SENSATION VS. PERCEPTION

A Study and Analysis of Two Methods Affecting Cognition

by

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Submitted to the Department of Architecture
In partial fulfilment of the requirements for the degree of

Master of Science in Art, Culture and Technology

at the

Massachusetts Institute of Technology

June 2019

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Abstract

In this thesis I discuss methods of projects that create cognitive effects that can be categorized into two situations: through *sensation* (outside stimulations/objective/bottom-up processing in neuroscience) or through *perception* (arousing background knowledge of inner mind/subjective/top-down processing in neuroscience). Similar effects can be reached through different ways. For example, to make something disappear, blending it into the environment through camouflage is changing the external stimulation, while a "lilac chaser illusion" is the result of influencing the retina and our brain.

I will apply research on human sensation and perception from two perspectives: the psychological (neuroscience) realm and the phenomenological. My research mostly focuses on theories of vision, current studies on physiological information processing in visual systems, and the phenomenological theories of sensation and perception according to Kant, Hegel, Husserl, and Merleau-Ponty. It also includes a conceptual framework for theories of perception, dreams, consciousness, imagination, and hallucination presented by Dennett, Windt, and Metzinger. I also explore case studies of artistic projects and discuss these in terms of the ways that controlling visual stimuli or influencing perception affects the ways we apprehend the visual. Practices that are famous for affecting and challenging human cognition, including light and space arts and opt arts, will be discussed. The artworks created by different artists, such as James Turrell, Ann Veronica Janssens, Richard Anuskiewicz, and Brio Gysin, will be discussed and categorized into either *top-down* (*sensation*) or *bottom-up* (*perception*) works of art based on the methodology used to affect audiences' experiences and cognition of their work.

Finally, I will also involve my own practice during past years in discovering the relationship between art and neuroscience, the outside stimulation and inside interpretation, the objectivity and subjectivity. Through this thesis, I will argue for an approach that allows for a new hermeneutics of seeing that ultimately enhances the viewer's capacity to perceive.

Thesis Supervisor: Judith Barry

Title: Professor of Art, Culture and Technology

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Acknowledgments

I would like to render my warmest thanks to my thesis supervisor, Prof. Judith Barry, for sharing her knowledge and wisdom to make this thesis possible. I enjoyed every single conversation with her.

I would also wish to express my gratitude to Prof. Caroline A. Jones for her insightful comments and suggestions on my thesis and my projects.

Great thanks to Mario Caro, without whom the thesis will not be possible.

Thanks to Renée Green, Gediminas Urbonas, Azra Aksamija, Nida Sinnokrot for the inspirations and guidance through my academic life.

Thanks to Marion Cunningham, Kevin Mclellan, Graham Yeager, John Steiner, and Chelsea Polk for the incredible supports in every semester.

Thanks to the Council for the Arts at MIT for the support and funding.

Thanks to my ACT fellows, Nicolás Kisic Aguirre, Nicolás Consuegra, Nolan Oswald Dennis, Laura Serejo Genes, Jessica Sarah Rinland, Pedro Zylbersztajn, Erin Genia, Zach Jama, Ringo Runzhou Ye, Gary Zhexi Zhang, Casey Tang, Luíza Bastos Lages, Matt Ledwidge, Nancy Valladares, Rae Yuping Hsu, and Ryan Aasen. It is a great pleasure to meet these amazing brains and warm hearts.

Thanks to Takatoshi Yoshida and Koichi Yoshino. It was a lot of fun to work with them.

Thanks to Xuenan Ni, my roommate of three years, for the food and fun we had together.

Thanks to Debarun Dhar, for being there whenever I need his insightful suggestion.

Finally, I would like to express my deepest gratitude to my parents, for their endless love and unconditional support.

1. Introduction

Towards a New Approach to Perception

The long history of research on sensation and perception conducted by scholars, from the ancient Greek philosophers to the modern neuroscientists, has provided us with a huge body of knowledge to think about how we experience the world. Studying how we sense and how we perceive is undoubtedly important in the art world, because

> Art constitutes a powerful stimulus and response to such sensory possibilities, allowing us to try on concepts, experiences and altered states and providing cultural space for debates about the merits (for example) of a temporary, visually induced schizophrenia, or an aesthetic stimulation of 'the smell of fear.'[1]

There are also sufficient artists that focus on affecting the sensory and perceptual consciousness to create unique and illusionary experiences for the audience, like James Turrell, Julia Voss-Andrea, Brio Gysin, etc.

The process of sensation and perception are often combined. These two activities are discussed together due to the difficulty in distinguishing them under many circumstances. (Schiffman, 1990). But in this thesis, I would like to separate and distinguish these two processes in order to propose a new approach to engaging and producing art. Therefore, I will claim that projects that create effects on an audience's cognition can be, and should be, categorized into two strategies: through an emphasis on *sensation* (outside stimulations/ objective/ bottom-up processing in

[1] Jones, C. A. (Ed.). (2006). *Sensorium: embodied experience, technology, and contemporary art*. MIT press. P5.

neuroscience[2]) or through a focus on *perception* (arousing background knowledge of inner mind/ subjective/ top-down processing in neuroscience).[3] We use art as a powerful stimulus to our mind, while similar effects can be reached in different ways. Analyzing and identifying the methods used to influence consciousness may help artists to achieve their ideal presentation and help viewers with reflections on the potential influence of the works. Art is an intuitive representation of the world, allowing the viewer to see how artist recognize the world around them. Separating the sensorial process from the perceptual approach enables artists to apprehend the world more thoughtfully. This approach also benefits the viewers. With a clearer idea of the two cognition-influencing methods and hence more self-awareness, the viewers can have a more insightful appreciation of some artworks, they will be better skilled at perceiving.

Sensation and perception of the world of observing

Before navigating through the issues, we need to clarify some terminology. Providing adequate definitions can be tricky since there are multiple definitions and explanations of the term sensation and perception, especially perception. Given the multitude of definitions of these terms, my intention is to define these in a way relevant to my discussion. Sensations are usually considered to be processes that are necessary for detecting the existence of something in the world. Sensations align with transduction, which is the conversion of physical, electromagnetic, auditory, and other information from the external environment to electrical signals in the nervous system. For instance, a sensory process might be detecting the intensity and color of the

[2] Bottom-up processing is also called data-driven processing, which refers to object recognition by parallel processing and feature detection. The brain takes sensory stimuli and combines them together to create a cohesive image in order to recognize the object.

[3] Top-down processing is also called conceptually driven processing. It is operated by background knowledge and predictions that allow brain to identify the whole object and then tell the component based on the expectations.

light or loudness of a sound. Perception interprets this sensory information so that we can understand what we are looking at or listening to. Sensation is very basic while perception involves certain higher functions of our cognition. There is often a chapter on perception in basic cognitive psychology textbooks (Solso, 1998).

In this thesis, except for discussing the definition of sensation and perception according to specific scholars and researchers, I am using the traditional sense-data theory, which states that sensation is stimulation (raw data) from the external physical world that is quantifiable, but uninterpreted. Sensation is unfiltered and unprocessed until it enters the central nervous system (CNS). Perception is the process of assigning meaning to sense-data in the CNS (Quine,1966).

Thus, my definition of the category of *sensation-affecting (*or *bottom-up)* is the method of playing with the raw data of the physical world, changing the cognition in a more straightforward way, and the category of *perception-affecting (*or *top-down)* is the method of affecting the process of interpretation. Further clarification including the definition of bottom-up and top-down processing will be explained in the first section of chapter three (*How vision works: sensation, process, representation, and perception in the neurosciences*). Moreover, I will study in depth the visual sense when discussing the theoretical frameworks, analyzing the case studies, and creating projects.

2. Methodology

I will apply research, an analysis of case studies, and artistic practices in the exploration of visual sensation and perception. In chapter three, "Theoretical Framework: Stimulation, Sense, and Perception," my research will cover scientific studies introducing how receptors and neurons work to provide vision, and how we interpret the sensory stimuli presented by Huberman, Marr, and Chevreul. Meanwhile, phenomenological approaches taken by Kant, Husserl, and most significantly, Merleau-Ponty, are also discussed. Merleau-Ponty's analysis of perception as an unreflected experience had been originally proposed in the nineteenth-century context. He describes how visual impressions are reduced and fixed in order to limit what we perceive. (Merleau-Ponty, 1964)

Also, in chapter three, selected works of a number of light and opt artists are analyzed as examples of the two methods I am investigating. These studies begin with detailed descriptions of how these works appear within their respective discourses. Then I try to categorize the projects into either *sensation-affecting (*or *bottom-up)* or *perception-affecting (*or *top-down)*. Projects categorized into the *bottom-up* group are using the *sensation-affecting method*, which is manipulating the physical world structures and changing the stimuli received by the primary neural receptors. Projects categorized into the *top-down* group are using the *perception-affecting method*, which is affecting the interpretation of the received stimuli to create an "illusion."

James-Turrell is one of the most important artists in my study. His art reveals a complex and relatively unknown cognitive process of seeing. (Edenso, 2015) Although his works are often described as "illusory" (Schuld, 2006), some of his light arts, like *Perfect Clear (1991)*, and his Light

Hologram Series, are using *bottom-up* process (*sensation-affecting*). In contrast, I would categorize Gysin and Burroughs' *Dreamachine* (1961), which is a stroboscopic flicker device that produces frequent visual stimuli, as belonging to the *top-down* processing group because the "illusion" reported by the audience is created by the brain instead of raw external stimuli. Other artists are also discussed, such as opt-artists Richard Anuskiewicz and Julian Stanczak, who focus on the *top-down* processing method to trigger perceived illusory experience for audiences. The installations created by Ann Veronica Janssens and Julia Voss-Andrea are examples of *bottom-up* category through experimenting with shapes and materials.

Chapter four and five (Project I & II) include my personal artistic practice in representing physiological signals of mind, dream, and perception (*Project I: Resonance Ver.M*), and my attempt to make a visible structure invisible by manipulating the external physical elements (*Project II: Sisyphus*). Project I can be categorized as employing the *perception-affecting method*, while Project II is an experimental work completely using the *sensation-affecting method*.

3. Theoretical Framework: Stimulation, Sense, and Perception

How vision works: sensation, process, representation and perception in the neurosciences

In line with the methodological overview provided in the previous chapter, I will now begin to discuss the neuroscience of vision.

Vision can be said to be the process of discovering the structure of the world from images presented in front of one's eyes, a fairly complex process. The study of vision is not just about how photons bouncing from objects in the physical world stimulate the sensory neurons in the retina; it is also about how we extract and process information to form an internal *representation* of the world we are experiencing. In this section, I will discuss the visual *sensation*, *process*, *representation,* and *perception* from the perspective of cell biology and neuroscience.

