation of him feeling his presence over time and eventually seeing his presence over time, bringing him to consciously shift his awareness towards his innate being.

This entire experience is about bringing mindfulness to the heart and the breath and slowly takes the participant on a journey to experience a state of coherence. This feedback loop begins with the body affecting the environment and then transitions into the environment affecting the body and ends with the body affecting the environment.

SPACE

	PARTICIPANT AFFECTING ENVIRONMENT		ENVIRONMENT AFFECTING PARTICIPANT		PARTICIPANT AFFECTING ENVIRONMENT	
						
LIGHT	blue and white pulsing LED's according to the heart's rhythm		sequence of slow changing colored LED's from blue to purple to pink		pure white LED increasing in brightness	RGBW LED panel lights to create rainbow shadows
SOUND	pulsing heart rhythm, tactile reverberations through exciters	soft pulsing heart rhythm, deep breathing sounds, tactile reverberations		very soft pulsing heart rhythm, deep breathing sounds (6 breaths/ minute) tactile reverberations	-	harmonic music
EXPERIENCE	sense of agency, induces relaxation	induces further relaxation		induces further relaxation, synchronization of breathing pattern to 6 breaths per minute	complete relaxation of mind and body	reinforces feelings of joy and appreciation
REPRESENTATION	introduces awareness towards the heart, introduces concept of a biofeedback experience	introduces awareness towards the heart and breath		introduces the underlying notion of synchronization	space for quiet contemplation	blissful state of coherence
	1 minute	*when BPM < 55*		*4 minutes*	*45 seconds*	*coherence score = 3+ / HRV > 550*

