HAPTICOTOPIA
IS THERE IMAGE WITHOUT VISION?

RODOLFO ANES SILVEIRA

LABCOM
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To my dear friend Luís.

Hapticotopia is derived from the agglutination of two words:

1. Haptic: term coined by the philosopher, psychologist and theorist Max Dessoir to define the sense responsible for capturing sensory stimuli captured by the skin

2. Utopia: name that, in Latin, means “nowhere”; in Greek, or “no” + topos “place”. It is a concept coined by the author Thomas Moore, in 1516, In his book entitled with said term. In it he described a society on an imaginary island that enjoyed the utmost perfection in legal, social, and political systems.

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PREFACE

Preface

Alhazen's fundamental work, *De aspectibus*, translated in the 12th century, also known as *Optica*, and made notorious by being cited by both Descartes and Newton, is based on the argument that vision (*visio*) is an impression triggered by light rays passing through the aqueous surface of the eye. This geometric phenomenon would eventually be understood by the science of perspective, the invention of which allowed for the illusion of tridimensionality in the plane, like the *vetro tralucente* that characterizes the Albertian conception of space, to be rooted in the placement of the horizon, the position of which dictates any representation.

Beyond this contrivance, the awareness of the opposition between art and reality, analogous to the spirit/body dualism, would come to support a certain "passion for the surface" characteristic of modern art, which finds its genesis in the conceptual opposition between linear and pictorial, formulated by Wolfflin after looking into Baroque art. This, in turn, acknowledges the centrality of apprehension, not only of the theme and figure, but of the expressive and material sense latent in the work.[1]

In the modernist conception, the line is not just an abstract and intangible entity that connects two points - it goes through the points, adapts, and builds its own surface. Such a dynamic assumption results, in good measure, from the transition from a predominantly frontal vision of the window and the easel, to an aerial vision, which, by replacing the horizon with the surface, would establish a whole set of rules that put less emphasis on the rules of composition, moving away

1. Daniel Arasse, *Le Sujet dans le tableau: Essais d'iconographie analytique*, Paris, Flammarion, 1997, p.15

from the search of the *trompe l'oeil*, and favor a bigger focus on the extensive multisensorial experience, which cinema would, of course, enhance. In that assumption of visual proximity paired with the frontality of the *mise-en-scéne*, the projections cause a fundamental change in the visual experience, by replacing the optic dimension of the visual perception by a haptic one, by what we may call the depth of the screen, which instigates an optical and tactile sensoriality: "*on voit de si près qu'on touche*", said Aumont[2], appealing perceptively to the spatio-temporal dimension of the analogy between touch and gaze, which is the condition that allows for a distinctive mode of vision.

More recently, along with the unhindered increase in the use of computer graphics, the search for greater immersion rekindles the allure of the maximization of textures, both real and virtual, in which the haptic memory takes center stage, highlighting precisely the dependence that the vision has of "what the hands recognize" - as Merleau-Ponty states, there is no vision without the body. An essential phenomenon to understand the passage from the mechanical paradigm to the electronic one, with remote reproduction, without the interference of the human hand (Gr. *acheiropoiete*), centered on the ability to experience and interpret, even if such experience still depends on 3D projection, the screen, and an array of technological simulation devices.

The idea that the eye regards and the hands operate is then nothing more than a preconception, as brilliantly shown by Henri Focillon[3] in his eloquent text on the *rapport* between the eye and the hand, in which he demonstrates the exploration of tensions and dynamics between optical codes with tactile referents, without one necessarily subordinating to the other. Similarly, Deleuze alerts to the need to "distinguish different aspects in the values of the hand: the digital, the tactile, the manual, and the haptic itself. The digital appears to correspond to the highest subordination of the hand to the eye: the vision has become interior, and the hand has been reduced to the finger".[4]

2. Jacques Aumont, *De l'esthétique au présent*, Paris, De Boeck Université, 1998, p. 21
3. Henri Focillon, "Elogio da mão", in *A Vida das Formas* (1943), Lisbon, Edições 70.
4. Gilles Deleuze, Francis Bacon. *Logique de la sensation*, Paris, Éditions du Seuil, 2002, p. 145.

The representation hides the object's objectality, makes it obscure, particularly in the digital domain. Subject and object form a sort of binary opposition, which is not symmetrical, as warns Heidegger. Man places the object outside of themself: "as the object is placed outside the subject by the subject themself, the knowledge of the object is now self-knowledge, and is through which the subject becomes conscious of themself"[5] A subject that does not do without a body that thinks, feels and is. A body that perceives the representation of the chest as a breath.[6]

*

Invoking these lines of force wisely and critically, in this essay, Rodolfo Silveira challenges the possibility of there being an image without vision, an investigation that results from his meritorious research process, carried out in the context of his PhD in Media Arts at the University of Beira Interior. He does so through an eccentric journey, which does not exclude the analysis of three fundamental elements of the work of art: light, sound, and touch, as well as their designated "sensorial portals", in order to offer a broad understanding of their specificities and interdependencies.

Throughout this essay this structure reveals itself to be necessary to the full understanding of multisensoriality, especially in the installation and performative domain that characterizes much of contemporary artistic production and enjoyment, which appeals to the syntopy between art and science, as well as resorting to sensory complementarity, largely resulting from the hybridization and crossing of boundaries between fields.

In the present essay, Rodolfo Silveira meticulously analyzes the theoretical, speculative, but also symbolic drift around the luminous phenomena. He also gives us a historical overview of the sound and acoustic spectra, and of the relation between touch and skin - which is rarely addressed elsewhere

5. Martin Heidegger, "*The Age of the World Picture*", in *The Questions Concerning Technology and other Essays* (translation by William Lovitt), New York, Harper and Row, 1977, p.128.

6. Marguerite Duras, *La couleur des mots. Entretiens avec Dominique Noguez*. Paris, Benoît Jacob, 2001, p.97.

- without overlooking a careful incursion into the physical, physiological, and somatic, perhaps synesthetic, aspects resulting from this perceptual, sensorial, and cognitive contamination.

As such, Hapticotopia is a book that naturally opens space to another diptych of great operative, critical, and even didactic value: the relationship between multisensoriality and intermediality is essential to the understanding of the diverse contemporary artistic practices, capable of stimulating practice-based research, particularly in universities and in institutions dedicated to the promotion, creation, conservation, study, and diffusion of art from the past, present, and future, as is the case of museums, whose performance is addressed in the second part of the book.

The latter naturally acknowledges the integration of various types of technological devices in art installations. This dissemination interacts in retrospect with the past, altering the stabilized conception of knowledge, interfering with the very condition of the observer, which becomes increasingly participant or, in the words of Hélio Oiticica: participator - a notion that appeals precisely to the insufficiency of vision and the progressive need to consider the public's involvement in art.

