Datafication as a Contemporary Artistic Process: An Exploratory Research into Eye Drawing using an Eye Tracker

By

Matthew Attard

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DATAFICATION AS A CONTEMPORARY ARTISTIC PROCESS

Declaration

I hereby declare that I am the legitimate author of this dissertation and that it is my original work.

No portion of this work has been submitted in support of an application for another degree or qualification of this or any other university or institution of learning.

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Abstract

This research investigates the implementation of recorded data into a contemporary artistic process. Data from an eye-tracker was used as a replacement of the traditional practice of drawing. This entailed a shake up of the conventional hand-eye coordination present during any drawing activity by limiting it to a strict brain-eye exercise. The artist's 'talented' hand was therefore obliterated from the practice's equation, and the role of an artist and a beholder levelled. The exercise of eye drawing through the use of an eye-tracking device brought forth a new and unnatural way of looking at the world, as intuitive eye movements were suppressed into the following of contours along the observed worldview. The natural impulse to refer to the curvilinear hand motions while drawing was also restrained. These concepts were explored throughout this research's methodology, alongside possible artistic developments from the generated data and the establishing of an eye-tracking device as an intriguing artistic medium. A communal eye drawing experiment was also conducted which resulted in surprising outcomes of very individualistic scanpaths, comparable to 'graphological' elements. The implementation of an eye-tracker as an artistic medium also gave the possibility to test a preliminary algorithm, 'correcting' an eye drawing by comparing it to the actual world view. The latter's experiment results can be important grounds to consider for future development in the manufacturing of 'eye drawing' devices designed to give individuals with physical hand impairments the opportunity to draw from the real world through the use of their eyes.

Dedication

To my niece, Millie Rose. Welcome to the world and to the family! Be kind and free…

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CHAPTER 1

INTRODUCTION

Aims and Motivation behind the Study

Drawing can somehow be defined as an active exploration of the individual's (doer, creator or artist amongst others) mental imagery. In fact, Berger (2005) describes it as; "an autobiographical record of one's discovery of an event - seen, remembered or imagined" (p. 3). It is an activity as old as the evolution of our closest human ancestors, spanning across all civilisations. In a sweeping assumption regarding its history, one can deduce that drawing developed from a primitive intuitive gesture towards becoming a skilful practice; to be then challenged by the development of new technologies such as photography and digital reproduction. It is, however, not just drawing which is challenged by the coming of our present Information Age, but also our own way of living, knowledge, attention and perception. We have speedily entered an age where every interaction we have with almost any technological machine leaves a retrievable, non-physical trace. A contemporary age of datafication has become well rooted into our cultural and social routines (Schafer & van Es, 2017). At the same time, the rapidly evolving technologies have permitted empirical studies to observe sections of our world which were not previously possible, with the latter part of the last century evidencing investment in brain research. We are diving deep into the neural mechanisms behind every human activity—religion, morality, law, politics, economics, art—while aiming at a better understanding of our species' nature (Ball, 2013).

The ultimate aim of this study is to use data generated through available contemporary technology like the eye-tracking device as a new medium for an artistic process. The objective is to test whether this collected data from eye-tracking technology—and therefore 'autobiographical' traces of seeing—can 'substitute' the existent hand-eye process during the traditional drawing process. The word 'seeing' is being here used other than the word 'perception', as throughout the development of this study's practice-led methodology, it became clearer that this dissertation was changing and challenging the natural mechanisms of observing the real world (made possible through the recording of data). As will be shown in chapter 3, *Methodology*, this study arrives to a procedure where the creator/observer shifts his/her eyes along mentally perceived contours of the object/s in front of him/her in an attempt to eye draw what is being seen. This is an unnatural process with respect to the 'usual' gaze fixations at attended areas of our visual field. Essentially, the method which will be later shown involves a 'creative mechanical' use of our eye movements, with the intention to draw what is being seen through the recording of the movements' traces (see chapter 3, *Methodology*).

The development of creative processes have been described as being both steady in their objective as well as influenced by the distinctive techno-historic contexts (Sapsed & Tschang, 2013). Because of the revolution of the digital way of reproducing images and media, Berger (1972) explained how things which previously were not apparent suddenly became visible to one's eye in *Ways of Seeing*, referring to television and the beginning of information technology. Nowadays, this is even more evident through the possibility of data recording our implicit and unconscious actions, such as our brain activity (through an EEG device) or saccades movements (through an eye-tracker).

These mentioned technological devices primarily exist as tools for the empirical world of cognitive science. In this view we are at a moment in history where art should not ignore science's inspiring descriptions of an objective reality, while on the other hand science must recognise that its truth is not the only truth. If we want to get closer to the deepest questions of who we are, science and art should complete each other (Lehrer, 2008). One can here argue that all art is subjective; in an article published in *The New York Times*, Saltz (2007) wrote; "Money is something that can be measured; art is not. It's all subjective". A great deal of art perception therefore depends on both the creator's and beholder's experience, and context. As hinted above, through the objective of this study, I am hoping that the role of the creator as beholder is further emphasised. The creative act will be primarily based on looking at the world and therefore on the perception of it, eliminating the need of the artist's 'skilful' aspect of drawing from the artistic process (through the use of devices such as the eye-tracker). This, however, does not necessarily mean that the way of perceiving will be done through a normal way of looking as our perception does not normally lead us on to trace (draw) around objects in the world through the use of our eyes. It will therefore be a new way of looking in need of development and exploration.

Overview of the Study

This research starts with the following chapter 2, *Literature Review*, which attempts to tackle most of the arguments involved with our knowledge of how we perceive the world (both empirically and philosophically), and the acting influences on the artistic process. For a more precise and in-depth analysis, sub-chapters of the concerned review also deal with the influences of the development of technology acting on both perception and art.

The review starts with a brief analysis of contemporary empirical knowledge of how we humans perceive the world through our vision. Since the aim of this research question is, ultimately, to establish a creative 'reproductive' process developed through the act of looking at the world, it was important to first understand our concerned cognitive processes from a contemporary empirical viewpoint (including a highlight on how we perceive and create art). This argument develops into selected case-studies from the history of art evidencing the artists' display of a clear understanding of scientific perceptive theories in their depictions. This also led to a brief discussion on the act of drawing itself as an activity juggling reasoning and intuition, exploration and definition.

Since devices like the eye-tracker fundamentally record a subjective vision, it was then of great importance to address perception from a phenomenological point of view. The empirical knowledge of our attention in the world was challenged through a philosophical view of perceiving. This prepared the way for discussions and case-studies of perceptive techniques in art, the impact of modern technology on our attention and perception, and finally our contemporary age of the data phenomenon and its application in the liberal arts.

A particular experiment involving a Life Class, then brought up a discussion about our subjective gaze and the application of eye-tracking technology (which will be further discussed throughout chapter 3, *Methodology*). Furthermore, chapter 3 illustrates a step-by-step development of this practice-based methodology into the eye-drawing possibilities which have been explored. The concluding chapter 4, *General Discussion*, then briefly tackles the major findings of this research's experiments, and mentions points which can be good points of departure for new questions.

My artistic practice prior this research consists in the attempt to deconstruct a drawing within the space of an environment through the use of sculptural material such as hanging sheets of plexiglass and wire (see pp. 116 - 123). The fundamental element in both the creation and viewing of these works is the 'intuitive' aspect of our visual perception. The sculptures present a duality between abstraction and representation, and play around the recognisable and the unclear through an exploratory subjective perceptive experience. The starting point of this dissertation's practical research reverses this process; drawing stems from a direct perceptive action as the recording of eye movements takes place prior to the creation of any artistic work.

CHAPTER 2

LITERATURE REVIEW

Our Brain is a Limited Resource

We are living in a contemporary world where empirical research acknowledges that our brain is a very limited resource. The factual data of an average of 100 billion neurons and more than 100,000 km of interconnections might give a different perception to this initial statement, but when put in context this network of neurons only runs on about 15 watts, while being restricted in size and capacity (Hofman, 2014). Our brain's intelligent competence prevails in the ability to handle multi-cognitive processes and cross-reference them with "saved" memories and acquired knowledge from past experience (Hofman, 2014). In order to maintain its efficiency, the brain, therefore, mustn't waste energy on irrelevant information of the surrounding world coming in through our senses. It evolved in a manner to cognitively respond in the most efficient way to our constant and contextual environmental changes.

Consequently, the reality we perceive is a constructed one: our conscious perception of the world is of a deceitful character (Noë, 2002, p. 1). Our brain's ceaseless cognitive processing makes us feel like we are living in a world which equals to that which we perceive. This however, turns out to be a deception; an alternate reality constructed by our brain (Simons, 2011). A proof that our active perception of the real world is nothing but a reduction of what our subjective realities advocate, is *Change Blindness* (Simons & Levin, 1998; Gibbs, Davies & Chou, 2016). *Change Blindness* suggests that only a hint of the richly visual world around us is being compiled and processed, otherwise immediate change detection would be experienced in such scenarios (Rensink, 2000). Other similar phenomena like *Inattentional Blindness* also support this claim; which phenomena have seen a rise in interest and literature since the last decade of the 20th century, and have also been tested inside the artistic environment (Levy, 2012).

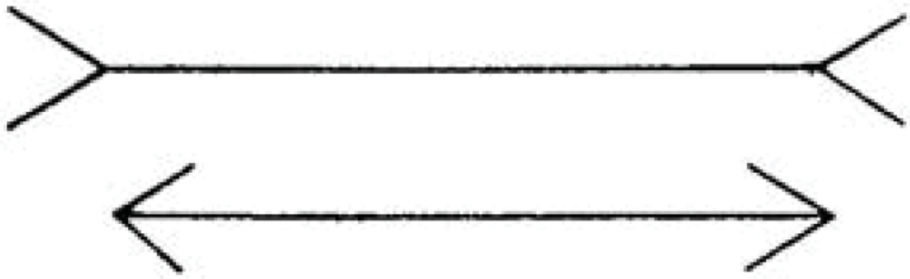


Figure 1: *Müller-Lyer*'s Illusion. (Merleau-Ponty, 2005, p. 5)

Illusions have a long history of their own suggesting our deceit in perception, both in art and in empirical research. Classic examples like the *Müller-Lyer*'s illusion (Figure 1) and the *Ebbinghaus Illusion* (Figure 2) are clear examples of how our visual perception can be swindled. Such phenomena have been extensively tested in lab environments, and empirical results now provide us with a better understanding of where our neurological processes physically happen inside our brain during the moment of 'deception'. For example, in the *Müller-Lyer*'s illusion case (Figure 1), our right posterior parietal cortex and the right temporo-occipital cortex are activated during our moment of deception while believing that one line is longer than the other, even if in reality they are mathematically equal (R. J. Sternberg & K. Sternberg, 2012, p. 122). The same illusion effect has also been observed under implicit circumstances, where test participants proved to be effected by it even through an inattentional process (Moore & Egeth, 1999). Barton Anderson's *Black and White Discs* (Figure 3) is a more recent deceptive illusion, in which light and texture are added elements playing on our perception. Even though both set of discs are scientifically identical, the top set appears to be much lighter than the bottom set when placed against the context of a dark background, and vice versa.

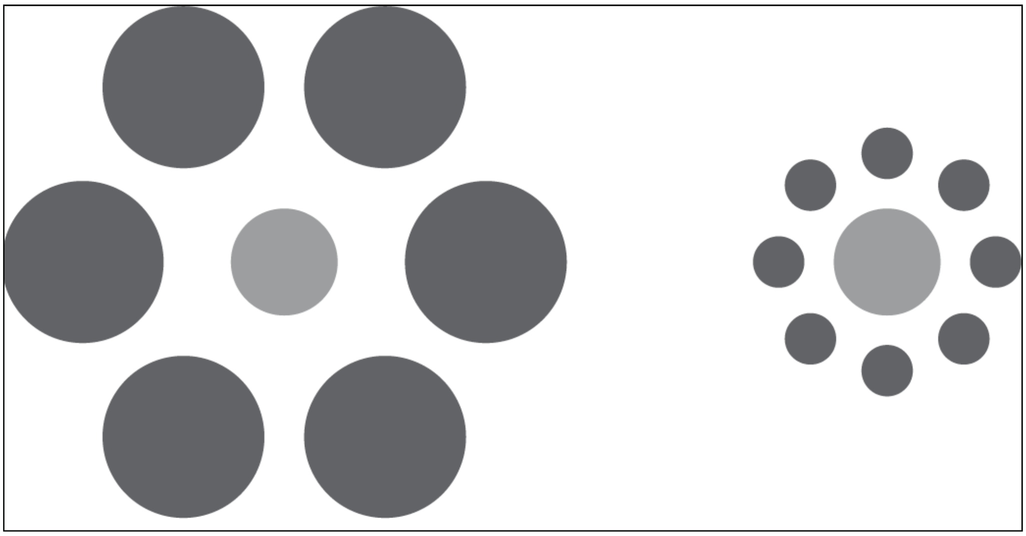


Figure 2: *Ebbinghaus Illusion*. (Gallagher & Zahavi, 2008, p. 96)

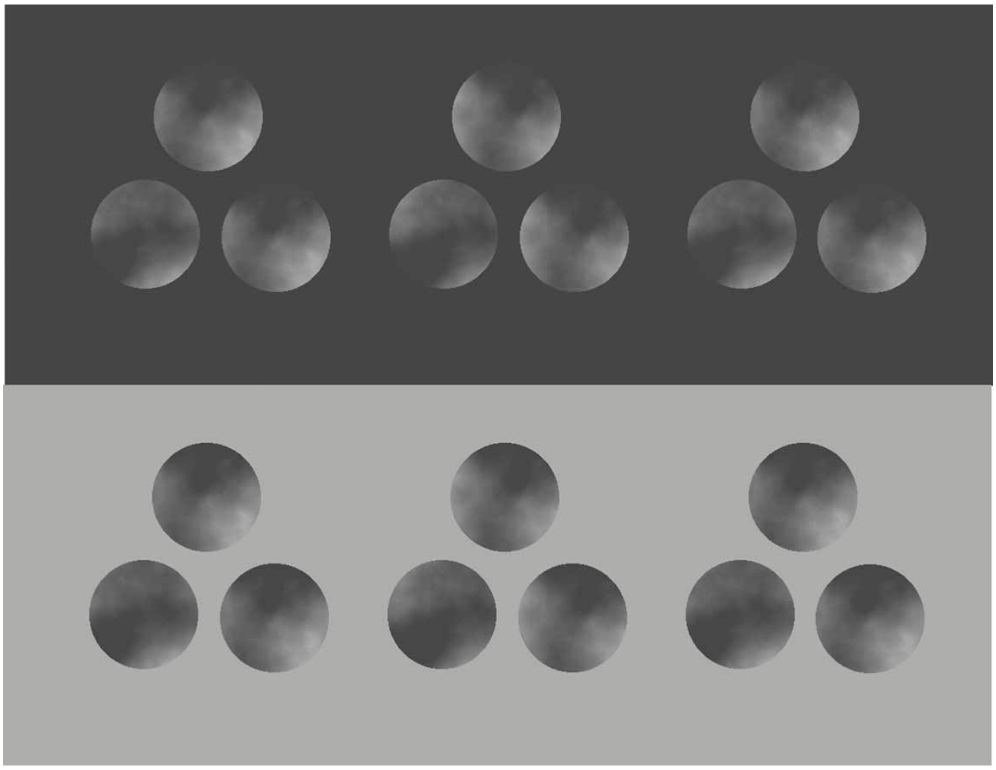


Figure 3: Barton Anderson's *Black and White Discs.* (Anderson, 2003)

As Gombrich (2002) states in his *Art and Illusion*, this attempt at judging on the difference between what's observed by our eyes and the resulting perception of the world around us derived from our mental processes, goes back to the archaic human speculation of perception itself (p. 12). He evidences this statement by citing Pliny's belief that the real instrument for our sight and observation is actually the mind, whereas the eyes' function is to act as a receiving and transmitting vessel (Gombrich, 2002, p. 12). It can be argued that the world of art (at least in the Western tradition) has an affinity with deceptive techniques, techniques which kept being both developed and challenged throughout its course up to our present day. Perhaps, an iconic Western illusory painting is Masaccio's *Holy Trinity,* situated in the Dominican Church of Santa Maria Novella in Florence (Figure 4). What I refer to as 'iconic' is the fact that it is the first known painting to have implemented Brunelleschi's technique of linear perspective in its artistic vision; it somehow marks a change in the general perception of the recent history of Western art (for more information on techniques implemented by artists, see pp. 55 - 80). In historical terms, it is accepted as the first known depiction implementing a perfect illusory vanishing point, and Brunelleschi might have drawn its initial sketch himself (Howard, 2012, p. 53). The real architectural context was fused with an imaginary portrayal, including its atmospheric details such as light and shadow calculations, as well as the structural study of the church's interior. The *Holy Trinity* is therefore a case-study of an early example where the artist injected an empirical 'technology' to his artistic objectives, creating a visual context for the beholder's brain to be 'tricked' into perceiving another vault opening within the actual church. For the first time there was an attempt at the creation of an illusion of the true world as comprehended by the Masaccio's contemporary society, which broke with the earlier tradition of representation (P, Murray & L, Murray, 2000, p. 40). Even in our own contemporary society, we look at the *Holy Trinity* (and other paintings) and our brain wants us to experience the illusion of a vault opening, however with a slight difference from the Renaissance beholder. Our perceptual impact is affected by today's contemporary context of a sensory overload (from virtual reality to 3D movies and hyperrealism amongst others), and somehow our awe in front of traditional painting and art is concerned more with the historical achievement and the painting's (or sculpture's) aura, as it can be very difficult to look at images we grew accustomed to with fresh eyes, or rather with a fresh brain.

Figure 4: *The Holy Trinity.* Masaccio. 1428. Fresco. Santa Maria Novella, Florence

Between Art and Science

Fast-forwarding through the history of Western art, we enter in the realm of the non-figurative with the coming of the modern era. Arnheim (1974) describes this as a divorce between concept and percept, while thought travels amidst abstractions (p. 1). Therefore, perceptively there is naturally a great difference between Masaccio's earlier depiction and, for example, one of Josef Albers' paintings (Figure 5). While Masaccio dealt with the merging of a naturalistic illusion and Christian iconography, Albers' depiction is deprived of any symbolic meaning but is solely concerned with brushwork, composition and colour. However, is there a difference between how both artists handled their depiction with respect to their historical context when one considers that both artists' body of work were breakthroughs to their respective contemporary societies? Is there a difference between Masaccio's interest in the theory of perspective and Albers' interest in the Gestalt theory? Gestalt lectures gave Albers the empirical explanation of a colour effect known as 'simultaneous contrasts' which had been intuitively implemented by artists for generations. The theory revolves around the changing appearance of colour when put against different backgrounds, usually resulting in dramatic differences (Berhens, 1998). The scientific verification meant for Albers that this visual perceptive process was not merely an intuition anymore, but a case phenomenon which could withstand being a subject in its own right for the visual arts; similar to how Masaccio elevated intuitive attempts at perspective (like Giotto's Figure 6) to a newly studied level of visual application.

Figure 5: *Variant "Orange Front"*. Josef Albers. 1948 - 1958. Oil on Masonite. 59.6 x 68.5 cm. The Peggy Guggenheim Collection, Venice.

Methodologically speaking, there is therefore little difference between Masaccio's and Albers' interest in the scientific visual theories which excited their artistic development respectively.

Figure 6: *Madonna Enthroned.* Giotto. ca. 1310. Tempera on panel. 3.3 x 2 m. Galleria degli Uffizi, Florence.

Both theories of linear perspective and "simultaneous contrasts" were factual empirical data which the artists then acknowledged, interpreted challenged through their works. Considering this point through the eyes of what Kandel (2012) states on the relationship between art and science (p. 449); the empirical Gestalt colour theory and the artistic vision in a painting by Albers are both similar in their way of being reductionists. The difference between the two is that the empirical theory tries to create an objective measurement through a general approximation, whereas the artistic work has an inevitable subjective imprint in its attempt of creating a portrayal formulated by the artist's everyday reality (Kandel, 2012, pp. 449 - 460). The author refers to the artistic process as a "model making of the world [which model making] …is also the core function of the perceptual, emotional, and social systems in the human brain" (Kandel, 2012, p. 449), consequently also present during the beholder's viewing of the work - the Aha! moments of insight.

Since the late 19th century, after the emergence of the scientific psychology field, perceptual modalities have been in a constant metamorphosis and are still in transformation to the present day

(Crary, 1999, p. 13). As soon as the world became strongly loaded with sensory inputs, perception/ attention became a fundamental issue in contemporary society (Crary, 1999, p. 13). Also, since the digital revolution of our present Information Age, we are still in the process of understanding our current social change. For example, there exists a general perception that Internet users are more prone to estrangement and isolation from society, whereas emerging scientific studies are proving this concept wrong (Castells, 2014, p. 10). Naturally, each case study also depends on the context of the individual.