TIME

Figure 21. *The feedback loop*

Figure 22. *The first phase of the experience*

Figure 24. *The third phase of the experience*

Figure 25. *The final phase of the experience*

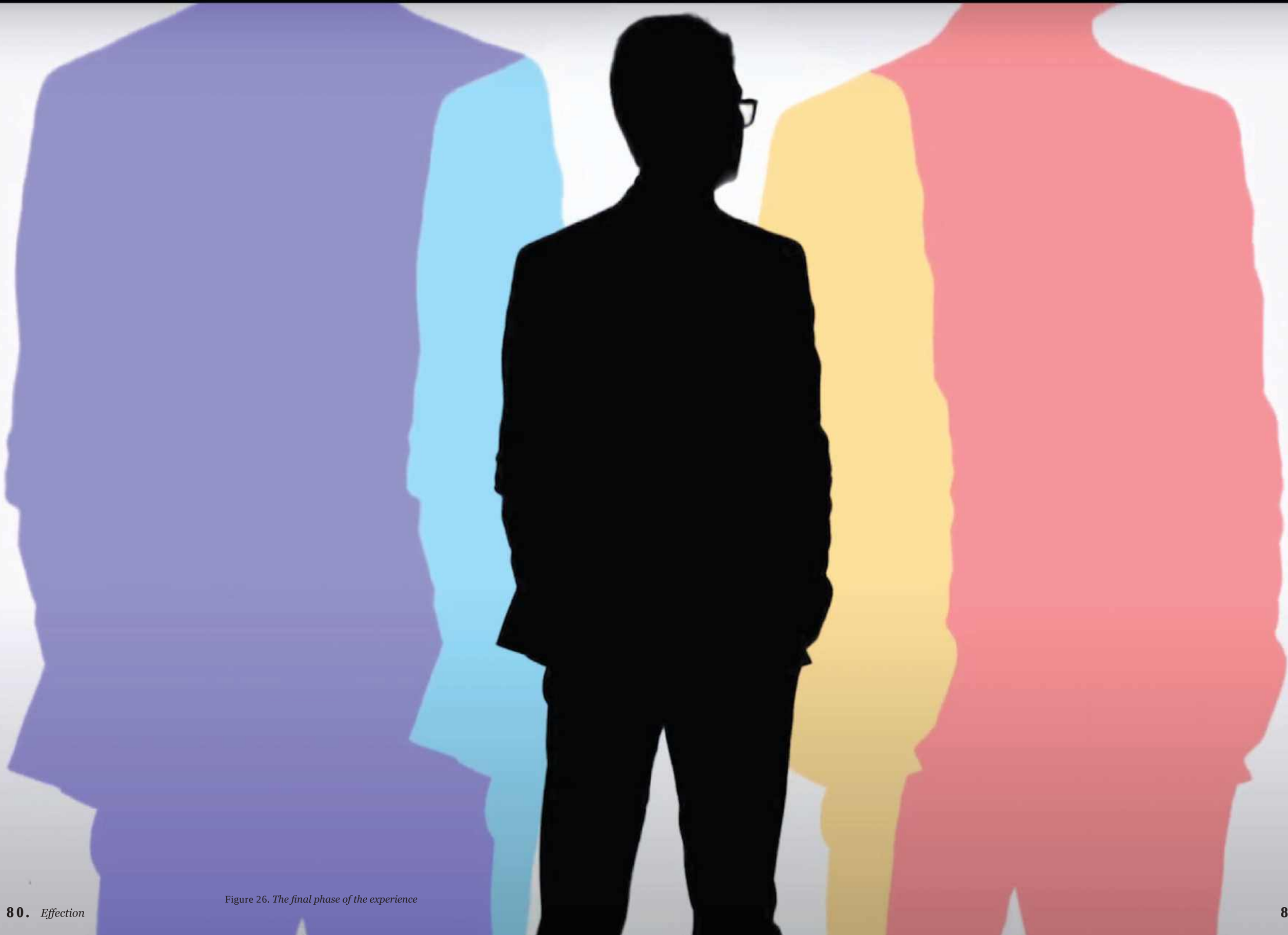


Figure 26. *The final phase of the experience*

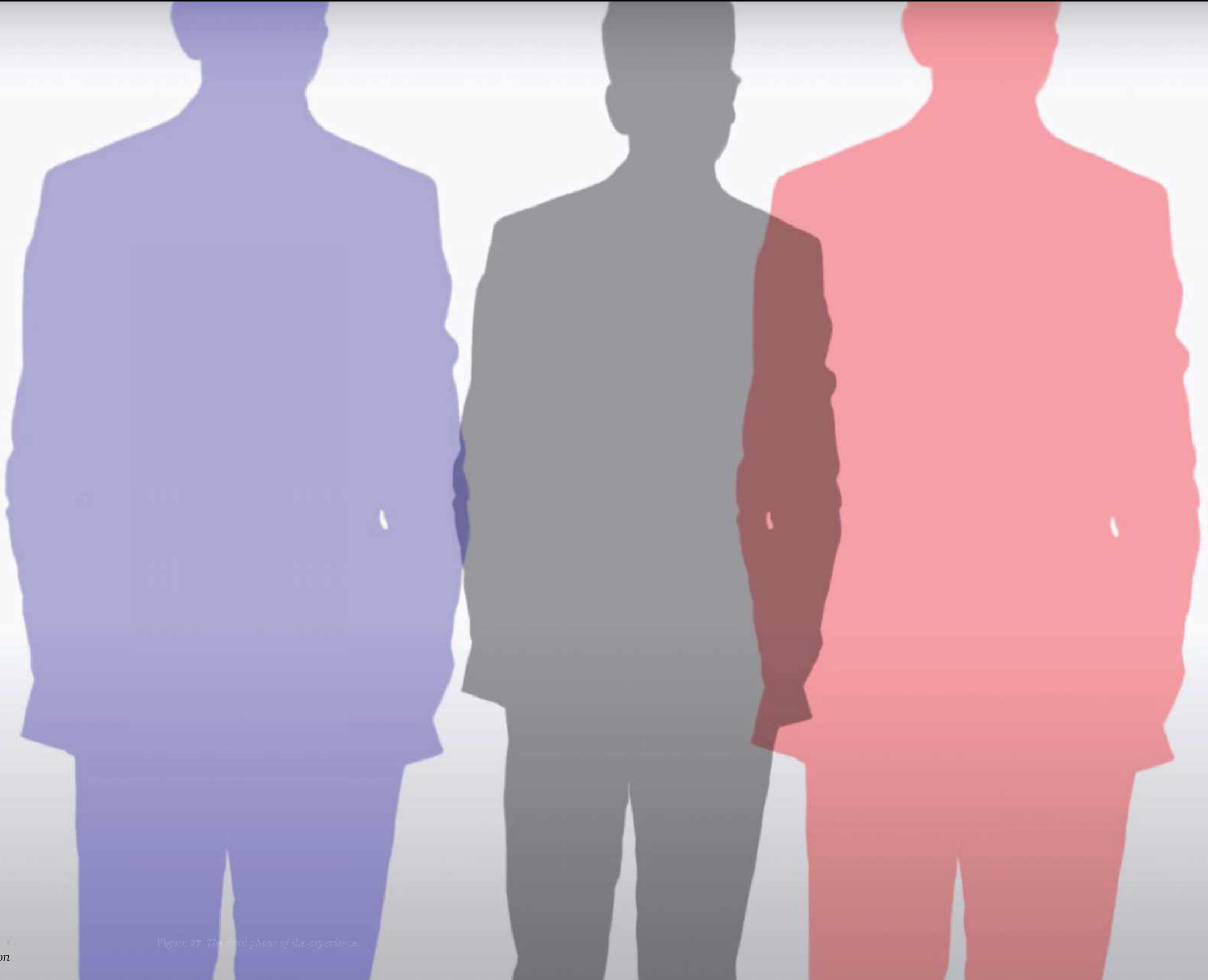
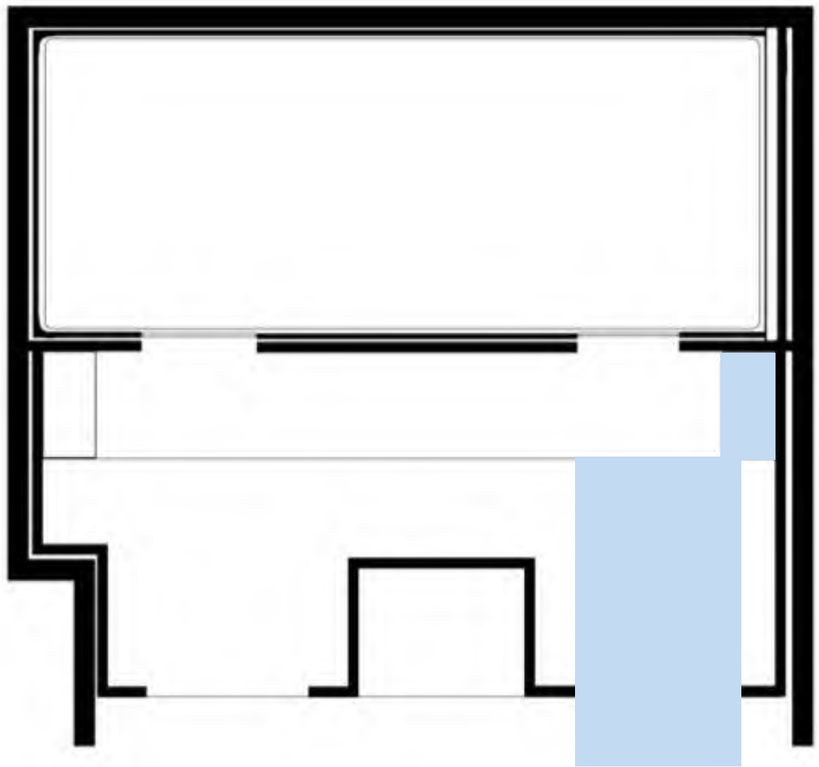


Figure 27. *The final phase of the experience*



5. Walking out

Figure 28. *Plan view of the post experience*

THE EXPERIENCE

Walking out

After 10 minutes of being inside the main experience room, the doors automatically open for participants to walk out of the space.
Upon exiting, they are asked to scan a QR code which directs them to a web page where they are asked to enter their details in order to gain a full scientific understanding of what they witnessed.
The web page directs them through a detailed explanation of the science behind the biofeedback along with a real time graph of their own heart rate changing through the experience.
The page also redirects them to *HeartMath*'s website for an even further explanation of the science and the technology.

This layer of technology enables participants to contextualize their experience and also serves as a slow transition back into the actual museum environment.