In this manner, using an extensive wealth of information from multiple sources and works as diverse as they are heterodox, Rodolfo Silveira essays, in the true sense proposed by Michel de Montaigne (1580), a reflective practice that, not being concerned with individual singularities, ends up being "a writing of the self" that refers back to the ancient dialectic between the particular and the universal and accepts tentativeness and mutability, in the face of a lucid awareness of the evanescence of the object that is reflected in the experience and that shapes the condition of the contemporary subject.

Francisco Paiva

FOREWORD

Foreword

Attempting to give an exhaustive, complete, and definitive answer to the central question of this book - Is there an image without a vision? - would be completely unthinkable. - Why, in fact? In one hand, the intellectual weight of the terms "existence," "image," and "vision" exceeds the knowledge acquired by humanity to date; in another, adaptation to new social and technological models in increasingly digital societies provides new meanings, interpretations, and approaches to the same terms. Also, the preposition "without" - an indicator of lack - leads us to areas where lack or absence prevail: places of pure speculation and difficult understanding that resist the existence or possibility of "seeing" without resorting to the organ of sight par excellence: the eye.

Post-truth, named Word of the Year by the Oxford Dictionary in 2016, and the mass production of synthetic images and sounds that have emerged as Deep Fakes since 2017, raise serious questions about the credibility of the image. This push for parallel reconstruction of a digital reality has sparked major social and political unrest around the world. We lament the destruction of political and social principles timed by the spread of hate messages and the imagined manipulation of truth, pushed by the idea that their content could make life better. Yet, faced with the possibility of creating a new political and social paradigm that benefits from the development of artificial intelligence, people are willing to put all their efforts into an imaginary synthesis, knowing that it will only provide a "version" of reality that suits the taste of this era, also called "the new normal." But would the hands that create this kind of reality protect the integrity of the synthesized visual stimuli and attempt to implant memories of another reality? Could this "reality" be real?

Hapticotopia explores this paradox: our preoccupation with creating new synthetic images while neglecting the abundance of images we already have. The images evoked by the senses are brought back through the immersive installation, which, while multisensory, focuses primarily on the haptic sense: a place to assess the extent of the hegemony of sight over the other senses. From there, the visitor, observing himself, acts as an autonomous agent, understanding the limits of the senses and grasping the space by reshaping his sensory sphere in favor of the context presented. These limits, created by the absence and excess of sensory stimulation, form the paradox of whether there are images without vision, which is our initial question.

From this starting point, this book has its origin in a doctoral project in media arts. This project envisages two parts: one materialized in an art installation, preceded by a theoretical-speculative essay on the central theme of the project. However, due to the constraints imposed by the pandemic in 2021, namely social confinement, it was necessary to develop new morphologies for the art installation. Since it was absolutely impossible to produce, build and exhibit the installation as planned, a website (https://hapticotopia.rodolfo-silveira.com) was created to allow a virtual tour - an interactive and digital simulation of the art installation - with the aim of demonstrating the conceptual intentions that would be implemented in the exhibition hall. But that is not all – on the aforementioned website you can also find some of the preparatory works for the research proposed and developed in this project: in particular, scientific articles, a blog and a video essay on the theme of "hands". All these preparatory works were extremely important to find the technology for the development of this project, to make the first sketches for a possible installation and to define the conceptual lines around the theme of "multisensory".

In this effort to understand the influence of sensory portals on the perception of reality, we have developed, as far as the essay is concerned, a strategy consisting of six introductory chapters on the senses and sensory stimuli. In this context, and considering that we intend to produce an art installation, three chapters have been written to evaluate the tendencies and current approaches of museum institutions, as well as to profile influences and implications analogous to the contemporary viewer, and furthermore to define the conditions necessary for immersion and the definition of conceptual strategies that lead to the installation Hapticotopia.

Thus, Chapter 1, dedicated to light, presents from a macrocosmic perspective the influence of the stars on the seasonality of harvests and how this knowledge has changed habits. This lack of knowledge about the firmament motivated several theories about the cosmos, vision, and the development of tools that enabled the expansion of the sense of sight. Both Galileo and the telescope and the discovery of the microcosm through Robert Hooke's microscope opened the door to new areas of research. The chapter ends with Isaac Newton's discovery of the visible spectrum.

Chapter 2, The Eye: The Cognitive Portal of Vision, discusses some mythological meanings and implications of the eye as a symbol, as well as the theory of visual pneuma advocated by Galen. Islamic influence and medieval theories of vision are briefly mentioned before the more anatomical aspect of the eye and the conversion and transformation of visual stimuli into action potentials are discussed.

Chapter 3 introduces the topic of sound and discusses the importance of sound stimuli as a complement to visual stimuli, also addressing their morphology and physical properties. Again, in line with Chapter 4, dedicated to the ear, some theories of hearing are presented, such as the theory of resonance, the theory of place, or the propagating wave, in addition to the theory of implanted air. In this chapter, the limits of the auditory system and the sensory limits are discussed, as well as the physiology of the components of the cognitive portal of the auditory system.

Since the previous chapters were devoted to the sense of distance, Chapter 5 is devoted to the sense of proximity, the sense of touch. After approaching the mythology of the sense of touch, various theories of the sense of touch and the physiological properties of the skin and mechanical sensors are treated with greater dominance. The chapter concludes with an account of the body that focuses on the somatosensory homunculus and the connection of the haptic sense with other modalities.

Multisensory is the title of Chapter 6, and as such, the entire written content culminates in the combination of senses. Thus, reference is made to the chemical senses of taste and smell, as well as their encoding processes and the importance of smell in memory. Consequently, various definitions of multimodality, internal senses, and other recognized senses such as proprioception are given, as well as the distinction between the concepts of sensation and perception. This is followed by a discussion of the combination of sensory signals and the influence of memory on the interpretation of signals and the construction of reality.

After establishing some preliminary concepts on multisensory perception, Chapter 7 aims to understand the old and current tendencies and functions as well as the possible futures of museum installations. It also briefly sketches the historical path of (art) installation as a category. The chapter concludes by mentioning the repositioning of museums and art institutions in the face of their forced closure due to the pandemic caused by the spread of the new coronavirus, COVID-19, in 2020, as well as some consequences of which.

Chapter 8 is dedicated to the Observer. This new observer is present in a digital ecosystem (outside world) and coexists in different digital characters, in a variety of new worlds. An assertion that reflects the human drive for discovery since the dawn of time and alludes to the influence of the hand and other increasingly digital tools in human evolution. In this sense, this chapter hypothesizes that through haptic visibility, subjectivity, memory, and the power of imagination in speculating about the future, a series of co-existences in many worlds emerge.