Humans possess the amazing ability to sense and recognize varied light intensities, color, shape, depth, and movement, and then integrate that information to create a cohesive model of the world. Vision is a highly adapted sense. It is the only sense that has an entire lobe to process the information, and half of the human cerebral cortex is involved with this sense. To learn about vision, we shall first look at the structure of our eyes (Figure 1):

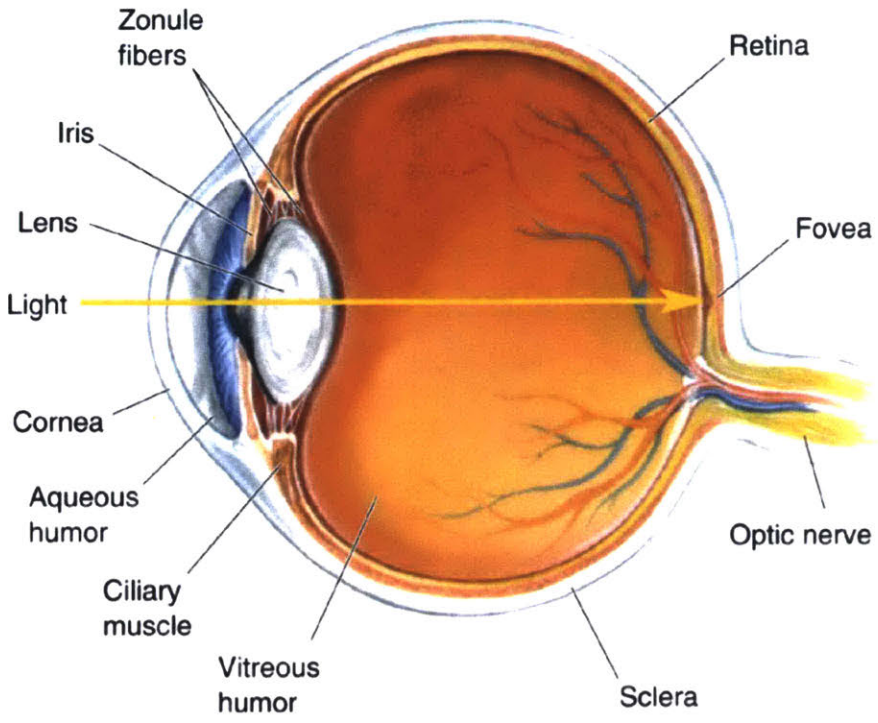

FIGURE 1 CROSS-SECTIONAL ANATOMY OF THE EYE. COPYRIGHT © 2007 WOLTERS KLUWER HEALTH | LIPPINCOTT WILLIAMS & WILKINS

The eye is a specialized optical device used to detect light in the form of photons. When one sees something in their eyes, light passes through the cornea, the aqueous humor, the lens, the vitreous, and then the retina. The retina is in the back of the eye composed of central nervous tissues and blood vessels. It is where incoming photons of light are converted to electrical signals.

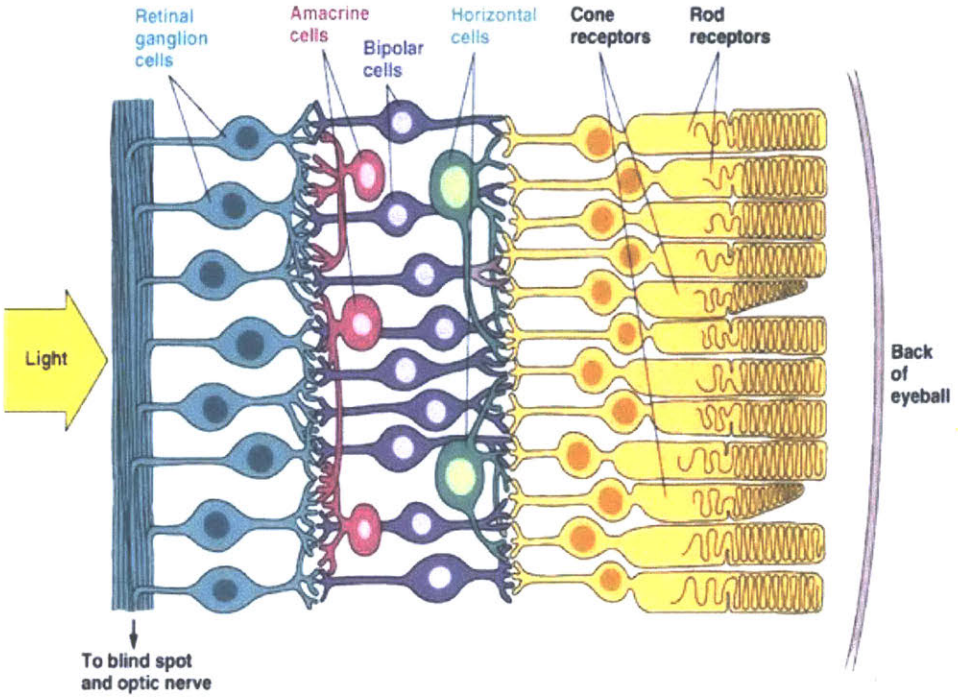

FIGURE 2 CELLS AND RECEPTORS OF THE MAMMALIAN RETINA. ARIZONA RETINA PROJECT: HTTPS://AZRETINA.SITES.ARIZONA.EDU/CONTENT/NEW-MOUSE-RETINAL-CELL-0

The retina contains two kinds of photoreceptors: cones and rods. Rods are specialized for detecting light intensity, and cones are specialized for detecting color. The connection between the rods and cones and the optic nerve fibers is not direct. There are five main classes of cells located in between (Figure 2). The photoreceptors (rods and cones) are the first layer of cells that fire signals when stimulated by photons. They then transduce signals to bipolar cells, which connect with ganglion cells. These two types of cells, adding amacrine cells and horizontal cells, collectively amplify, screen, and compress signals. Since the number of ganglion cells is less than that of photoreceptors, each ganglion represents a combined activity of many rods and cones. When information from photoreceptors is combined, the resolution and detail of the eye perception is reduced. Then via optical nerve the processed information is sent to midbrain

(Baccus, 2007). Then midbrain is treated to control eye movement and pupil size based on the retinal signals received. The input information resting on the lateral nucleus of the thalamus is visually perceived and sent to the visual cortex for further processing. Information about shadows, colors, relative motion, and depth is combined to provide our visual experience in the visual cortex (Huberman et al., 2008).

Through the visual pathway I describe above, we walk through the general steps from sensing the light to perceiving the experience. The cellular boundary line separating these two steps, in this thesis, is the photoreceptor. Once the photon hits the receptors on the retina the rest of the steps are active signal processing, which is the work of the central nervous system. In fact, the retina is considered part of the CNS. It is considered to be an out-grown brain tissue. Therefore, both changing the external physical light properties and affecting apparatus such as lens, pupil, and vitreous humor (if anyone can) could count as approaches to the *sensation-affecting* method. My project *Sisyphus* is an example, and so is Ann Veronica Janssens' aquarium series and James Turrell's hologram series. All these works make use of the refraction and reflection of the light to create interesting visual sense experiences. Further details are described in the following section of case studies in this chapter and chapter five.

After the light hits the retina, all the approaches are *perception-affecting*, except for the control of eye movement, lens adjustment, and pupil size. These activities are controlled by midbrain, which is part of CNS. But this process is categorized as sensation-affecting as it does not involve signal processing of photons. It is a process of altering the light that will stimulate the receptors, which is changing the external lights, in the eyes.

Instead of understanding visual processes through the interaction of biological cells, David Marr proposed a computational paradigm for studying the visual system. In his book, *Vision: A Computational Investigation into the Human Representation and Processing of Visual information*, vision is separated into "computational theories." The visual system is carrying out steps of computational goals following certain strategies, including "explicit naming, modular design, least commitment and graceful degradation." The first and secondary visual cortex is where you can learn about the so-called "illusory contours," which is the potential result of interaction between edge-detecting units and line-detecting or grouping units. These inputs sum at "contour neurons" in the secondary visual cortex (Marr, 1982).

Chemist Michel-Eugène Chevreul spent years investigating optical color mixing. He is considered to be the first to explain the concept of *simultaneous contrast* (or *chromatic induction*) in color perception. Chevreul found this question somehow by accident. He found that it is possible to reduce the number of dyes and still be able to produce a rich range of colors. What he did is to combine the thread of different colors by weaving them together, the resulting fabric appears to be a new color different form either of the color of the thread used. This is because the appearance of a color can be significantly affected by the color directly next to it. In 1839, Chevreul introduced his law of *simultaneous contrast*, and defined it as: "two adjacent colors, when seen by the eye, will appear as dissimilar as possible"[4] (Chevreul, 1967). In addition to the development of the textile industry, this law penetrated to the world of art and later influenced the movement of impressionists, neo-impressionists, and orphic cubism (Olsson,2009).

[4] Stromer, K., & Baumann, U. (1996). *Color Systems*. Trans. Randy Cassada. Konstanz: Regenbogen Verland Klaus Stromer. Germany. P73.

Pointillism was a neo-impressionist painting style inspired by the theory of *simultaneous contrast*. After studying Chevreul's Principles of Harmony and Contrast of Colors (1839) Georges-Pierre Seurat started to draw with dots of pure color and provide striking image with this technique. The same theory and technique was later applied to inkjet printing.

FIGURE 3 GEORGES-PIERRE SEURAT.(1887 - 88). *PARADE DE CIRQUE/ CIRCUS SIDESHOW* [OIL ON CANVAS]. 99.7 X 149.9 CM. METROPOLITAN MUSEUM OF ART, NEW YORK, NY.

FIGURE 4 DETAIL OF *PARADE DE CIRQUE/ CIRCUS SIDESHOW*.

The oil painting *Parade De Cirque* (*Circus Sideshow*) (Figure 3) is one of Seurat's most famous painting because it is the first painting for him to draw a night scene (Thomson, 2017). The leading color of the painting is perceived to be purple, blue, and green. However, the orange dots are substantially applied in the picture, which does not affect our perception of the dominant color, but they created a perception of warm, soft light when we look at the whole picture.

Other than painters, the idea of *simultaneous contrast* in color perception also interested gestaltists, people who study gestalt psychology. Gestalt theory was founded in 1910 by Max Wertheimer, Kurt Koffka and Wolfgan Köhler, three German psychologists (Behrens, 1998). It provided the foundation for modern perception studies in both psychology and philosophy. It is an attempt for the mind to form a global whole governed by the law of prägnanz. The basic idea

of the principle is that our brain prefers order to chaos, which implies that our brain understands and interprets external stimuli as a whole rather than many little parts. This is part of the theoretical basis of my *perception-affecting* method. Sometimes the experiences we perceive are results of prediction, not stimuli. Gestalt psychology is also the theoretical base for Rudolf Arnheim's *Visual Thinking* (1969). In this book, he defies the traditional split between seeing and thinking, and the higher status of thinking compares with seeing. He argues for involving all mental operations, including memory, thinking, and learning, in process of perception.

Phenomenology of sensation and perception

Having discussed some of the theories that attempt to describe the processes of visual sensation and perception, I will now turn to a discussion of phenomenology in order to consider vision from a philosophical perspective. The physiological study of sensation and perception is an objective exploration of the quantifiable data and signals, while the study of phenomenology is the study of more subjective examinations of experiences in response to our world. Therefore, phenomenology is not only developed within philosophy but also as an important subject in psychology. Subjectivity cannot be discarded when we are discussing sensation and perception of people.

In the Oxford English Dictionary, phenomenology is defined as:

> 1. a. *Philosophy*. The metaphysical study or theory of phenomena in general (as distinct from that of being). Obsolete.
>
> b. The division of any science which is concerned with the description and classification of its phenomena, rather than causal or theoretical explanation.

2. *Psychology*. The methods of description and analysis developed from philosophical phenomenology applied to the subjective experience of phenomena and to consciousness, esp. in the fields of Gestalt psychology, existential analysis, and psychiatry.[5]

As its root meaning implies, phenomenology is the study of *phenomena,* which is the appearance of things, or things as they appear in our experience. It is a discipline, or methodology in some circumstances, (Giorgi ed., 1985) of studying the structure of experience, or consciousness, from the first-person point of view. Different from ontology, which is the study of being or what is, and epistemology, which is the study of knowledge, phenomenology has a rich history in the areas of philosophy, science, sociology, and even daily usage.

Here, I will offered just a brief look at the development of the term. In the eighteenth century, *phenomenology* meant the sensory appearances of the world based on observations and experiences. *Phenomenologia* is the Latin term of phenomenology and was introduced in 1736 by the German pietist Christoph Friedrich Oetinger to describe the system of the divine relationships among the things we can observe in the physical world (Oono, 2012). Subsequently, the term "phenomenology" was first used in philosophy by the Swiss mathematician Johann Heinrich Lambert for naming his "doctrine of appearance,"[6] the appearance based on empirical knowledge to distinguish it from the subjective illusion and error of objective surfaces. Lambert took his study of optics and photometry as a phenomenological discipline and thus his

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[5] Dictionary, O. E. (2018). *Oxford English dictionary*. https://en.oxforddictionaries.com/definition/phenomenology *Retrieved Dec, 26, 2018*.