Our current historical circumstance is, however, being shaped to a point where it is characterised by an influx of generated data on a daily basis. Most of our daily digital interaction translates into a data point or virtual trace, even during simple daily operations like when surfing the web or paying by credit card (Urist, 2015). One can say that an age of datafication has sedimented well into our cultural and social routines (Schafer & van Es, 2017, p. 11). We therefore also live in times where research evidences how our brain perceives the world through its own individual constructed 'reality', because of factual reports generated from recorded data. How is this influencing our current contemporary artistic practice? How can this contemporary influx of information act in the same manner linear perspective and 'simultaneous contrasts' influenced Masaccio and Albers, respectively? What is the importance of data resulting from studies evidencing that the neural time course of art perception for processing content is faster than that of processing style (Augustina et al., 2011)? What is the validity of a study stating that drawing aids in the formation of a more stable memory trace due to its integration of multiple cognitive processes (Wammes et al., 2015)? I believe that contemporary art should start addressing such questions in a more profound manner, and that we should intertwine such information with our phenomenological experience of perceiving the world into a relevant contemporary artistic practice.

How do we Perceive the World?

In his introduction to *Suspensions of Perception,* Crary (1999) argues; “that the modern problem of attention encompasses a set of terms and positions that cannot be construed simply as questions of opticality” (p. 2). Crary is here referring to perception as attention, and throughout his study he attempts to illustrate how attention became a major focus of modern individuality since the mid-19th century. He is correct when stating that attention cannot be fully understood solely through opticality research, as the way we perceive the world has more parts to sight apprehension. I still feel it is necessary for the purpose of the study to briefly highlight the most important biological mechanisms happening in our brain in order to delineate the essential visual processes through the knowledge the empirical world has till our present day.

Because of our brain’s evolved efficiency, the act of perceiving the world feels like a normal ordinary task of an effortless nature, and we do not really have to think about what to look at and how to make sense of it. It seems as; “inevitable as water flowing downhill” (Ramachandran, 2011, p. 45). In fact, our perception of the world is the result of an incredibly complex system of synchronised processes, and an outcome of primate evolution which led us to becoming the human species we are today. This same evolution overlapped the borderlines between visual perception and our human imagination, which allows us human beings to shuffle visual elements into new consolidations, such as any mythological historical narratives, for example. Compared to the fewer than a dozen visual areas present in most carnivores and herbivores with which we share Planet Earth, us humans have possibly more than thirty (Ramachandran, 2011, pp. 41 - 74).

Crary (1999) starts his analysis of perception from the mid-19th century not only because of the social, urban and psychological changes acting on perception and attention throughout the beginning of modernity, but also in view of the determination that the truth of vision lay in the body and human perception, which had entered the; “domain of the quantifiable and the abstract” (p. 12).

Since this realisation, we are now in a position to know that in order to understand visual perception we need to eliminate the notion that information received through our eyes is simply passed on to the rear end of our brain to be re-projected in our mind's eye. In fact, as soon as visual information enters our visual system as rays of light, it is transformed into neural motifs at the back of our eyes. It therefore does not make sense to keep regarding this visual information as being an image, but as data or information (Ramachandran, 2011, pp. 41 - 74).

When staging down the sequence of events which lead us to visually perceive our surrounding environment, the process of course starts with light. Light originating from any light-emitting source (from the sun to candles) bounces off most physical objects in our world; from these array of light waves only a few find their way through our eyeball. Two types of photoreceptor cells on the retina receive the entering light—cones and rods—where the former are not particularly light sensitive but can distinguish between colour hues, while the latter are very efficient in low light situations but are colour-blind. Both types of cells pass on the processed information to bipolar cells, which on their own behalf stimulate ganglion cells gathered together at the optic nerve (Reisberg, 2010, pp. 40 - 48). An average human is estimated to have around 260 million photoreceptors shared between the cones and rods, while only about 2 million ganglion cells exist to transfer the retina's information to the visual cortex at the rear of both brain hemispheres. In order for the carrying of the information to be efficient, many rods quantify their outputs into one single ganglion cell. Cones feed a ganglion cell in much fewer numbers instead, allowing for more detailed information to follow through and hence a sharper image (Gazzaniga, Ivry & Mangun, 2014, pp. 184 - 197).

Figure 7 illustrates the main pathway of the optic nerve connecting the retina to the visual cortex, where almost all fibres end up in the primary visual cortex of the occipital lobe. The other 10% of the information streams through different pathways into subcortical structures in the mid-brain area (Gazzaniga et al., 2014, p. 122). Here, special attention is being given to our visual perception as opposed to the auditory, olfactory, gustatory or somatosensory processes for two main reasons. Firstly, it is the sensory mechanism which empirical science knows most about (even though as in the case of most brain research the more this area advances, the more questions arise). Secondly, the information processed by our visual mechanisms seems to lead over our other senses when perceiving the world around us, and because of this it also seems to have greatly influenced the way we think. For example, linguistically we say 'I see' in affirmation that something is clear and comprehensible to us (Gazzaniga et al., 2014, pp. 184 - 197). Vision processes are therefore inevitably also the main operative sensory areas during both the creation and the observation of art, even though not the only ones.

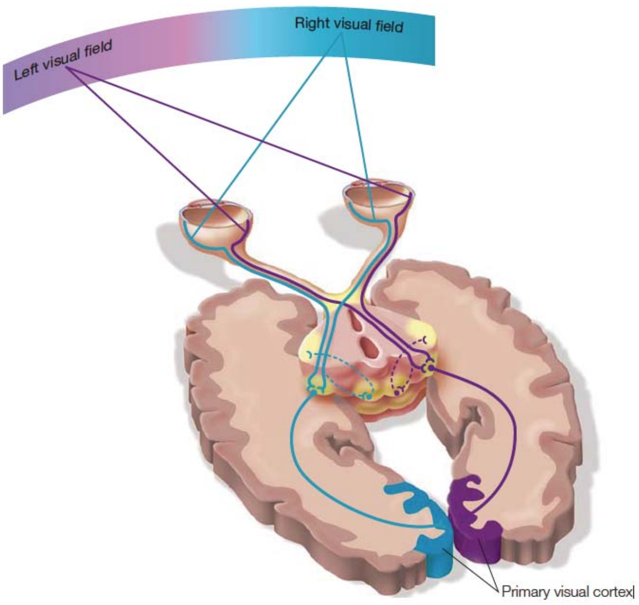


Figure 7: Pathway from our left and right visual field to the primary visual cortex, through the optic nerve. (Gazzaniga et al., 2014, p. 122)

A contemporary question in some neuroscience and cognitive science books is:Why did our primitive ancestors' brains evolve so much with respect to its several visual sections? The theory that visual processing happens in a hierarchical way seems to have been a part of a logical answer to this question, however the idea that the processing arrangements consist more of akin multiple pathways other than one simple stratified model is starting to be reasoned out (Figure 8). Each visual area has its own way of representing the information driven by the optical nerve; for example, some cells calculate edges, while more sophisticated ones merge information from neighbouring cells in order to display shapes. Consecutive processing attempts to match processed information with stored memory; therefore, the visual areas are categorised according to their cells' functions which depend on what type of data processing they execute (Gazzaniga et al., 2014, pp. 184 - 197).

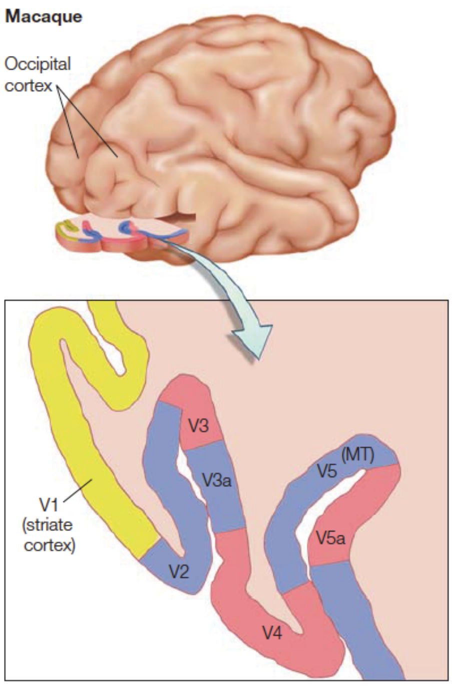


Figure 8: Seven different visual areas illustrated along a cortex. Visual processing is not restricted to proceed sequentially from one to the next. (Gazzaniga et al., 2014, p. 190)

This very basic and brief description of the neuronal journey from the retina to the visual cortex at the back of our brains suggests a very different approach from the intuitive impression that our visual perception functions like a camera. As Gibson (1986) had already stated, we should abandon the idea of our human eye as being a dark chamber with an upside down image formed at its rear as a result of a lens, while specifying that vertebrates and molluscs have an eye of this kind (p. 61). He instead suggested to look at vision as forming part of our perceptual system (together with both the brain and eye) where the process is circular (Gibson, 1986, p. 61). The assumption of having an inverted image being passed on to the back of the brain for readjustment would create a fallacy known as the homunculus fallacy. For the inverted image to be correctly reinterpreted at the rear end of our heads, there would be the need of a homunculus—"a little man"—who in turn would need another homunculus understanding the image on the "screen" and so on. Thus creating an impossible infinite loop (Ramachandran, 2011, p. 48).

It is important to keep in mind some patient case studies in order to better picture the complex processing behind our daily automatic visual perception of the world. Some individuals who suffered a stroke and totally recovered their visual sensibility and language efficiency afterwards, still had an impairment in recognising objects in the world. Patient G. S. became such a case after he suffered from a stroke in his thirties. He showed no problems in his coordination, measurement, judgment, colour or general shape recognition, but would fail to recognise a candle from a crayon. Therefore, his visual perception failed even though he showed no signs of trouble in his eyes and optic nerve (Gazzaniga et al., 2014, p. 219). Ramachandran (2011) also speaks about *John*, who after an appendicitis operation started suffering from the same condition. He had no intellectual restrictions or verbal limitations, and while he could understand an animal from a plant he could not understand what animal it was (p. 46). When looking at a mirror, he knew his reflection was his but could not recognise his face anymore; in other words, he knew that the reflected person was him but could not see it (Ramachandran, 2011, p. 46). These examples of visual agnosia have provided insight on what processes cross path during our perception of the world, specifically during object recognition. Neuroscience went through some major realisations because of such case studies; such realisations can be very relevant to any contemporary visual art practice today. Firstly, there is a great difference between the terms perceive and recognise, and secondly, we are programmed to perceive the world in terms of "*unified objects*" (Gazzaniga et al., 2014, p. 220). Particular descriptive details like colour, texture, motion and size have their individual neural pathways for processing, but perception needs a further step in order to make sense of the world. When looking at a sea-view we do not simply sense an infinite number of blotches of shapes and colour, but these particular details are unified into the perception of an extensive seascape. At the same time, this perceptual ability has an admirable degree of flexibility and a tight link to memory (Gazzaniga et al., 2014, p. 221). Therefore, should I happen to bump into an Austin Mini Van from the late sixties, my visual cortex will process the scene I'm sensing; a late 60s Austin Mini Van parked in a street, while at the same time link the perceived object to the memory that my grandfather used to own one.

However, it also appears that in order to preserve an ongoing memory maintenance as an active biological mechanism, memory itself is in a continuous wrestle with the process of forgetting, while also reinterpreting itself. Even a reminder has the ability to transform a consolidated memory back into a changeable state, which memory becomes prone to re-encoding depending on the individual's training and reactivation characteristics (Haubrich & Nader, 2016).

There are three other empirical points regarding the nature of our perceiving of the world which I would like to refer to. Firstly, we live in a world which surrounds us with an infinite amount of stimuli for us to interpret and perceive. These stimuli are not to be exchanged for signals coming from the world, as this would imply that the world is trying to communicate with us (Gibson, 1986, p. 63). To a certain extent, it is therefore entirely up to us how to perceive our surrounding environment. On the other hand, a slightly different context can be explained with respect to an artistic intervention. Like the inscribed and uttered words of language, art, in general, is the result of a man-made activity which still provides us with a certain degree of stimuli. Art presents its information for any beholder to look at, and to the contrary of the stimuli coming from the world around us, the stimuli received through art are of second-hand nature (Gibson, 1986, p. 63). Whatever stimuli art presents us with, have already been arbitrated by the perception of the world of the first observer/creator.

The second point I would like to illustrate involves a simple illusion known as the Necker cube (Figure 9) which had been discovered by accident by Louis Albert Necker. The fascinating phenomenon of this illusion is the fact that through its simple skeleton outline, the cube changes orientation; it can appear to be both below or above the viewer depending on which perception the viewer's brain chooses to attend to. Therefore, as Ramachandran (2011) states; "even a simple act of perception involves judgment and interpretation", which makes it an active assumption of the world and not a static form of mechanism (p. 48). The recent discovery of the canonical neurons found in our frontal lobes, seem also to suggest this by evidencing that the clear division between action and perception exists in our language and not necessarily in our brains. These neurons fire during the act of a particular movement, such as for example, the grasping for an apple. However, the same neuron also fires at the appearance of an apple. Ramachandran (2011) explains this as if; "the abstract property of graspability were being encoded as an intrinsic aspect of the object's visual shape" (p. 44).

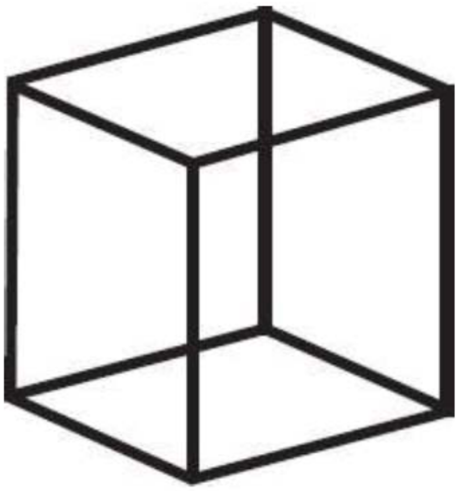


Figure 9: *Necker Cube*. (Ramachandran, 2011, p. 48)

The last point links with the previous brief explanation that our visual cortex has a number of functional areas working in parallel and process the given information accordingly depending on their specialisation. Many areas of functional specialisation exist; among them those for the recognition of facial expressions, facial recognition, form recognition, body language, motion detection and colour identification. Zeki (2009) uses the latter two areas to explain a perceptual asynchrony happening during our visual perception processing (pp. 35 - 38). The cells leading to the coordination for perceiving motion seem to be genetically inherited, as well as some specific cells situated in a different functional area of the visual cortex which generate constant colours. Experiments have shown that colour perception precedes that of motion by about 80-100ms (Zeki, 2009, p. 37); a value which seems insignificant in our daily-time realm, but can be of great difference in the neuronal-time sphere (especially when considering that the time for a nervous impulse to move to the next is somewhere around 0.5 and 1ms). If we agree with Zeki (2009) that to perceive something is akin to becoming conscious of it, the above mentioned experiments challenge the idea of a "unity of consciousness" (pp. 35 - 38). Since both the colour and motion functional areas are spatially distant from one another (colour lies in activity area V4 while motion in activity area V5, see Figure 8), and the perceptual processing of the former is faster than the latter, then our visual consciousness is spread both through space and time in our brain (Zeki, 2009, pp. 35 - 38). Also, this shows us that we visually perceive what processes the brain has completed and that functional areas do not wait for others to finish their computations. Hence, going back to the initial discussion, our perception of the world around us is a constant reconstruction supplied by our brain. We shall in this context also not forget the initial part of a relevant quote by Arnheim (1974) from his introduction to *Art and Visual Perception*; "All perceiving is also thinking…" (p. 5).

How do we Perceive (and Create) Art?

Our visual system makes up an important part of the brain, and it might be the case it occupies up to a quarter of it. Visual perception is also one of the most efficient ways for us to gain insight of the world around us, and maybe this is why we have been often described as a visual species (Zeki, 2009, p. 35). During our human brain evolution, the boundary between what can be considered as visual perception as opposed to visual fantasy started to overlap. While other mammals can most probably picture some primitive type of visual imagination, us humans are the only species who developed the capability of altering, switching and combining visual imagery, creating symbolic visual manifestations. An ape can most probably picture the image of a banana in its mind, but we evolved the means to conceive the image of, for example, a centaur or an angel (Ramachandran, 2011, p. 44). Ultimately, art as we know it today falls inside this realm of reasoning, together with all the other implications which developed with it throughout its history. I would like to take a few steps back in time from today's contemporary art world and briefly deal with some theories on why our brain can possibly make art, before discussing how we perceive art today.

The caves of Altamira are an utmost important discovery on several human levels. Apart from the archaeological importance and direct insight they provide with respect to our distant ancestors, the art found within the caves provide us with one of the profound questions about the Upper Palaeolithic art research: were the people inhabiting these caves already selective on assigning specific spatial areas to particular functions such as rituals? The criteria to attempt answering this question can be infinite, and most will revolve around the analysis of the present wall decorations. Should one note the distribution of the represented animals, or the difference in the technique of representation, or the dimensions of the pictorial images, or what? (Williams, 2002, p. 38). Together with a number of hand prints and other 'tribal' patterning, we find the exceptional bison of Altamira (Figure 10), a series of horses and finger traces which sometimes seem to suggest images, as in the case of a bull's head (Williams, 2002, p. 38). This sense of imagery then culminates in the deepest section of the caves, with what are known as 'masks' (Figure 11), which consist of rock bulges that have had their contours covered in paint, resulting in faces (one seems like a horse) looking at the beholder (Williams, 2002, p. 38). How important is this interplay between the early creators and what appears to be suggestions coming from the cave rocks and 'randomly' doodled patterns? How much do we share of this intuition with our worthy ancestors?

Figure 10: *Bison of Altamira*.

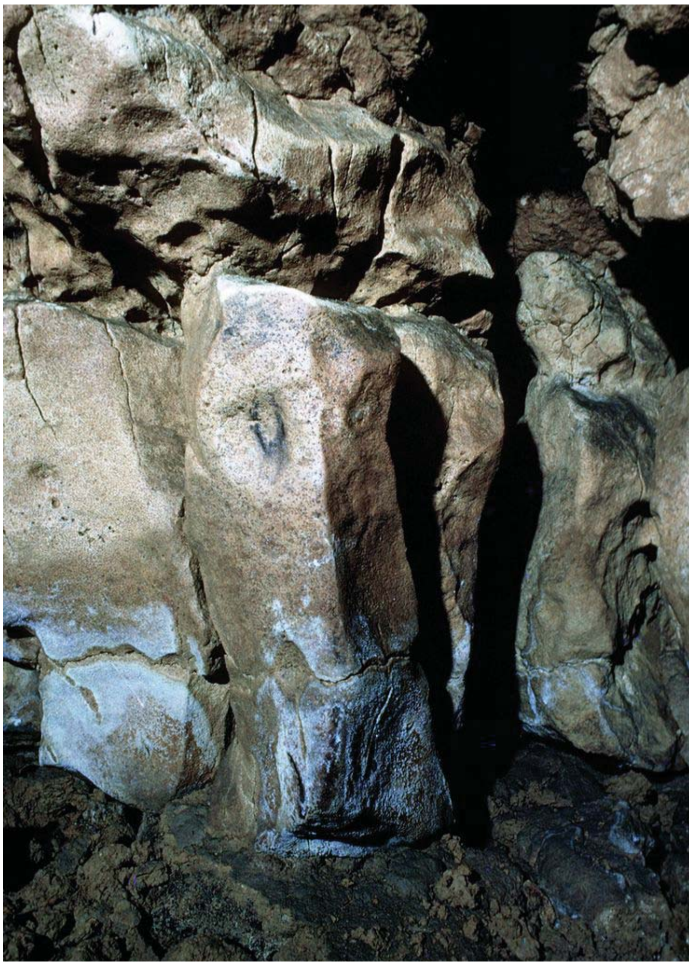


Figure 11: *Horse Mask*. (Williams, 2002, p. 121)

Figure 12: *Bison with eight legs.* Still-frame. (Herzog, 2010)

Shimamura (2013) starts his introduction of the research on how we experience art in our brain by stating that what we are familiar with will most likely equate with what we'll understand and visually enjoy (p. 1). Such a statement might raise questions, especially when read from the point of view of today's artistic practice, but it does fit in a whole range of discussions about how our visual perception can be conditioned by our acquired brain concepts, knowledge and experience. Even in their 'primitive' nature, a particular difference between the context at Altamira and that of Chauvet is noticeable. As illustrated by Werner Herzog's documentary; *Cave of Forgotten Dreams* (Herzog, 2010), the people living in the Chauvet cave did not choose to represent themselves, unlike what we see in Altamira. This was an animals' place and they somehow chose to depict their familiarity with them and not possible fears of them; a familiarity so big, that some drawings also suggest an attempt at a representation of movement. We hear Herzog narrate; "the artist painted this bison with eight legs [Figure 12]… it is almost a form of proto-cinema" (Herzog, 2010). Throughout the cave, there is only one hint at a human portrayal; a pair of female legs and her genitalia (Figure 13). These legs are however not entirely hers, but seem intertwined with the overlapping bison — there is no disengagement between one depiction and another. These people lived their present with an integrated perception to their surroundings, and perhaps because of this humanity in representing the perceived world around them, we feel phenomenologically closer to their drawings than for example a stylised Egyptian mural (McBurney, 2011).