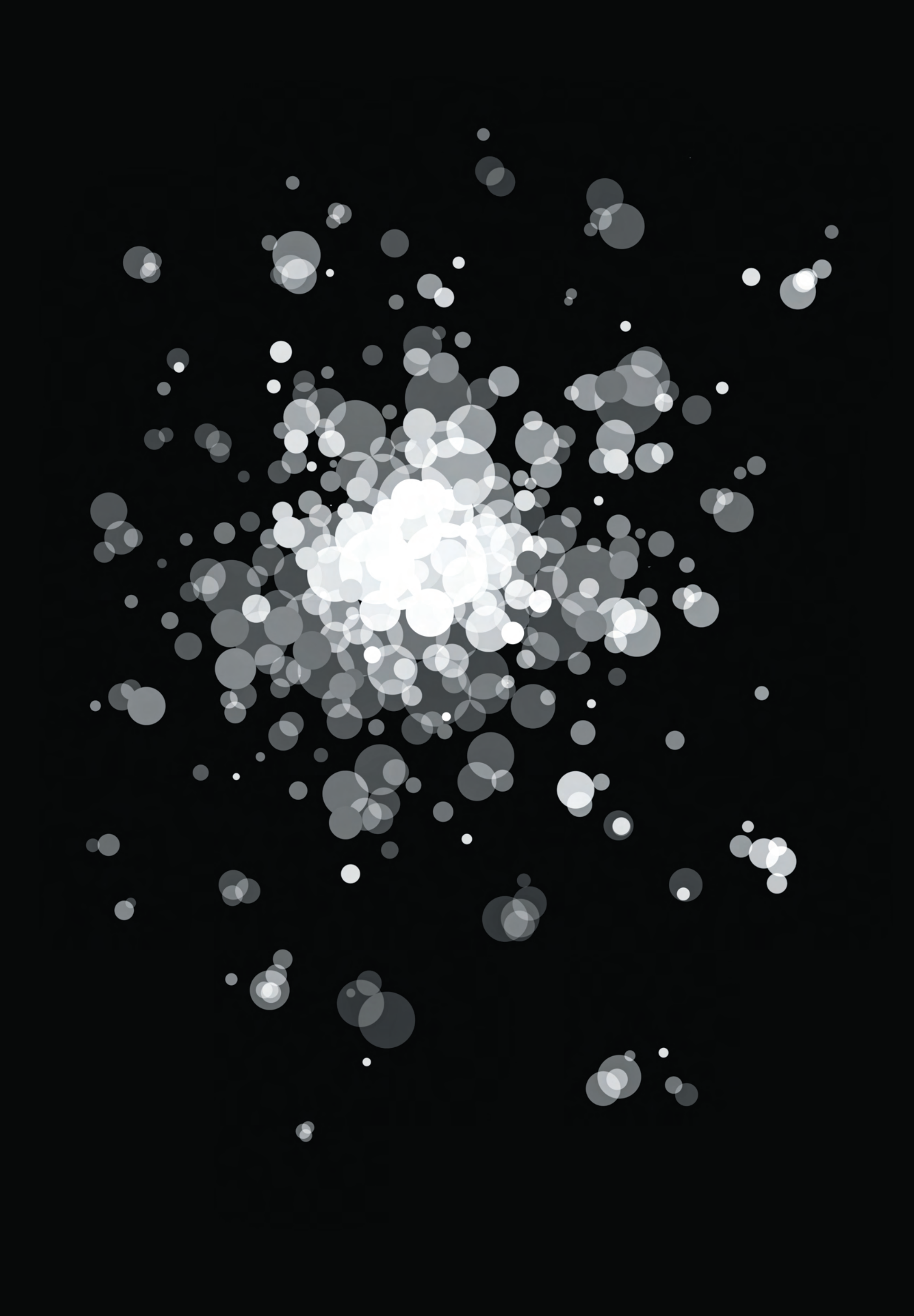
Chapter 9, the final one of this essay, will clarify the conceptual options of the installation we have called Hapticoptia. In this way, several arguments will be presented for the existence of a "haptic visibility" in everyday life and for the influence of digital tools in the production of images and in the art market. This is followed by the value of the hand as a tool for creation and the way in which haptic stimuli can lead the viewer to create a kind of vision through imagination will be highlighted. The Speculative Futures subsection aims to situate the conceptualization of the Hapticotopia installation in the speculative realm and suggest possible tours of the theaters of memory. It also presents different technological approaches to multisensory technologies and proposals for immersion. The essay concludes with four conceptual guidelines that argue for a multisensory experience in the Hapticotopia installation.

Consequently, part II, which can be seen on the website https://hapticotopia.rodolfo-silveira.com, describes the entire development of the work until the construction of the plan. As mentioned above, although it was not possible to build the installation due to various constraints (which are described in detail in this part), extensive and thorough preliminary work was done. Therefore, this part deconstructs the various organizational charts that were proposed for collaboration (across faculty and universities), down to the earliest state of the lone researcher. The various technologies identified in audio, touchless haptics, and biometric reading are also presented. In addition, the various room plans that were created and rendered in a 3D environment and adapted to different rooms at different times are presented. Thus, the production and software development planning, the different budgets based on spaces and events, and the list of meetings for the construction and execution of all processes leading to the installation are presented chronologically with the respective and successive information and decisions resulting from these actions. Also presented are the materials, interventions, and arrangement of elements in the exhibition space, as well as the structures and bases for the central platform and all the steps leading to the digital construction of the virtual visit, with the corresponding technical, descriptive and justifying information.

It is imperative to emphasize that it is not the intention of this work to exhaustively analyze the physiological processes of the senses, the physics of sensory stimuli, or the mnemonic processes of multisensory technology, including all the problems that stem from subjectivity or arise from consciousness that many theorists have long grappled with. Nor does it pretend to question the origin of the image. Rather, the core of this work is to gain insight through art, to provide audiences with multisensory experiences, and to create borderlands where judgment is suspended, where phenomenological introspection and reorientation are possible, and where this journey that human evolution has taken over millions of years between “feeling, representing, knowing, being” is initiated into possible places of recovery and actualization in the present.

LIGHT

DISCOVERING THE VISIBLE SPECTRUM



Chapter 1

LIGHT. DISCOVERING THE VISIBLE SPECTRUM

Macrocosmos

Life in the light is a condition of most multicellular organisms. In a sense, the immensity of the sky and the cyclic and organic nature of the planet, which we tacitly know, have driven the development of sensory portals in countless species responsible for rich and uncontrollable exchanges and interactions with the environment. What we seek and interpret in light is inscribed in the most intimate desire for communication and understanding, an intrinsic condition of the sense of sight.