[6] In the preface of Lambert's *Neues Organon (1764)*, he called phenomenology "the doctrine of appearance," according to James' translation.
James, G. A. (1985). Phenomenology and the study of religion: The archaeology of an approach. *The Journal of Religion*, 65(3), 311-335.

philosophical and physical works are often connected. (Mishchenko, 2014) Later he started to correlate his theory with Immanuel Kant, who is the first person to work on a phenomenological approach to epistemology. According to Henry E. Allison, Kant pushed the theory of perception from theocentric-based to anthropocentric-based, which means we see things from our first-person perspective instead of from a God's perspective. To Kant, our experience is based on the perception of the physical world and *a priori* knowledge. The human mind is both passive and active. It is passively receiving the sensory inputs from the external objects, and it is at the same time actively understanding the concepts from the perceived phenomena and synthesizing them with comprehension. (Rockmore, 2011) (Allison, 2004)

In 1807, Georg Wilhelm Friedrich Hegel wrote The *Phenomenology of Spirit* (or *The Phenomenology of Mind)*. Hegel thought that our experience of the world is not an instant action but mediated through knowledge and cognition, following Kant's theory. He also discusses three levels of consciousness, of which *sense-certainty* is the first level, *perception* is the second level, and *force and understanding* is the third level. Hegel rejected what sense-data theorists[7] required--to recreate perception out of raw, uninterpreted sensa. He claimed that the immediate knowledge is not the "richest" knowledge. We can only know something we are experiencing through other richer forms of knowledge, which need the next levels of *perception*, and *force and understanding.* Sensation is thus a passive receiving process according to Hegel. Without the active process of shaping what we perceive, "All that it says about what it knows is just that it is"[8].(Rockmore, 1997)

[7] The term *sense datum* (*sense data*) is found by George Edward Moore, and Bertrand Russell.
[8] Hegel, G. W. F., Miller, A. V., & Findlay, J. N. (1977). Phenomenology of spirit. §91, p85

Although Lambert, Kant, and Hegel's works introduce the original idea of phenomenology, the establishment of the school happened years after. Franz Brentano used the term *phenomenology* to identify his "descriptive psychology," a classificatory science of mind activities fundamental to the self-evidence of inner perception. From there, Edmund Husserl, who studied with Brentano from 1884 to 1886, established the school of phenomenology (Smith DW, 2013) (Spiegelberg ed., 2012) (Moran, 2005).

Husserl defines sensation as intrinsically intuitive contents without any meaning, and perception is part of the process of interpretation of the meaningless contents. His definition is the same as the definition for the two terms in this thesis. So, this clarified the perceptual phenomenological feature that the mind of active subjects receiving same sensuous data can depict different contexts. Husserl integrates phenomenology with psychology through two elements in the "act of consciousness"[9]: a *matter* and a *quality*[10]. The *matter* of a mental act is the interpreted meaning that makes sense for the mind to recognize an object. The *quality* of a mental act is how the object is perceived by the subject body (Hopp, 2008). For example, believing a dress is in blue and black, and doubting a dress is blue and black have same *matters* but different *qualities*; while believing a dress is blue and black, and believing a dress is gold and white has the same quality but different matters, even though in the real world it is a same picture of the same dress[11].

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[9] Hopp, W. (2008). Husserl on sensation, perception, and interpretation. *Canadian Journal of Philosophy, 38(2),* 219-245.p221.

[10] Ibid.

[11] In 2015, a photo of a dress became viral on the internet. People argued whether the dress was blue and black or in gold and white. It is a typical example depicting how different people perceive with the same sensorial stimulation.

Husserl regards the process of sensation as passively accepting raw data which needs to be interpreted by intentional act (*matter* and *quality*) to form perception. Husserl's work has greatly influenced Maurice Merleau-Ponty and he agreed on and followed many of Husserl's theory, but the perspective on passive sensation is not included. Aside from holding that sensing is more than passively receiving outside stimulations, Merleau-Ponty shares with Husserl a belief in the creative receptive role taken by perception. The objects we experience around our subjective body are always related to "certain human intentions."[12] Thus, the influence of an individual's personal experience should not be ignored when one seems to be passively perceiving.

This idea of active perception also makes sense in the real world. If our mind is just passively receiving sensory stimuli, we cannot extract order, regular pattern, meaning, abstraction or interpretation of things form the world. We will not be able to form distinctive background knowledge that provides us with divergent aspects of thoughts from the same sensory stimulation. This idea of active perception is similar to Hegel's third level of consciousness (*force and understanding*). The difference is that Merleau-Ponty includes the active thinking then process of perception while Hegel put it at an ambiguous place that is between the passive *sense-certainty* and active *force and understanding*.

A simpler and more explicit example of the active perception is Ludwig Wittgenstein's famous rabbit-duck illusion. It is an ambiguous image from which people can recognize either a rabbit or a duck, interchangeably, when we when we try to change our mind and attention. The visual experience seems to change according to our switched prediction and attention, not according

[12] Reynolds, J. (2019, May 8). Maurice Merleau-Ponty (1908 – 1961), *Internet Encyclopedia of Philosophy*, Retrieved from https://www.iep.utm.edu/merleau/

to any alternation of the visual cue like color, shape, shadow, distance or movement (Reynolds, 2019).

FIGURE 5"KANINCHEN UND ENTE" ("RABBIT AND DUCK") FROM THE 23 OCTOBER 1892 ISSUE OF FLIEGENDE BLÄTTER

Therefore, we are not seeing merely the objective world. It is constrained by "a myriad of factors that ensures that the relationship between perceiving subject and object perceived is not one of exclusion"[13], so that the "perceiving subject" and the "object perceived" can match, and form an explanation that convinces ourselves (Reynolds, 2019). The relationship between the observer's body and the physical world thus should not be separated. As Merleau-Ponty wrote: "Inside and outside are inseparable. The world is wholly inside and I am wholly outside myself."[14] I agree with his idea that the perceiving subject and the perceived object affect each other. But in this thesis, I still insist on separating these realms with the terms "internal" (perception/ top-down) and "external" (sensation/ bottom-up). Here it should be conceived as a process involving factors, or causes, of the resulting cognition and consciousness. I am not separating the process after the

[13] Ibid.
[14] Merleau-Ponty, M. (2013). *Phenomenology of perception*. Routledge.P174.

factors (or causes) are sensed (or perceived) by an individual. Thus, I'm not against Merleau-Ponty's theory here.

Merleau-Ponty's view on the primacy of perception explains his view on dreaming. In his limited paragraphs discussing dreaming, Merleau-Ponty does not explicitly regard the waking perception as identical to dreaming. He just mentioned "the difference between perception and dream not being absolute"[15]. Against the conventionally granted opinion that dreaming is a "secondary or degraded perception"[16] compared to the waking perception, Merleau-Ponty implies that dream and perception are closely related. Time and space are anchored through the *lived body*. The body is the perceiver of all kinds of perception, or experience. Therefore, the dream is one mode of experience that binds to the "pre-thematic bodily anchor"[17]. (Morley, 1999) Here we suggest that dream is a form of pure perception, as external stimuli do not raise awareness so there is no (or minimum) sense data input.[18] Since the *lived body* is the perceiver of the experiences, each individual will perceive differently even when they are awake and facing the same stimuli input, not to say when they are asleep. This means nobody can share the experience of their dreams with another one since it is impossible to have people with the exact same background knowledge. This thought inspired my Project I: *Resonance Ver.M*, in which I experimented in multiple ways to share the experience of my dreams with viewer. I tried to connect the

[15] Merleau-Ponty, M. (1968). *The visible and the invisible: Followed by working notes.* Northwestern University Press. P6.
[16] Morley, J. (1999). The sleeping subject: Merleau-Ponty on dreaming. *Theory & Psychology*, 9(1), 89-101. P3
[17] Ibid.
[18] Here we do not consider the cases of affecting someone's dream by purposely introducing sensory stimuli such as light and sound.

experience of pure perception of two *lived bodies*. Further description about the artwork is in chapter four.

Neuroscience & Vision: Case Studies

Bottom-up perspective (sensation-affecting): change the outside physical world

James Turrell is famous for his experiments exploring light and perception. His early work focused on exploring the perceived experience of artificial lighting in indoor environments. His *Perfectly Clear* (1991) is one of his most well-known projects (Figure 6). It is a huge ganzfeld, which is a field without any edges and contours, or any familiar visual markers. In a ganzfeld, the entire apparatus of physical reality becomes unrealistic and unreliable. In the room, unstructured, uniform color areas are changing over time. Viewers will lose their sense of position and depth.

FIGURE 6 JAMES TURRELL. (1991). PERFECTLY CLEAR (GANZFELD). PHOTO BY FLORIAN HOLZHERR. MASSACHUSETTS MUSEUM OF CONTEMPORARY ART, NORTH ADAMS, MA.

Patrick Beveridge believes that Turrell's work creates a kind of hallucination that let viewers question whether they were experiencing an effect of their own retina, or whether they correctly identify a uniform colored light field at a distance from the eyes (Beveridge 2000). I agree that this work does include some *perception* factors, but uniformed sensory stimuli are still overwhelmingly more powerful than any other factors. What Turrell does is completely remove noisy stimuli like edges and visual markers so that viewers have lost all references for discerning and interpreting their depth and position. Meanwhile, he uses changing color lights to ensure enough photon keep activating the viewers' photoreceptors. In other words, he tries to remove all elements that would trigger a visitors' interpretation and perception while using the strong sensation stimuli to grab visitors' attention. Thus, I personally think this project worked more on sensation instead of perception, different from many people have been thought.

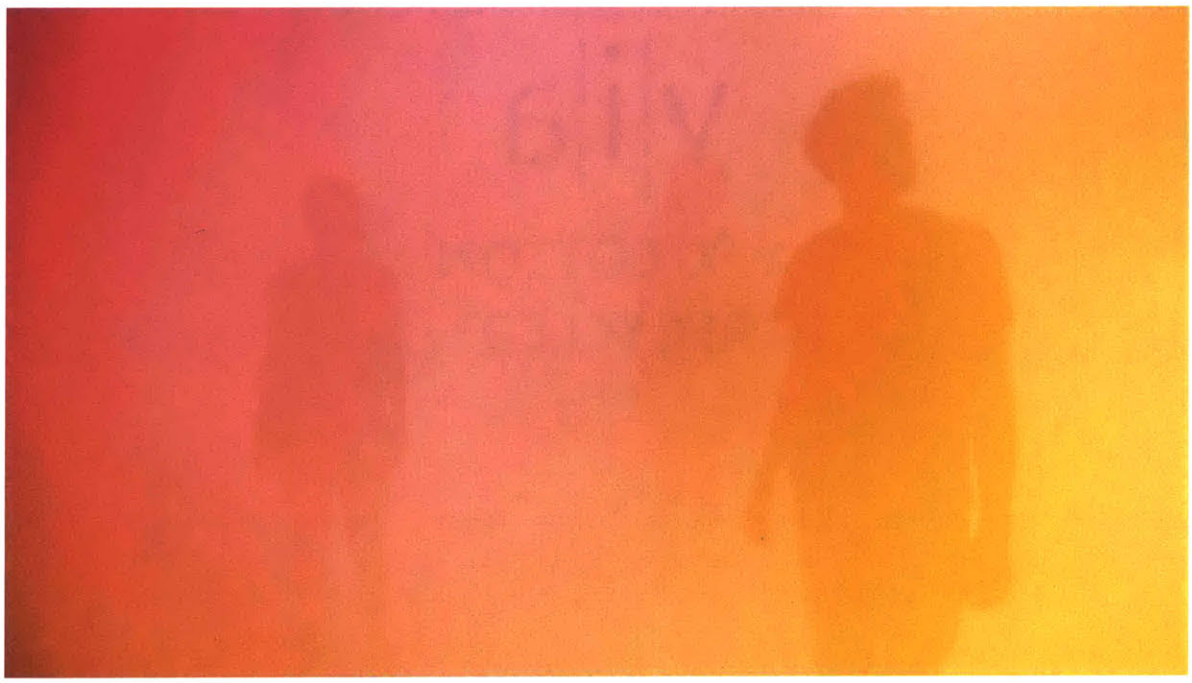

FIGURE 7 ANN VERONICA JANSSENS. (2015). *YELLOWBLUEPINK*. WELLCOME COLLECTION. LONDON.