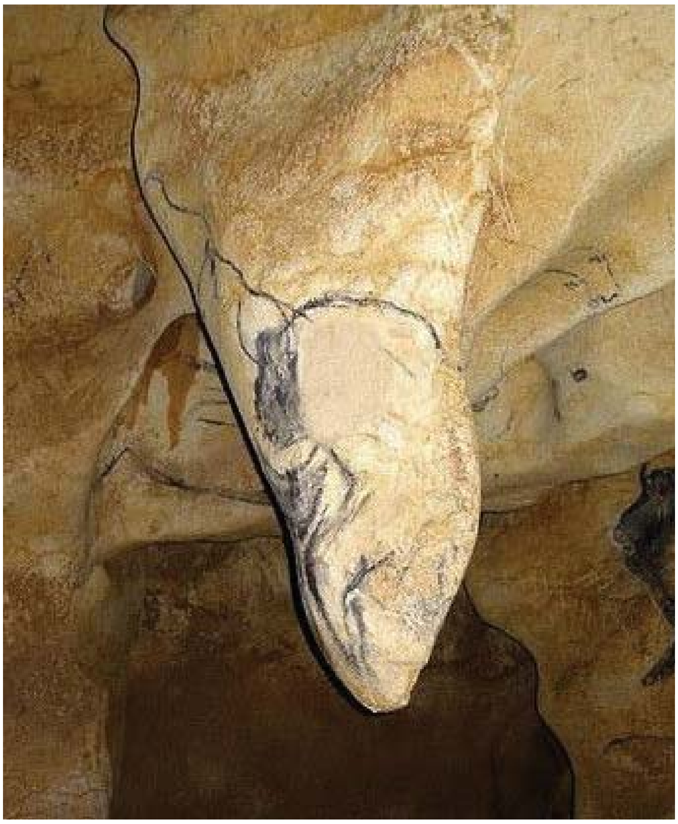


Figure 13: *Bison with female legs and genitalia.* Still-frame. (Herzog, 2010)

In Chauvet's drawings, like in some Altamira instances, we again sense that some imagery evolved out of the suggested rock formations themselves — an intertwining between the modern human visual imagination which helped distinguish us as species, and an intimate understanding of their dwelling context. About 32,000 years later, we now know that this imaginativeness involves most of the same processes our human brain implies during visual perception. The empirical research on this topic shifted into new light in the 1990s when neuroimaging advances could capture and record visuals of our brains' processes. On a general basis, throughout visual imagery, subsets of our occipital and temporal regions are engaged; areas which are also active during visual perception, unlike the also-triggered frontal and parietal regions (MacKisack et al., 2016). What does this neuroimaging data tell us about the perception and creation of art?

Figure 14: High contrast photo of the head of a cow. (Shimamura, 2013, p. 17)

When looking at Figure 14 for the first time, it will probably be extremely difficult for an individual to recognise what is being depicted in this image. Instead of a perceived figural representation, it is most probably that the portrayal as an abstract composition of random dots and black blotches is seen. However, as soon as the explanation that it is a very high contrast photo of the head of a cow is given—where the darkest patches consist of the cow's snout, eyes and ears—it is very difficult not to perceive the cow's head every next time this same image is looked at. This is an effective example to illustrate that when our brain acquires knowledge, it is then capable of making sense of the perceived information. How different is this example from our human ancestor looking at rock formation patterns inside a cave before making sense of it in paint and charcoal?

Williams (2002) argues about different stages in our conscious perception, where the initial stage consists of geometrical visual percepts that appear to us because of how the human nervous system is wired (pp. 132 - 139). Known as entoptic phenomena, these percepts are the same for people with different cultural background. It is logical then, that pattern is the first kind of art form which the human being marked on a support which was not the human body itself (Morriss-Kay, 2010). Williams (2002) refers to the subsequent stage as an "alert problem-solving consciousness" where there is the attempt at making sense out of the entoptic phenomena patterns, turning them into iconic forms (pp. 132 - 139). Conscious processes in the visual brain acted on behalf of the first human perceptions to attribute iconic representation to some form of likeness in a stone, in part, similar processes which still act upon us as we for example try to figure out a facial expression in a painting (Morriss-Kay, 2010).

Computer-engineers were once of the idea that bottom-up models of human robots could make sense out of received visual information from video inputs; an objective that turned out to be an extremely difficult task especially when considering that we make sense of the world mainly through top-down processing (Shimamura, 2013, p. 18). These processes are so innate that we are mostly unconscious of how much learned knowledge we use while perceiving visual scenes. While Figure 14 is being perceived for the first time as an abstract composition of black and white marks, our brain undergoes through bottom-up information, whereas once we know what to look for, top-down processing takes over. Basically, the anticipated knowledge of what we expect to visually understand drives our sensations into perceiving it (Shimamura, 2013, p. 18).

Kant seems to be a preferred philosopher with neuroscientists and psychologists whose work revolves around art. Some questions which are being posed today by neuroscientific research do have a past as disputes in the history of philosophy. For example, in his *Critique of Pure Reason* Kant (1998) states that our knowledge begins with experience, but does not follow all that arises out of experience. Kant (1998) was here suggesting that we perceive the world (and also art) by associating the information coming through our senses to pre-existing concepts inside our brains, while we conceive judgments based on the evaluation of beautiful things which can also be detached from the object's function (Shimamura, 2013, p. 7). Perhaps this is why Kant's (1998) writings are favoured by neuroscientists working in the field, as without the use of imaging techniques he had divided our perceptual process into what comes out of inherited concepts and acquired concepts. Zeki (2009) gives a good example of an inherited concept by explaining the regulation of colour generation happening in our brain, and explains that while he uses the word concept to discuss such processes, Kant had already done so when he theorised that some kind of mental principle had to merge with incoming sensory information in order to make sense of it (p. 22). Zeki (2009) shows us how in the case of colour, our brain has to regulate the receiving information in order for us to still perceive a leaf as being green even during a sunset when much more red wavebands are present. He adds that our brain has solved this perceptual problem through the use of a ratio-taking concept, where the ratio of light of any incoming waveband reflected from the surfaces of the environment around us does not change, and therefore the brain is apt of determining a constant colour to a particular surface even if interfered upon with different reflected light (Zeki, 2009, p. 22). Knowledge acquired concepts are then both flexible (as they are alterable through new experience) and limited (as the momentary experience creates synthetic concepts). In order to recognise a house, our brain is not contingent on one particular model, but on a concept of what's a house where points of view, dimensions, materials and everything else about its physical structure are not important for pinpointing a house (Zeki, 2009, pp. 21 - 25).

When perceiving art, a huge chunk of our acquired knowledge comes from our cultural background; again this seems so effortless that we hardly notice how much we depend on our implicitly acquired knowledge. For example, in the previously mentioned study by Augustina et al. (2011) a group of volunteers who were unacquainted with art history was found to process content prior to style when perceiving paintings by Cézanne and Kirchner. Would this have been the same with a group of art historians? In front of a cubist painting, an art literate would most probably process cubism first (acquired knowledge), prior to dealing with its content. This of course, would probably also depend on how much 'cubist' the observed image is.

From this point of view, it is by no surprise that Western art has been largely conditioned by an idea of an imitation or representation—a mimesis of the real world—throughout its history starting from Plato (Shimamura, 2013, p. 4). Plato's teachings despised the idea of art as he regarded it as only a mere copy of reality; a fake attempt at representing the surrounding natural environment, which could never find its place in Plato's ideal world. On the other hand, Aristotle appreciated art, but precisely did so for its nature of being a representation. When stating that this mimesis of the real world conditioned the course of Western art, it does not mean that there was no artistic reaction against the sole concept of representation in art. On the contrary, if we look at modern period concepts like Dadaism the idea of mimesis in the Classical sense crumbles down, but still, the irrational act was mocking and trying to break free of the mimesis past itself. Therefore, the idea of representation was still somehow present.

If we shift our focus to the East, we find a different story which does not revolve around representation but a response to finding beauty in all things. As Ramachandran (2011) writes, an ancient Indian myth narrates that after Brahma created the universe, the goddess Saraswati developed an aesthetic sense in people since they didn't know how to appreciate the beauty of Brahma's creations (p. 156). The author then lists a personal contextual example between the West and the East, as he reflects upon the fact that the stone and bronze sculptures he grew up praying to in the Shiva temple in Mylapore, were in the West found in museums and galleries in reference to Indian Art (Ramachandran, 2011, p. 159). While at their place of origin (in their cultural context) these sculptures were such a part of the daily fabric that it was difficult to distinguish between what's art and daily routine. On the other hand, the context of the Western gallery changes these sculptures' perception into a definitive one.

Why is it important to look back in history in order to attempt an answer at questions regarding the perception of art? In most of our contemporary art practice and theory we have had a tendency to push the limits of what art is. Despite its repetition, blankness, emptiness, irony and suspicion, we still find hope in contemporary art (Collings, 2000, p. 262). We have arrived at a point where “art fits with everything else”, belonging to an atmosphere of the “now” (Collings, 2000, p. 13); maybe also because of a continuous (sometimes implicit) reference to Duchamp’s genius provocations on art itself starting with the ready-made. Yet, already in the 1970s, there was claim that “Art may seem to be in danger of being drowned by talk” (Arnheim, 1974, p. 1). Metaphorically speaking, if one tries to define what murder is during an ethics class, the initial reflections would not be on whether assisted suicide is murder, but clearer cases would be the highlight in preparation for eventual questions as assisted suicide (Dutton, 2014). Looking back at what the early humans achieved inside the Palaeolithic caves, means looking back at a time when ‘artistic’ practice was not exercised for art’s sake, and it would be inaccurate to regard these human creations as ‘works of art’ from today’s point of view (White, 2009, p. 324). The birth of art is an act of play—a visual game ‘protesting’ the then-attended world—of opposite value to the slightly preceding acquired skill of tool-making in the name of work (Bataille, 1980, p. 27). This intelligence to play and to conceive things, which are essentially ‘useless’, distinguishes us as human beings more than our capacity to work (White, 2009, p. 329). In order to better understand where we are at during our current moment of something resembling an information glut, it might be important to sometimes take three steps back and assess what is relevant and what is not.

In his *Art and Illusion*, Gombrich (2002), made a comparison of two different constellation interpretations between two diverse cultures, as he found it quite instructive to correlate distinct visual meanings given to a same constellation. Our Western culture has been reading Figure 15 as a *Lion* since ancient times, whereas native tribes in South America perceive this differently. Ethnologist Kosch-Grünberg had asked some native hunters to project the night sky for him, and Figure 16 was the resulting image. In their cultural context, the dotting of the stars is seen as a *Scorpion*, as they eliminate what Western culture depicts as the *Lion*’s tail and hind legs (Gombrich, 2002, p. 90). Figure 17 is another interpretation of the *Scorpion*’s projection done by another native

Figure 15: *Lion Constellation.* (Gombrich, 2002, p. 90)

Figure 16: *Scorpion Constellation.* (Gombrich, 2002, p. 91)

Figure 17: *Scorpion Constellation.* (Gombrich, 2002, p. 91)

hunter from a different tribe, in which the projection of the scorpion is much more vivid than the previous one; "as he cared more for the represented image than the real positioning of the night stars" (Gombrich, 2002, p. 91). It might be appropriate to here note the second part of the earlier mentioned quote by Arnheim (1974) where; "…all reasoning is also intuition…" (p. 4). We reason out what we visually see as much as perception is a product of the mind. It has earlier been emphasised on, how our acquired background knowledge works implicitly within our perceptive processes, and possibly, this is the "intuition" Arnheim (1974) referred to. The native hunter reasons out the projection of the night sky, while at the same time acts intuitively when materialising this mental projection through his background knowledge, such as the incident in Figure 17.

There seems to be evidence that visual perception can also be linked to acquired knowledge relating to the spoken language in a particular culture, such as the case of the Himba tribe and their perception of colour (Davidoff, 2005). Anthropological and psychological studies have shown that as opposed to the 11 colour categories existent in the English language, the Himba tribe (a monolingual tribe) in remote Namibia have only got five, where the description for blue and black

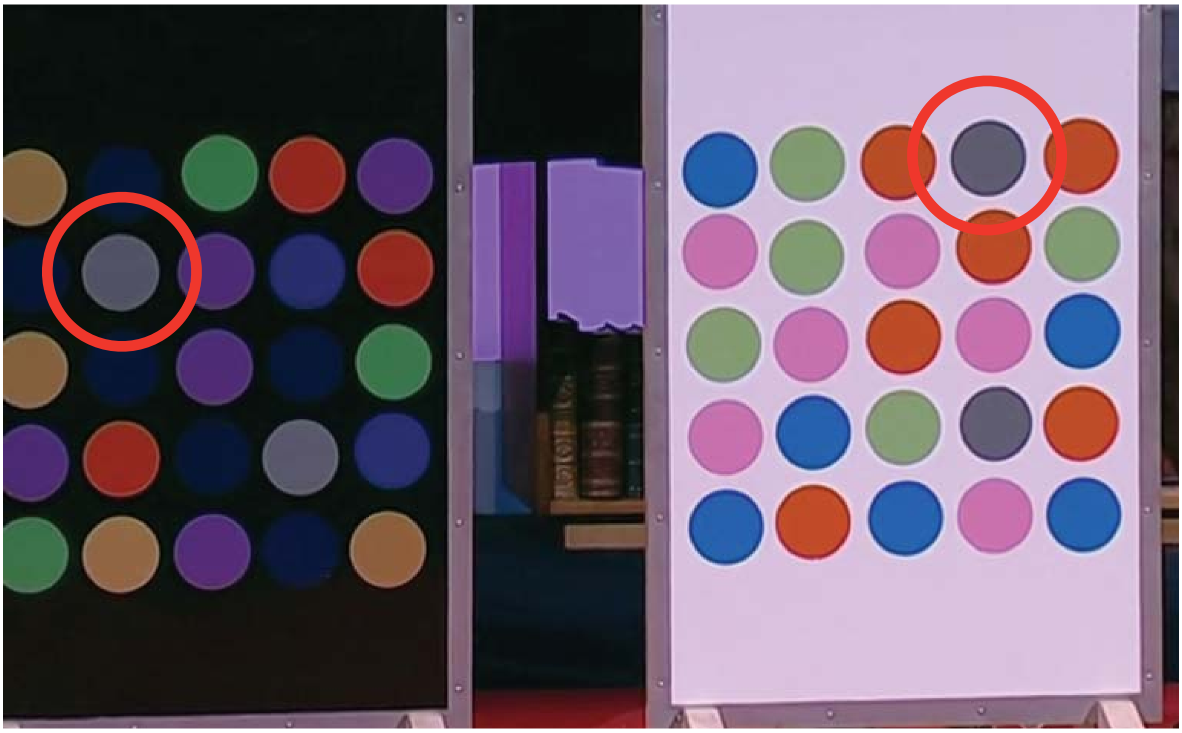


Figure 18: Still-frame from Lotto's demonstration during TEDGlobal. (Lotto, 2009)

refer to the same colour. A study has shown that when still quite young, both English and Himba children are perceptively at the same place, whereas as they get older (and are therefore acquiring knowledge through their use of language and memory), the English children's most recurring mistake is to mix-up blue with navy blue, while Himba children exchange blue with black (Davidoff, 2005). This, and other such research, do not support the theory that there exists only one set of universal colour kinds, but instead suggest a change in colour perception through the learnt cultural language, equating to the acquired knowledge concepts (Goldstein, Davidoff & Roberson, 2008). However, one should also keep in mind another factor influencing our colour perception. When delivering a lecture for TEDGlobal, Lotto (2009) asked the audience to select which colour matched from two panels—one had a number of coloured dots placed on a white background, while the others on a black one—Figure 18. Only about one third of the public guessed that it was the grey colour which proved to be identical in both panels. The context of the perceived colour is again of crucial importance in this experiment. Even though we evolved the ability to detect light in a very advanced manner, we can still be deceived by colours reflecting differently because of their

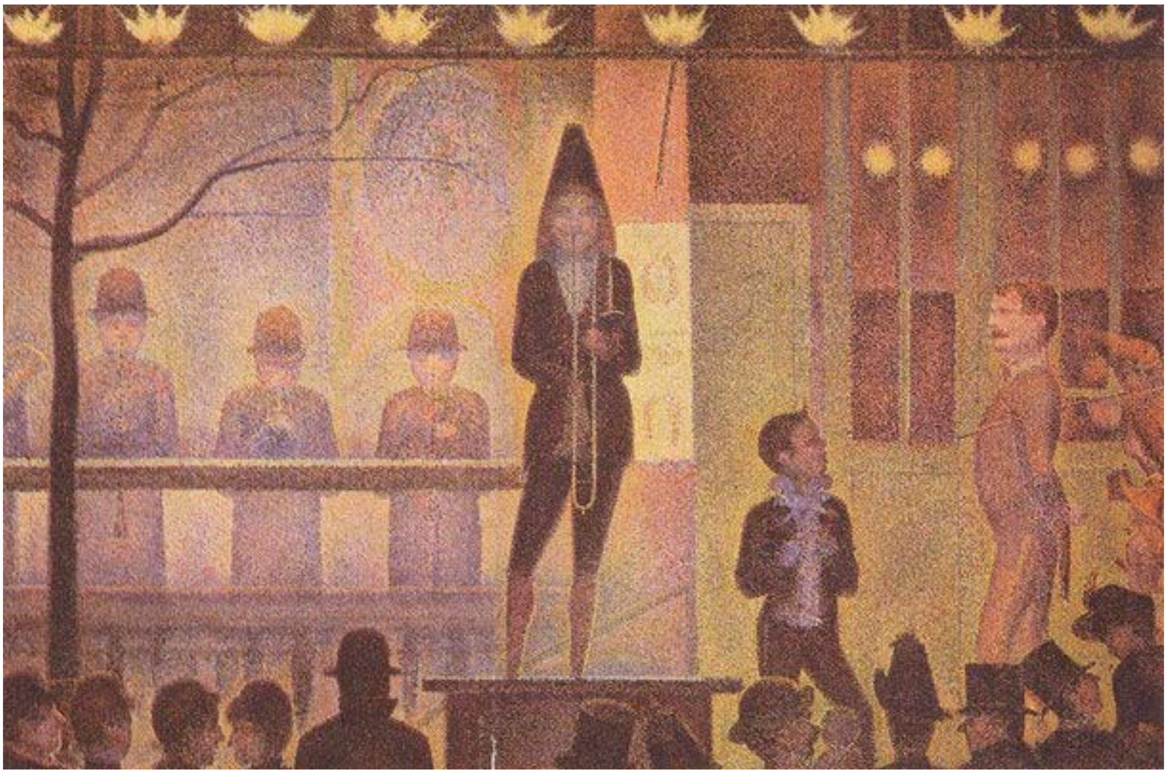


Figure 19: *Circus Sideshow (Parade de cirque).* Seurat. 1887-1888. Oil on Canvas. 99.7 x 149.9 cm. The Metropolitan Museum of Art, Bequest of Stephen C. Clark, 1960.

neighbouring colours or contextual background. Neuroscientists are today researching why this happens in our brain, but isn't this related to what artists have for centuries been exploring intuitively? For example, how much of Lotto's demonstration can be noted in a painting by Seurat (Figure 19)? His paintings are a consequential result of the newly emerging models of subjective perception, as he evolved towards a crucial awareness of "the synthetic and disintegrative" mechanisms of perception (Crary, 1999, pp. 148 - 155). His work is a constant challenge to control and reason out the unsettling aspects of our attention (Crary, 1999, pp. 148 - 155).

Some of the above arguments might seem to generalise art as being socially constructed, and thus 'exclusive' to its native culture, which argument would need several studies to perhaps prove. What interests this study is perhaps the theory that arts which are so ingrained into a local culture, cannot possibly be understood by other human beings. But how true is this if Japanese prints are also enjoyed in Brazil and the Italian opera is loved in China (Dutton, 2014)? In the end, there is probably still a certain level of universality in both creation and perception of the arts; in its many possible ways, art is practised by almost all known human cultures (Morris-Kay, 2010) and perhaps this is where advances in neuroscience such as neuroaesthetics can provide an insight. However, it can also be a dangerously speculative zone. A major concern lies in the fact that researchers in this recently developed field need to be aware of the vast uncertainties and the distinctive development in critical art theory about terminologies like "aesthetics" and "art" itself (Brown & Dissanayake, 2009). At the same time, definitions from the empirical discipline seem to be very valid for the development of contemporary artistic process, such as the discipline's consideration of art as being a distinctive scope for 'problem solving' (Nami & Ashayeri, 2010).