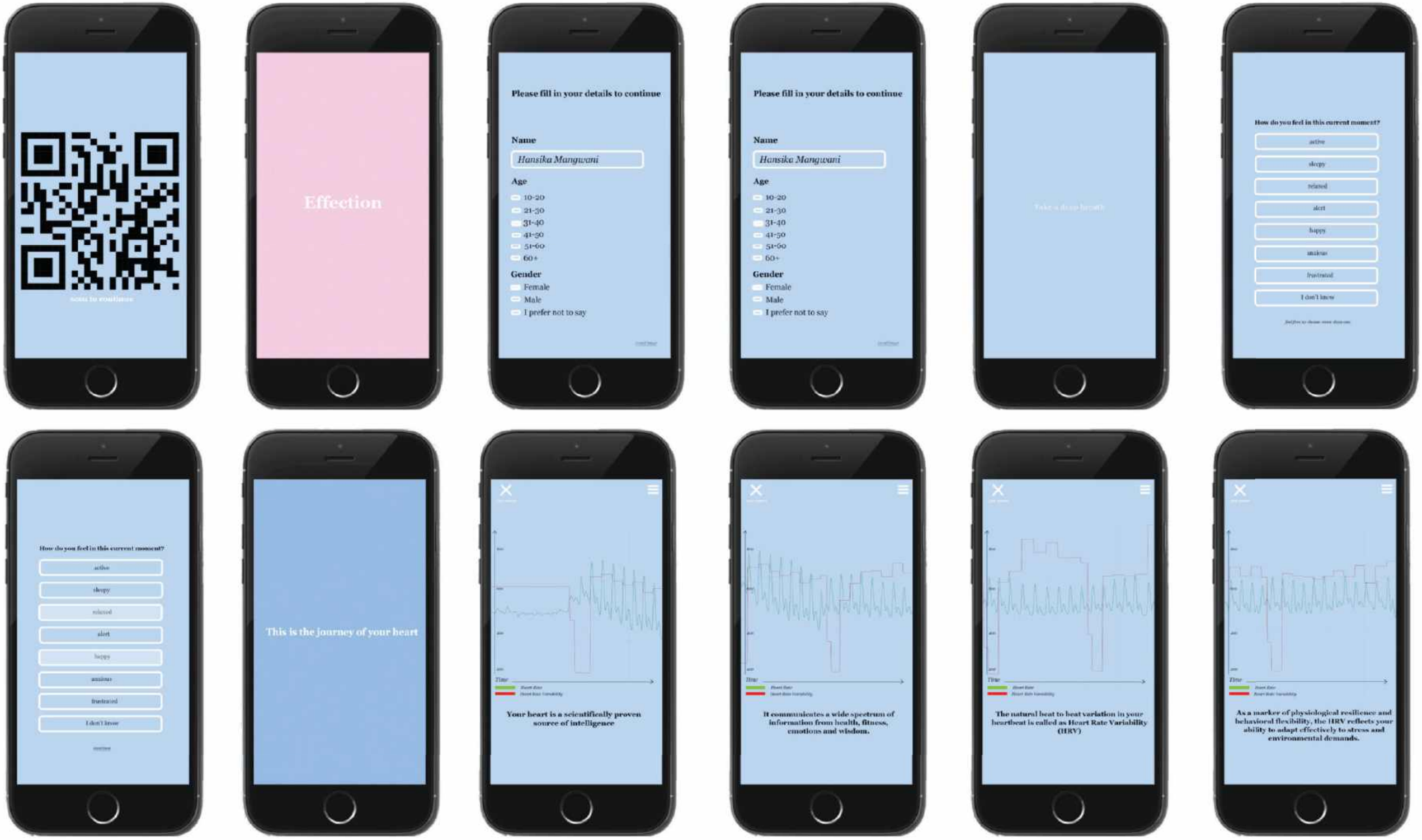
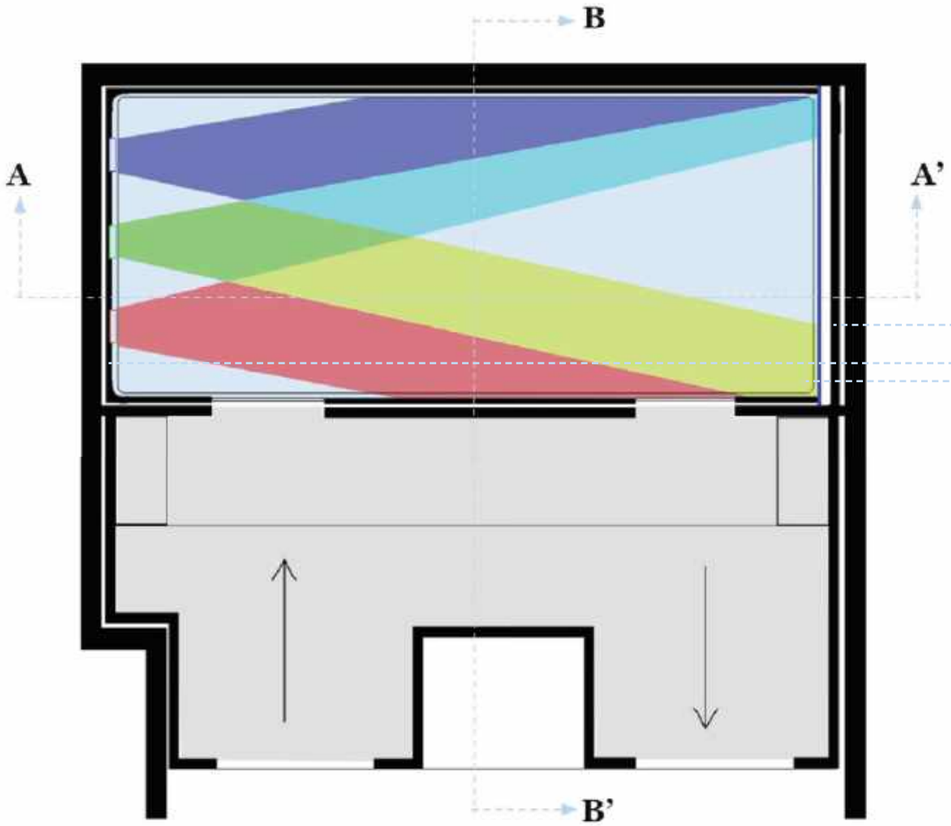


Figure 29. *User interface of Effection's web page*

Figure 30. *User interface of Effection's web page*

STRUCTURE AND MATERIALS



1. Lighting plan

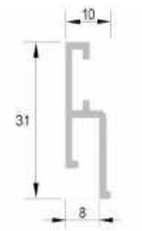
Figure 31. *Lighting plan of pre, during and post experience*