The same idea applies to the mist sculpture created by Ann Veronica Janssens (Figure 7). The artwork is a space filled with illuminated dense vapor that makes the surroundings opaque. The media and practice are different from Turrell's work, but Janssens also created an immersive ganzfeld that deprives the senses of surface and depth from the audience.

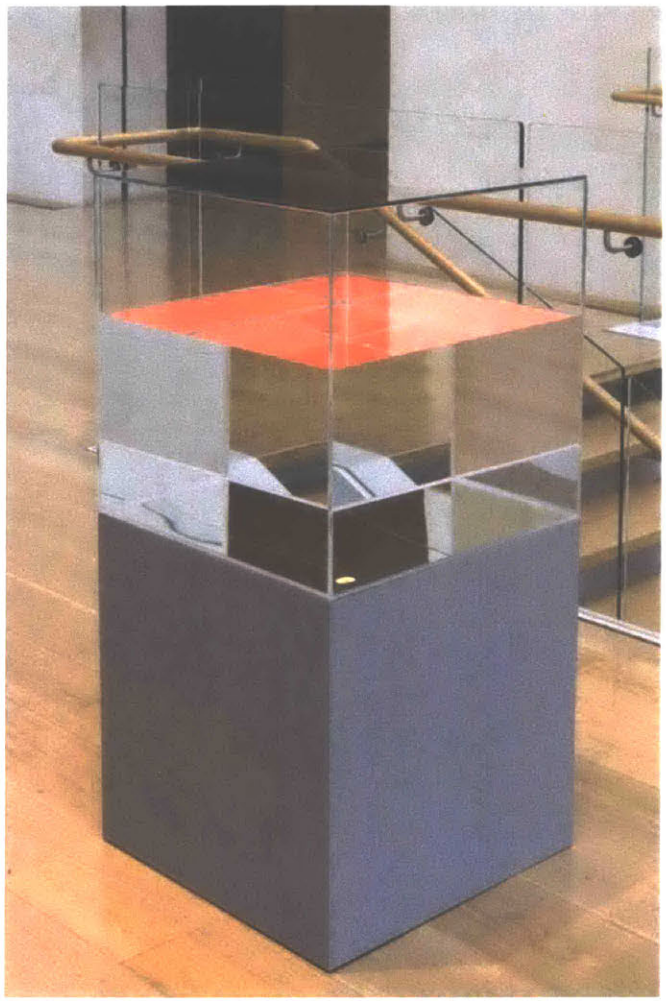

FIGURE 8 ANN VERONICA JANSSENS. (2010). *ORANGE 55*. GLASS, PARAFFIN OIL, FLUO SERIGRAPH, AND PAINTED WOODEN BASE. 55 X 55 X 55 CM, BASE: 55 X 55 X 55 CM. NASHER SCULPTURE CENTER, DALLAS, TX.

Embracing the idea of minimalism and being fascinated by the visual language of science, Janssens creates various kinds of artworks using space, light, and color to explore the sensory

experience. She works on expressing immaterial features of matter with different materials and plays with the physical phenomena though *sensation-affecting* method. *Orange 55*, one sculpture from her distinguishing aquariums series, is a great example. It is a glass cube filled with paraffin oil and a layer of serigraph on top of the liquid. The different physical properties of the paraffin oil, the serigraph, the air, the glass, and the painted wood created a confounding visual experience as they reflect and refract the light in different ways. Art critics often see Janssens as an artist working with viewers' perception, while I argue that most of her works are focusing on physical properties of the materials and hence influencing viewers' sensation. She does interesting experiments on the reflection and refraction of light and materials, which inspired me on my Project II: *Sisyphus*.

FIGURE 9 QUANTUM MAN, 2007. © JULIAN VOSS-ANDREAE.

The *Quantum Man* created by Julian Voss-Andreae is a result of his exploration of interpreting the dual form of an electron as a wave and particle at the same time under the theory of quantum physics. The figure is composed of many vertical, parallel steel slices. The sculpture seems almost to disappear from certain perspectives. This "disappearance" plays no trick with the interpretation of perception: the paralleled steel slices are thin when observed from the side position. The design of the figure is simple but strong; it also has a great expression of the dual nature of matter in the world of quantum physics. (Miller, 2014)

Top-down processing (perception-affecting): perception influenced by personal background

In the last section, I discussed the sensation-focused characteristics of some of Turrell's works. It does not mean that I disagree with the idea that his works do not have strong perceptive factors. His work *Hind Sight (Dark Space)* (1984), is an enclosed dark room with no light perceived, or that can be easily perceived, by viewers. The almost insensible dim light source is placed so that it is not "seen" by the viewers. Turrell expects an experience of "seeing yourself see" from this.[19] In this case, sensory receptors are not activated, and the attention is back to the internal mind. With the dim light, viewers trying to capture the weak stimuli may reinforce it in their perception process, which causes a level of "illusion." It is more *perception-affected.*

Turrell's artwork reveals the complex and relatively unknown cognitive processes of seeing. (Adcock & Turrell, 1990). Philosophers and scientists have had many debates on whether *qualia* are possible to study with scientific means. Fyodor Dostoevsky and? Erwin Schrodinger denied that consciousness can be accounted for by physics. David Chalmers also claims that physical

[19] This is described in the artist statement in Turrell's personal website retrieved on Jan 16, 2019: http://jamesturrell.com/work/type/dark-space/

sciences cannot explain qualia in his *The Conscious Mind* (1996). In *Shadows of the Mind* (1994), physicist Roger Penrose believes that ideas from quantum physics are needed for explaining consciousness. On the other side, Daniel Dennett believes that a science of consciousness is possible. Gerald Edelman, like many other biologists and neuroscientists, argues that consciousness is a biological phenomenon, at the same time he also rejects dualism in his books *The Remembered Present* (2001) and *A Universe of Consciousness* (2000). But from the perspective of a phenomenologist like Merleau-Ponty, all that a scientific text can explain is the particular individual experience of that scientist.

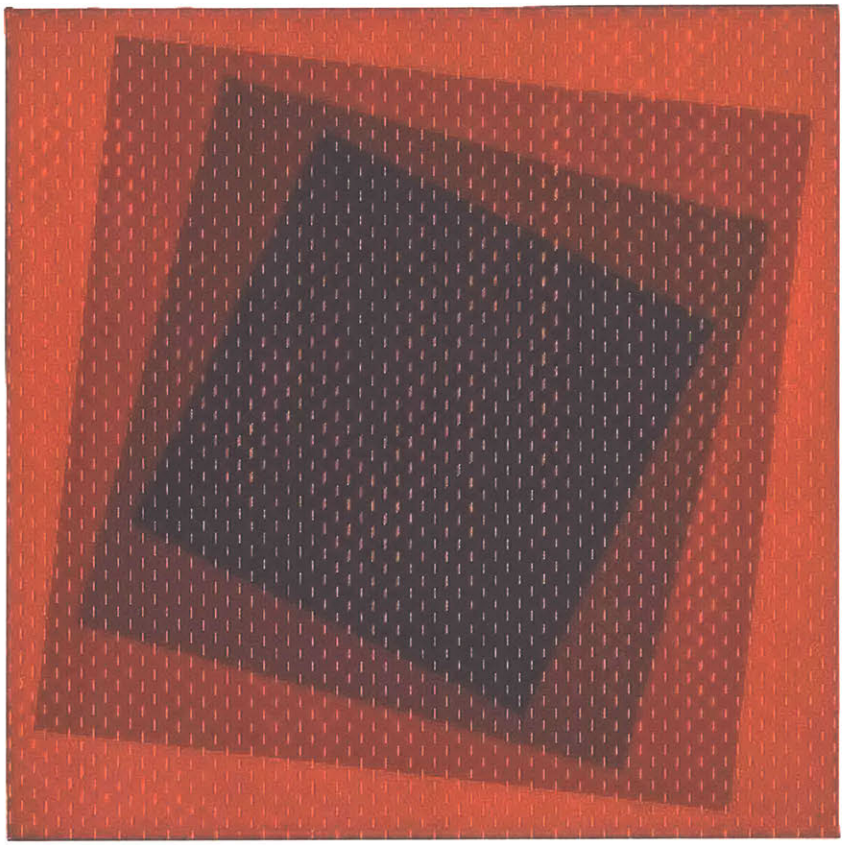

FIGURE 10 ACCUMULATIVE, 1975. © JULIAN STANCZAK.

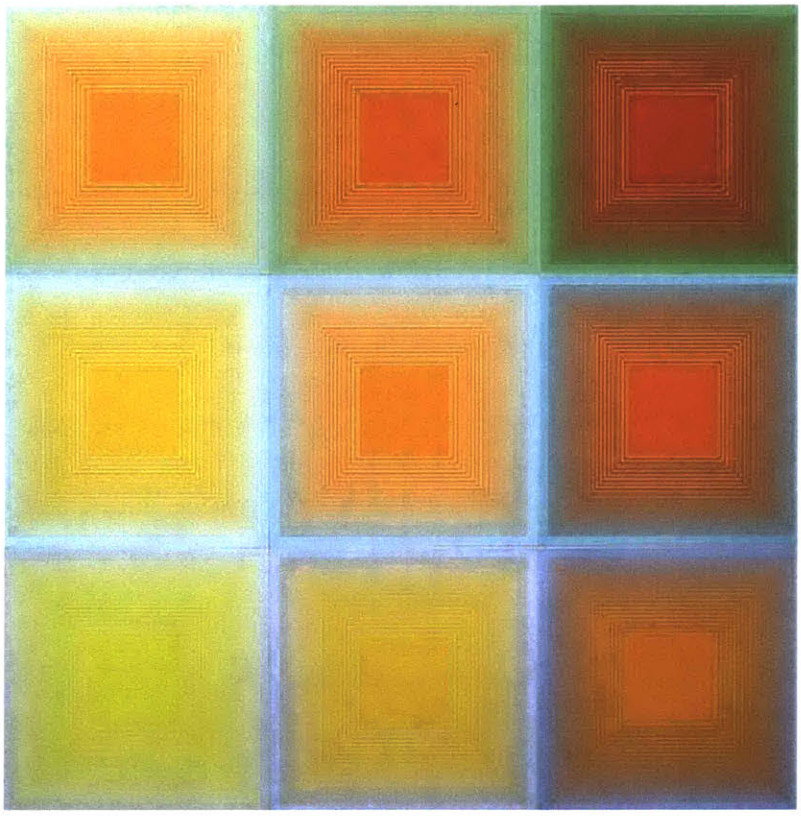

FIGURE 11 SPECTRAL NINE, 1969. © RICHARD ANUSZKIEWICZ. PHOTO COURTESY OF THE LOWE ART MUSEUM, CORAL GABLES, FL.