Now that both the limitations and phenomena of our perceiving brain have already been touched upon, it is opportune to comment about the eye. Visual perception is not only the outcome of a fabricated experience by the brain, but also a result influenced by the limited power of the eye. Apart from the high resolution foveal area, its power and efficiency are largely restricted, while being in a nearly constant motion of saccading from place to place (having an average of three to four saccades per second) within its visual reach (Noë, 2012, p. 2). The data being passed on by the retina is therefore fragmented into alternating snapshots and blanks (Noë, 2012, p. 2). It is widely accepted to state that our visually perceived information greatly depends on where we fixate our attention, as our visual field is mostly receptive towards the centre of the retina in the foveal region; an area of approximately 2° surrounding fixation point (Findlay & Gilchrist, 2003). Attention is therefore what guides our visual perception, directing our foveal area accordingly.

A strand from the empirical sciences is closely working with magicians in this respect. Magic has been an occupation which intuitively exploits human attention for centuries. For example, an experiment tested the effect of the magician's social cuing on subjective perception and attention, and the results clearly hint that the audience's attention was in fact significantly influenced by the magician's directional cue (Kuhn & Land, 2006). How much are we influenced by "directional cuing" while perceiving the real world, or a work of art? We tend to neglect that any visual thing (including any type of representation in art) is remarkably dynamic in nature. We tend to forget this because of our metric based descriptions; like that of three equal straight lines meeting at a 60° angle becoming an equilateral triangle (Arnheim, 1974, pp. 410 - 415). Therefore, such definitions may sometimes overlook the experiencing of the primary visual forces given by our visual perception (Arnheim, 1974, pp. 410 - 415); being led by the "directional cuing" in a scene. It is also worth noting that most participants in the previously mentioned Kuhn and Land (2006) experiment, claimed to have noted the ball during a last throw (even though the ball never left the magician's hand) and were convinced to have spent much of the time focusing on the ball itself, only to be proved wrong by the eye-tracking data showing that their gaze was fixated on the ball only when the latter was physically present. Kuhn and Land (2006) conclude that since this proves the oculomotor system was not deceived, the participants' perception was predominantly based on expectations. How much of this information can prove to be influential in our contemporary world of art, where by now, we have a number of schemas of what to expect once we enter any contemporary art space? From the creator’s point of view, how can an artist challenge his own expectations in his own work?

Drawing as Visual Discovery

In 2005, the BBC series *The Secret of Drawing* written by Graham-Dixon (2005), presented an experiment where both presenter (an untrained artist) and Sarah Simblett (Professor at the Ruskin School of Art, Oxford, London) attempted a 2D portrait life-drawing while wearing an eye-tracking device. The resulting differences were very clear; both in the drawing itself as well as the eye-tracked scanpaths as seen in Figures 20 and 21. Being untrained, Graham-Dixon, naturally found it very challenging to translate what his mind was perceiving onto a 2D space, and as he himself describes, he didn’t know where to look as if there was a missing connection between his eyes and the gesturing on paper (Graham-Dixon, 2005). Towards the end he also attempted a last

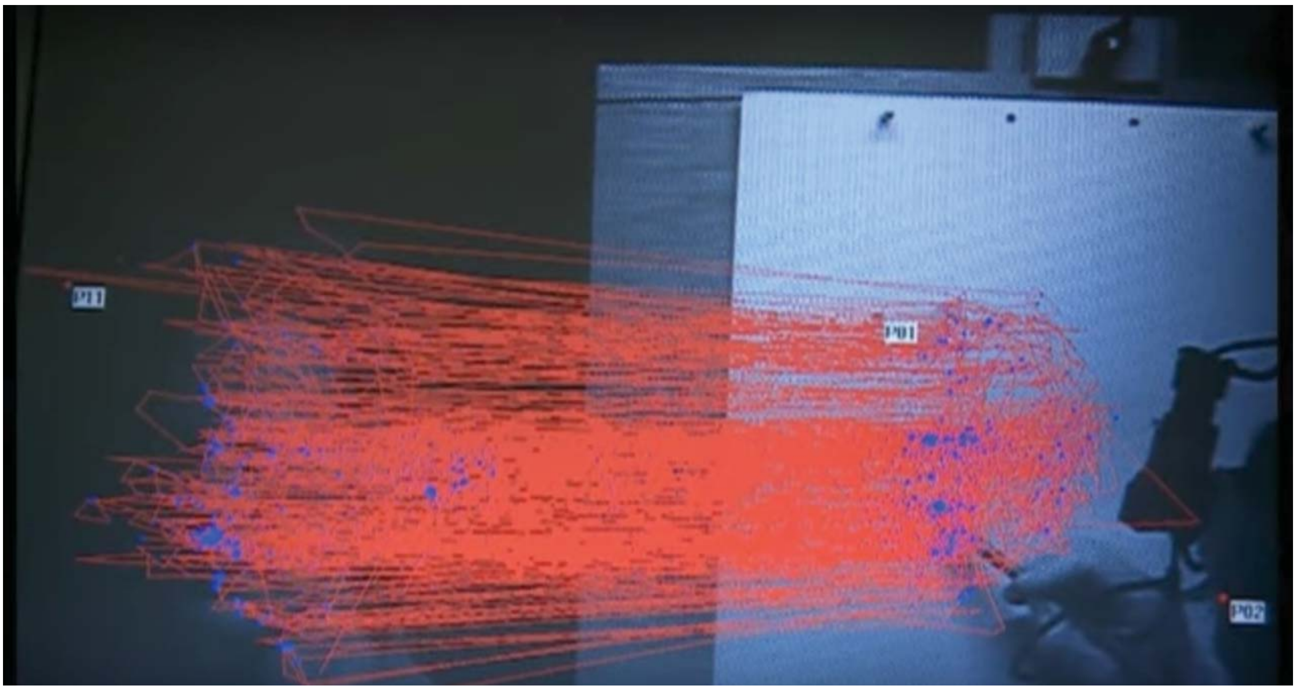


Figure 20: Still-frame of Andrew Graham-Dixon’s eye-scanpath. (Graham-Dixon, 2005)

resort strategy by smudging into his charcoal drawing using his hand; “as if it was a childlike instinct” (Graham-Dixon, 2005).

When comparing his eye-tracking results (Figure 20) with that of the trained visual artist (Figure 21), the data evidence is quite clear. There seems to be no gaze-drawing coordination in Graham-Dixon’s scanpaths, which lines result in a chaotic network. On the other hand, Figure 21 is very ordered and clear. What the artist gazed at matches that which was immediately reported on paper. This suggests that the captured visual information was translated into the 2D drawing not by using a holistic approach, but as a build-up of “abstract” details which then unify into one portrayal through their existence in their own right (Miall & Tchalenko, 2001). The artist’s behaviour is also guided by the evolving depiction itself as each glance at both model and drawing affects her decision making, turning the intuitive process of looking and perceiving into an objectively driven one (Miall & Tchalenko, 2001). The process of looking becomes some kind of duality between instinct and intellect, which perhaps is as old as the human desire to create images (Graham-Dixon, 2005).

Figure 21: Still-frame of Sarah Simblet’s eye-scanpath. (Graham-Dixon, 2005)

This analysis does not mean to suggest that the act of drawing merely consists of copying what we see in the real world; if that were the case, most of us would then have the ability to actually do it (Cohen & Bennett, 1997). Drawing is instead an intricate process dealing with the illusory, which therefore includes several aspects and possible outcomes. An early empirical study on why most people are not able to draw what they see, suggests that the most crucial aspect which has to be taken into consideration for a successful life drawing is the correct perceptive analysis of the object being drawn (Cohen & Bennett, 1997). The artist's motor coordination, decision-making and misperception of the drawing itself seem to only obstruct a 'correct' drawing in a minor way (Cohen & Bennett, 1997).

This analysis has certainly both an empirical and an artistic truth to its claim, but lacks other aspects. During the act of drawing, the artist deals with the drawn object through a double reasoning between what he sees of the object and what he knows about it. To a certain extent, none of the two can overpass the other, but at the same time both lead to different aspects of the drawing's creation. In this view, the previously mentioned empirical claim, might risk in failing to do justice to why we have been drawing throughout our history. The act of drawing does not only concern the act of measuring and putting down, but it consists in more of a two-way process where the artist is also receiving (Berger, 2005, p. 77). For an accomplished drawing to occur, this dialogue can never be of a question and answer nature, but it is a "ferocious and unarticulated" one instead, sustained by a certain level of faith, as one starts the drawing process by delving in the dark (Berger, 2005, p. 77).

A more recent empirical study suggests instead that visual memory plays an important role in one's ability to draw, as the process of drawing from life involves the juggling of glances between the drawing and the object (McManus et al., 2010). This study somehow feels closer to the world of artistic practice, as the studied participants were themselves art students and therefore the underlying scientific differences between the concerned individuals were extracted from subjects with a certain degree of familiarity of the discipline. These concerned students were tested primarily with variables which also concerned dyslexia and spelling, and none seem to really influence one's ability to draw. The study instead suggests two aspects which interfere upon drawing; the ability to both copy simple angles and proportions, and the accuracy of one's visual memory of both immediate and delayed recall (McManus et al., 2010). Other research suggests that visual memory serves the perceptual-motor processes more over longer timescales, other than processes which are of an immediate nature (Huette, Kello, Rhodes & Spivey, 2013). Basically, it has been proven that during eye-hand tasks, the coordination for this cognitive process is direct and to a certain extent memory is not needed in the same way as when one observes a scene in order to portray it later. Therefore, during eye-hand coordination, the eye tends to both guide and lead the hand at the same time (Huette et al., 2013). Therefore what happens should the hand task be eliminated and the eye 'draws' on its own? (see experiments in chapter 3, *Methodology*).

Notwithstanding how interesting such empirical observations can be for artistic practice, they still do not take into consideration the reason behind the 'impulse' of drawing and making. Even though associated to both writing (Tisseron, 2011) and reasoning, drawing is very different as moments of it are as instinctive as biological functions 'comparable' to processes like digestion and separate from any conscious intention (Berger, 2011, p. 120). Drawing is a research exercise and therefore at the same time, an exercise in search for a direction. It can be comparable to other orientation processes taking place in nature. During the act of drawing we are somewhat closer to how birds navigate, or to how trees adapt in finding a way to sunlight (Berger, 2011, p. 120).

Perhaps this analogy between the act of drawing and the instinctive search for orientation can be easily observed in doodling; an activity which has recently started to be seen in a new light after it used to be considered as a waste of time (Shellenbarger, 2014). Empirically, doodles have always interested psychology and psychiatry, as neuroscience considered the activity as an opening into the patient's or child's unconscious thinking. However, it is now being reconsidered in view of many of its evident aspects and contextual differences when practiced. Firstly, studying the doodling brain might help in the understanding of its ‘default’ networking when idle (Schott, 2011). In relation to this, doodling also seems to be naturally employed in situations of boredom and impatience, where it actually seems to lessen such conditions (Schott, 2011). Still, its most important powers with respect to artistic practice are its creative generating of new ideas, and its problem-solving possibilities (Schott, 2011). Studies suggest that during our daily routines daydreaming seems to be related to the same high arousals present during states of boredom, and doodling might in turn improve one’s cognitive performance during such states as the activity itself suppresses daydreaming (Andrade, 2010).

In her TED talk from 2011, Brown argued that during her practice she encounters a general cultural problem with respect to how doodling is viewed by society. She stated that there exists no complimentary definition of the activity, and runs through the history of its meaning from the 17th century onwards; where the word itself has been associated to refer to a fool, to the act of ridiculing someone and to describing a corrupt politician amongst others (Brown, 2011). She adds that in her opinion the worst definition of all comes from our present day, which assimilates the verb ‘to doodle’ to ‘doing nothing’ or to engage in the making of meaningless marks; a high contrast with evidence of how doodling helps us to think and implement creative problem solving (Brown, 2011). In this view, doodling may be seen as an archaic form of drawing—a more intuitive and unconscious way of marking a paper—but doodling possesses the psychological condition of ‘having nothing to lose’, which makes it an even more powerful research tool. Its function in artistic practice is to freely explore, be ambiguous and at the same time find a way towards a future. I believe that doodling can be recognised as ‘a sort of gateway’ to drawing; essentially as a mapping externalisation of our mental thinking, which gives us the freedom and opportunity to test our non-verbal thinking with the luxury of not being necessarily totally conscious about it. Perhaps, it is of no coincidence that archaeologists in South Africa who unearthed what seem to be deliberate geometric cross-hatches from 77,000 years ago (i.e., 40,000 years preceding the oldest known form of art) opened an academic discussion by associating these findings with doodling (Balter, 2002).

There exists another universe of drawing which is worth noting; that of algorithmic drawings. Even though the term ‘algorithmic’ might seem to shift our thinking immediately to our nearer *Information Age*, its concept has been around for quite some centuries. In the year 825 a Persian mathematician, Abu Jaf’ar Mohammed ibn Musa al Khowarizm issued a procedure on how to work out quadratic equations; a procedure being a set of step-by-step instructions on how to act in front of an issue in order to obtain a result—an algorithm (Dehlinger, 2005, pp. 102 - 104). Therefore ‘algorithmic drawings’ consist of portrayals drawn up by a set of rules which the artist imposes upon his activity, doing to his drawing what a software program does in information technology (Dehlinger, 2005, pp. 102 - 104). Figure 22 is an example of an algorithmic drawing representing a tree by Hans Dehlinger, and it is clear that with respect to a ‘free-hand’ approach in drawing, this portrayal is clearer in its linear and coherent direction; it is the result of a generated image through a specific set of rules (for more on this argument, see pp. 81 - 99).

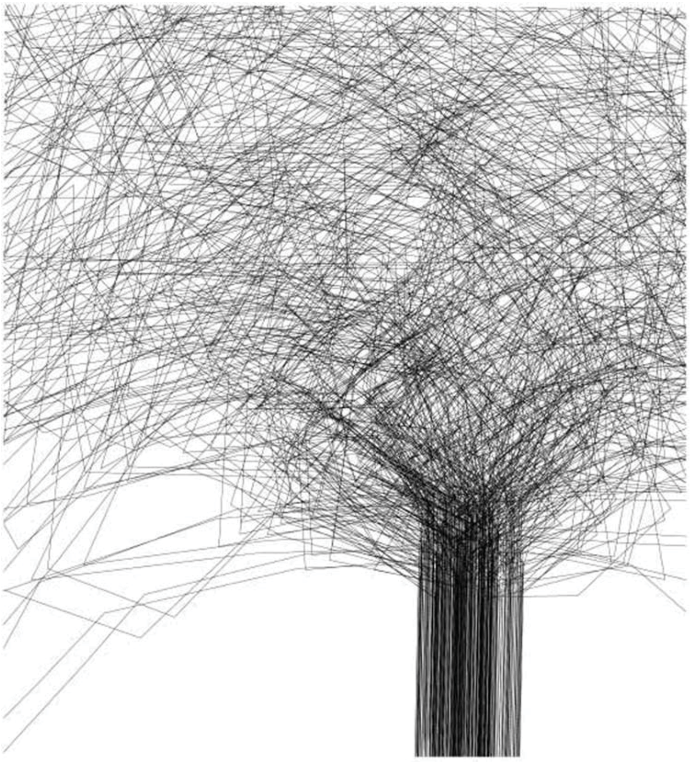


Figure 22: An algorithmic drawing representing a tree by Hans Dehlinger. (Dehlinger, 2005)

Figure 23: An example of an algorithmic shape blending involving letters. (Sederberg & Greenwood, 1992)

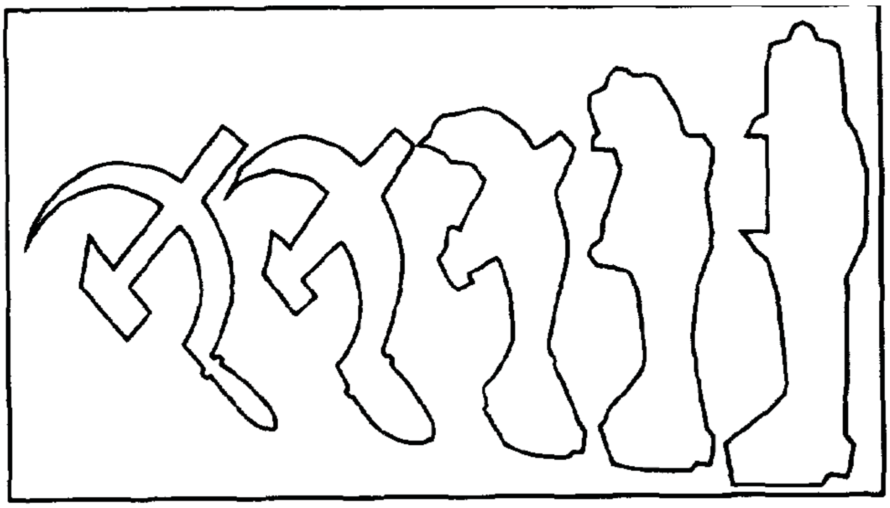


Figure 24: An example of an algorithmic shape blending involving images. (Sederberg & Greenwood, 1992)

Algorithmic drawings of course also exist outside the realm of the artistic, and one particular strand of algorithmic drawings in information technology concerns shape blending. Figures 23 and 24 are both such examples where the algorithm's aim was to smoothly blend the two 2D polygonal shapes at the furthest ends of the composition by considering the shapes to be wire constructions which are slowly bent and stretched towards the objective shape (Sederberg & Greenwood, 1992). I would like to compare this to Figures 25 and 26 which are drawings John Berger's son included in one of their correspondences (Berger, 2005, pp. 123 - 144). At first glance I find an apparent similarity between the algorithmic shape blending results; they are linear, simple and clean. This however suddenly turns into a crucial apparent difference. The digitally coded images tell a story of a pre-set objective where no line is dubious in its next move, and the final appearance for the 'drawing' evolution is clear. Berger's tell a different story. Like calligraphy, most of them are made with the pen never leaving the paper and therefore they flow into their next heading with all its dubiousness (Berger, 2005, p. 129). A straight line is never perfectly straight, just like an eye-gaze's path. The story they tell blends its protagonists with a certain enigmatic aura. This story is not literal, defined or instructed. It resembles instead the swiftness of a visual birdsong (Berger, 2005, p. 129).

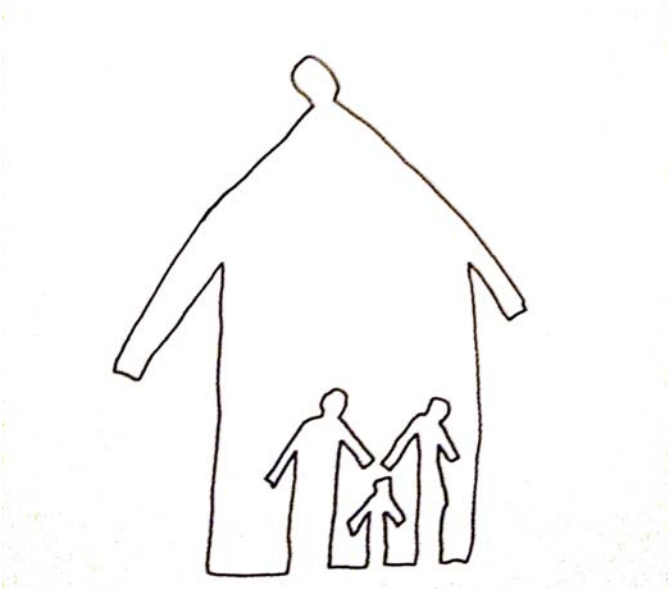


Figure 25: A drawing by Yves Berger. (Berger, 2005, p. 137)

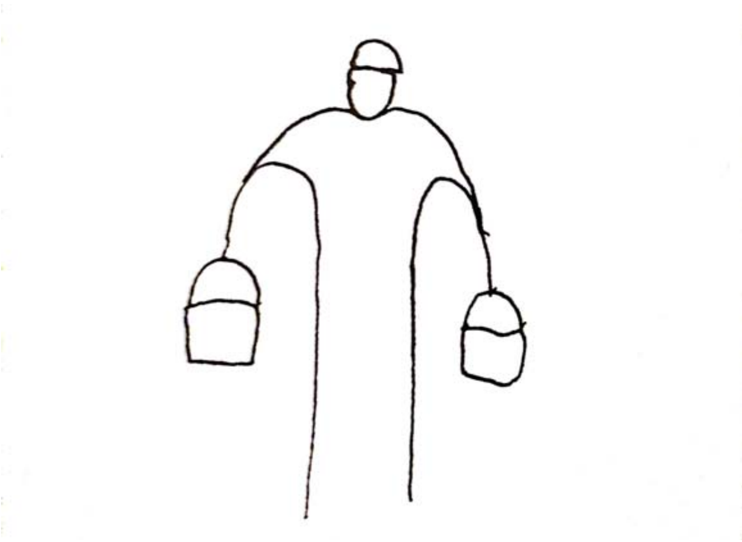


Figure 26: A drawing by Yves Berger. (Berger, 2005, p. 133)

The query of why, how and where our state of mind is while we draw offers a whole array of answers motivated by different cultures, traditions and necessities, some of which also come from outside the world of artistic practice. It has been mentioned at the beginning of this chapter that drawing is a two-way stream. The individual both measures himself in front of what is being drawn (or with a mental image), but also ‘receives’ impulsive information. Therefore, how an individual subjectively perceives the world around him is essential to how and what he draws.