In order to achieve a uniform lighting effect, special attention was drawn towards detailing of the structure.
As for the lighting, on the far end of the structure is a highly translucent material with a 90% diffusion rate that serves as a stretch wall behind which is a series of RGBW LED modules that serve as the prime and sole source of light. This unique detail results in a consistent glow of light diffusing through the wall into the space where it is then reflected across due to the white paint on the surfaces.
When inside the space, the lights seem hidden and all that is visible to the naked eye is pure reflected light which seems to create an envelop of coloured air around.
The rainbow coloured shadows are achieved by flushing 3 dimmable RGBW LED panel lights inside the extreme opposite end of the wall with the green LED in the centre, only to strengthen the sharpness and colour variations in the rainbow

BackMatrix 49 RGBW Professional Nichia LED module 24V 4290lm 58.8W

White +RGB LED Panel Light
Power: 6W/9W/16W/24W
Beam Angle(°): 180°

Nereide translucent stretch ceiling
90% diffusion



stretch ceiling rail

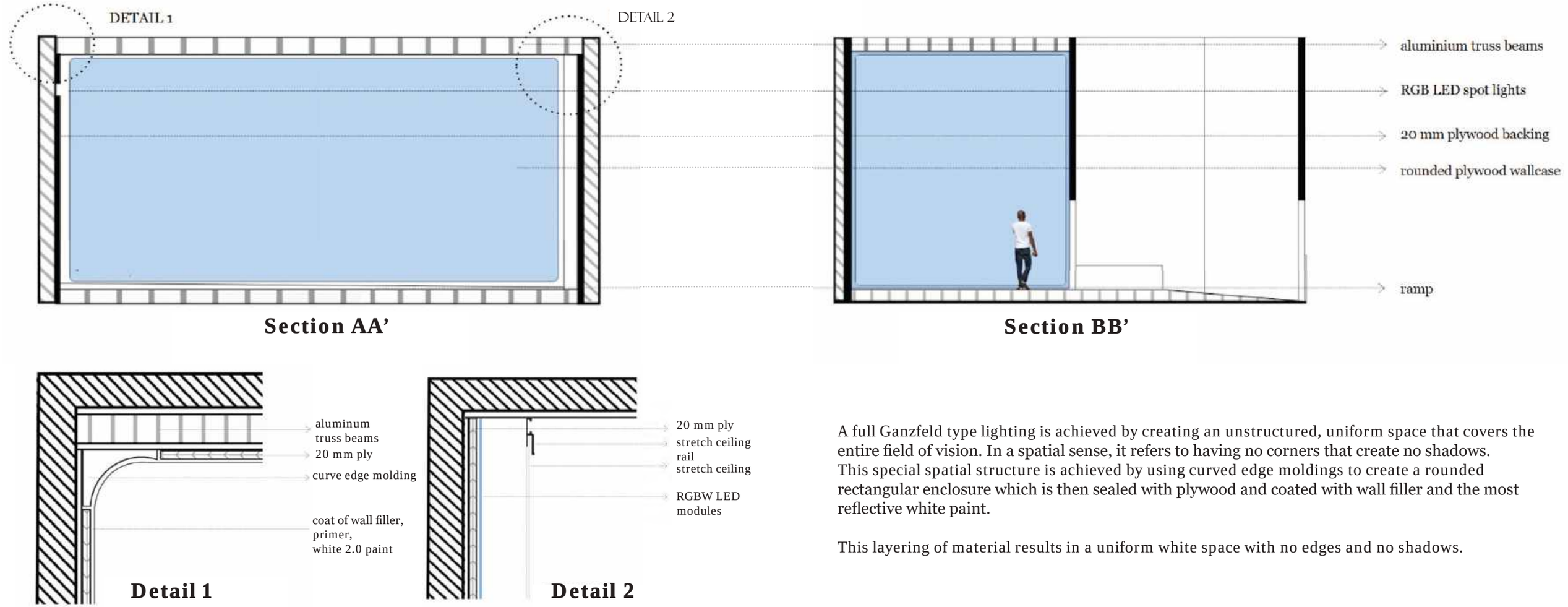
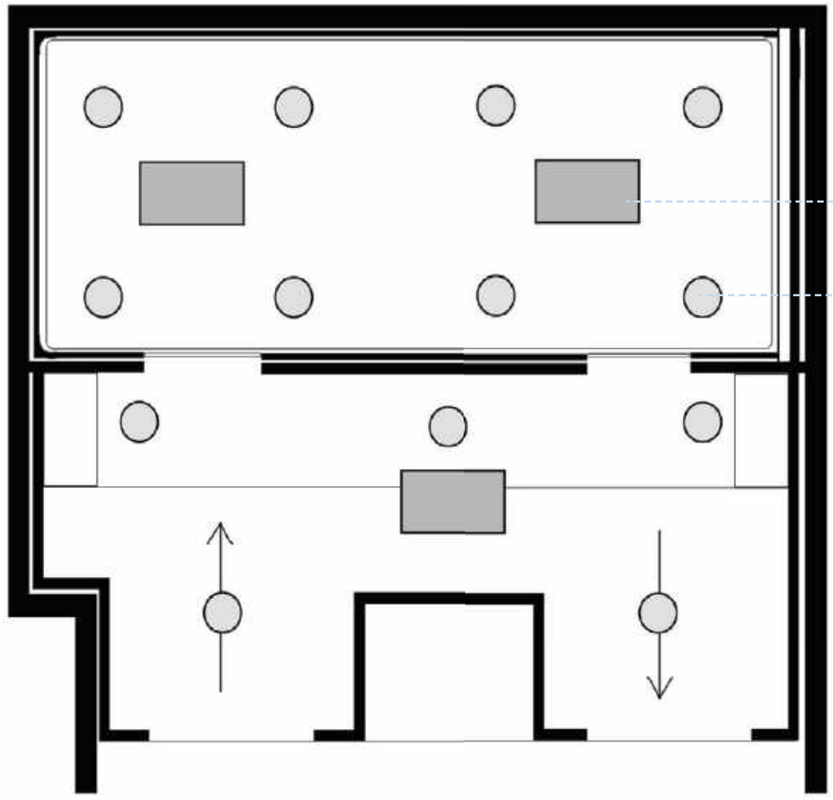


Figure 32. *Sections and details of built structure*

A full Ganzfeld type lighting is achieved by creating an unstructured, uniform space that covers the entire field of vision. In a spatial sense, it refers to having no corners that create no shadows. This special spatial structure is achieved by using curved edge moldings to create a rounded rectangular enclosure which is then sealed with plywood and coated with wall filler and the most reflective white paint.

This layering of material results in a uniform white space with no edges and no shadows.