We do not know how primitive man perceived the nocturnal spectacle of starlight. We can only surmize that the simple cyclic condition inherent in the passage of a day would have been sufficient to develop routines and habits for subsistence out of an attempt to understand the cosmos. It is certain that the unknown word “universe” has stimulated thinking about the environment surrounding us in countless generations before the written record. Memories and problems about many of these questions will have been passed down through time by oral tradition to keep the species together and ensure its survival, even to the point of theoretical speculation about what we now call vision.

From the pictorial inscriptions of Lascaux to the hill of *Goebekli Tepe*, rooted in the peoples of Mesopotamia, in the most distant traditions of the Inuit, the increasing fertility of Egypt to our days, this eternal conflict between day and night, light and darkness, the immanent phenomenological movement of the celestial spheres, influences life and the perception of reality. Population growth has also driven the development of the protoagrarian economy and thus the spread of Homo sapiens across our planet. The pursuit of subsistence, cyclical climatic conditions, and the need to procure food-not only for survival but also as a currency of trade, a source of power, and a means for rulers to control populations-likely drove the advent of numbers, writing, and the need to conduct comparative analyzes of annual income (Aydon, 2000: 39-52).

Through extensive cataloging, the legacy of several Babylonian priest-astronomers, and the stellar knowledge of the Sumerian people (3000 B.C.) recorded in cuneiform on various clay tablets, we are able to more concretely grasp population growth, the seasonal development of agriculture, the phenomenological character of the celestial bodies - the phases of the moon, the constellations, the occurrence of comets, and the position of the planets - and to recognize the beginning of the great analytical exploration of the cosmos[1]. This tradition of the various Mesopotamian peoples, whose great masterpieces of cuneiform writing include the lunar ephemerides[2] - the systematic record of the lunar cycle-allowed for an annual comparative assessment of the celestial spherical cycles and harvests. In addition, tables such as Enu¯ma Anu Ellil (1600 BC - 1200 BC) and Mul.Apin (700 BC) contain various astronomical schemes as well as lists of stars, omens, and astronomical predictions (Brown, 2009: 462). Thus, the concrete analysis of syzygies[3] - equinoxes, eclipses, in short, the alignment of celestial bodies - would translate many of the possible agricultural omens and successes.

1. "The Sumerians are credited with the invention of cuneiform writing, the first basic socio-political institutions, and a money-based economy. The most important cities were Ur, Kish and Lagash. During the third millennium BC, Sumer became an imperial power. By 2340 B.C. the Semitic peoples of Akkadia conquered Mesopotamia, and by 1950 B.C. the ancient civilization had crumbled." "Sumeria" World Encyclopedia. Accessed April 28, 2020, available at Encyclopedia.com: https://www.encyclopedia.com/environment/encyclopedias-almanacs-transcripts-and-maps/sumeria.

2. These determined the moments of luni-solar conjunction and opposition (the so-called syzygys), the lengths of the first and last lunar visibilities, and the details of eclipses. The intervals between the syzygys depended on the varying speed of the Moon and the Sun, with the latter having the dominant effect (Brown, 2009: 465).

3. Sizygas in astronomy, a term also used for the conjunction and opposition of the planets with the Sun. Much of lunar theory depends on the phenomena and circumstances of syzygies. T. F. HOAD "Syzygy. The Concise Oxford Dictionary of English Etymology. Retrieved April 28, 2020, available at Encyclopedia.com: https://www.encyclopedia.com/humanities/dictionaries-thesauruses-pictures-and-press-releases/syzygy

Referencing time was a well-known practice among the Egyptians[1]. Measuring time with a *gnomon*[2] stuck in the ground was probably the birth of the sundial. Later, however, around 2500 BC, both the Babylonians and the Egyptians assumed a calendar[3] with more than 360 days, based on the assumption that there were twelve lunar phases and that each lasted about 30 days: although still an imperfect solution, the Babylonians extrapolated the months as needed, while the Egyptians opted for a 365-day calendar. The system we know today is based on the same principle, but with a shift of one day every four years (King, 1955: 1).

The regularity of celestial events and the desire to analyze them motivated and still motivates the development of various astronomical measuring instruments such as the Merkhet[4]. It is believed that the perfect alignment - north/south - of the Great Pyramid of Giza in Egypt was due to the precise measurement of this instrument. Since then, the desire to accurately measure the universe has been the basis for many studies by astronomers. In the hills where the cities of Uruk, Borsippa, and Sippara were located, archeologists have unearthed tablets with detailed records of astral observations dating from the last centuries of the pre-Christian era and containing the names of the astronomers Kidinnu and Naburiannu (King, 1955: 3). The rigorous cataloging of the cuneiform tablets from the texts destroyed by the Persians ended with the death of Alexander the Great - the beginning of the Hellenistic period in 323 BC - saved by many archeologists, represents about 400 years of astronomical observation that did not obey any specu-

1. According to historian Henry King: "The earliest known sundial is an Egyptian one from the 10th to 8th centuries B.C., when it was probably in regular use" (King, 1955: 1).

2. "A device that is erected next to a rock or structure of interest to provide a vertical reference of the sun's position through the shadow it casts on the ground. It was used during the manned exploration of the moon." T. F. HOAD "gnomon. The Concise Oxford Dictionary of English Etymology. Accessed April 29, 2020, available at Encyclopedia.com: https://www.encyclopedia.com/humanities/dictionaries-thesauruses-pictures-and-press-releases/gnomon-0

3. The Editors of Encyclopaedia Britannica. (n.d.). Egyptian calendar | dating system. Available at https://www.britannica.com/science/Egyptian-calendar

4. "The Egyptian pyramids were built in perfect north-south and east-west alignment. This precise construction was achieved with a visual aid, the merkhet, which was used to determine the direction of the North Star with a plumb line." The Invention and Progress of Scientific Instruments | Encyclopedia.com. (2020, March 31).Accessed April 28, 2020, available at https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/invention-and-advance-scientific-instruments

lative principle: for its part, it contained only the evidence of a predictable astronomy of the peoples of Mesopotamia and occasional references to the exact calculations in Neo-Assyrian characters (Brown, 2009: 462).