Richard Anuskiewicz and Julian Stanczak developed Opt Art. It exploits the fallibility of vision to create a sense of movement. This style of visual art aimed at triggering and making use of optical illusions. Many of their works are great examples for Chevreul's color phenomenological theory of *simultaneous contrast*, such as Stanczak's *Accumulative* (1975) and *Conservative Green: Minus* (1979) and Anuskiewicz's *Spectral Nine* (1969). The illusive images of Opt Art give the viewer the impression of movement, swelling, hidden images, wrapping, flickering or vibrating patterns. The scientific theory that backs the illusion created by this form of art is the top-down processing, a cognitive process that initiates with our thoughts, which flow down to lower-level functions, such as the senses.

Gysin and Burroughs' *Dreamachine*

Our consciousness and perception enable us to realize our existence. This topic is always fascinating since it is a mysterious area that requires wide interdisciplinary and transdisciplinary research, including art, neuroscience, philosophy, physics, psychology, etc. Thomas Nagel's idea of the consciousness of an organism is "that there is something it is like to *be* that organism".[20] Another important feature of consciousness is that it involves acts and each act has contents. Our emotions, our love, hatred, fear, doubt, desire, belief--they are all acts of consciousness. Many scientists and artists have researched the relationship between the physical world and our conscious experience.

In *The Doors of Perception: Heaven and Hell (2010)* Aldous Huxley described a state of hallucination induced by a stroboscope. It is a piece of equipment that can make the cyclical movement appear to become visually slow or stationary using certain frequency of flashes of light (A timing light). (Huxley, 2010) With this instrument, people can produce altered states of consciousness, which lead to the invention of the *Dreamachine*. The inspiration for this art project began with the invention of the electroencephalograph (EEG) machine by psychiatrist Hans Berger in 1929. Scientists and physicians used the non-invasive EEG to detect the electrical activity of the human brain. It was the first time that scientists visualized and quantified the invisible signal of the mind. Later, neurophysiologist William Gray Walter invented the toposcope in 1957, using 22 small electrodes attached to the scalp to depict the intensity and rhythms of brainwave signals in different areas of the brain (the frontal, lateral, parietal, and occipital lobes).

[20] Nagel, Thomas. "What is it like to be a bat?" The philosophical review 83, no. 4 (1974): 435-450.

In his book *The Living Brain (1957)*, he mentioned that the point of the device was to illustrate the complexity of behavior of the brain but at the same time to view the activity of the neurons in a simpler and more aesthetic way. This made the analysis of the relation between the physiological function and behavior become feasible in the context of cybernetics and systems theory. (Walter, 1953)

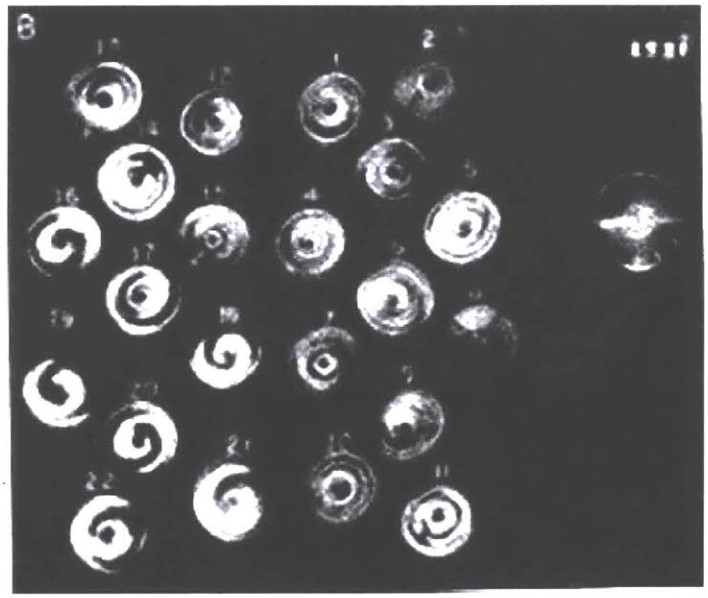

FIGURE 12. WALTER'S TOPOSCOPE

Welter's theory in his book inspired a lot of artists and scientists, including Brion Gysin and William Burroughs. The scientific foundation of the *Dreamachine* was based on Welter's finding that stroboscopes could produce visual hallucinations. People could experience non-existing, changing colors and geometric designs. Before that, the altered state of consciousness was considered achievable only with the help of psychedelic drugs.

The feeling of being in an altered state of consciousness (hallucination) is complex. It could include unreasonable or non-existing visual sensations and non-visual sensations such as

kinesthetics and cutaneous. It could be a combination of extreme emotional experiences, being confused, feeling pleasure or fear, losing the sense of time, etc. People could also experience complex narratives, everything was dreamlike. It is very subjective and hard for someone without an adept writing skill to describe the event precisely. But we could have a peek into that mind state from Aldous Huxley's *The Doors of Perception, Heaven and Hell (1954)*, in which he depicted his experience in the special states of consciousness (hallucination) induced by mescaline.

FIGURE 13 BRION GYSIN (LEFT) AND WILLIAM BURROUGHS FACING THE DREAMACHINE.

In 1961 Gysin showed the Dreamachine in Morocco, describing it as "The first art object ever made to be looked at with your eyes closed." [21] The cylinder-shaped installation was placed on a rotating turntable; it had holes along the sides and an internal light source. When the turntable rotated at a certain speed the light flickered at a constant frequency. The light was designed to be emitted at a rate between 8 – 13 pulses per second. The frequency corresponds to the alpha waves, the neural oscillation usually present at a relaxing state. When people experienced the machine with their eyes closed, the flickering lights stimulate the optic nerve and altered the brain's electrical oscillation, leading people into a hypnagogic state. Burroughs and Gysin's work then initiated the interest of many other artists like Tony Conrad and Paul Sharits.

The artwork also intervened with the direction of scientific research at that time. After the publication of *The Living Brain*, Walter's ideas were not immediately accepted by his colleagues. Aldous Huxley had encouraged the study of Walter's theories, but did not stimulate much interest. Through Allen Ginsberg, Gysin got connected with Dr. Timothy Leary, a clinical psychologist at Harvard University and director of the Centre for Research in Personality at that time, and showed him the *Dreamachine*. In May 1961, Leary wrote to Huxley, telling him that "we are trying out some of Grey Walter's ideas."[22] Walter's stroboscopic studies are still playing a role in the latest neuroscience research. In 2016, Prof. Li-Huei Tsai, the director of the Picower Institute for Learning and Memory in the Department of Brain and Cognitive Sciences at MIT,

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[21]Elena Agudio, http://static1.1.sqspcdn.com/static/f/693431/13118857/1310246062563/BOOK.pdf?token=pzqQP9kLwCdsT9ICLmzPF0gmyyE%3D. *Retrieved Dec, 26, 2018.*

[22] Haill, Luciana. "ICT & Art Connect: Revelations by Flicker, Dreamachines and Electroencephalographic Signals in Art." In *Proceedings Conference: AISB50, At Goldsmiths University, Volume: The Future of Art and Computing: A Post-Turing Centennial Perspective*. 2014.

presented a light-based technique that opened the door to an entirely new direction of research on Alzheimer's disease. The technique is simply a "Dreamachine" flickering at 40Hz to enhance gamma oscillation, which was found to be able to reduce beta-amyloid level significantly in the visual cortex of mice in the early stages of Alzheimer's (Iaccarino et al, 2016). This research is not directly related to the topic of this thesis, which is affecting cognition through sensorial and perceptual approach, but it is very interesting to see how certain repetitive visual stimuli can cause a physiological change in the brain without an active and meaningful interpretation. The reason for the beta-amyloid level to reduce remains unknown. Further studies are needed to confirm if this technique can promisingly relieve symptoms of Alzheimer's disease. If it does work, this can be regarded as affecting cognition through sensorial approach. Although this is not about art, it is still interesting to mention.

The Visual Sense of Presence: Deprivation and Creation

The *Dreamachine* I discussed above is not a machine that creates dreams. It is a machine that generates simple and constant flickers that induce a sense of hallucination. As mentioned in chapter three, we regard a dream as an ultimate version of perception, which is an experience without awareness of outside sensory input. Our sense of presence has been recreated in the mind. We cannot reach that stage while awake, but we still have many methods to influence our nature of presence and create an experience that is less real and more dreamlike.

Virtual Reality is a great way to use overwhelming information to affect people's nature of presence, the consciousness of being present at a place and of the relation between body and space. Many works have been made under this concept. Eg. Eric Siu's *Optical Handlers – Eeyee*

(2012) is an optical device that splits a users' vision into two and relocates it onto their hands. The extended vision allows people to observe the world from the perspective of the limbs.

The theory of telepresence was developed by Marvin Minsky. He described telepresence as operating objects in the real world through remote access technology. The Skype conference is one common example; video technologies give geographically separated participants a sense of being together in the same location. Or a surgeon using a computer to control robotic arms to do the operation, in this case, the operator has access to affect a remote object in the real world through televisual tools. (Minsky, 1980) Thomas B. Sheridan expanded Minsky's definition in his *Presence: Teleoperators and Virtual Environments.* The term telepresence was shortened to presence. Except for controlling real-world objects remotely, the term also refers to the effect of losing the awareness of one's physical position in the real world when people are immersed in the virtual environment and interact with it. (Sheridan, 1992)

Metzinger analogizes virtual reality with a dream, he notes the sense of presence realized in a dream is also "exactly what modern designers of virtual realities are trying to achieve" (Metzinger, 2009). Based on Metzinger's idea, Windt thinks dream and VR technologies are having a similar role in "illustrating the simulational nature of consciousness itself" (Windt, 2015).

The sense of immersion (created by changing the position of the screen from a further distance to the position in front of the eyes) can be powerful. Margaret Morse, Oliver Grau and Martin Lister described immersion as an entry into the image, where the existence of the screen interfaces is tending to disappear from user's sight. But Lev Manovich and Kaja Silverman argue that at the current stage of digital technology development, it is only a theoretical disappearance

of the screen since the physical existence of the screen is undeniable. From that, Silverman holds the idea that "vision is always a matter of mediation."[23] People can thus always see through the physical screen and actively get themselves immersed in the simulated world. This can also be noticed in some studies of the visual realism in VR. Sanchez-Vives points out that so far there is no convincing evidence to confirm that visual realism is an important factor contributing to the sense of presence. (Sanchez-Vives, 2005) In an experiment on studying the influence on subjective sense of presence by the visual realism of virtual reality, scientists displayed various levels of realism of various scenes (line drawings, without and with textures, and with photo-realism). At the end of the experiment, it was found that there was no significant differences of the heart rate of participants in each group. All of them showed a significant increase in heart rate when they encountered the simulated pit-fall (Zimmons & Panter, 2003).

The virtual reality I have been talking about is the form that disengages the viewers' vision from their physical space. The presence of the body is separated into two pieces: one is the physical body that remains in the material world, which is a "body that cannot see the world it occupies" [24] , the other is the electronic stimuli that fill the user's entire field of vision, making the user blind to the physical world, providing a new virtual environment for the user to achieve the manipulation of presence (Ross, 2006). In the rubber hand illusion performed by Botvinick & Cohen (1998) through manipulating the visual and tactile information (synchronizing a stroke with a brush), the feeling of the ownership of the hand was relocated to a rubber hand rather than the participant's real hand. It is a proprioceptive drift that relies on visual-proprioceptive

[23] Ross, C. (2006). *The aesthetics of disengagement: Contemporary art and depression*. U of Minnesota Press. P129
[24] Ibid. P131.

integration. This does not just happen on the hand; through virtual reality the ownership of the entire body can be shifted, and the original body can be alienated with mere visual and tactile stimulations (Slater et.al, 2009). This is just the manipulation of visual presence, what about other senses? What if (almost) all the senses are deprived and (almost) all input stimuli are removed?

The isolation tank: deprivation of sensory.