Phenomenological Aspects of Perceiving

It is here important to mention our phenomenological aspects of perceiving our being in the world. The research project aims at ‘drawing’ by looking, and therefore perceiving; activities which include several subjective implicit processes needing reflecting upon. For example, Figures 1 and 2 have been discussed in the first chapter from an empirical point of view. But how do we visually experience such scenes outside the empirical lab?

Merleau-Ponty tackled this problem by assimilating Figure 1 to a landscape in his *Phenomenology of Perception* (Merleau-Ponty, 2005). He reasoned that on a misty day we naturally get an obscure perception of the scene, but it does not mean that the landscape within itself is unclear. Analogous to this, the *Müller-Lyer*’s lines are certain of their properties within their

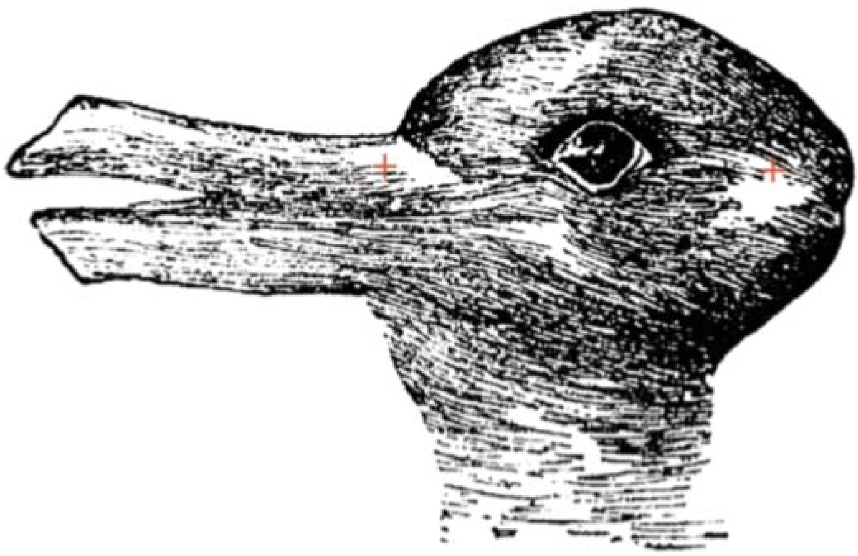


Figure 27: *Duck-Rabbit Figure*. (Malach, Levy & Hasson, 2002)

empirical world, which we then imprecisely interpret through our inattentive perception. Gallagher and Zahavi (2008) add the *Ebbinghaus Illusion* (Figure 2) to this reasoning through which they acknowledge the fact that during our phenomenological perceiving of such scenarios it is relevant and useful that our perception is deceived, or else our perception would suffer a degree of misinterpretation (Gallagher & Zahavi, 2008).

Our knowledge of perception is therefore 'divided' into two categories. On one hand we study empirical data which records and observes how our brain perceives the world, whereas on the other hand phenomenology attempts a justification for the why we (subjectively) perceive the world in such a manner; it puts our experience of the world into context. The previously mentioned illusions are however abstract in their nature, and to a certain extent deprived of contextual facts. What can be said then about a portrayal concerning contexts where our perception deals with an ambiguous figure or drawing?

A classic case-in-point is the rabbit-duck illusion (Figure 27), which has been tackled extensively in perceptual psychology literature (also mentioned by Gombrich, 2002, p. 4). Firstly, it is worth mentioning what Kihlstorm (2004) cited in a letter to the editor of *Trends in the Cognitive Sciences*, that the image's description should not be that of an illusion, but a drawing. Different to the previous illusions (Figures 1 and 2), Figure 27 does not only deal with our implicit perceptual unconscious, but also involves retrieval of our acquired-knowledge of the world depending on where our attention focus is. Therefore, when one focuses on the left area, a duck face is perceived, whereas once the focus is shifted to the right the perceived face changes into that of a rabbit. Even if one is aware of the possible perception of both faces, they are only possible one at a time.

As in the process of drawing, this might appear as a purely technical process with a logical explanation, and empirically, the rabbit-duck drawing has also been recently tested from a new point of view through a topography map of the neural activity present during the distinctive object recognition (Malach, Levy & Hasson, 2002). However, what is phenomenologically interesting is the study where participants were asked to perceive the drawing on an Easter Sunday, and the results proved to verge towards the rabbit-face perception (P. Brugger & S. Brugger, 1993). This seems to link to Merleau-Ponty's (2005) affirmation that; "Each part arouses the expectation of more than it contains, and this elementary perception is therefore already charged with a *meaning*" (p. 3).

In the first chapter the empirical evidence to how acquired knowledge through our cultural context affects perception has already been objectively discussed. In this view, the Easter Sunday case-scenario has somehow an added distinctive element to it: the subjective experiential expectation of what to perceive due to a temporal cultural awareness. Perhaps the case-study fits two of Husserl's three modes of phenomenological acts, which modes were discussed by Gallagher and Zahavi (2008). The signitive act of the general Easter bunny context implicitly acted upon the imaginative-pictorial act of focusing on the rabbit-face other than the duck-face.

An important real-life case scenario with respect to our phenomenological perception of the world might be that of patient S.B., who was born in 1906 and went completely blind when 10 months of age. Fifty-two years later he was one of the first blind patients to undertake a cornea transplant regaining his sight. Although this resulted in being a fully-successful intervention, and therefore a great medical achievement, it did not work as well in the phenomenological perception of S.B.'s world view. After surgery, neuropsychologist Richard Gregory reports S.B. as suffering from constant depression, and admits his doubts that the ex-blind man lost more of his life by regaining his sight (Gregory & Wallace, 1963). During his frequent visits, the neuropsychologists would find S.B. fascinated by the fact that objects constantly changed shape, form and colour, and would not stop walking around them (Gregory & Wallace, 1963). A clear explanation of this from a phenomenological viewpoint, can be found in Husserl's lecture series, *Thing and Space* (Husserl, 1997). S.B.'s astonishment of how to perceive an object in space is reminiscent of Husserl's basic analysis of perception that when we look at an object in the world, it is never given to us in its totality. It is impossible for our vision to look at an armchair and see all of it; we are only visually capable of defining a specific profile from the infinite points of view possibilities instead. At the same time, no object is fractionally perceived inside our brain, but is still somewhat perceived as a complete mental reconstruction (Gallagher & Zahavi, 2008). S.B.'s (visual) perception lacked this process. His mental expectations of the visual world could never develop these phenomenological concepts during his long period of blindness, and therefore found himself in utter confusion once he regained sight. An object could not be conceptually perceived in its totality by his new visual being, but consisted instead of endless hints of what that object could look like. This is analogous to the following phenomenological explanation:

> The blind man's world differs from the normal person's not only through the quantity of material at his disposal, but also through the structure of the whole. After the operation he marvels that there should be such a difference between a tree and a human body. (Merleau-Ponty, 2005, p. 201)

One should here keep in mind the phenomenological credo "to the things themselves", stating that we should let our concepts and theories be guided by our experience (Zahavi, 2010). In this view, S.B.'s blindness meant that he could still experience his world in the way it was given to him; through the other senses and cognitive processes. Our perception of the given world is of course not only assumed through our vision. Merleau-Ponty talks about the importance of our body in perception, describing it as being in the world as much as our heart in our organism (Merleau-Ponty, 2005, p. 181). He illustrates this by analysing the simple event of him walking about his flat, where the visual scenes presented to him are of an infinite nature, whereas his body awareness of his movements aid in grasping the unity of that environment/object.

> It is a question of tracing in thought that particular form which encloses a fragment of space… In order to be able to conceive the cube, we take up a position in space, now on its surface, now in it, now outside it, and from that moment we see it in perspective. (Merleau-Ponty, 2005, p. 181)

Figure 28: *Body Press.* Dan Graham. 1970-1973. Paper and black and white photographs of performance mounted on cardboard. (Private Collection)

However, the cube is invisible to us, and inconceivable as cube to our body. It is here worth noting the not so obvious notion that the mind receives information of the given world through the brain, but the brain in turn draws its world knowledge from the body, mapping the interaction happening between body and the surrounding environment (Damasio, p. 75).

In his last incomplete work, Merleau-Ponty (1968) elaborates on a similar argument by asking us how is it that our look does not hide things while enveloping them, and that they are unveiled by veiling them (p. 131)? Our perceiving-perceived of the world in terms of time, space, movement—of our being in it—signifies that our body is made of the same flesh of the world, and therefore it is perceived in the world and reflected in it, but not only. It is also a '*mesurant*' of all the dimensions of the world through a sort of 'reflectedness' (Merleau-Ponty, 1964, p. 249). Taking as example Dan Graham's work, *Body Press* (Figure 28), we see an appropriation of the above Merleau-Ponty's descriptions as the camera views performed throughout this work become a 'seeing flesh' (with which the viewer has to identify) and bounce between subject and object (Doyle, 2004, p. 107). Graham instructed his two nude performers (male and female) to guide the filming camera up their body towards their heads by pressing its back to their reflective flesh, while both were standing inside a reflective cylinder. Once both cameras reached their heads, they were exchanged. Graham uses the cameras to give the body various viewpoints of the world which it was inhabiting during filming, with a reflective play as different viewpoints captured both an operator's self-distorted reflected image and the other performer operating the other film.

I find that Graham's *Body Press* gives us a sense of awareness that other viewpoints exist at different heights and angles of our body. As mentioned earlier, our daily perception of the world seems so effortless that looking at the footage of a leg from the point of view of the same leg might hit us both as curious and strangely familiar. Perhaps, such a work of art can make us encounter what Merleau-Ponty (2005) describes as the experience of the separate 'senses', which is attained only when one undertakes a very particularised attitude. He for example illustrates a scenario where while sitting in his room, and looking at the sheets of white paper lying about the table, he perceives the setting as a whole and would say that they look equally white; whereas if he analyses his perception, he experiences their change in appearance as some are situated in light and others in shadows (Merleau-Ponty, 2005, p. 202)—this reflection is very different in spirit from Zeki's (2009) empirical colour-regulation analysis mentioned earlier (see pp. 13 - 20).

Merleau-Ponty did not regard the perception of space as a pensiveness state consisting of the areas behind and in front of a body, as in perspective. He instead considered it as a territory of

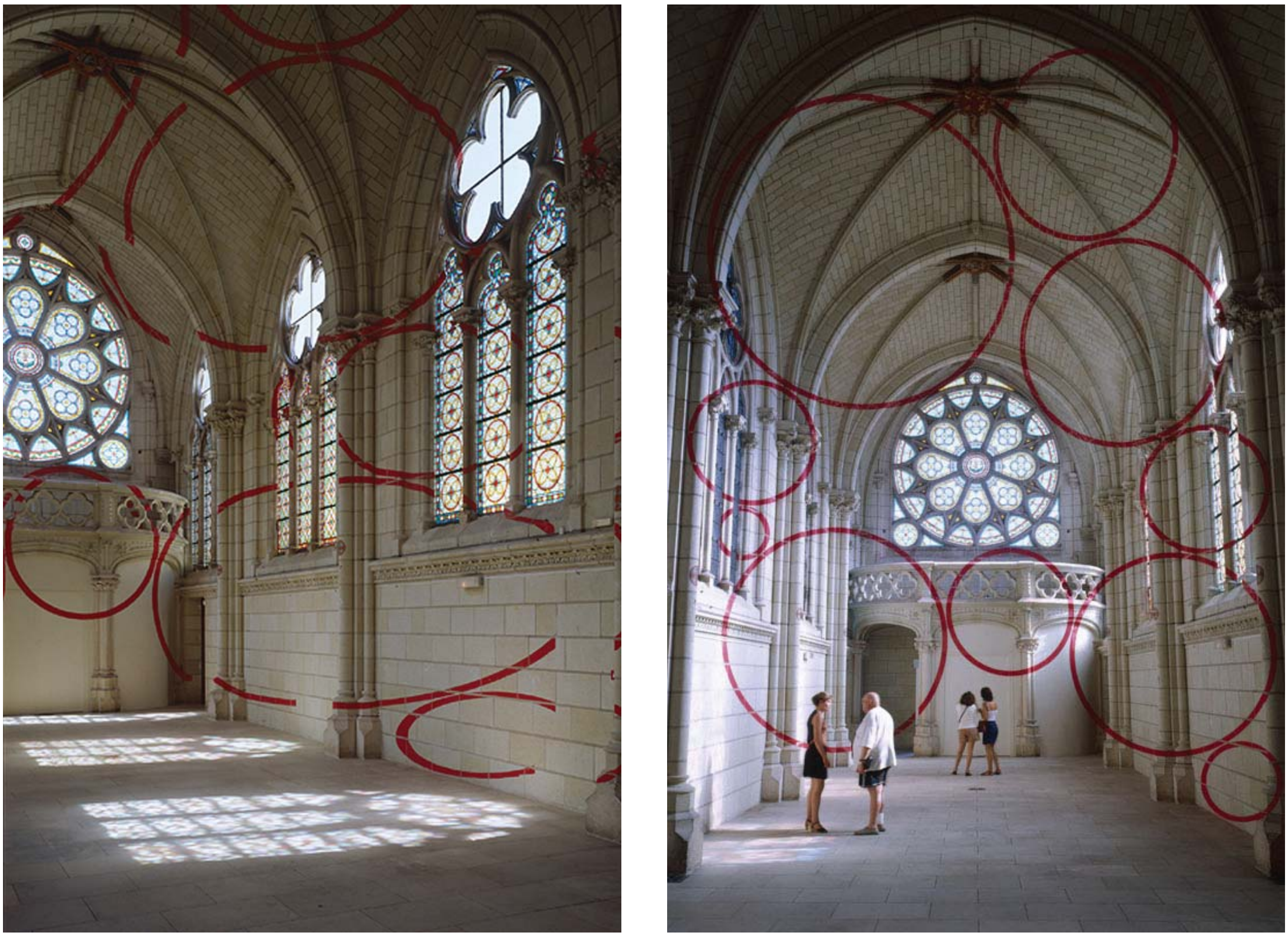


Figure 29: *Encerclement à Dix.* Felice Varini. Installation. Deconsecrated chapel in Thouars. (Lopez-Duran, 2004, p. 101)

interaction and exchange between body and space, where the presence of depth is not a question of being a third dimension but becomes “the very reversibility of dimensions” (Lopez-Duran, 2004, p. 100). In this awareness, he noticed a truth of all perceived things: that the perception of space and its being as a thing are not dissimilar issues (Merleau-Ponty, 2005, p. 131). However, what happens when the process is reversed? What happens when instead of being confronted with the laws of conventional perspective, we have to perceive a plane projected into the space creating a thing that is not really there? Felice Varini’s work *Encerclement à Dix* at a deconsecrated chapel in Thouars, France, does exactly this (Figure 29). Ten red circles are perceived floating around an implausible space between the church entrance and the rose-window wall when the viewer stands still at a fixed and immobile position. As soon as the body moves, the pictorial ‘illusion’ breaks, and the architecture together with the artist’s deformed and calculated lines start taking over our perceptive highlight. What Varini creates is not an illusion and is not an anamorphic trick: he is neither representing a fictional space like in painting nor hiding an image as in anamorphosis (Lopez-Duran, 2004, p. 101). He is instead making us, as beholders, aware of the authentic architectural space our body inhabits while perceiving *Encerclement à Dix*—he puts us in the state of a 'particularised attitude'. The apparent subject is the composition created by the ten circles, but this is a means for the artist to make our perception juggle back and forth between the reality of calculated geometry and the apparent metaphysical nature of the composed red circles. The circles themselves would seem insignificant as choice for a subject, if not for the observation of the pre-existence of an 11th one in the central rose-window (Lopez-Duran, 2004, p. 101). In order for Varini to successfully immerse our perceptive abilities in that particular architectural space, he anticipates his creation onto what had already been calculated and what is present.

Empiricism, including empirical philosophy are interested in the detailed explanation of the sensations taking place inside an individual's mind in the same way "one might describe the fauna of a distant land", and the empiricist must therefore be aware that he himself is also an individual who perceives while doing his research (Merleau-Ponty, 2005, p. 185). An objective observation of the world has always been of great importance to the empirical professional realm, securing a non-fictitious interpretation of the world. However, for the artist the world does not necessarily have to be of a deterministic and objective nature, and the "objects" created give meanings to processes of observations (Lappin, 2013, p. 40). Making art has undoubtedly a creative element, but observing it does not differ; and its perception can also be heavily influenced by the viewer's knowledge, as previously discussed in pp. 13 - 20. Art draws a model from the world which prefers not to deal with the world's 'operationalism' just like what Graham and Varini accomplished in the examples mentioned above. The artist also holds the right to observe the world without the obligation to appraise what he sees, while science makes limited models of the world at several rare intervals remaining truthful to its nature (Merleau-Ponty, 2005, p. 159). The artist evaluates what he sees through his subjective perception. For example, when Giacometti stated that what interested him in painting was resemblance, he added that it was a resemblance as seen by him, and which would at the same time make him want to discover more of the world. He was here referring to the 'imaginary'; that which is immediate to our body as it is a representation of "the life of the actual" and yet distant from the actual as a work of art will always have an analogue nature depicting a synthetic texture of the real (Merleau-Ponty, 2005, p. 165). Most probably Merleau-Ponty took interest in Giacometti as contemporary to when the philosopher started reasoning out the phenomenology of perception, the artist paralleled this research visually (Figure 30).

Figure 30: *Piazza.* Giacometti. Bronze. 1947 - 1948. 21 x 62.5 x 42.8 cm. The Peggy Guggenheim Collection, Venice.

Giacometti recalls a particular day in 1945 as having given him the opportunity to encounter a new awareness of space in its entirety; to perceive the distance that allowed people to appear not as their natural size dictates but as they really are after understanding the difference between his way of seeing in the streets and the way things appeared in a photograph and film (Schneider, 2008, p. 65). Each of his sculptures coexisted with a responsibility to represent "a way of feeling space" (Sartre, 1999). His preoccupation was with how to translate our phenomenological experience of the given world into matter, and the obsession with how far or close, tiny or tall, fine or intuitive his subject should appear is present in every figure worked, marking his perceptive experience. This requests us as beholders to enter the realm of our own imagination, while looking and sensing an invisible border surrounding his figures which we should not enter for the sake of our visual comprehension (Schneider, 2008, p. 69). In a way this precedes the beholder's immobility in front of that one point of view of realisation.

For Merleau-Ponty, the philosopher (just like the artist) has the fundamental work of gaining an "access to truth" through perception, and in this view Giacometti constantly thinks and questions what is being perceived by his vision (Tavani, 2015). This is what gives Giacometti a phenomenological approach towards his art:

> …there's also something else. If I copy the surface of a head exactly in a sculpture, what's inside? Nothing but a great mass of dead clay. In the living head, the inside is just as organic as the surface, right? (Auster, 2003)

The artist interrogates what might appear to be obvious during our daily routine. His questions are materialised visually, and deal with what is invisible through the visible. It is also a question of never being sure of what one sees and of what one makes in response, while the more questions arise, the more visual possibilities break open in this ceaseless relearning of how to look at the given world. For Giacometti this also came at a price, as the curiosity of the given world seemed to shrink to solitary individual objects:

> The pleasure of taking a walk in the forest has disappeared for me because the first tree on a sidewalk in Paris is already enough. That's enough for me in the way of trees; to see two of them would make me afraid. …the curiosity to see something is reduced, because a glass on

a table astonishes me much more than before. (Auster, 2003)

The ‘flesh’ of the world is represented to us through a specific understanding originating from the artist’s ‘body’; the artist’s ‘gaze’ is the primary ignition of this whole interrogation (Tavani, 2015). The artist’s body is the junction of the several visual ‘scans’ happening simultaneously in the midst of our given world, apart from also being the intermediary for the filtering, decoding, reinterpretation and translation of these perceived evaluations. These operations are of course loaded with a perceptual awareness, but inevitably there are processes which happen outside of the artist’s realm of consciousness.

The bodily action happening away from any affective attention forms part of a body schema. Gallagher (2005) categorises this beyond being a perception or a conceptual understanding, but a “prenoetic” performance, its function that of aiding our structure of consciousness (p. 32). He argues that through these performances, the body relates itself to the environment by both adapting certain attitudes to the latter and by merging consequential elements to its own body schema, just like when the hammer becomes an extension of the carpenter’s working body (Gallagher, 2005, p. 32). In this sense, the artist’s charcoal grasped by his hand in front of his canvas, stops being a simple tool, but becomes a prenoetic vehicle translating the perceptive data of the received given world into the subjective understanding mentioned earlier. The artist’s attention is partially aware of its bodily movements while directing the charcoal on paper, but some gazes and other actions cannot be part of this conscious intentionality. They are rather a component of Gallagher’s body schema, which in their own way might flicker the artist’s consciousness towards a new questioning of the environment the body is inhabiting.