In the Greek school, especially the Ionian, it is assumed that the explanation of the cosmos is based on the results of a conception far removed from the observation of the stars. As far as is known, knowledge of geometry was still rudimentary in Greece six centuries before Christ (Robson, 2000: 93-113). Thus, the will to equate the world was only speculative and had no mathematical basis: there were not yet instruments that could extend vision beyond the field of view[1]. Nevertheless, the need to equate the architecture of the cosmos drove the thinking of several philosophers. Thales of Miletus, in his attempt to find a rational explanation for the astral phenomenon, relied on the idea that the planet was a smooth disk, a living organism like a water lily floating in water. His disciple Anaximander, on the other hand, imagined the planet as a small cylinder surrounded by the cosmos and kept in equilibrium by the inner fire that flows out evenly from both sides and makes it float. He also assumed the existence of a large hole in the moon, the plugging of which would cause eclipses. Anaximenes, another pre-Socratic philosopher[2], postulated the fluctuation of the planet in the air and the existence of a starry sky associated with a large spherical body. Part of this concept was also pursued in the 5th and 4th centuries BC. Both Plato and Aristotle advocated the idea of a planet that was spherical (because it was the most perfect geometric shape) and located at the center of the universe due to it being its most natural place. (King, 1955: 4). The school founded by Pythagoras believed in a world of harmonic relations of atoms introduced by Democritus and Epicurus, which not only displaced the power of mathe-

1. The clarification of the visual ray by mathematics would come later, but since then they can never exist separately. C.f. Research. (2021, January 6). Applied Physics and Applied Mathematics. Available at https://www.apam.columbia.edu/research-6

2. “Democritus’ theory of perception depends on the claim that eidôla or images, thin layers of atoms, are constantly moved away from the surfaces of macroscopic bodies and carried through the air. The visible properties of macroscopic objects, such as their size and shape, are transmitted to us by these atoms or filaments, which tend to be distorted as they pass greater distances in the air, since they are subject to more collisions with air atoms.” C.f. Democritus (Stanford Encyclopedia of Philosophy). (2016, December 2). Available at https://plato.stanford.edu/entries/democritus/

matics, but also opened the speculative path through vision, that is, if on the one hand there was the clarifying impulse of the cosmos, on the other hand there was also the questioning of the visual grasp of reality.

The visual ray

Various philosophical doctrines of ancient Greece attempted to explain how vision works. Sophists, Presocratics, Atomists, and Stoics all equated a field of investigation of perception in different ways and generally questioned the nature of visual sensation. Nevertheless, all doctrines shared the same basic idea: sensory experience arises from physical contact of the sense organ with an object of sensation (Smith, 1996: 21). It is precisely because of the difficulty in demonstrating this invisible exchange of information that the need arises to theorize such a sensory process. However, even if there was a common denominator, the difference between the various doctrines was at a fundamental level that shaped the cosmogony of the time.

Since then, two main currents have emerged, known as "emission theories," which have influenced all studies of vision up to the present day. The first, the intromissionist theory, i.e., the afferent, refers to the influence of the matter of the object on the eye. This doctrine, supported by the atomists, confirmed the existence of *eidola*[1] or "images" (Latin imago): a small layer of atoms (filaments) spaced at regular intervals from the surfaces of macroscopic bodies, which, according to the theory of perception of Democritus of Abdera (pre-Socratic philosopher) , behave elastically, expanding or contracting when transported by the air. According to this doctrine, these filaments, by their action on our sense organs when contracted, enabled us to create impressions of objects and activate visual perception. Aristotle's visual theory, elaborated in De Anima, is part of the intromissionist theory of emission. However, it does not take into account the materialistic

1. "Plural of eidolon (figure, representation, specter, ghost). Derives from the word eidos. One of the terms with which Plato indicated the idea and Aristotle the form, it is used in contemporary philosophy, especially by Husserl, to indicate the essence that becomes evident through phenomenological reduction (see PHENOMENOLOGY). For the classical meanings of this word, see FORM; IDEA; SPECIES" (Abbagnano, 1988: 317).

approach of his atomistic colleagues, who emphasize the "transparent" medium as the transmission medium of the effect produced by the object. He therefore replaces the material threads or the mechanical impression of the eye with the quality of the transparent: color. "The visible is color, and it is this that includes the visible in itself - in itself, not because it is visible by its definition, but because it possesses in itself the cause of being visible" (De Anima, II, 7, 418a28-31). The transparent continuum will be the medium whose transmission effect promotes the "physical" contact between the object and the eye.

The second "emission theory", the extramissionist, i.e., efferent, postulated the origin of the sense of sight as the result of the "visual fire/flow" that "physically" reaches the visible objects. That is, according to this Pythagorean doctrine, the material nature of vision, which consists of fire, causes the visible objects to announce themselves through the rays that the eye emits when it "touches" them. The emission of this light, inherent in fire, is the necessary condition for visual perception in contact with material nature. In this sense, the eye takes on a specific form of visual "pneuma" that impregnates the air on the surface of the eye and transforms it into a visual pathway (Smith, 1996: 22).

The central concept of both emission theories enabled Euclid to undertake a geometric analysis of vision centered on the "visual ray." A geometric model that postulated visual flow in the form of a cone emanating from the "ray" of the eye, defining the eye as the center of vision and the visual field. Ptolemy also based his theory on the same concept, but claimed "that the physical emanation of visual flow is perfect and continuous in all directions. In contrast, Euclid denied the physical reality of the single ray. For him, the visual ray is nothing but a convincing analytic fiction" (Smith, 1996: 23). Nevertheless, and even in contradiction to its physical existence, but in full geometrical assertion of its existence, the conceptualization of the "visual ray" left to subsequent generations an entire speculative conception and consequent research in favor of a credible theory of vision.

Galileo's telescope

Twelve centuries later, Galileo, then 23 years old, due to lack of funds and the decision to abandon his studies, unsuccessfully tried to change his age to twenty-six in order to get a job as assistant professor at the College of Bologna. This misfortune led him to new paths. Two years later he obtained a professorship in Pisa, where he taught medical students the legacy of Euclid and astrology. Although astrology is discredited today, the idea that celestial bodies influence earthly life seemed credible at the time (Mlodinow, 2016: 129). However, the tiny salary, gambling, and fierce intellectual sarcasm with his various colleagues prompted him to leave Pisa and get three times his annual salary (180 escudos) for a teaching position at the College of Padua, near Venice, where he stayed for eighteen years. There, through experimentation, he developed his great scientific legacy that amazed the world. Despite his achievements in the field of physics, such as the law of inertia, he became most famous for his conflict with the Catholic Church. Galileo lived during a time where the Aristotelian tradition and the view of St. Thomas Aquinas were supported by the Catholic Church, which defended the geocentric model with the Earth at the center of the universe. In his lectures at the College of Padua, Galileo tried to hide his doubts about Ptolemy's system for he distrusted its validity (Bernal, 1971: 408).