After talking about sense simulation and stimulation, I am going to discuss the deprivation of the senses in order to see what will happen to our perception and cognition if sensorial input is tuned down or removed. The simplest example of sensory deprivation is using blindfolds to block the sight or using earplugs to cut off the hearing. A more complicated and typical example of a device is an isolation tank, which was developed in 1954 by psychiatrist John Lily. It is a tank filled with a highly-concentrated magnesium sulphate solution at body temperature. The tank is lightless and soundproof. It is a device that can deprive all five senses of people floating inside. It has been used as a way of alternative medicine.

Researchers show that short-term sensory deprivation is relaxing and good for meditation, which will benefit the participants. However, this kind of situation for a long-term will also do harm, causing extreme anxiety, hallucinations, bizarre thoughts, and depressions (Sireteanu et al, 2008). In these sensory deprivation cases, there are no outside sensory stimuli (or minimalized sensory stimuli) taken by the sensory receptors. When these gates for connecting our inner mind and outside world shut, our *background knowledge* gets the highest level of attention and thus hallucinations can occur. This is pretty similar to, but less lively than, dreaming.

If long-term deprivation of sensations from healthy people that are used to receiving all sorts of sensory information has some of the effects described above, then what about those who are congenitally deprived of senses? Helen Keller lost her sight and hearing due to an unknown illness when she was only 19 months old.[25] Without vision and sound, she lost the two most important ways to sense the world and communicate with others. Thus, she relied on the tactile sensation of her fingers to learn most of things and developed her own system of metaphor – her unique ability to connect a concrete object to an abstract idea, and her language that assigns visual and acoustic stimuli to experiences of other senses. So, she feels the warmth on her skin of "sunshine," and she notices the vibration in her body caused by "thunder." According to Kleege, Kelly also offers a comprehensive phenomenology of her everyday sensory experience. She prefers to think that she reassigns her attention from sight and sound to taste, smell and touch in her daily life. Therefore, she always tried to represent her experiences with her sense of taste, smell, and touch in a natural way, in place of using abstract and mystical expressions that go beyond the perception of sensation. (Kleege, 2000) Moreover, she does not avoid talking about visual and auditory clues:

> *The velvet of the rose is not that of a ripe peach or of a baby's dimpled cheek. The hardness of the rock is to the hardness of wood what a man's deep bass is to a woman's voice when it is low. What I call beauty I find in certain combinations of all these qualities and is largely derived from the flow of curved and straight lines which is over all things.*[26]

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[25] Strictly speaking Keller is not a congenitally sensory derived case, but her senses were deprived at a very early stage, and she is a famous and typical model of the deaf-blind group as well as a writer. We can learn a lot from her words. (Plus, her book *The World I Live In* is in the reading list.)

[26] Keller, H. (2003). *The world I live in*. New York Review of Books. P6

She "feels" the world not just through her remaining three senses but also through reading, which means that she can "see" through other authors eyes. That becomes her knowledge and her background information for perception.

4. Project I: *Resonance Ver.M*

In the previous chapter, I discussed the visual sensory stimulation and deprivation, especially the stimulation created by virtual reality. I worked on a small VR game project called *D2* several years before, aiming at reading players' mental fitness and relieving their stress. We tried to affect the players' sense of presence and then designed to monitor their movement patterns in the virtual world for further analysis. However, currently I am not working on any VR projects, but the topic of my ongoing work is about dreaming, which I would like to claim it to be "(to some extent) an ultimate version of virtual reality" in my thesis.

Resonance Ver.M is an interactive video projection installation that allows the audience to have a peep into the artist's internal world. The project is the combination of a series of experimental executions including self-training, performance, EEG recording, interpretation of the bio-signal, subjective dream log, exhibition, and interaction. The artwork shows an approach to the investigation of the dreams and a new form of "Human-Human interaction" through electrophysiological signals. It also introduces an innovative form of interaction between the reality and dream world, the conscious mind and the unconscious brain.

People spend almost one-third of our lives sleeping and 15% - 20% of the sleeping time dreaming (Cauter et al, 2000). Dreaming has always been a fascinating topic for both artists and scientists for centuries, yet it is still a mystery of human cognition. Psychologists have come up with multiple theories of dreams without a concrete agreement, as Sigmund Freud described: "the theory of dreams has remained what is most characteristic and peculiar about the young science,

something to which there is no counterpart in the rest of our knowledge, a stretch of new country, which has been reclaimed from popular beliefs and mysticism."[27]

Since the 1960s, contemporary artists have been working on interactive arts through neural investigations to reposition the role of neuroscience in contemporary art, and at the same time redefine the interdisciplinary art practices neurologically. The *Dreamachine* discussed in chapter three is a typical example. It flicks at a frequency that corresponds to the alpha waves (8-13 pulses per second), which is the neural oscillation often present at a relaxing state. Nowadays, brain hacking gadgets are an unobtrusive part for artist, makers, and many other people who are not neuroscientists thanks to the easy accessibility of portable EEG sensor products.

People have more freedom in creating brain-computer Interactive projects with those inexpensive consumer-grade EEG devices. Projects have been done in brain signal visualization, performances wearing EEG sensors, installations triggered by certain mind stages, and brainwave interaction between two or more conscious visitors. However, so far there is no project paying attention to the interaction between two different mind states: conscious and unconscious. *Resonance Ver.M* is the first project that explores the potential of this type of uncommon interaction.

Exploring dreams and sleep intervention are themes found in many projects in contemporary art and human-computer interaction. Roberto Toro and Nathalie Regard created *80 Days in Dreams* (2014,) which is a sculpture of the sound simulation of Nathalie's dream during 80 days. Nathalie has been sleeping with an EEG sensor which recorded her brainwave activity while sound stimuli

[27] Freud, S. 1933. *Revision of the theory of dreams.* Standard Edition, 22, 7-30.

was used to induce dreaming. The signals collected in the 80 days were then transferred into sound waves and cut into a sculpture. *Essence* is a wearable system trying to achieve rehabilitation from nightmares by introducing odors in the REM sleep stage. It is an olfactory necklace that is wirelessly-controlled and provides olfactory senses when the wearer is asleep. (Amores & Maes, 2017)

The processes in the attempts of investigating new possibilities of brain-computer interaction also inspired many interactive projects focusing on the communication between the audience and their brainwaves. *Mutual Wave Machine* (2010) and *Measuring the Magic of Mutual Gaze* (2011) are both interactive neurofeedback installations that allow two visitors to experience shared brain activity. Participants are encouraged to achieve the stage of brainwave synchronization. The multimedia art installation *My Virtual Dream* (2013) designs a computer game in which players controls the modulation of the alpha and beta frequencies through neural feedback to of the mental states (Kovacevic et al, 2015).

Preparation before the recording night

Before the night of performance and recording, I spent 30 days writing a daily dream journal. This process helped me gradually in recalling clearer contents in my dreams over time. I also participated in a sleep study run by a joint research group from the MIT Computer Science & Artificial Intelligence Laboratory (CSAIL) and Massachusetts General Hospital (MGH) to get a personal sleep report. According to the report, an average of 18.4% of my sleeping time is in the Rapid Eye Movement (REM) sleep stage. A sleep intervention plan was created based on my pattern of occurrence of the REM sleep (dreaming).

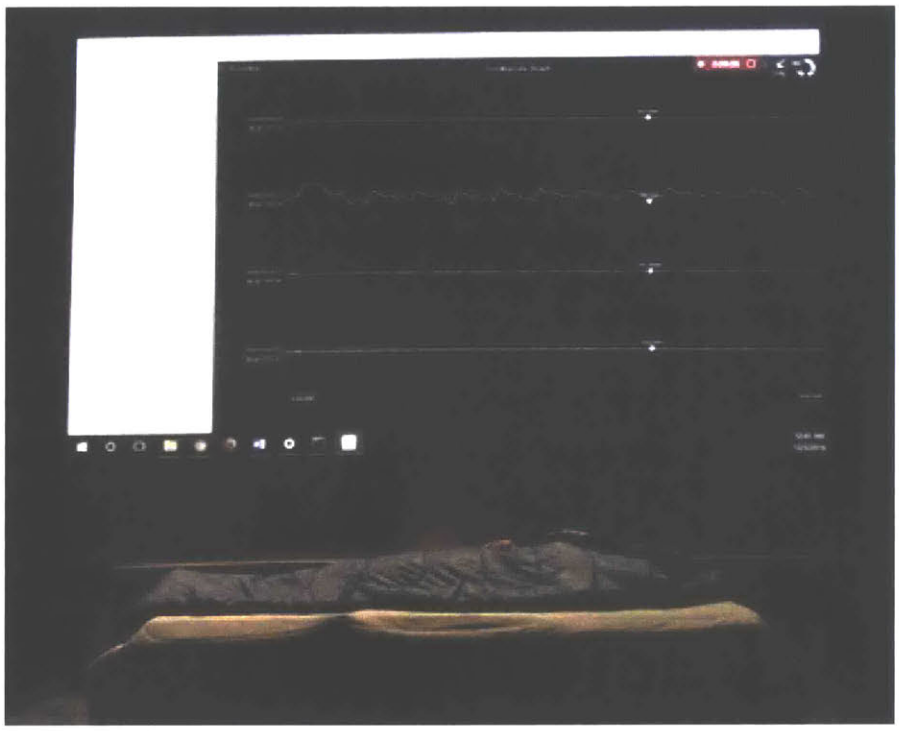

FIGURE 14. SLEEP PERFORMANCE OF THE RECORDING NIGHT.

The Recoding Night

On the day of recording, the entire process was live-streamed on Periscope as an online-performance. The MUSE EEG headset was used to track my brainwave activity while sleeping. I started to sleep at 0 am. The preset alarm rang every hour since 2 am. I woke up, wrote down the dreams I remembered, reset the EEG recording, and went back to sleep. This procedure was repeated for 6 times by 7 am. Four out of six times the dreams were remembered and recorded.

Dream Rebuild

The four pieces of dreams were titled Dark Cosmo, Monsters' Lunch, Acupuncture, and Dublin Coin. They were resumed through multiple operations. The samples of certain REM sleep periods were retrieved from the collected EEG data. The data was then converted into unreadable

Chinese characters by mapping and matching to the Unicode. This represents an objective interpretation of the dream.

The notes of the dream segments were written in Chinese for the sake of time-saving. Later they were translated into English paragraphs. Digital illustrations were created based on the notes and the lingering traces of memory of the dreams. Subjective modifications of the dream contents were applied in the creation of illustrations.

I forget what has happened.

It is a quiet, dark space, feel like cosmos.

Someone, maybe it's me, maybe not, sitting on a floating chair. A chair that has mixed candy colors and the shape of Lorenz's model of chaos.

Beneath the chair was a bondless, white, shining pond. I know it will turn into lava if I dropped. I never see it, but I just know it.

Maybe it happened before?

Maybe nothing has happened.

The translated dream plot of the first dream *Dark Cosmo*.