Perhaps this phenomenological discussion of elements coming from the environment being appropriated by the body is an offshoot of both our phylogenetic (in an evolutionary sense) and ontogenetic (as in personal growth) development. Through our upright postures of both walking and standing we extended our visual horizon of the surrounding environment, while at the same time we liberated our hands for the possible physical manipulation of it (Gallagher & Zahavi, 2008, p. 138). Furthermore, we separated ourselves from the ground and created a sphere of independence around our bodily selves; both from the environment and to a certain extent from other bodies, all through underlying processes of complex brain structures that eventually gave us our rational thinking (Gallagher & Zahavi, 2008, p. 138). Apart from this, as Sartre had already stated in 1943, the body can also be experienced as-object when viewed upon by the *Other*'s gaze, or more specifically "as-intentional-object-for-others", which goes beyond one's conscious acts (Legrand, 2010, p. 188). The body is also experienced as-physical-object when it is the agent which both grants and limits an

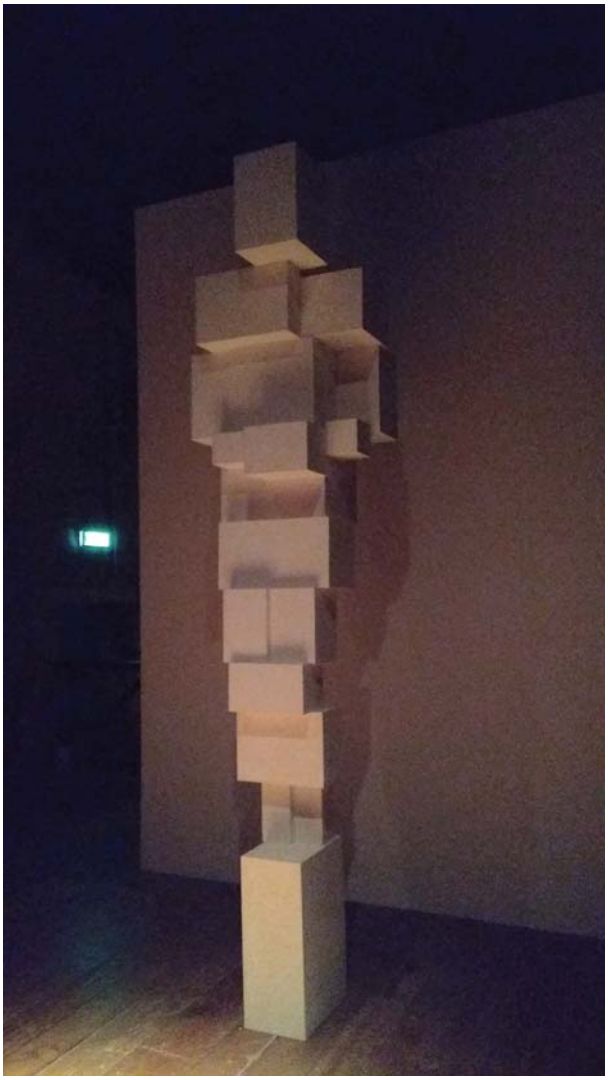


Figure 31: *Gut X*. Anthony Gormley. 2013. Hollow plaster blocks. 313 × 73.5 × 69.5 cm.
Own Photograph, 2017. Venice.

individual's intentions; the individual's desires come into being through the possibilities of the body, while at the same time the body itself imposes its organism preconditions which can range from biological needs such as eating to unintentional acts such as unconscious reactions and movements (Legrand, 2010, p. 188). An artist looks for both the advantages and disadvantages of one's own body, combining them into a favourable context where to question our perceived given world (see Chuck Close's case study, pp. 89 - 90).

Giacometti's earlier comment about the subject's appearance in a photograph should not here pass unnoticed. Photography, as with every technological advance, brought with it new phenomena which keep evolving to the present day. Ritchin (2009) argues that one of the difficulties in tracing these, lies in the fact that for many of us the world is perceived as photographic even in the absence of an actual camera (p. 21). He here too cites Giacometti in explaining that his world view was a photographic one (just as he believed it for most people) arguing that one never sees things but through a screen (Ritchin, 2009, p. 21). Artists today still question what is a worthy perceptive challenge, and the means of doing so in our century have largely multiplied. For example, in appreciation of Giacometti's work, artist Anthony Gormley stated that unlike Giacometti in today's contemporary world he is trying to find an alternative to the representation of a body as an object (Figure 31), and think of it more as a place, replacing the idea of appearance, resemblance and unconscious accidents with something which is more present (Morris, 2017).

A Brief Overview of Perceptive Techniques in Art

It is probably safe to state that since the times of the ancient civilisations, the human being has had a curiosity (some type of obsession) and an intuition to trace and fix the apparent visual world onto a physical material. Both the why and the how evolved according to the changing contexts of human history, and the following chapter aims to give a brief outline of the techniques created throughout the centuries ranging from tracing a mark on the cave wall to 3D scanning in our digital age. The aim is here to give a preparatory background for this research study's project/s which are ultimately that of 'drawing' through an eye-tracking device.

The earliest painting examples found in the prehistoric caves (which have already been discussed above) are perhaps easier to admire than to place in the context of why these early humans left their mark on the cave walls. We can speculate, fantasise and believe certain theories and studies, but the truth of what these drawings represented to the early community is distant from us as we have no written form of language from this time to decipher. Having said this, by anthropologically studying tribes such as the aborigines, we are coming closer to the understanding that these paintings had a dimension nearer to that of the ritual (also incorporated with dance and music) other than just the idea of marking a trace on a wall (Spivey, 2005). What is distant from us is also their sense of time, as their entire life activities were fulfilled with the immense present and presence of their surrounding environment: we are instead detached from everything that surrounds us, they were not (McBurney, 2011).

After the development of writing, we then have an ancient myth, metaphorically recalling the birth of painting and sculpture in the Western world. In his *Natural History*, Pliny tells the myth of how the daughter of Butades, a potter at Corinth, traced the outline of the shadow of her lover's profile onto the wall moments before his departure (Pliny, 1968, XXXV). In a way, this is somewhat similar to what Plato describes in his *Allegory of the Cave* when depicting the scenario of what feels to be the philosophical condition of the human mind, where the prisoners shackled inside the subterranean cave were convinced that the moving shadows projected onto the wall consisted of reality, of the real world (Plato, 2007). Plato's story seems to juxtapose an enlightenment happening with the emancipated, and according to Kenaan (2006) the analogy with Butades' daughter's act of tracing an apparent image from "reality" onto the wall lies within its "un-enlightenment" (pp. 29 –

42). In the iconoclastic nature of the Platonic philosophy itself, one can assimilate the image of the lover's shadow, and consequentially the painted imitation, with a convincing fake reality: Butades' daughter endorsed a *mimetic* replica of her lover (Kenaan, 2006). On the other hand, in order to perceive the meaningful load behind Pliny's story, one must first detach himself from the contemporary concept of what does a work of art consist of, and from its being a product within itself. One should instead focus on the act of tracing accomplished by the daughter in the light of its non-objective significance towards the world. It is true that her action was probably born out of love and a state of heightened emotion, but the drawing on the wall was irrelevant to the real world, as it could not stop the lover from departing. It instead left Butades' daughter (without being an artist) with a fixed image—a visual memory—which was not a substitute for reality but something else.

Throughout the story of our Western culture, artists have come up with techniques which go beyond Butades' daughter's intuition of imitating reality through the tracing of her lover's shadow. Classical art developed its naturalist tendencies to impeccable heights, only to be forgotten by the Christian Medieval times and resurface with the Italian Renaissance. The intellectual match of the classical ideals were planted during the Early Renaissance to fully bloom with the High Renaissance. The figure of the artist rose from the category of the craftsman it had been assigned to during the Medieval period, and artists began to write and theorise about their practice. Figures like Alberti, Brunelleschi and Da Vinci earned respect for their discipline not only through their respective creation of revolutionary visual artistic work, but also through their writings which talked about and were proof of a new kind of knowledge artists then possessed (Carroll, 2010, p. 5). The first discourse we know of speaking about a human theory of vision as "rays" acting according to certain physical laws of nature, comes from the first Renaissance with Alberti's *De Pictura*, and what the artist's attitude accomplished in such climate is; "a generalisation achieved by the precise definition of the spatial relation of the viewer—artist to that field" (Summers, 1990, p. 6). Brunelleschi's work influenced the liberal arts in this same optical spirit, which gave birth to the application of the principles of linear perspective in order to achieve an imitation of spatial naturalism in painting (as discussed in Masaccio's Figure 4). Both Alberti's and Brunelleschi's writings represent a point in history where a progression from wall architecture to space architecture occurred (P. Murray & L. Murray, 2000, p. 61); through scientific calculation the liberal arts concurred a new dimension in their portrayal of the real world.

Kelly (2011) argues that Brunelleschi's way of representing the world through these perspective principles can be described as a detached perceptual attitude, where unlike an absorbed perceptual experience, time and specific attention is given to the details of the visual elements in front of the beholder (p. 97). Brunelleschi's way of reviving the laws of perspective was in itself an experience of this sort, as while tracing the octagonal Florentine Baptistery through the use of a mirror, the architect had to maintain a detached perceptual attitude by concentrating on an outline instead of the things themselves (Kelly, 2011). Pliny's story seemed more concerned about finding a value for a man-made image—an 'artificial' (but detailed) record of reality—after an intuitive human act not far in its nature from the prehistoric cave images. On the contrary, the perceptual process of a visual explanation of the space we live in, brought with it mechanically-built aids which served artists with a simpler viewpoint of the real world during their attentive measures of generalising the third dimension onto a 2D surface. Through an empirical viewpoint, Brunelleschi observed that a set of parallel lines appear to converge at a vanishing point when transferred onto an image. However, it is also worth noting that few scholars disagree upon this Brunelleschi "peephole and mirror" story of discovering the existence of the vanishing points (Brooks, 2017).

By 1525, Dürer had already read about the Italian theories of perspective, and published *A Course in the Art of Measurement with Compass and Ruler,* which dealt with this fascination of measuring the world through geometry and vision. The edition also included guidance for the usage of perceptive support such as the net-like grid through which an artist could measure the looked-upon world as seen in *Artist drawing a reclining model* (Figure 32), where through the help of the grid system, the artist is visually resolving challenging issues such as the foreshortened body of a nude figure (Snyder, 2004, p. 322). In a way, this is analogous to Brunelleschi's experiment with using the mirror in order to outline the environment in view of describing and measuring it on a 2D surface.

Figure 32: *Artist drawing a reclining model.* Albert Dürer. 1525. Woodcut. 7.6 x 21 cm. (Snyder, 2004, p. 322)

Kemp (1990) describes the skill of geometrical calculation as a sort of "*applied Euclid*" and a large-scale perspective machine worth mentioning comes from Jacopo Barozzi da Vignola (Figure 33), which was published in Danti's treatise in 1583 in Rome (pp. 168 - 170). This again operates through monocular vision with a fixed eyehole in the centre of a sight, which could slide up and down the vertical scale and across the horizontal axis by turning a shaft. The regular scales thus provided a veil of lines of the observed subject's key points, ready to be transcribed into a smaller scale drawing (Kemp, 1990, p. 168 - 170). This machine is loaded with more technical precision because of its specific coordinate calculation than the grid example shown by Dürer (Figure 32), which practice gave more room for an artistic interpretation than Barozzi's. Another monocular peephole example from Dürer's same 1525 treatise is Figure 34, illustrating *A draughtsman drawing a portrait*. The peephole was an assurance that the viewpoint of observation remains unchanged while the outlines are being traced, and even though it gives an archaic technological feeling, it quickly became prominent when applied in the camera obscura (Arnheim, 1974, p. 284).

Figure 33: *Jacopo Barozzi's Perspective Machine.* (Kemp, 1990, p. 174)

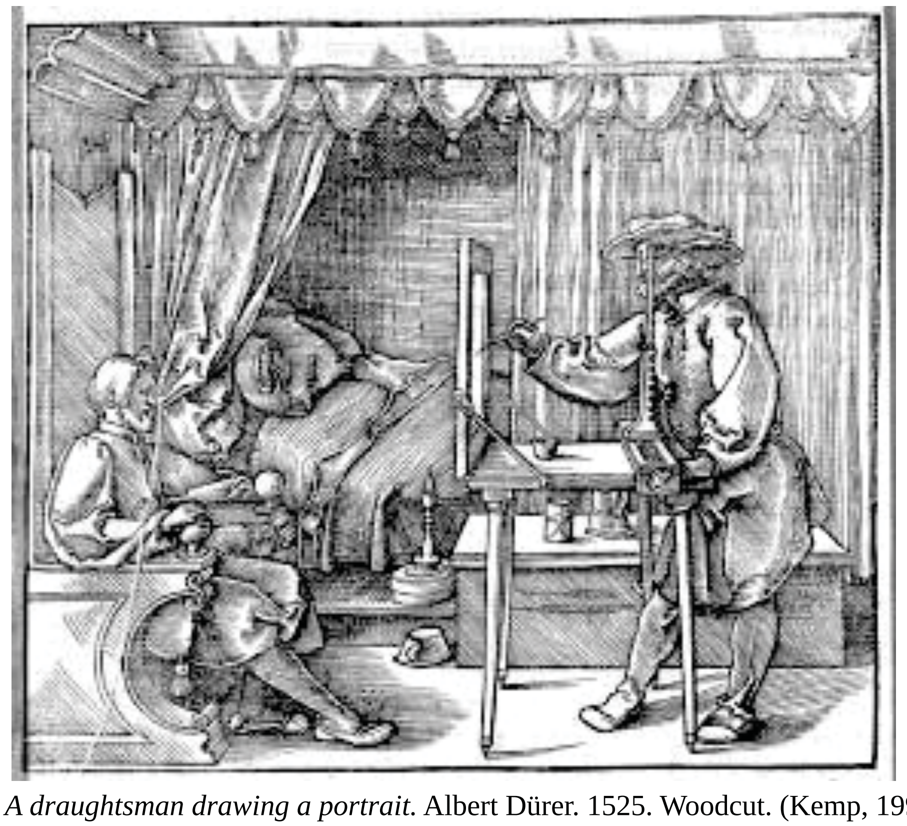


Figure 34: *A draughtsman drawing a portrait.* Albert Dürer. 1525. Woodcut. (Kemp, 1990, p. 172)

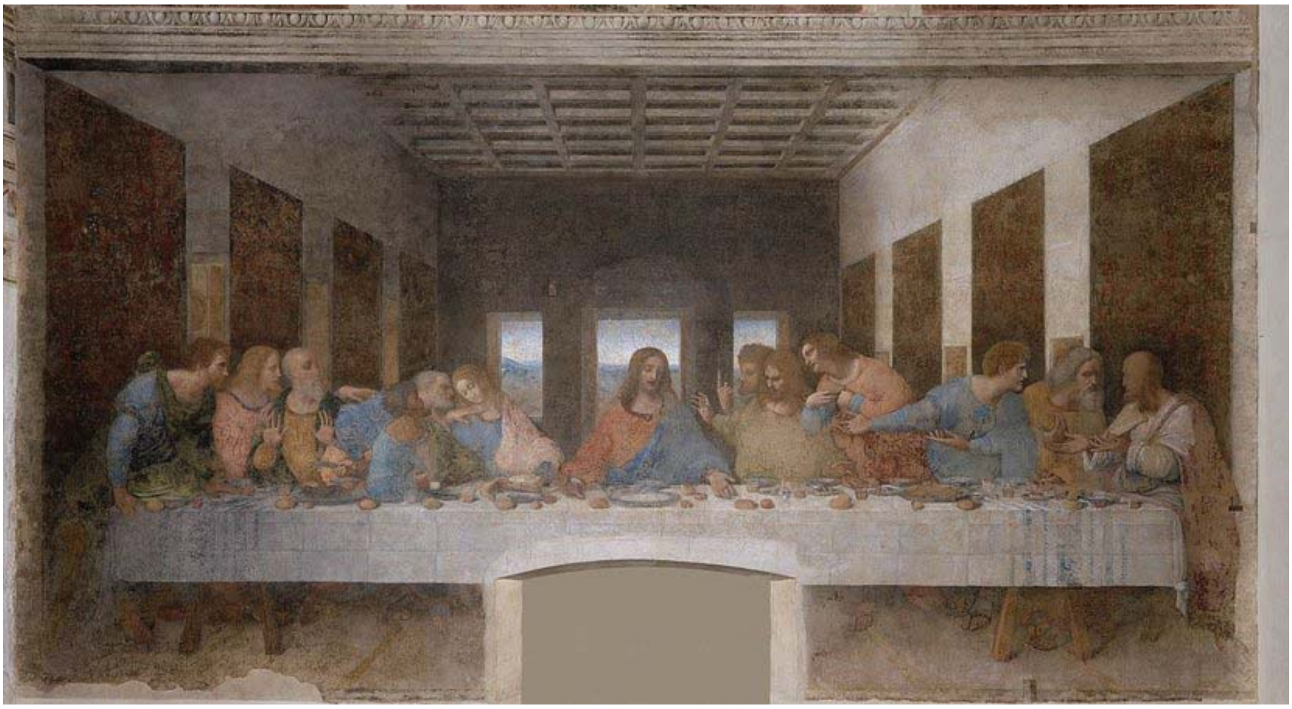


Figure 35: *The Last Supper.* Leonardo Da Vinci. 1490s. Fresco secco. 460 x 880 cm.
Convent of Santa Maria delle Grazie, Milan.

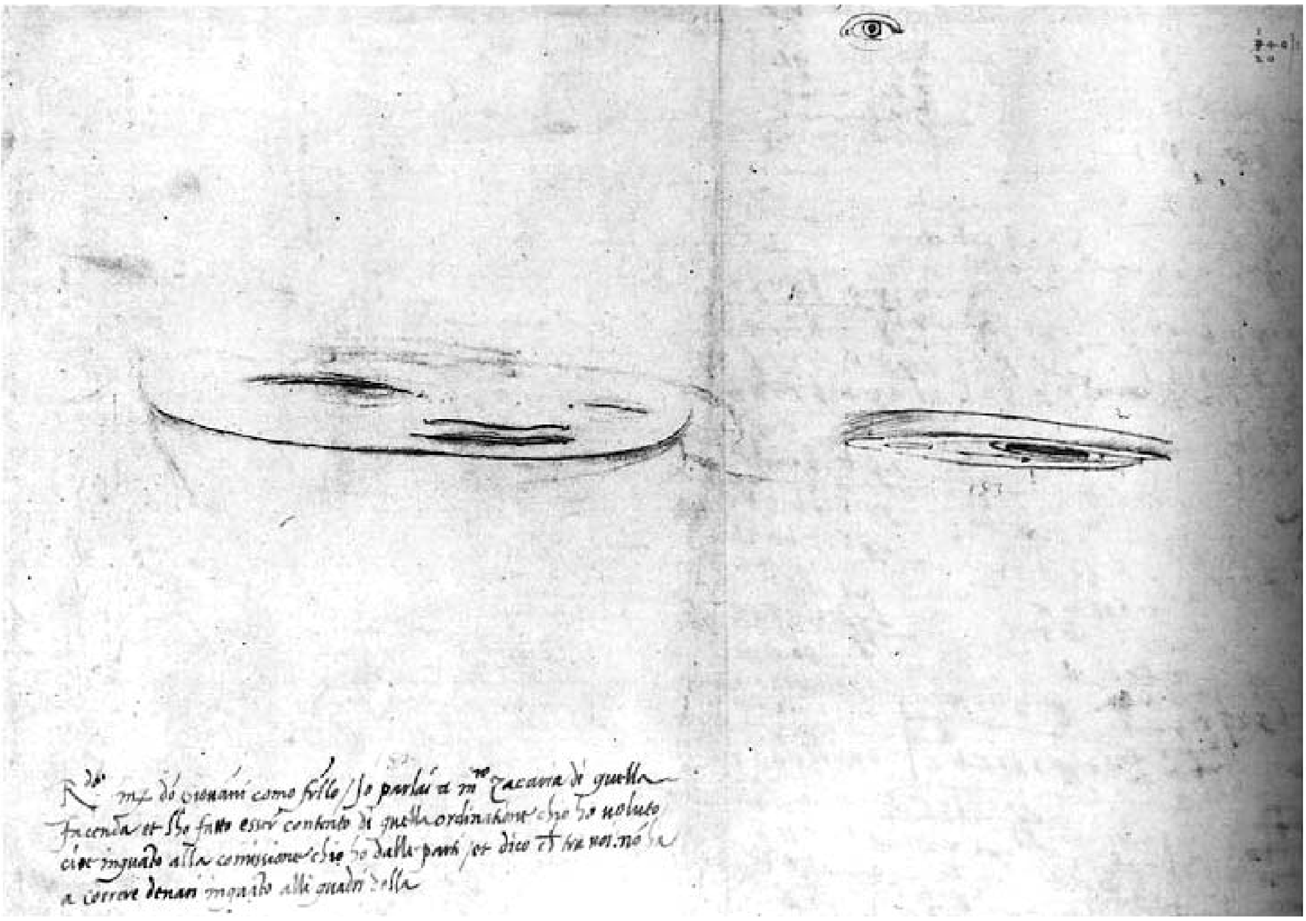


Figure 36: Leonardo Da Vinci's anamorphic drawing of an eye. (Lopez-Duran, 2004, p. 97)

It is perhaps widely accepted that the quest for empirical knowledge to be applied in the arts of the period is most notable in Da Vinci's notebooks, forming the *Codex Atlanticus*, 1483 - 1518. One of the best examples of human curiosity is found entirely illustrated in these volumes, ranging from engineering machines to endless anatomical drawings of deceased corpses, as he strongly believed that no painter can paint the human figure without the knowledge of what's beneath our skin. Many claim that the pinhole camera was also invented by him, to be equipped later with its lens and mirror construction (Arnheim, 1974, p. 284), and in view of this, da Vinci's comments on perspective were again very mechanical; "nothing else than the seeing a place behind a sheet of glass…on the surface of which all the things may be marked." (da Vinci, 2008, p. 113). At the same time, perspective's perceptual implications on the beholder were (and still are, or can be) of a metaphysical nature. Panofsky believes that in depictions like *The Last Supper* (Figure 35), the miraculous and supernatural event becomes a continuous reality of the viewer; as the superhuman appearance is projected into the beholder's natural space of vision (Crary, 1999, p. 199).