2. Sound plan

Figure 32. *Sound plan of pre, during and post experience*

The soundscape is rather simple with a Bluetooth amplifier embedded under the plywood flooring, inside the aluminum ramp. The amplifier is connected to multiple audio exciters that are screwed onto the plywood flooring from under, creating ambient tactical vibrations that transmit throughout the entire space, resulting in a full experience.

Dayton Audio HDN-8 Audio exciter transducer

Nobsound G3 2 Channel Bluetooth 5.0 Amplifier Treble & Bass Control

COVID 19 COMPLIANCE

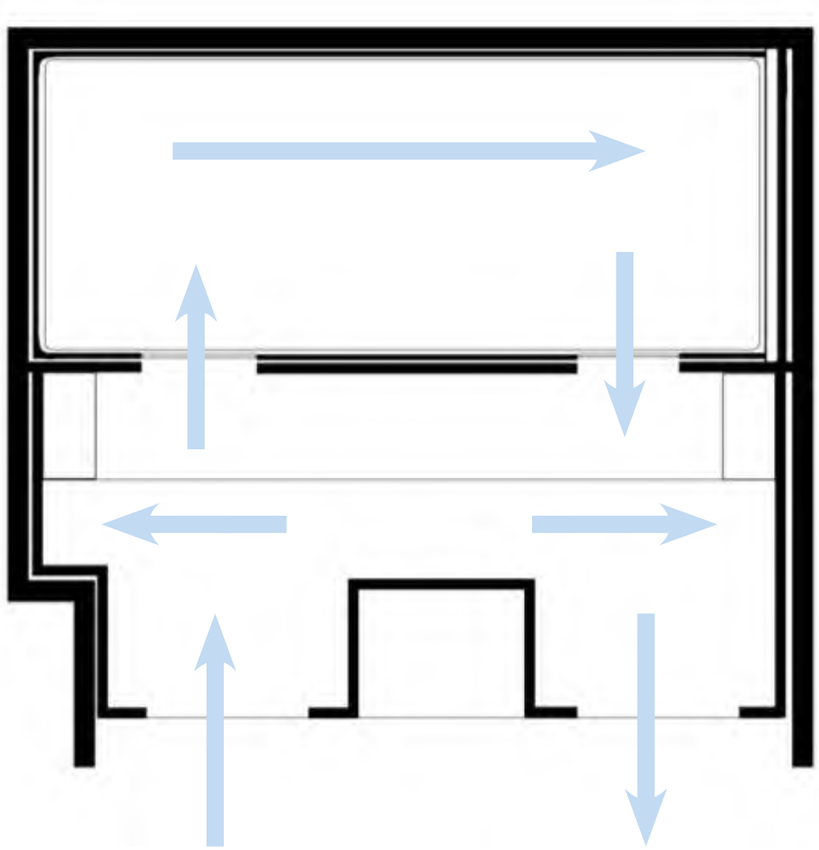


Figure 33. *Circulation plan depicting a Covid friendly design*

The Covid 19 Pandemic has changed the definition of interaction.
Private spaces and public spaces have had to undergo major restructuring and development. These modifications are here to stay until the foreseeable future.

Effection, as a design proposal during the peak of the pandemic has adhered to all Covid norms and regulations. The circulation pattern ensures no retracing of steps and since it is a single person experience, a maximum of 3 people would be in the space at the same time – the participant waiting for his turn, the participant experiencing the design and a staff member to ensure smooth movement and organization throughout.

The space also prioritizes accessibility and inclusion by means of smooth uniform ramps all around the built structure.

More so than anything, we have all witnessed unprecedented change this year and we have all come out even stronger than before. During this period, *Effection* serves as a medium for people to understand their heart's intuitive intelligence and power, adding as a reinforcement to the positivity with which we have all come out of this.

We will be more equipped to deal with change.

PROTOTYPING

1. Electronic setup and coding

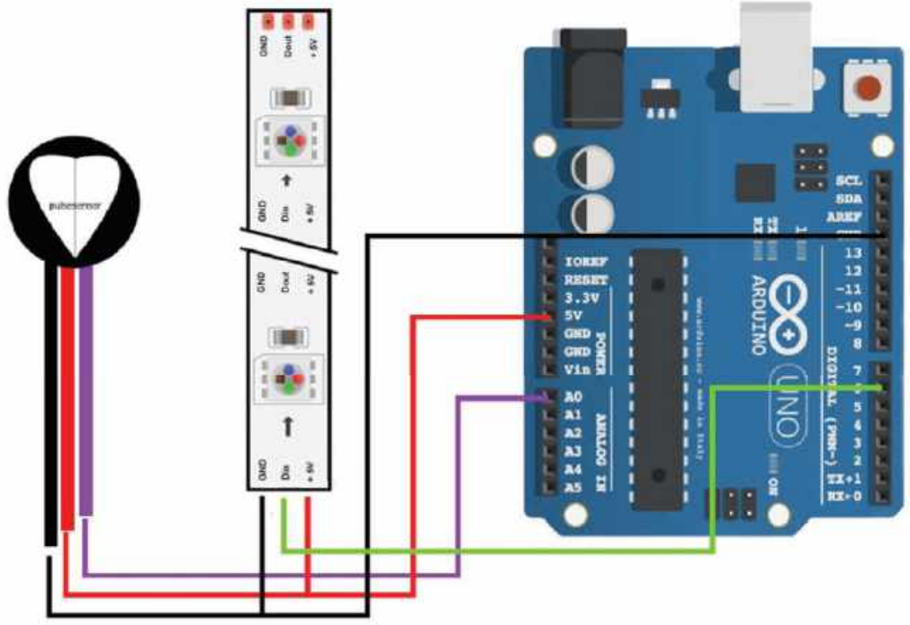


Figure 34. *Plan for electronics testing using Arduino, RGBW LED's and a pulse sensor module*