FIGURE 15. PART OF THE CHINESE CHARACTERS CONVERTED FROM THE DATA OF THE FIRST DREAM DARK COSMO

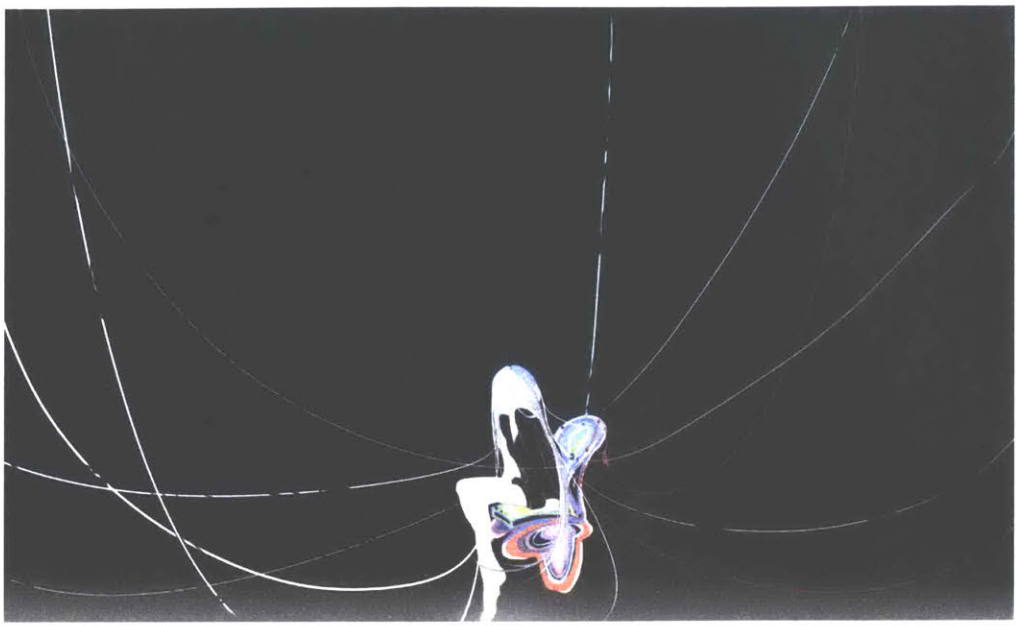

FIGURE 16. THE ILLUSTRATION OF THE FIRST DREAM DARK COSMO.

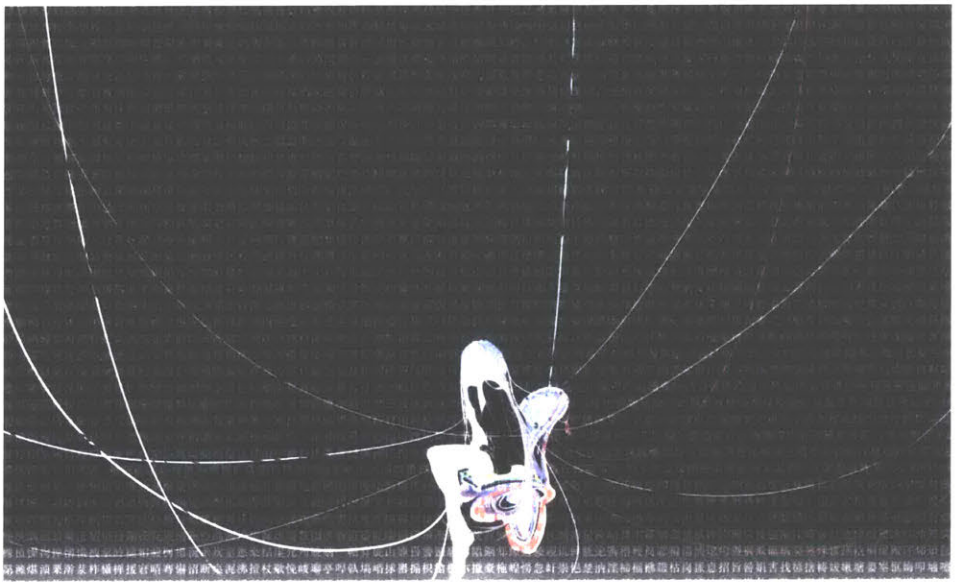

FIGURE 17. THE ILLUSTRATION OF THE FIRST DREAM DARK COSMO HOVERED BY THE CONVERTED CHINESE CHARACTERS OF SIGNALS.

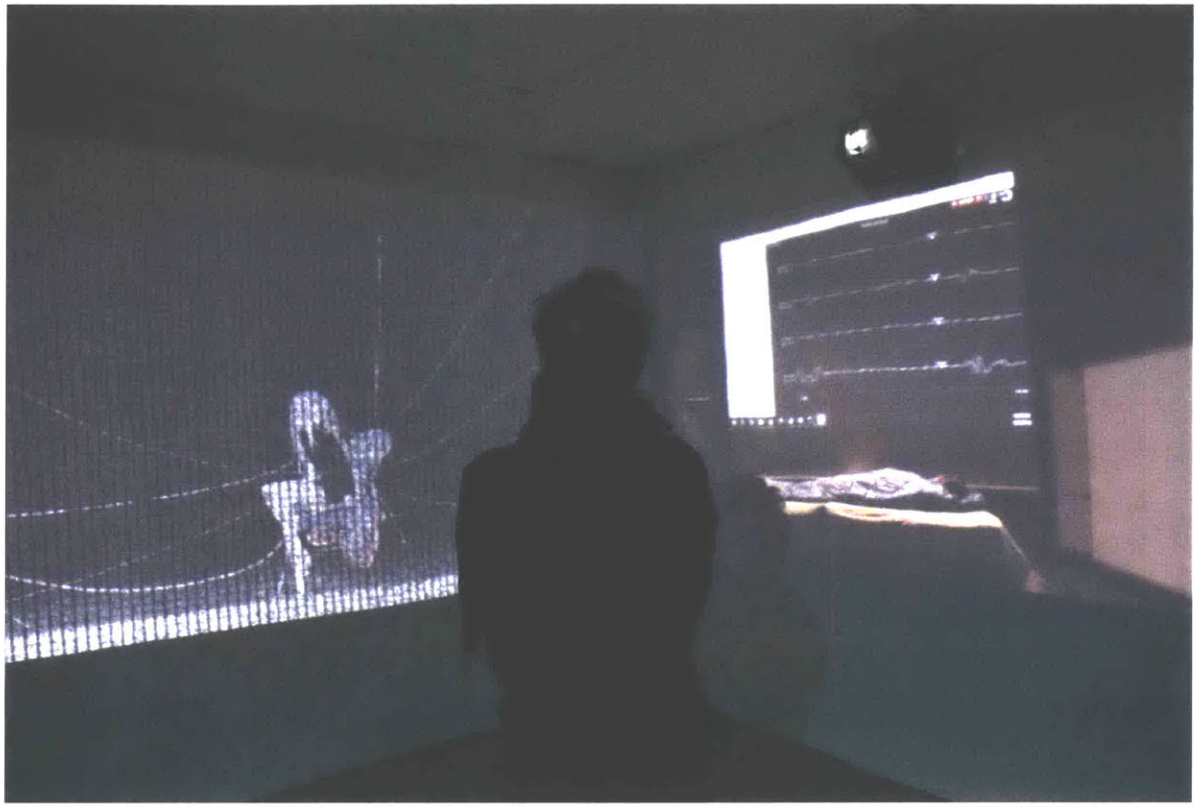

FIGURE 18. THE AUDIENCE WATCHING THE VIDEO OF THE INSTALLATION.

Presentation and Interaction

The presentation is a 3-channel immersive projection installation. From the first channel, the audience can see the edited documentation of sleep performance. From the second channel, the combination of objective and subjective interpretation (illustration hovered by converted characters) is presented. On the third channel, fragments of the translated dream reveal if the audience put on the EEG sensor and have synchronization with the dreamer's brain signal of a specific plot.

Although this project does not mean to change the audience's perception or cognition, it is an attempt to explore my own personal 'state of consciousness'. According to Merleau-Ponty, the dream and waking worlds are distinguished from one another as different modes of experience, but both are grounded in a *general being* that is common to all human experience (Merleau-Ponty, 1945). Although he never thinks dreaming should be equal to waking perception, he still thinks that dreaming states are proximate to, and linked with, perception:

> Mythical or dream-like consciousness, insanity and perception are not, in so far as they are different, hermetically sealed within themselves: they are not small islands of experience cut off from each other, and from which there is no escape.[28]

I partly agree with his idea that dream-like consciousness is never isolated from normal perception but at the same time, they are different modes of experience. I prefer to understand dream as another version of perception mainly caused by neuroactivities inside the brain without much real-time stimulation from the outside world. However, certain neuroactivities are inevitably 'stored' information of previous stimulations gathered during the sober stage. In this case it is no longer top-down processing since there is no 'down' part.

5. Project II: *Sisyphus*

This project is working on the refractive index of materials, purely a manipulation of sensation through changing the external physical elements in the *bottom-up* group. Refractive index (RI) is a fundamental optical property of materials. It is a number that describes how fast light travels

[28] Merleau-Ponty, M. (2013). *Phenomenology of perception*. Routledge.

through the material compare to the speed of light in vacuum. For example, the refractive index of glass is 1.474, which means that light travels 1.474 times faster in a vacuum than in glass. The light will be bent if it runs into a material with a different RI, and the degree of the angle of incidence is determined by the RI of the materials. If the light enters a material with the same RI, the light does not bend, and no edge is detected. In other words, the material becomes invisible.

In many index-matching experiments glass (n~1.474) is always used since its RI is close to the RI of Glycerin (n~1.473). However, glass is not an ideal material for prototyping customized installation structures, thus I wondered if it is possible to create a mixture of solution that matched the refractive index of Acrylic (n~1.490 - 1.492). If it's possible then it will be a very interesting and powerful tool for many different applications.

After some research and experiments, I decided to use a mixture of methyl salicylate (n~1.538) and isopropyl alcohol (n~1.478), as these are the only pair of chemicals that I found to fulfil the following requirements:

1. Both chemicals are transparent in color.
2. These two chemicals are soluble to each other. (otherwise, emulsion will happen and make the liquid lose the transparency)
3. The mixture should be able to reach n~1.490 – 1.492.
4. Not dangerous, nor toxic.

A study shows that sugar solution at a concentration of around 80% can reach the expected RI value (Snyder & Hattenburg, 1963) However, this is an oversaturated number compared to the

solubility of sucrose at room temperature.[29] Thus, the sugar solution is not applicable (Figure 16), and my only choice is the mixture of methyl salicylate and isopropyl alcohol.

There are many researches working on calculating the refractive index of mixture solutions. Here are at least nine equations using different parameters to quantitatively calculate the refractive indexes of mixtures of two matters.[30] These equations prove that there are no big variances under room temperature (Sharma et al, 2007), so here I pick the simplest Arago-Biot equation to do the calculation:

$$N_{mix} = \frac{\sum Vi \times ni}{Vtotal}$$

[29] Theoretical solubility of sucrose at 25 °C is around 67%. In my test the solution was almost saturated at 40%. And the solution became thick and sticky.