Even though perspective's privilege is that it conveys to the beholder a belief of a perceived reality, its two-dimensional physical nature evidences its incompleteness as it illustrates only one of the infinite possible views (Amoruso, 2016, p. 374). Leonardo himself interpreted this with what is credited as the first anamorphic drawing in the history of Western art (Figure 36). This is a process reversing perspective's own principles, where the beholder's eye switches the distorted lines from their real physical plane to a virtual one, where the distortion of an image anticipates its portrayal (Lopez-Duran, 2004, p. 97). At the same time the distorted traces highlight the abstract and symbolic nature in the depiction of the real (Amoruso, 2016, p. 374).

Both the process and the outcome of an anamorphic drawing still revolves around monocular vision. What it plays around with is a sense of illusionary space inside the physical two-dimensionality of its support through the creation of a virtual plane from a specific point of observation. In his controversial thesis, David Hockney claimed that the perspectival renderings of the Renaissance and post-Renaissance are all monocular, as they were literally traced from the camera obscura lens (Kelly, 2011, p. 100). The fact that they are monocular may be appealing, but the claim that all were traced through optical aid might sound a little limited, even though there is sufficient evidence that painters like Vermeer used such a device to achieve their level of detailing (Arnheim, 1974, p. 284). In one of his discussions about Vermeer, Kemp (1990) mentions an experiment by Steadman of the reconstruction of the artist's room (Figure 37) through the analysis of six of his paintings; which model confirms a very close correspondence between the image clarified by the convex lens and the paintings themselves (pp. 193 - 196). Kemp (1990) relates Vermeer to a photographer, where after composing his subjects in space, the basic outlines of the represented scene are recorded on screen to be later fulfilled by his unique way of painting. Hockney's (2006) thesis that most artists post 1420 employed similar optical methods, caused quite a stir in the art world for a number of reasons. Most of them were discussed during a two-day

The 'viewing points' for the pictures are shown as 1, 2, 3, 4, 5, 6, and the visual angles are extended through these points and towards the rear wall until the bases of the secondary triangles equal the widths of the pictures.

1 *Woman and Two men*, Brunswick, Herzog Anton Ulrich Museum.
2 *The Glass of Wine*, Berlin-Dahlem, Gemäldegalerie.
3 *Lady Writing a Letter*, Blessington, Sir Alfred Beit Collection.
4 *Lady Standing at a Virginal*, London, National Gallery.
5 *The Music Lesson*, Collection of Her Majesty The Queen.
6 *The Concert*, Boston, Isabella Stewart Gardner Museum.

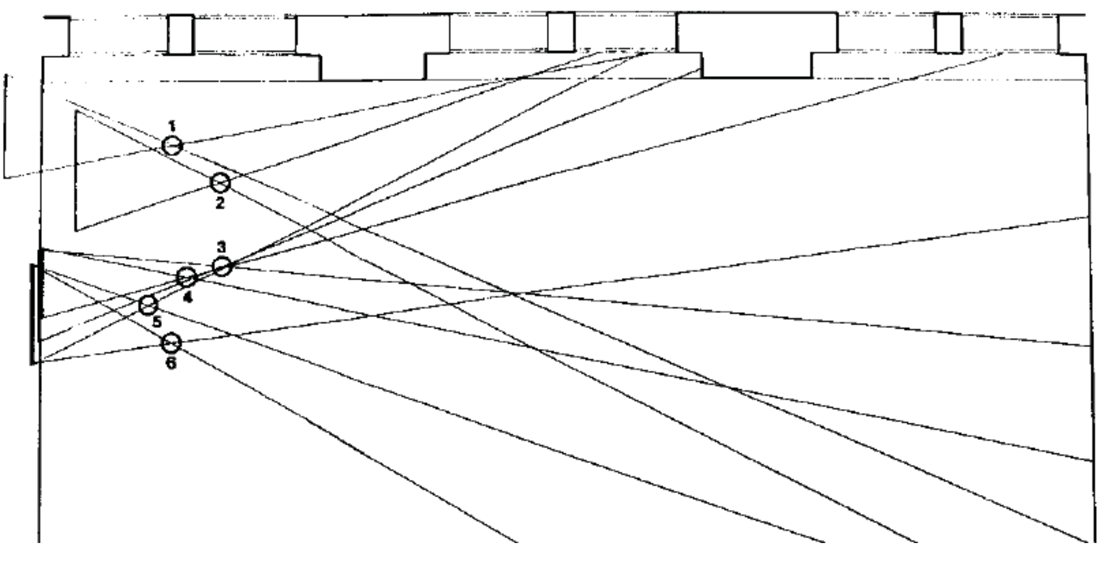


Figure 37: Ground plan of Vermeer's room as drawn by Philip Steadman. (Kemp, 1990, p. 199)

conference held at the New York University in 2001, where both Hockney and Arizona physicist Charles Falco (Hockney's collaborator) were present alongside Susan Sontag, Martin Kemp, Jonathan Crary, Chuck Close, among others (NYU, 2001). Hockney also produced a TV documentary together with the BBC illustrating visual evidence to his theory, which starts by comparing a blown-up detail of a drawing by Ingres with an Andy Warhol traced image (Figure 38); claiming that while Warhol's tracing process was well known, Ingres' zoomed-in lines evidenced a similar procedure (Hockney, 2003). Elkins (2002) wrote a review after the NYU conference took place, and two important points are to note. First, controversy towards Hockney's theory is so strong because sometimes art historians tend to think of the Old Masters as having unparalleled talents; on this premise it is very difficult to accept the notion that optical aid was used in the creation of their work. Secondly, Crary stated that he was not moved by Hockney's claims as they were purely limited to an optical definition, whereas the ingredients of illusion are often contextual and non-optical (Elkins, 2002). While the first point tells us to look at art from a viewpoint closer to

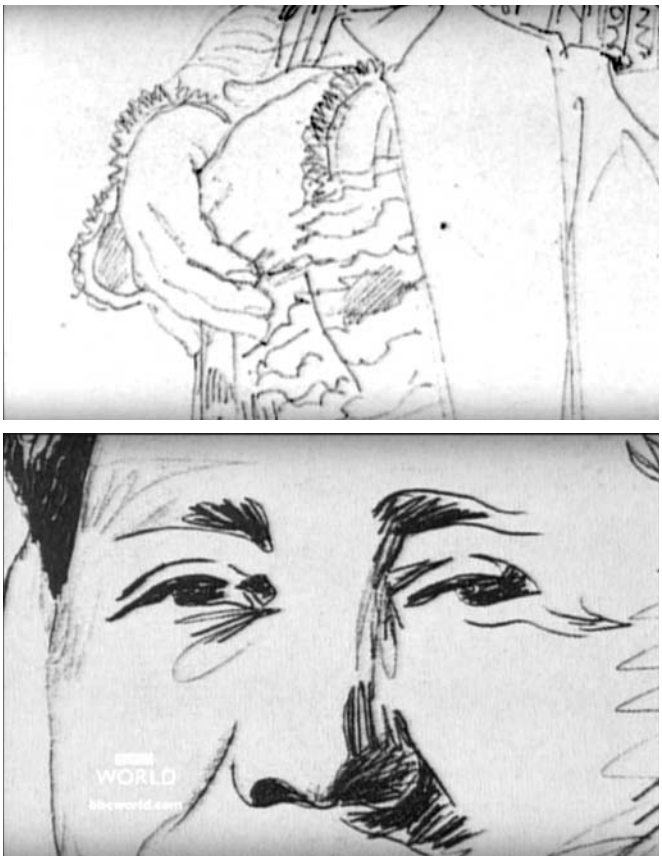


Figure 38: Comparison between Ingres' and Warhol's quality of line. Still-frames. (Hockney, 2003)

a human dimension, it can help us understand that if Vermeer, Ingres or any other artist in history used optical tools, it does not necessarily mean that their way of representing the world is purely an automated and mechanical one. On the contrary, the mechanical application can be necessary as a stage to achieve a unique, intimate and slow portrayal of the fraction of the world being observed—it can be an important step in placing what's being represented in a contextual meaning. After all, why is it a problem if Ingres used an optical device as an initial step whereas Warhol's application of a projector is not? In view of this, one must also note what the man who fixed an image for the first time inside the camera obscura, Fox Talbot (2010), wrote in his recount of how he came up with his invention; "After various fruitless attempts (of tracing an image trough the camera obscura), I laid aside the instrument and came to the conclusion, that its use required a previous knowledge of drawing, which unfortunately I did not possess" (p. 3).

As shown in Crary's (1999) *Suspension of Perception,* one of the most influential happenings after the 19th century with respect to perception, was the rise of a subjective concept of vision. Together with the evolution of capitalist modernity, both still cause an ongoing renewal of our sensory approach to the world: a ceaseless regeneration which we have been going through for the past century (pp. 11 - 13). The 19th century saw the introduction of new visual instruments like the stereoscopes, which were described by their inventor Wheatstone, as two simultaneous projections of an object hitting both retinas from similar parts. Other scientists and mathematicians like James Elliot were experimenting with stereoscopic inventions even while not aware of Wheatstone's advances, and the aspect of any stereoscope was to allow each respective eye to perceive an image individually, initiating the modern study of stereoscopic vision (Howard, 2012, pp. 80 - 82). A new research climate triggered the several disciplines of the time, which steered society into the modern age. As Foucault described it, through a "great eschatological dream" of the 19th century man became an object of knowledge in order for him to evolve into the subject of his own freedom of existence (Crary, 1999, p. 45).

This was the century which made historical human desires possible through a new mechanical revolution. As Benjamin (1972) puts it in his *A Short History of Photography,* there is less ambiguity around the invention of photography than that surrounding the birth of printing, as the hour of its emergence had arrived after centuries of men striving towards the goal of capturing images in the camera obscura from Leonardo's time or before (p. 5). In this climate, I also find a curious historical humanist loop, as it is well noted that Fox Talbot, H. F. originally referred to his method of fixing an image onto light-sensitive paper through a camera obscura as skiagraphy, referring to shadow writing and to the non-apparent referent (Derrida, 2010, p. 1). The argument of tracing an image in our Western history started with the shadow in Pliny's story, and at the same time the shadow is phenomenologically external to our body, but which image we immediately recognise as belonging to us. In Merleau-Ponty's (2005) terms; "we recognise our shadow… recognise visualisations of our body which are usually invisible" (p. 132). Therefore, the shadow is an element of recognition, fascination, desire and creation, while at the same time it is also a shadow which represents the death of representation in photography itself. A cartoon by Cham (Amédée de Noë) from 1839 (Figure 39) illustrates this 'misphotography' through a technical accident where a fogged negative could only develop into nothing else other than a black abstract square (Turner, 2006). The witty caricature already depicted the other side of a new technique capable of mimicking reality: nothingness as a result of a random recording of optical perception (Stoichita, 1997, p. 189).

The previously mentioned mood of independent inventors working towards the same objective of fixing reality onto paper can also be proven by the legal difficulties Niépce and Daguerre faced over obtaining their copyright as authors after succeeding at the same time to present their state with their invention, a dispute which contributed to an accelerated development of the technology, together with its commercialisation (Benjamin, 1972, p.5). According to Benjamin (1972) this suspended a philosophical reflection on the birth of this new medium for

Figure 39: *Misphotograph.* Cham (Amédée de Noë). 1839. (Stoichita, 1997, p. 189)

Figure 40: *Nicaragua.* Koen Wessing. 1979. Black and white photograph. (Barthes, 1981, p. 22)

some decades, which he then tackled himself (p. 5). A notable comment from his essay is his comparison between a verbal description of an event and a photograph of the same, where for example it would be possible to roughly describe the way somebody walks, but not that fraction in time when a person starts this action, and photography makes us aware of this optical unconscious (Benjamin, 1972, p. 7). Photography gave the opportunity for freezing moments which were concealed to the naked eye; it made visible that which was not. Apart from this awareness of perceptual views which do not usually meet the eye, it also recognised another aspect of the real world: a moment. Photography points at a subject not only as an object but also as an event which is taking place in front of the lens; and it enhances the fact that; "this (event) took place, and it took place only once" (Derrida, 2010, p. 3). It is the recurrence of what occurs for one time only. This can be assimilated to Barthes' reflection upon a photograph which made him pause while glancing through an illustrated magazine: a photograph showing a divergence of two events—two nuns and two soldiers in a ruined street in Nicaragua (Figure 40). The photograph did not please Barthes, nor interest him and neither intrigue him: it existed, and its existence was held by the eventful co-habitation of two groups not belonging to the same realm (Barthes, 1981, p. 23). This co-existence, of that moment in time, can only be repeated through the one repetition portrayed by this photograph.

Photography also slightly broadened the horizon of a limit presented by perspective: that of perceiving through a still viewpoint. This point has to be treated with caution, as one can always argue that behind the lens it is always the work of one subjective point of view; of the photographer. However, since its emergence photography immediately dealt with several options of the portrayal of diverse vantage points; approaches with substantial transformations of perception. Firstly, it gave way to the creation of social hot spots like the *Kaiserpanorama* (Figure 41), where by preceding cinematography and rooting back to the peep hole, it created a space aligning one's subjective attention with a machine by offering the public individual viewing screens where one could observe

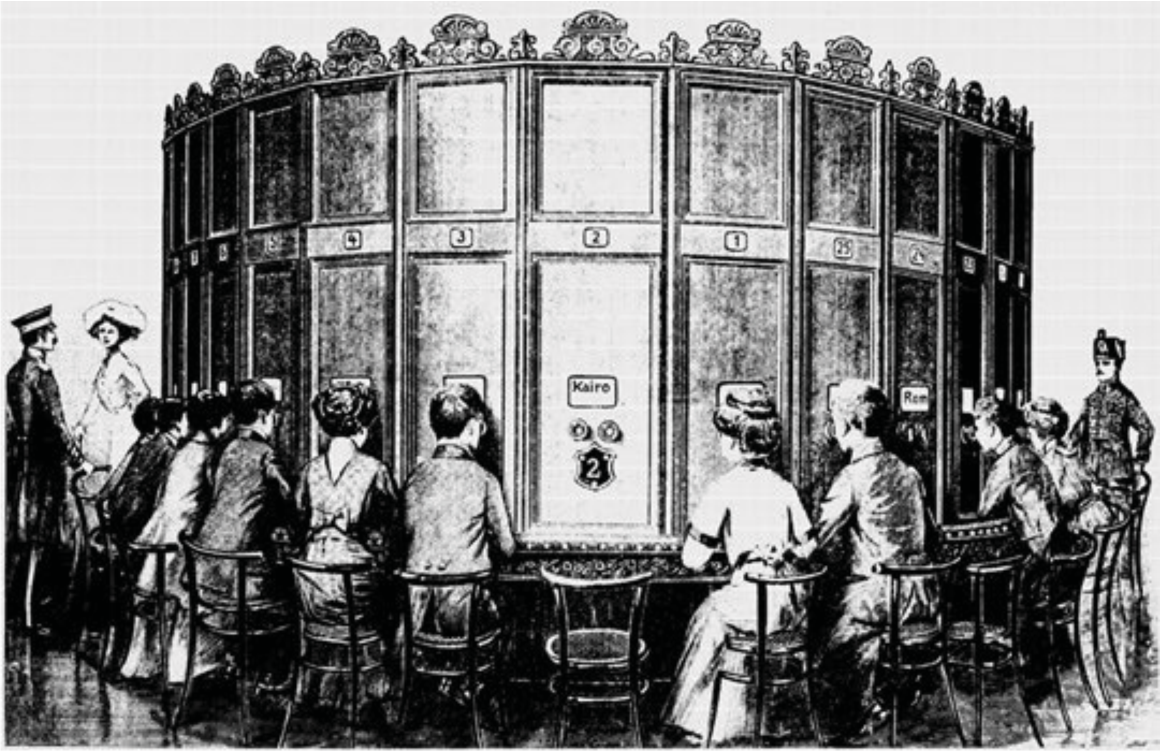


Figure 41: *Kaiserpanorama*. (Crary, 1999, p.135)

a series of mechanised moving images (Crary, 1999, p.136). Such public places also created new itineraries in the perceptual social dimension, and as Benjamin notes, even if such established social machines were quickly outmoded by the introduction of film, they manifested a curiosity for development, and somehow also managed to provide a space for an isolated contemplation of a “divine image” in a public sphere (Benjamin, 2008, p. 52). Apart from the *Kaiserpanorama*’s new concepts of subjectivity (in a public dimension) merged with mechanised moving images, how much did it also precede our current modes of living and perceiving our real world through a screen (see pp. 75 - 80)?