At this time, around 1600 in Holland, weeks after Jacques Metius (Descartes, 2010: 452), the formula for the optical magnification of an image was discovered in the workshop of Hans Lippershey: the combination of a concave and a convex lens would produce the first monocle[1]. The so-called *Spyglass* magnified the image only two or three times. But the potential Galileo discovered in this lens combination was to change the way the world was viewed. Based on Euclid's "visual ray" the distortion of light created in the outer "objective" lens was corrected in the "ocular" lens, again creating an image of a dwelling. The degree of magnification is determined by the

1. "The incident that finally made Galileo change his mind occurred in Holland in 1600, when two children playing in the workshop of an obscure spectacle maker named Hans Lippershey put two lenses together and looked through them at a weather vane at the top of the town's church steeple. The picture was enlarged" (Mlodinow, 2016:129).

distance (f) between the lenses. After much experimentation with Murano glass, Galileo offered his first telescope to the Senator of Venice in 1609 as an instrument to defend the walled city. The nearly ninefold magnification of the image made it possible to detect enemies at a distance of two and a half hours. This military advantage for the city of Venice earned him a lifetime extension of his post and a doubling of his salary. Later that year, in his tireless pursuit of research and after much experimentation, Galileo developed a new telescope that offered a magnification of nearly twenty times. Seeing such optical magnification at the level of the celestial body closest to the planet, he realized that the potential of this instrument could confirm the heliocentric theory, supported first by Copernicus and later by Giordano Bruno, and prove that it clearly reflected the place of planet Earth in the cosmos.

The various descriptions and measurements of the lunar craters and other planets published in the book Star Messenger (Venice, 1610) proposed to change the cosmology of Aristotle and expanded the imagination of Europe. This fame earned him the position of philosopher to the Grand Duke and chief mathematician at the College of Pisa, where he announced the discovery of Jupiter's moons, which confirmed the thesis the Catholic Church was pressuring him to omit[1]. Later, when conflict with the Vatican was inevitable, in 1616, after snubbing Pope Urban V, who up until then was a great admirer of his, and rejecting the proposed insertion of a passage confirming the teaching of the Catholic Church, Galileo was condemned for heresy and forced to renounce his beliefs. Almost twenty years later, at seventy years old, perhaps out of love for his loved ones and the harsh punishment imposed on Giordano Bruno by the Inquisition, he knelt before the tribunal and accepted the false claims that the Earth was not the center of the universe (Mlodinov, 2016: 105-135).

1. After his audience with Pope Paul V, "the authorities forbade him to teach that the sun and not the earth was the center of the universe and that the earth moved around the sun and not vice versa" (Mlodinow, 2016: 132); c.f.: Freely, J. (2012). *Before Galileo: The Birth of Modern Science in Medieval Europe*. New York: Overlook Duchworth, p. 272.

Even if the Earth was not at the center of the cosmos, which was assumed years later with Newton, this story shows the commitment, tenacity and urge to think outside the box at a time when the prevailing "world view" was dictated by power interests and people were consequently "blind". Galileo was not the first to produce this idea, but he provided the scientific "proof" through numerous observations of Jupiter's moons. For the first time in the history of humanity, the immensity of the celestial void revealed a small gap through which astrologers, cosmologists and physicists set out to discover the architectural principles of the macrocosm.

Microcosms

The expansion of the "visual ray" of the senses expanded the world view. The telescope - an extension of the eye - raised the interpretation of the cosmology of the universe to a new level of understanding of the origins of life. Entering this new world of probabilities means thinking about accepting a new interpretation of the now visible reality. It means, then, the strengthening of the imagination and the liberation from haptic subjection as a sense of certainty - haptic (in relation to the tangible world) - that re-educates the vision for the equation of the real.

However, not only the macro world was within reach of optical applications. These new instruments extensively enhanced the power of the observer's vision on objects and allowed scientists and philosophers to study worlds once invisible to the naked eye. These have also conditioned the "small world" where a "cellular genealogy of composing organisms propagates and transforms itself over time, in the form of cells, in a succession of generations, a 'microcosm'" (Cherlonneix, 2013: 25).

The invisible alien micro-world present in the detailed drawings in Robert Hooke's book *Micrographia* (1665) astounded the world. The English natural philosopher and mathematician was one of the proponents of microscopic imaging and, to a large extent, responsible for cementing microscopy as a technical field. He began his work in astrology at Oxford University at a crucial stage of the development of better and more powerful telescopes. However, he soon became aware of the various optical aberrations produced by hand-cutting the glass that weakened the refraction of light, limited image fidelity and the possibility of higher magnifications. Also, the claims of these vision instruments and the consequent size (length) needed to validate the interpretation of Christopher Wren and his colleagues, in 1650, on the rings of Saturn, exceeded the technical execution capacity of the lens cutters (Hunter & Schaffer, 1989: 33).

It was around 1656, in a period where both the Royal Society and several European academies realized the importance of far-reaching telescopes in institutional notoriety, that Hooke acceded to the international exponent of astronomy. In a period when the Commonwealth was flourishing, joining the great names of natural philosophy such as Robert Boyel, Christopher Wren, John Wikings or Seth Ward meant entering a narrow circle of research and investigation concerning the development of new prototypes of optical magnification (Hunter, 2017: n.p.). Later, in 1657, in order to publicize and reinforce the practical benefits of the development of such instruments and to make known the various ongoing investigations, Wren's theory of rings of Saturn was announced worldwide. There, Hooke learned of Wren's extensive technical contribution on microscopic instrumentation. In this sense, Hooke only followed up on Wren's work on the exploration of micro-images (Hunter & Schaffer, 1989: 34).

The minute magnification of the bee body in the *Apiarium* and *Melissographia*, published in 1628 by Federico Cesi and Francesco Stelluti, or even Jacob de Gheyn II's *Rana* (1628), were beginning to reveal a sign of the time's growing interest in the miniscule (Ford, 2015: 25). Thus, it would not be strange to expect that Hooke's years of research, collection and representation through minute drawings would not also be a success. In September 1665, like Galileo's drawings of the lunar craters, the publication of Micrographia amazed the world with the visibility of the microcosm, immediately becoming a best-seller. Unveiling this micro-world meant unveiling an invisible reality and initiating a new way of looking at reality. The great disproportionality between the micro-creatures should certainly have been interpreted with horrendous or pompous and unusual magnificence. Thus, there was a concrete departure from Euclid's definitions 4 and 5[1] and therefore a new education of the eye, adapting vision to a new reality, as Hooke warns his readers in the preface of Micrographia: "these infirmities of the senses result from a double cause, either from the disproportion of the object to the organ, in which an infinite number of things can never enter them, or else from an error in Perception, in which many things, which are within their reach, are not received in a correct manner" (Hooke, 1665: 7). These new images questioned not only the apprehension of reality, but also populated the memory and imagination of the world opening the doors of the macro and microcosms to free exploration. Robert Hooke was known for his many contributions to science: the concept of the "cell", found in the cork filament net; the law of elasticity; and his contributions to the gravitational law of celestial bodies.