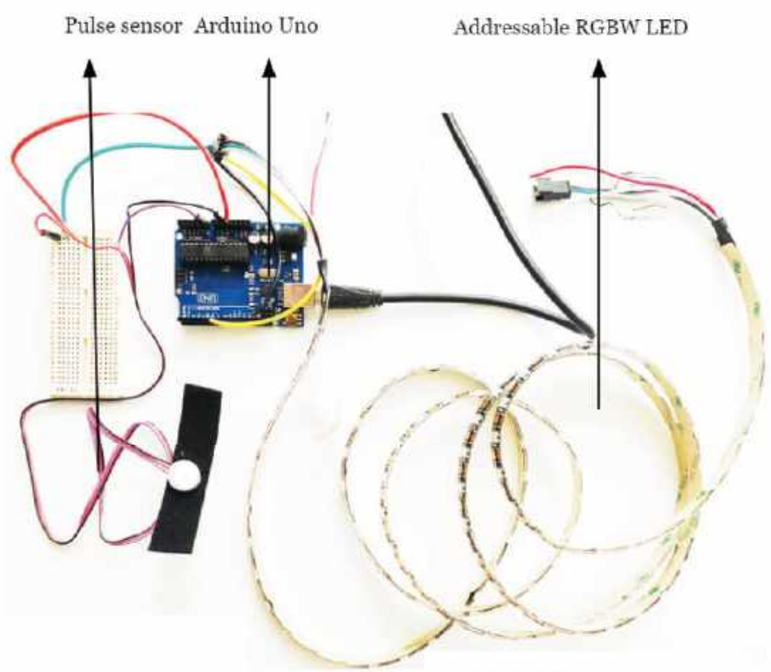


Figure 35. *Low fidelity setup of electronics testing using Arduino, RGBW LED's and a pulse sensor module*

```
#define USE_ARDUINO_INTERRUPTS true    //
#include <PulseSensorPlayground.h>     //

#include <FastLED.h>

#define LED_PIN 6
#define NUM_LEDS 120

CRGB leds[NUM_LEDS];

//  Variables
const int PulseWire = 0;       //
const int LED13 = 13;          //
int Threshold = 550;           //

const int Output_type = SERIAL_PLOTTER;


PulseSensorPlayground pulseSensor;  //


void setup() {
  pinMode(LED_PIN,OUTPUT);         //

  Serial.begin(115200);            //

  //
  pulseSensor.analogInput(PulseWire);
  pulseSensor.blinkOnPulse(LED13);       //

  pulseSensor.setSerial(Serial);
  pulseSensor.setOutputType(Output_type);
  pulseSensor.setThreshold(Threshold);


  FastLED.addLeds<WS2812, LED_PIN, GRB>(leds, NUM_LEDS);
  FastLED.setMaxPowerInVoltsAndMilliamps(5, 500);
  FastLED.clear();
  FastLED.show();

  //
   if (!pulseSensor.begin()) {
    Serial.println("Detected pulse");  //
   }
}



void loop() {

  delay(20);


int myBPM = pulseSensor.getBeatsPerMinute();  //
                                              //
 int myIBI = pulseSensor.outputSample();


if (pulseSensor.sawStartOfBeat()) {           //
 Serial.print("BPM: ");                        //
 Serial.println(myBPM);                        //
 // Turn all lights LIGHT BLUE
     for (int i=0; i<NUM_LEDS; i++){
      leds[i] = CRGB(100, 100, 255);
      FastLED.show();
      delay(10);
     }


 if ((myBPM)<55)   {          //
Serial.print("BPM: ");                        //
 Serial.println(myBPM);                        //
 // Turn all lights BLUE
     for (int i=0; i<NUM_LEDS; i++){
      leds[i] = CRGB(0, 0, 255);
      FastLED.show();
      delay(10);
     }

 // Turn lights from BLUE to VIOLET to MAGENTA
 for (int i=0; i<NUM_LEDS; i++){
  leds[i] = CRGB(10*i, 0, 255);
  FastLED.setBrightness(2*i);
  FastLED.show();
  delay(10);
 }

   } else {
    // Turn all lights OFF
     for (int i=0; i<NUM_LEDS; i++){
      leds[i] = CRGB(0, 0, 0);
      FastLED.show();          //
      delay(10);
   }

   // write the latest sample to Serial.
pulseSensor.outputSample();


 if (pulseSensor.sawStartOfBeat()) {
  pulseSensor.outputBeat();

 }

   if ((myIBI)>1200)   {          //
// Turn all lights WHITE
     for (int i=0; i<NUM_LEDS; i++){
      leds[i] = CRGB(255, 255, 255);
      FastLED.show();
   }
```

Figure 36. *Arduino code*

For prototyping purposes, I used a pulse sensor connected to an Arduino UNO which was further connected to a series of addressable RGBW LED strip lights.
The code generated not only the BPM (Beats Per Minute) but also the HRV (Heart Rate Variability) values which I then used as an input data into Maxmsp - a visual programming language to further experiment with the interactions