[30] The name of the nine equations are: Arago-Biot, Gladstone-Dale, Lorentz-Lorenz, Eykman, Weiner, Heller, Newton, Oster, and Eyring and John. (Sharma et al, 2007)

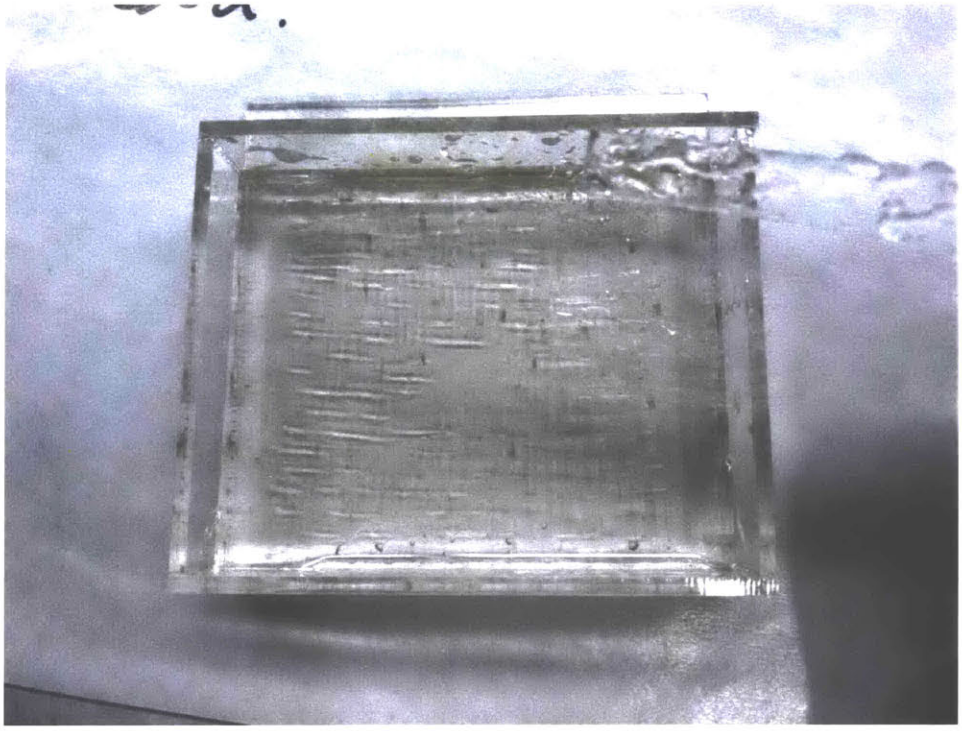

FIGURE 19 TESTING DIFFERENT MATERIALS. THE LIQUID USED IN THIS IMAGE IS 40% SUCROSE SOLUTION (N~1.399). THE INTERNAL MAZE STRUCTURE IS VISIBLE SINCE THE RI DOES NOT MATCH

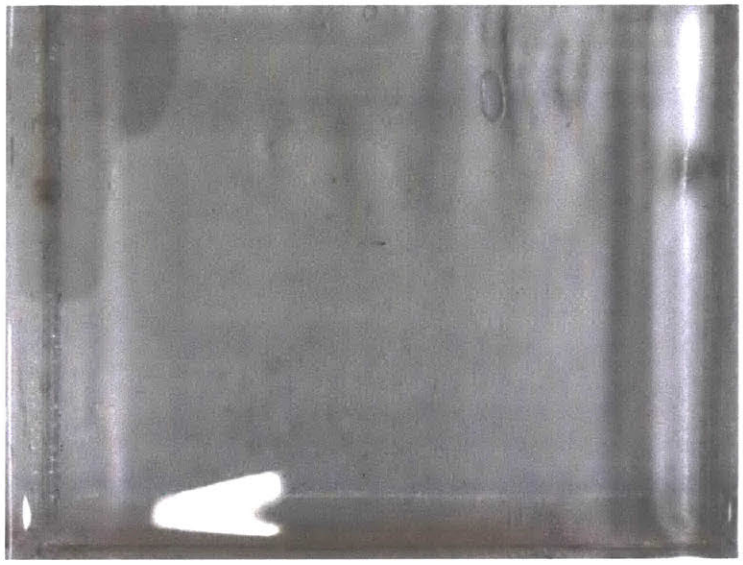

FIGURE 20 METHYL SALICYLATE MIXED WITH ISOPROPYL ALCOHOL, THE RI OF THE SOLUTION REACHED AROUND 1.491 THUS THE ACRYLIC INTERNAL STRUCTURE IS INVISIBLE.

Although the mixture of methyl salicylate and isopropanol solution is able to match the RI of clear acrylic, this chemical is a strong solvent for PMMA (Polymethyl methacrylate, which is acrylic glass) so the mixture keeps dissolving the solid acrylic and it can destroy a structure in 1 – 10 hours based on the structure of acrylic. This characteristic makes the project an attribute of transiency. The intensive dynamic reaction is happening all the time while nothing is sensed by our photoreceptors. It is there, it is collapsing, it is dissolved--it exists, but it can never be sensed.

Then, clear 1/4" acrylic board were designed, laser-cut, and assembled into a simple multiple-gear system. A stepper motor was used to drive the gear on the top left of the glass vase. However, the edges of the gears and holes are not completely invisible in this case (Figure 9). While the clear straight acrylic stick seems to be a perfect match (Figure 10,) I am still trying to figure out the reason. It may be because of the slight difference of RI between the two acrylics. The potential reason may also be because of the circularized shape of edges, or just dust. Further testing needs to be conducted for figuring out the answer.

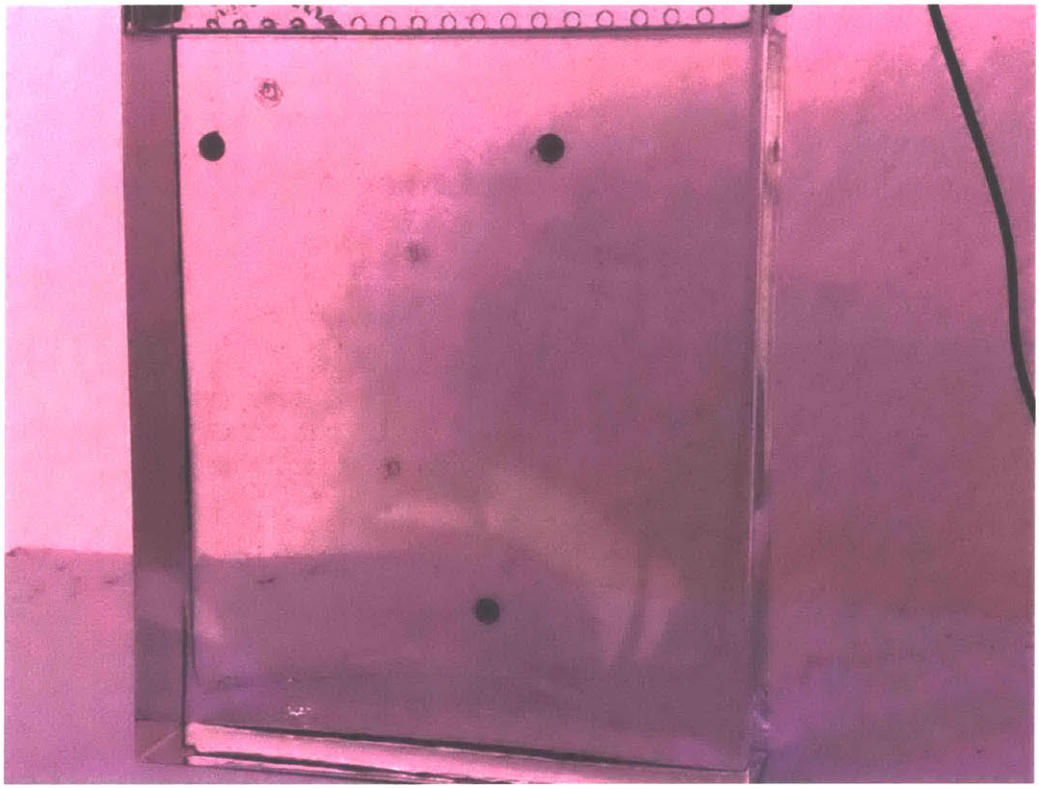

FIGURE 21 ABSTRACT KINETIC INSTALLATION SISYPHUS.

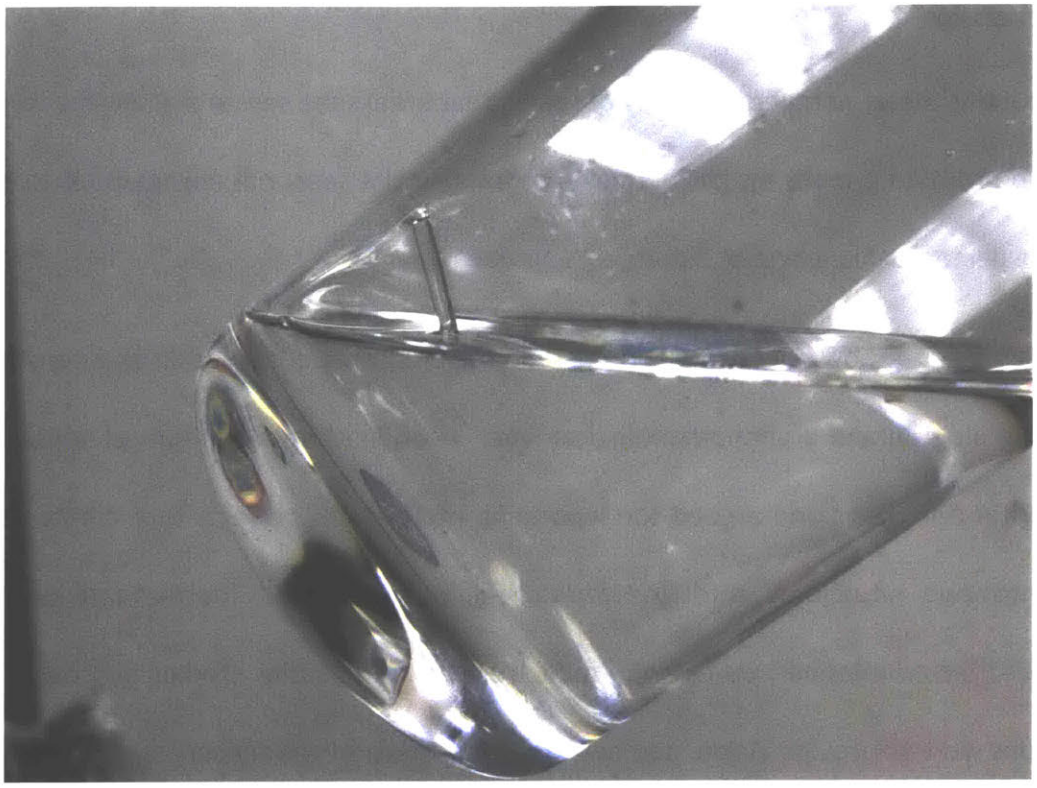

FIGURE 22 THE CLEAR STRAIGHT ACRYLIC STICK SEEMS TO BE A PERFECT MATCH.

6. Conclusion

Throughout this thesis, I argued for a way of seeing that breaks the sensorial from the perceptual in order to promote a more insightful means of training the sensorial engagement to become part of the perceptual in a kind of dialectical approach.

I have attempted to show how people understand the processes of sensation and perception, in both a physiological and a phenomenological way. I confined my definition of sensation and perception in this thesis and argued for separating methods of projects that create cognitive effects into two situations: through *sensation-affected* method (*bottom-up*) or through *perception-affected* method (*top-down*). I made reviews on scientific studies on how receptors and neurons work to provide vision, and how our eyes interpret the sensory stimuli as an optical apparatus. Then I discussed phenomenological approaches to experience of sensation and perception. Husserl and Merleau-Ponty's idea of active perception is the foundation of what makes the *perception-affected* method possible. In this thesis, the *sensation-affecting* method in vision is to manipulate the physical light properties and optical apparatus before the photon hits the retina. After the light reaches retina, the rest of the processes are related to *perception-affecting*.

I discussed how some light and space art works influence viewers' cognition through one of the two proposed methods, and how the creation and deprivation of sensory will affect the visual sense of presence, with the example of virtual reality and isolation tank. I illustrated the association among the sensation, perception, and the dream, and their relationship to my practical art projects, *Resonance Ver.M* and *Sisyphus*.

My two art projects presented some exploration on affecting and representing physiological signals of mind, dream, and perception (*Resonance Ver.M*), and on manipulating the external physical elements (*Sisyphus*). *Sisyphus* is an experiment on the *sensation-affecting* method; while *Resonance Ver.M* is an experiment entirely focusing on inside world with no (or minimalized) sensory input, which make it an ultimate version of *perception*. They explained the two categories proposed in this thesis in two extreme ways.

I understand some may think that these two projects are not enough since they are both too extreme, and we have not discussed how to work with the combination of the two since many of times we need to face the case that both sensation and perception are available. But this is the point where I have been reached so far. The journey will go on and I may keep working on something that can be used for analyzing the situation when both factors are involved, or both methods are applied. This is a direction that I can further explore and experiment in the future and see more new potential there.

What I have endeavored here, however, is to articulate an approach to the reading of images that takes into account both the neurological and psychological processes of seeing such that both the artist and the viewer can more consciously engage their roles.

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