The visible spectrum

Isaac Newton was born the year Galileo died (1642). Considered a singular genius in the history of humanity, he devoted his youth to the study of iconic and revolutionary works of natural philosophy. His fascination with the unknown and the universe set him on a path toward the ancient principles of light and the laws of the universe. At Cambridge, at Trinity College, at the age of only eighteen, the young scholar immersed himself in the many classics from the philosophy of Plato and Aristotle to the art of eloquent communication called rhetoric, to logic, ethics, history and more. Natural philosophy, from the 19th century on simply considered "science," had a particular influence on his journey. Giving special attention to astronomical and mathematical studies, he focused, among many others, on Copernicus'

1. "4. And that things seen at a greater angle appear larger, and things seen at a smaller angle appear smaller, and things seen at an equal angle appear to be of the same size; 5. And that things seen within a greater angle appear higher, and things seen within a smaller angle appear lower;" (Euclid, 1943: 357).

heliocentric theory in *On the Revolutions of the Heavenly Spheres*[1]; *The Starry Messenger*[2], from Galileo; and in Descartes' seminal text on analytic geometry, *Discourse on Method*[3] (Christianson, 2005: 20). However, finding it strange, he questioned the motion of celestial bodies and was intrigued by the principles Galileo had described about the possible law of inertia. These were the principles he would later use in formulating the laws of universal gravitation and the three fundamental laws of classical mechanics. Newton was concerned with the behavior of large bodies as well as small ones. So he decided to select only the knowledge that made sense to him, such as Democritus' theory of matter, of the small invisible particles called atoms (eidola).[4] According to the philosopher, the formation of the world and the universe resulted from a constant movement of this whirlwind of particles, the same particles that he said were in the essence of light and that Newton would use in the corpuscular theory of light propagation (Christianson, 2005: 18).

In 1665, after graduating from Trinity College, due to the great plague that ravaged the city of London, he was forced to return home, to Woolsthorpe, a small village north of the infected city. There, he is said to have had the famous epiphany with the fall of an apple, from which he would deduce the law of universal gravitation. Surely Aristotle's explanations of falling objects, Galileo's experiments on the tower of Pisa concerning the acceleration and resistance of air, and even Galileo, Brahe, and Kepler's studies of planetary motions may have been his alluded to "shoulders of giants" that allowed him to spot the relationship between the movement of the apple and the force that attracts the moon. In the words of physicist Brian Greene:

1. Copérnico, N. (1543). *De revolutionibus orbium coelestium*. Nuremberg: Petreium.

2. Galileu, G. (1610). *Sidereus Nuncius*. Republic of Venice: Thomam Baglionum.

3. Descartes, R. (1637). *Discours de la Methode pour bien conduire sa raison & chercher la vérité dans les sciences*. Leiden: Ian Maire.

4. In Leibniz's system of metaphysics, monads are basic substances that make up the universe but lack spatial extension and are therefore immaterial. Each monad is a unique, indestructible, dynamic entity with a soul, whose properties are a function of its perceptions and appetites. C.f. Gottfried Wilhelm Leibniz (Stanford Encyclopedia of Philosophy). (2013, July 24). Available at https://plato.stanford.edu/entries/leibniz/

"Einstein would argue that it was Newton's head that ran to meet the apple, not the other way around." (Greene, 2004: 67).

Newton had other interests besides motion and mechanics; he also sought to understand the phenomenon of colors. The reasons that led him to this topic were due to the fact that there were chromatic aberrations in the lenses of telescopes which, due to the incorrect coloration of images, made it difficult to focus the image. This was a topic already described, and somehow tried to be clarified by authors such as Descartes, in Boyle's *Experiments and Considerations Touching Colors* (1664), and in Hooke's *Micrographia* (1665) (Westfall, 1980: 156).

Although there is still an enigma about the exact location of the purchase of the prisms needed for the "crucial experiment", it is likely that this purchase took place at one of the fairs outside the terrible plague that ravaged London in 1665 and 1666. However, his experiments are thought to have taken place at Woolsthorpe (Christianson, 2005: 157; cf. Westfall, 1980: 157). Still, what we are interested in understanding is the change in perspective regarding the nature of light. In this sense, we should also mention that the Aristotelian tradition, still very influential in this period, postulated the presence of color in the "transparent continuum": a pure and singular light, where colors were mixed in light and dark. The same idea was held with plenum of the universe, equated also by Descartes: a "defining property, or 'essence,' of material substance with three-dimensional spatial extension" (Stanford Encyclopedia of Philosophy, 2017: n.p.). The quality of this transparency was somehow referenced by the actualization of the state through the presence of an "essence" capable of activating its alteration.

The suspicion revealed by the chromatic aberration in the telescopes' lenses led Newton to a crucial experiment, which can be described as follows: in the darkness of one of the rooms in Woolsthorpe, he punched a small hole in the shutter and intercepted the sun's ray on the prism; the spectrum resulting from the chromatic dispersion produced by the prism was projected onto the opposite wall. To his amazement[1], the rectilinear shape it presented contradicted the spherical shape Descartes had described in *Dioptrique*[2]. The visual representation of the spectrum enunciated the separation of the various colors at different angles. And so was born the new law of refraction of light, which would only need to be described by mathematical principles. Still, in Newton's eyes, the division of so-called "pure" light could exist. The question was simple: Where did colors originate? From the prism or from light itself? In search of an exact answer, he made several holes in several sheets of paper in order to isolate the various colored beams. By carefully positioning the second prism, at a relative distance so as not to cause any light contamination, making it intersect with only one of the beams, he realized that, even with the refraction of the prism in the isolated color, it remained unscathed; without a multicolor refraction, it kept only the same color. In this sense, the spectrum produced was not originated by the prism, but was contained in the light. Thus, Newton's crucial experiment revealed that Light was impure: the immaculate light from the nearest star contained within it all the colors of the visible spectrum. What the gifted young natural philosopher discovered that day started a giant revolution in both religion and science, which continues to our days.

1. "In August 1665, Sir Isaac Newton, who was then not yet 24 years old, bought at the Sturbridge fair a prism to make some experiments with Descartes' book of colors, and when he got home, he made a hole in his window shutter, darkened the room, and placed his prism between that and the wall, and found, instead of a circle, light made (...) rectangular in shape, with circular ends, convinced him at once that Descartes was wrong, causing him to discover his own hypothesis about colors which he could not demonstrate for want of another prism, and for the purchase of which he remained until the next Sturbridge fair, later proving what he had before discovered. " Note inserted in Newton's manuscript in the Keynes collection in the King's College Library at Cambridge (Keynes MS 130. 10, ff. 2v -3) (Westfall, 1980: 157).