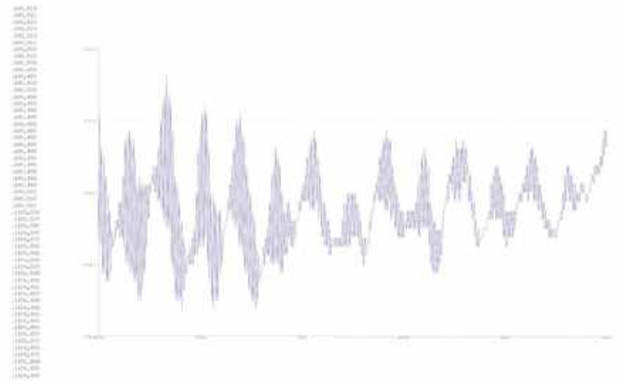
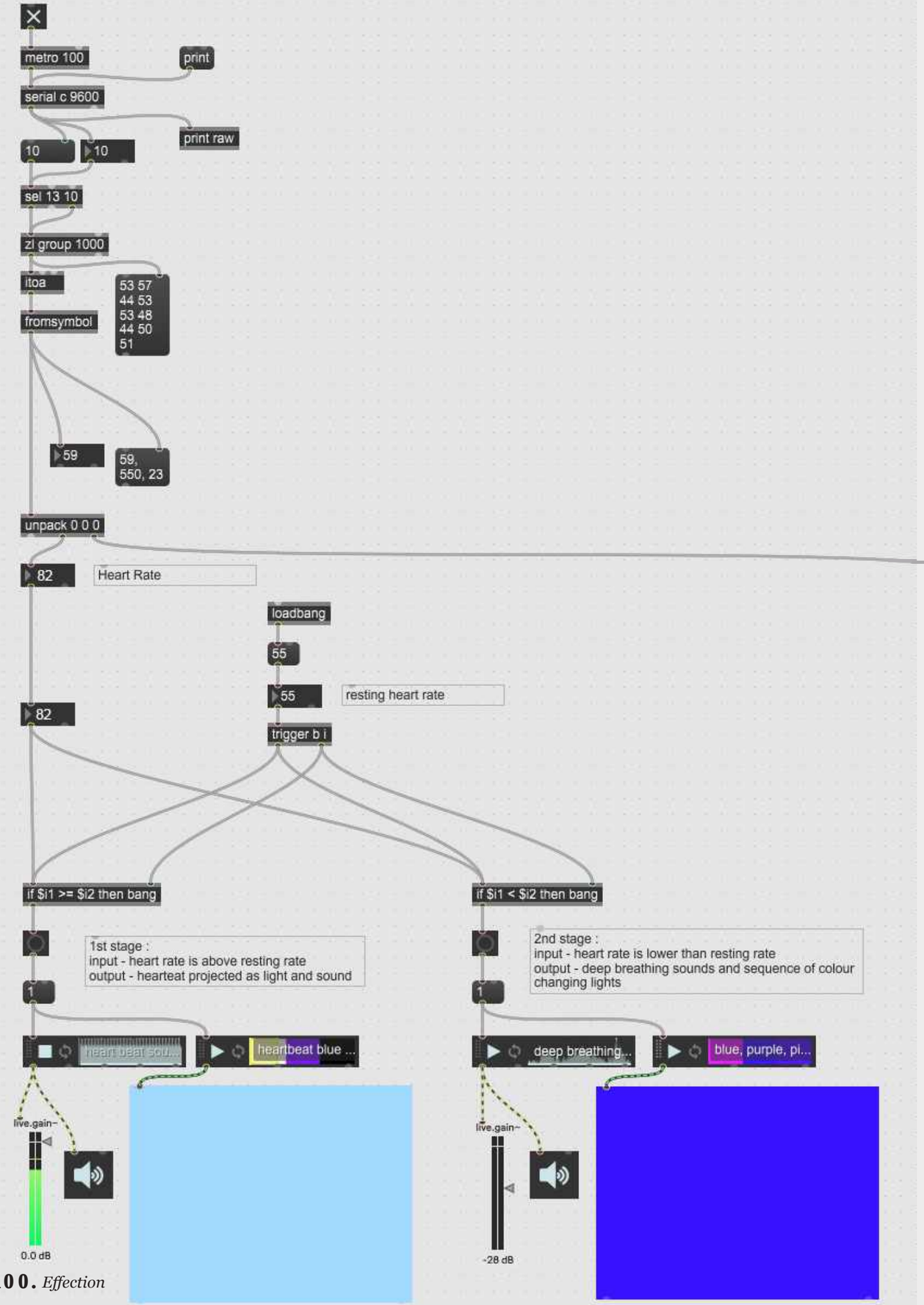


Figure 37. *BPM, HRV values and heart rhythm graph generated via code*

2. Coding and interaction

The patch created here uses the BPM and HRV/IBI values as an input data to further trigger a series of audio visual outputs.

1. When the BPM > = heart rate projected as light and sound
2. When the BPM < = deep breathing sounds and a sequence of slow changing colors from blue to purple to pink
3. When IBI < 1000 = plain white color increasing in brightness
4. When IBI > 1000 = harmonic music specifically designed to activate the heart area



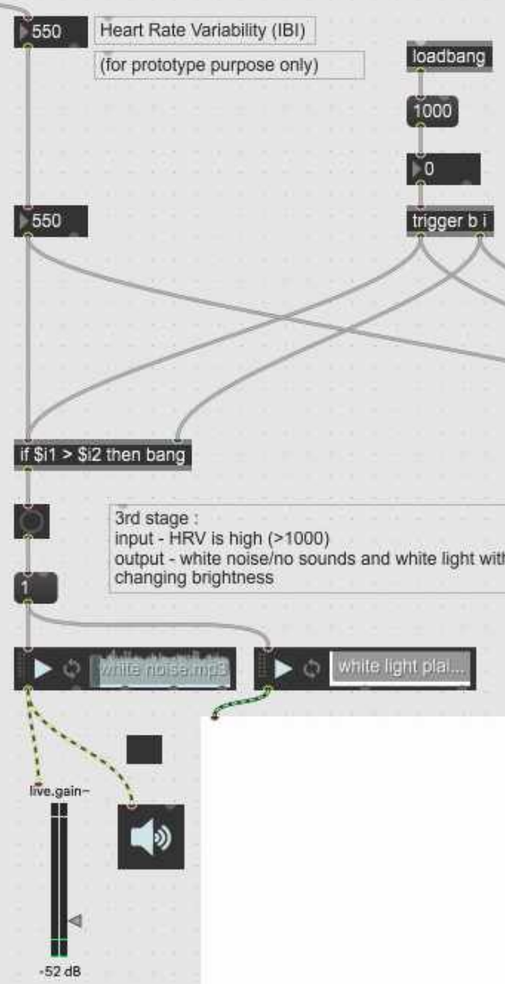
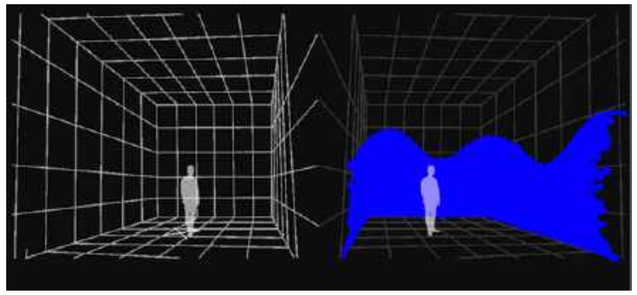
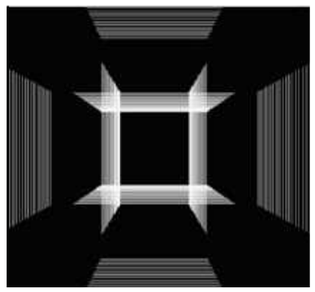
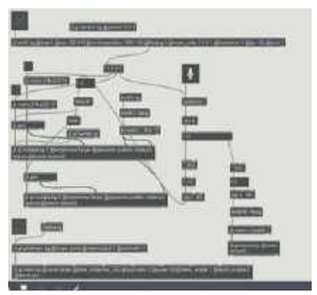