2. Spherical aberrations were directly linked to the concave or convex geometry of the lens. "In possession of the sinusoidal law of refraction, originally formulated by Willebrord Snell in 1621, he showed that a lens with spherical surfaces cannot represent axial point objects as point images. His geometric study of lenses with ellipsoidal and hyperboloidal surfaces revealed that a plano-convex lens, whose backward curved surface was hyperboloidal figure, would meet this imaging criterion for infinitely distant point objects. He thought that this theorem was highly odiferous and held that by this means it would be possible to increase the apertures and magnification of telescopes. Although spherical aberration could be corrected in this way, Descartes failed to differentiate between this and chromatic aberration, ignoring the physical principles involved" (King, 1955: 48); c.f. Descartes (2010). The dioptric. Discourses I, II, III, IV and VIII. Scentiae Studia, 8(3), 451-86. http://dx.doi.org/10.1590/S1678-31662010000300007 .

Considerations

This brief trip about light aimed to revive the memory and establish a conductive line between the discovery of the Cosmos, through the "marvelous lunettes" - using Descartes' words - and the visible spectrum. However, it is necessary to pay tribute to great authors, remarkable figures in natural philosophy and science, who, although not mentioned in the previous pages, are an integral part of the incredible history regenerated daily by Humanity. Although the unknown remains resilient, both in earlier centuries and today, the scientific legacy, relating to a broad knowledge of the place of life in the cosmos, is exuberant.

From the understanding of light, it was possible to discover the cycle of time and, consecutively, the sundials, water clocks, tower clocks, or wristwatches, the principles of the small Newtonian telescope, which provided an optical magnification of about 40 times, on whose principles large telescopes of today are still based, or even the age of the stars through the spectral reading of light, documented in the extensive work of the Italian priest Angelo Secchi. Also, the contributions of Galen, Alhazen, Al-Kindi, the Islamic invention of the *Zenith* instrument, Keppler, Descartes, the gravitational law and laws of Newton (and his eternal companion and helper in many experiments, John Wickins), Einstein's theory of relativity, among many other great names and other contributions that increased the credibility and scientific notoriety, establishing bases to support the theoretical thought of light. Thus, the countless discoveries made in previous centuries built pillars of understanding of the Universe today, broadened the speculative horizons and made it possible to develop means, measuring instruments, and find scientific proof of all the cosmic dynamics and cosmological splendor.

Investigating light has become a goal of humanity. Therein lies the key to the ambiguous decoding of the universe. From Galileo's marvelous telescope, technological development and scientific research, in a joint effort, have achieved tremendous feats. Once Maxwell's laws of electricity and magnetism were established, the speed of electromagnetic waves such as light made it possible to calculate the size of the Universe. Both the nearly 30-year-old Hubble telescope in permanent solar orbit, and its successor JWST[1] or "Webb" and the recently launched WFIRST[2] infrared telescope, to be launched respectively in mid-2021 and mid-2020, will exponentiate Galileo's ambition and extend the vision even further, decoding the lucid place of light across the most diverse fields of research. Perhaps even Max Plankt's quantum physics; Lord Kelvin's *dark matter*; Einstein's cosmological constant, later called *dark energy* by Michael S. Turner; Quarks; Neutrinos; or even the new readings of the infrared radiation of the Universe will make us rethink the *Big Bang* theory again and the still unknown story of the beginning of the Universe and consequently of the beginning of life will continue in persistent renewal. Generally speaking, one could even say that everything we know about the Universe is revealed by light. However, the possible dazzle of such magnificence still lies in what sustains the sense of sight: the eye.

1. Acronyms for: "James Webb Space Telescope"; Staff, S. X. (2020, April 30). NASA's Webb Telescope to unravel riddles of a stellar nursery. Available at https://phys.org/news/2020-04-nasa-webb-telescope-unravel-riddles.html.

2. Abbreviations for: "Wide Field Infrared Survey Telescope"; Balzer, A. (2020, April 21). Um conto de dois telescópios: WFIRST e Hubble. Available at https://phys.org/news/2020-04-tale-telescopes-wfirst-hubble.html.

About the author

Rodolfo Anes Silveira, after starting his professional career in the audiovisual sector in Portugal with the completion of the course at the Technical School of Image and Communication in 1999, has since then worked as a freelancer, providing various services of sound treatment, creation and mixing, both live as well as in post-production. Years later, in 2012, after finishing her degree in Cinema, Video and Multimedia Communication at Universidade Lusófona, with special focus on the area of cinematography, she interned at the Council of Europe, in Strasbourg, France, in the Audiovisuals department. Returning to Portugal in 2013, she took a training course in Augmentative Language at the Catholic University of Lisbon and a training course in entrepreneurship for creative industries at the Lusófona University. At the end of the same year, he attended the seminar on colour correction for cinema at the University of Television and Film Munich (HFF) where he stayed as a guest student and obtained extra training in various areas of technology and filmmaking practices in cinema. Besides also starting his career as a Freelancer in the field of film in Germany, he worked as a tutor in several seminars at the same university between 2014 and 2017. From there, he was invited to join the department of Cinematography at the end of 2017 in the position of study coordinator. Also in 2017, he started a PhD in Media Arts where he investigated multisensory perception in installation art with a special focus on haptic sense and haptic feedback technologies in non-contact mid-air as well as their possible application in interactive and immersive art installations. In 2019, he was invited to take up the position of assistant professor in the department of cinematography and in 2021 he also moved on to a similar position in the department of visual effects at the Hochschule für Fernsehen und Film, Munich. In January 2022, he finished with distinction his PhD in Media Arts at the University of Beira Interior.

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HAPTICOTOPIA
IS THERE IMAGE WITHOUT VISION?

"In the present essay, Rodolfo Silveira meticulously analyzes the theoretical, speculative, but also symbolic drift around the luminous phenomena. He also gives us a historical overview of the sound and acoustic spectra, and of the relation between touch and skin - which is rarely addressed elsewhere - without overlooking a careful incursion into the physical, physiological, and somatic, perhaps synesthetic, aspects resulting from this perceptual, sensorial, and cognitive contamination.

As such, Hapticotopia is a book that naturally opens space to another diptych of great operative, critical, and even didactic value: the relationship between multisensoriality and intermediality is essential to the understanding of the diverse contemporary artistic practices, capable of stimulating practice-based research, particularly in universities and in institutions dedicated to the promotion, creation, conservation, study, and diffusion of art from the past, present, and future, as is the case of museums, whose performance is addressed in the second part of the book.

In this manner, using an extensive wealth of information from multiple sources and works as diverse as they are heterodox, Rodolfo Silveira essays, in the true sense proposed by Michel de Montaigne (1580), a reflective practice that, not being concerned with individual singularities, ends up being "a writing of the self" that refers back to the ancient dialectic between the particular and the universal and accepts tentativeness and mutability, in the face of a lucid awareness of the evanescence of the object that is reflected in the experience and that shapes the condition of the contemporary subject."

Francisco Paiva

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