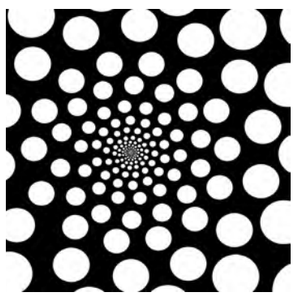
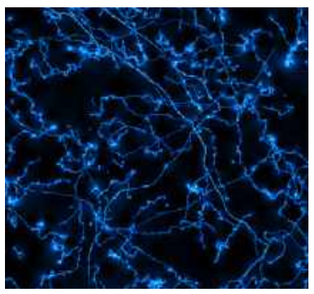
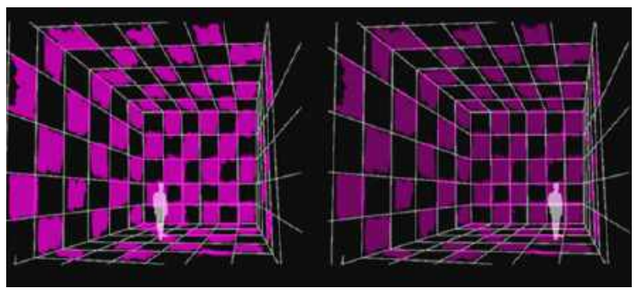
Figure 38. *Max patch*

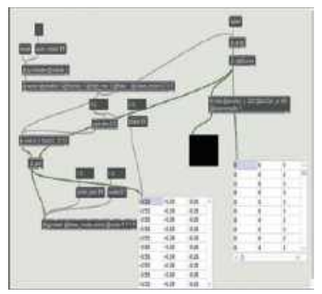
07

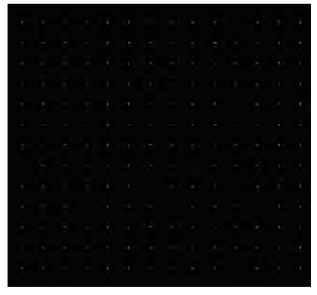
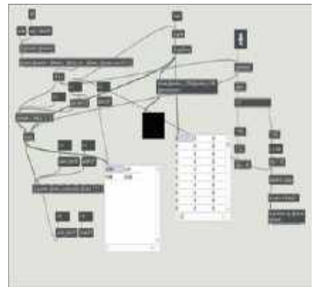
APPENDIX & REFERENCES

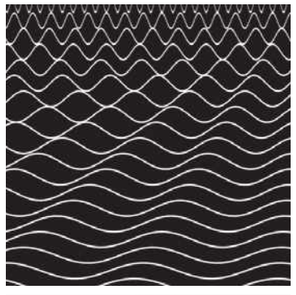
APPENDIX

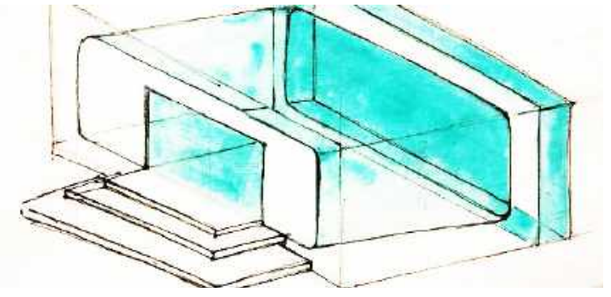
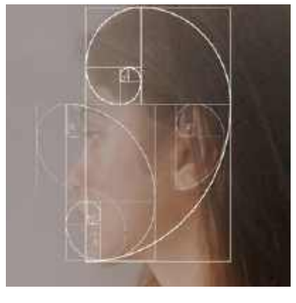




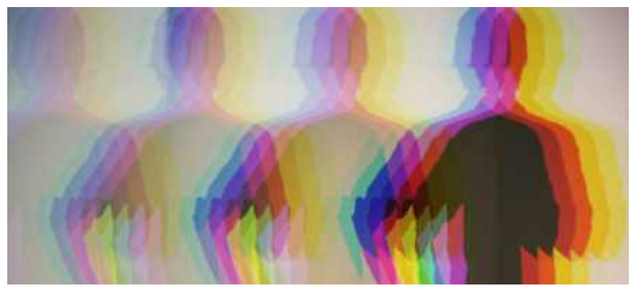
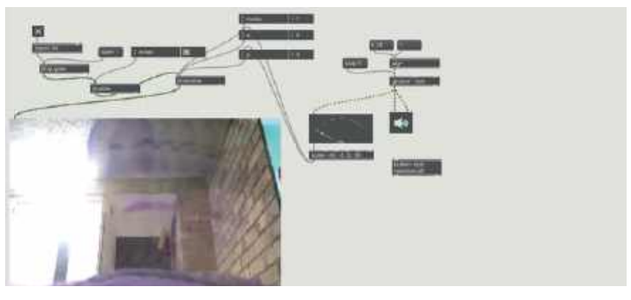
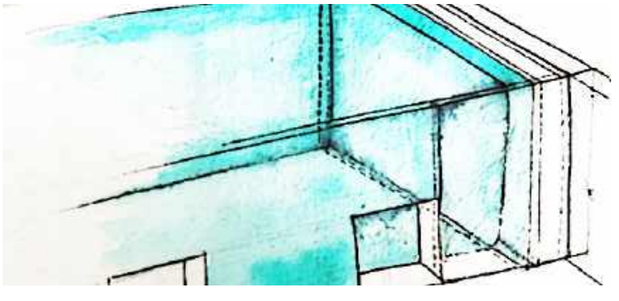








Concept - *connections between the human body and nature (Golden Ratio manifestations)*

Feedback - *to consider abstract representation of the manifestations*

Concept - *connections between the human body and The Universe*

Feedback - *to break away from the conventional representations of the cosmos and dig deeper to find the final layer of connection*

Concept - *connections between the human body and The Universe*

Feedback - *to use light as a medium to represent the connections*

Concept - *connections between the human body and The Universe*

Feedback - *to test different ways light could be used to symbolize that connection via an interactive media*

Concept - *connections between the human body and The Universe*

Design - *using different interactive softwares (MaxMsp, TouchDesigner) to test the interaction*

Concept - *connection between light and the human body*

Design - *using different interactive softwares (MaxMsp, TouchDesigner) to deepen the interaction*

Concept - *connection between light, emotions and the human body*

Design - *using different interactive sensors to test the interaction*

Concept - *connection between light, emotions and the human body using the heart as a medium*

Design - *using different light media, sound media, heart sensors and space design to portray the connections*

Figure 39. *The design development through the last 5 months*

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FUTURE WORKS

In the future, I would really like to take this project forward by using an Inner Balance Sensor for prototyping and testing in order to fully understand the intricacies of the interactions.
I would also like to visit Melbourne Museum and understand its spatial context in depth to be able to contextualize my built structure so that the experience is as homogeneous as I expect it to be.