If photography laid bare to the naked eye what previously was not visible, experiments like Eadweard Muybridge’s sequential images of moving horses (Figure 42), exposed the precise and formulated nature of perception which was unprecedented (Crary, 1999, p. 138 - 144). Muybridge unlocked perceptual existences in time, calling for an attention manifestation from which space is deleted (Crary, 1999, p. 138 - 144). Concurrent to Muybridge’s perceptive dismantling of the real world, Etienne-Jules Marey worked on mutual experiments, with the significant difference that the

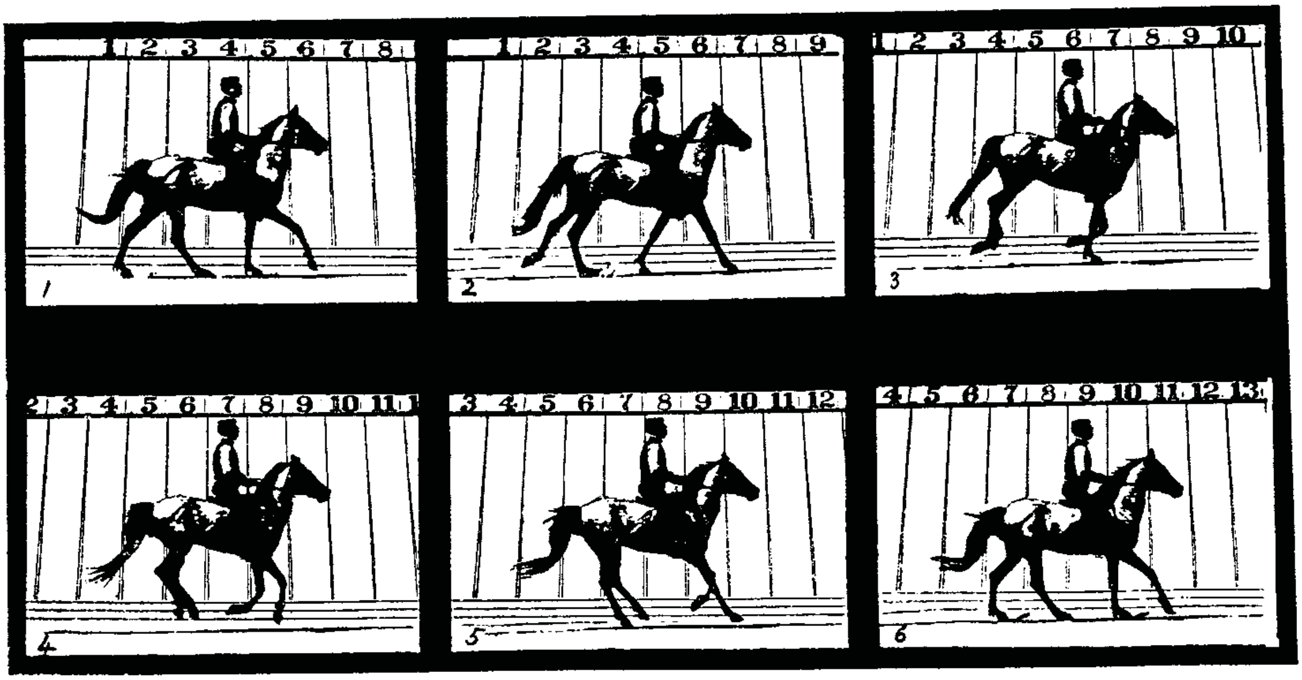


Figure 42: *The Horse in Motion.* Muybridge. 1878. (Crary, 1999, p. 145)

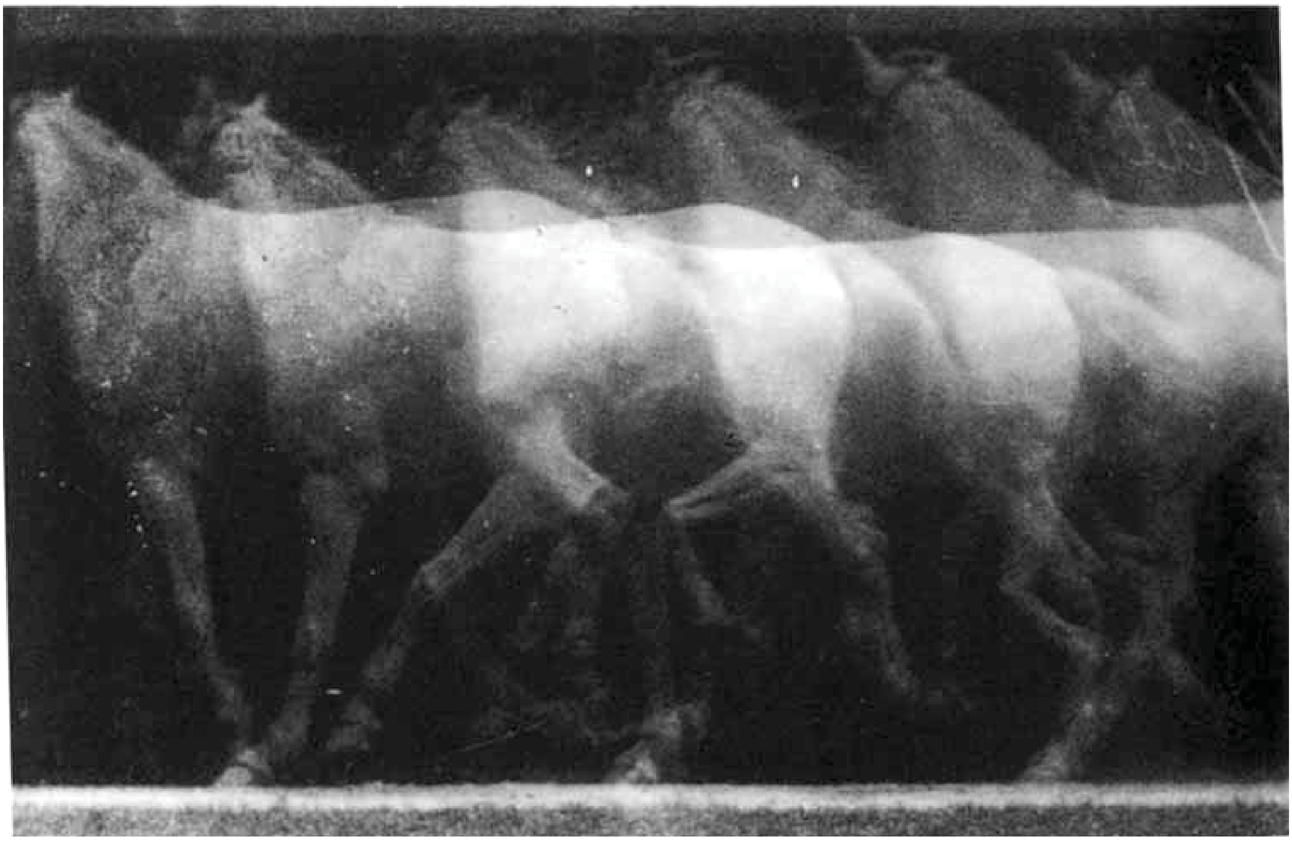


Figure 43: *Mouvements d'un cheval blanc*. Marey. Chronophotography. 1886. Marey Museum. Beaune, France. (Manning, 2012, p. 94)

sectioned perceptual frames were re-composed on a single visual field (Figure 43). Marey devised a new means of framing, through the use of a stationary plate equipped with a rotary shutter which could shoot at an exposure of 1/1000; an invention coined chronophotography. His interest was purely scientific and even though looking through a single viewpoint, several moments in time were frozen on a same surface (Marbot, 1980, p. 61). The implications of this on the perceptual regeneration were considerable, also in painting itself. One simply needs to look at Duchamp's *Nude Descending a Staircase* (Figure 44) and compare it with the classical perspective mode of portraying reality. With the significant innovations of the new technologies, a new rationale entered the perceptual mechanisms which were distant from the traditional query of mimesis. Therefore, speed and movement could now become a subject of interest for art, in the same way it was for the empirical realm.

Figure 44: *Nude Descending a Staircase No. 2.* Marcel Duchamp. 1912. Oil on canvas. 147 x 89 cm. Philadelphia Museum of Art. (Hughes, 2005, p. 53)

Figure 45: *Pearblossom Hwy., 11 — 18th April 1986 (2nd. Version).* David Hockney. 1986. (Gayford, 2016, p. 78)

Figure 46: *Mont Ste-Victoire*. Paul Cézanne. 1906. Oil on canvas. 63.5 x 83 cm. Kunsthaus, Zurich. (Hughes, 2005, p. 19)

After the options of photographing for the sake of photography had been exhausted, photography has also been used outside its pure photographic function. In the 1980s, David Hockney created a series of works consisting of Polaroid collages, which he classifies as “drawings” and not as photography (Figure 45). Like in the photographs cited above, time and perspective are again two elements playing a crucial role in the perpetual changes, this time of the end of the 20th-century. The contemporary individual understands the ‘now’ by correlating it to history, modifying the angle of vision with every added layer; just like when a painter adds a brushstroke because of a fresh thought and observation (Gayford, 2016, p. 79). With his Polaroid compositions, Hockney addressed a contemporary issue in photography as a medium: it too became limited in its technical nature of portraying an instant in time from a single point of view, to which Hockney objected. In a conversation with Gayford (2016), the artist explains two things: his Polaroids exploded the one single viewpoint into as many images fit the composition, and secondly, the work is closer to a drawing because of the moment he decided to compose one image out of a collage of photographs (pp. 79 - 84). Indeed, *Pearblossom Hwy* (Figure 45) gives the feeling of being some kind of hybrid between Muybridge’s and Marey’s earlier world, upgraded with an extensive view onto the real world through added windows and enhanced instantaneity. If with the rise of the technical advancements of the 19th-century, artists started portraying the instability of perception itself instead of the appearances of the world (Crary, 1999, p. 288), like in Cézanne’s *Mont Sainte-Victoire* (Figure 46), Hockney adds to this perceptual aspect by presenting a comprehensive attentiveness into one reconstructed composition.

Crary (1999) introduces this argument through an analysis of Manet’s *The Balcony* (Figure 47), which even though it is an image portrayed at the very verge of modernity (preceding bolder works of change like Cézanne’s and Seurat’s), it is a painting which figuratively finds a new place for the observing subject; distant from the classical perceptual structure (p. 83). The three protagonists in this portrayal bring forth a new sense of immediacy which is still developing and

Figure 47: *The Balcony*. Manet. 1868. Oil on canvas. 124 x 170 cm. © RMN (Musée d'Orsay) / Hervé Lewandowski. (Crary, 1999, p. 82)

Figure 48: *200 Campbell's Soup Cans* (Close-up). Andy Warhol. 1962. Oil on canvas. 182 x 254 cm. Private Collection. (Hughes, 2005, p. 349)

infiltrating our lives till the present day. The figures exert an unfiltered self-presence, while Manet's vision disintegrates the need for the objectivity of an exterior world co-existing with a subjective interiority (Crary, 1999, p. 84). Manet achieved this because he knew painting, which he injected with the modern uncertainties of visual perception; uncertainties which resided somewhere between a new kind of immediacy and a subjective contemporary attention. Decades after Manet's *The Balcony*, we see an offshoot of this in the emergence of television. As seen above, the mechanical camera changed the way people saw, but with television this way of perceiving entered the individual's home, and consequentially our time, psychology and lifestyle. Benjamin (2008) had argued about the work of art losing its uniqueness in time and space at the place where it happens with the existence of its mechanical reproduction through photography. Television took this a step further. While surrounded by his furniture and memories, an image can enter the beholder's intimate space through a screen concurrently to a million other houses and possible contexts (Berger, Blomerg, Fox, Dibb & Hollis, 1972, p. 20). The image's meaning is therefore merged with other meanings, and while it travels in the form of waves, and signals (or nowadays digitally), its signification changes accordingly. From today's camera we receive a constant stream of images, through which there is no natural way of paying an equivalent attention to such visual glut and therefore we zap, surf, scroll, and glance through. At the same time the televised screen holds on to its roots of emerging as the most pervasive and efficient system managing our attention, with its full amalgamation with our social and subjective life (Crary, 1999, p. 71).

Everything the screen gives us slightly interests our attention for an instant; for that instant, and the image we tend to most remember is the clearest and simplest one (Hughes, 2005, p. 346). Contemporary mass culture thrived on this aspect, which it combined to the possibility of endless repetition and modification. One need only look at Andy Warhol's iconic *200 Campbell's Soup Cans* (Figure 48) and how the Renaissance idea of fame as a reward for one's accomplishment started being substituted by the concept of a celebrity (Hughes, 2005). Perhaps the above factors are what strongly contributed to what Crary, J. describes as a culture which is so ruthlessly based upon the principles of a short attention span because of its perceptual overload, that its morality is that of "getting ahead" (Crary, 1999, p. 36). Art did not only appropriate from this culture in the celebrity manner of Andy Warhol, but also of its technology and of its psychology of "accelerating sequence of displacements and obsolescences, part of the delirious operations of modernisation" (Crary, 1999, p. 13).

In November 1973, Vito Acconci recorded *Theme Song* (Figure 49), a 30 minute-long video revolving around the television screen format. He recorded himself lying down in a living room, face to face with the viewer. His face appeared much larger than the rest of his body as he talked to the viewer while playing songs from a tape recorder. He wanted to build a relationship and follow it through with the viewer, and therefore he invited the viewer in his own space and also brought his

Figure 49: *Theme Song*. Vito Acconci. 1973. Still-frames from black and white video.
(Acconci, 2006, p. 374)

legs around into the “viewer’s space”. In one of his notes for this work he wrote that since he obviously couldn’t know who the viewer was to be in front of him, he had to build him/her up; and once this relationship took shape Acconci had to also end it (Acconci, 2006, p. 374). Acconci here acknowledged that the relationship has to end because through the one-way type of communication offered by his technology, the relationship could never work. After each ending, he instead finds himself at the same point he had started from; on the other side of the screen, and re-loops. Every relationship which he starts with any viewer, is instantaneous and temporary. It will always have to end, and while he is the one starting it and ending it, he can be offered no opposition if he decides to claim that it’s the viewer who ended it.

It is very difficult to try to guess what would have *Theme Song* looked like if Acconci developed it during the past decade. Aspects of it might still look and sound the same; Acconci recorded himself to communicate with the viewer not only through language, but also through his image. His immediacy and intuitive vision in his presence is comparable to the attitude of *The Balcony*’s figures, but Acconci’s self-confidence in his body is much stronger; more candid and explicit. He communicates through a locked gaze towards an unknown viewer. How much of this is reminiscent in today’s infinite number of uploaded selfies on the web through platforms ranging from Instagram to Facebook (Figure 50)? The screen’s limits presented in Acconci’s technology did go through an upgrade though. They developed into becoming portable and interactive. The one-way communication also developed into multiple possibilities of communication, also giving groups of people the opportunity to simultaneously converse. We now find ourselves constantly perceiving the world through a screen, from art shows to foreign cities (Figure 51). In a way our perceptive attitude in front of any screen is also a process between evaluation and modification, which is what Foucault referred to as being a network of permanent observation (Crary, 1999, p. 76). On the other hand, we must also be aware that in today’s collage of potential, our gaze is not the only one that counts; and that we too can be gazed upon by vision machines outside of our

Figure 50: A group selfie taken by Ellen DeGeneres during the Oscars 2014.

Figure 51: We now find ourselves constantly perceiving the world through our mobile phone screen, from art shows to foreign cities. Own photographs. Venice, 2017.

control (Ritchin, 2009, p. 76). Also, the concept of the human photographer, the artist and the scientist as the sole observers of the real world is past (Ritchin, 2009, p. 76). The digital realm is all around us; specifically, because we are now surrounded by the screen. It plays around with what's true and fake, as has the power to edit reality and present it back to us as real through its virtual world. The screen has also been developing into other different modalities; as Eco (1986) cites, holography had already been developed in the 50s achieving a full-photographic imitation of what's real in a three-dimensional projection (pp. 1 - 56). As one shifts his attention around the projected scene or object, one perceives parts of the object which would not have been possible in the real world due to its 'limited' laws of perspective; while perceiving this there is a level of credibility equal to its level of fakery (Eco, 1986, p. 12).

It is therefore of second nature to us to perceive the world through some kind of optical technology, and it feels like the images surrounding us do not primarily refer to us anymore, but to the "millions of bits of electronic mathematical data" (Ritchin, 2009, p. 76). This is akin to how science nowadays treats the visual information entering through our eyes as data or information and not as an image anymore (see pp. 13 - 20). At the same time, other contemporary philosophers like Flusser (2000) regarded the image as having become a metacode for texts; a reverse of the original order of texts being metacode for images (pp. 8 - 13). Throughout his chapter he argues that an image used to be of a "magical" nature with a "circular time" quality, which was demolished through the linear invention of writing. A conflict between writing and image was thus born —"historical consciousness against magic"—where writing's capacity of "conceptual thinking" was used in order to decipher and translate an image (Flusser, 2000, p. 11). Flusser's argument is therefore that throughout their historical course, both image and writing jointly imposed on each other, and with the contemporary age considerable "conceptual thinking" is being accomplished by the (conceptual) image, whereas important imagination is being found in scientific texts: technical images are trying to organise texts into being understandable again (Flusser, 2000, pp. 8 - 13).

These theories were brought forth in the beginning of the 1980s; where are we at three decades later in this scenario of a fast-paced world?

In his critical view on photography, Benjamin affirmed that our human sense perception changes with our mode of existence, where both our sense perception and medium through which it is processed, determine and are determined by our context (Benjamin, 2008). Our context concerns the *Age of Information*. Ritchin (2009) explains how we entered the digital age, but at the same time the digital age has entered us; and therefore we no longer talk, read, listen, photograph, see, or even make love the same way as before (p. 9). At the same time we also tend to forget that the images surrounding us and constituting of our daily "reality" by constantly reconstructing it into one global platform, were created by ourselves (Flusser, 2000, p. 10). In the digital age, our sense of time is distinct from any other preceding eras; the digital medium itself is of a non-linear nature in contrast to any prior analogue means. Ritchin's (2009) preoccupation in his book *After Photography* seems to revolve around the point Marshall McLuhan once made that; "one thing about which fish know exactly nothing, is water" (p. 9). We are the fish in this scenario, and our water is media. If we become totally submersed by it through all its possible forms, how can we then understand what implications we are going through? How can we use this endless amount of data (resulting from an array of technology) to make sense of who we are through an artistic process?

Modern Technology and Data Art

In one of his definitions of technology, Ellul (1964) described how every human activity including the most primitive ones, like the gathering of fruit from the tree, obviously involves a certain technique (p. 20). The technical act then happens as an improvement of this, with a quest for the replacement of the natural exercise with technical forms aiding in greater efficiency through their complex design (Ellul, 1964, p. 20.). To this extent, he is in agreement with Heidegger (1977) who starts his essay, *The Question Concerning Technology*, by claiming that technology is both a means to an end as well as a human activity (p. 4). Whether we acknowledge it or not, we will continue to be intrinsically connected to it, and the real issue lies in how we grow accustomed to technology as being something neutral, which in turn makes us impassable to its essence (Heidegger, 1977). We are born in a world surrounded by technology, which somehow prolongs our bodies into aiding every aspect of our human activity; from the simplest acts like sweeping the floor (broomstick) to the more complex ones like long-distance traveling (aeroplane). What Heidegger means by our consideration of technology as being something 'neutral', is our daily attitude in our busy schedules of not thinking about the technological things themselves, with respect to what they are in themselves (Bolt, 2011, p. 71). To a certain extent, before being the 'fish' inside the world of the digital images (water), the water can also consist in our rapid lifestyles in relation to all the technology we employ.

Heidegger (1977) talks of modern technology as being a *revealing*, which does not bring-forth and unveil in the classic philosophical sense of *poiesis*, but as a *challenging-forth*. The unveiling behind modern technology consists in the disclosure of its own intertwining tracks, by regulating itself as a result of following different types of the same challenging *revealing*; unlocking, transforming, storing, distributing, and switching about happen (Bolt, 2011). Heidegger 's (1977) argument is directed towards the figure of the contemporary artist in our technocratic society by Bolt (2011). Heidegger's evaluation of modern technology can serve as a good reflection for the artist, through the acknowledgment that our regulations are those of 'instrumentalism' where everything exists as a resource for doing something; a conceptual artist uses his ideas as technological means for his artwork, whereas a performance artist uses his body (Bolt, 2011, p. 71).

Therefore, in the two distinct previously mentioned examples; Vito Acconci used his body, intimate environment of a living room, concept, recorded music playing from tape, video input (recording camera), and video output (television screen), as technical resources for his *Theme Song*,

Figure 52: Anselm Kiefer’s studio. (Prodger, 2014)

whereas David Hockney used the polaroid apparatus, the printed image and his concept of drawing instead. On the other hand, artists like Anselm Kiefer embraced a new aspect of modern technology; that of a factory-like approach to artistic creation. In the mid-80s, he inaugurated his studio inside an old factory (Figure 52) where he employed specialised labour and developed technological techniques which permitted his artwork scale, his production, as well as his workforce to increase extensively (Bolt, 2011, pp. 69 - 85). His technical resources in the Heideggerian sense range from the smallest paintbrush to the 200-acre studio-factory itself, going through materials such as clay and soil, machinery such as hydraulics and metalwork equipment, skilled workforce and his sense of history amongst others. In a way this fits Kiefer’s cyclic description that; “no atom is ever lost” (Prodger, 2014), and therefore his technical resource consists in literally every atom around his enormous studio. Many contemporary artists now outsource the creation of their artwork (for example Jeff Koons, Barry X Ball, Tony Cragg, Damien Hirst), where in our technocratic society, the idea of an artist working via his hands or body—via himself as his own being—faded away and was replaced by some kind of "*project manager*" figure (Bolt, 2011, pp. 69 - 85). For such contemporary artists, art has developed into a discourse of an industrial production (as means).

We have here two associations with previously mentioned arguments. The first one relates to the figure of the artist himself. I discussed earlier how the figure of the artist emerged from being a simple, unknown craftsman to a well-known figure, praised for his handy talents, during the Renaissance. This figure then adapted to the changes brought forth by the modern-age developments, and started being given a more of a celebrity-like character during the post-war period. The contemporary artist working in a factory-like studio has now a new stance; the celebrity-like figure is further enhanced (especially through the use of media platforms) which character has been combined with that of being a director for the manufacturing of his own work through the possibilities brought up by technological advancements. There is perhaps no exhibition which embodies this artist character other than Damien Hirst's *Treasures from the Wreck of the Unbelievable* exhibited at both Punta della Dogana and Palazzo Grassi, Venice, contemporarily to the 2017 Venice Biennale (Figure 53). The show is still undergoing a huge controversy, partly because of the huge budget (£50m) spent on it (Gompertz, 2017), and partly because some claim that the technical excellence resulting from the new means of production, resulted in lifeless sculptural forms which "*can be painful to look at*" (Russeth, 2017). Other critics regarded it as an "extravaganza" and unprecedented in its conception, execution, and grand-scale (Cumming, 2017). Hirst had been working on the show for ten years, digitally fabricating a story of an incredible treasure on board of the biggest ship in the known seas, *Unbelievable*, which sunk 2,000 years ago. Hirst wants to make us believe this story, and by directing his studio an impressive array of sculptures were produced through top-notch technological facilities using a collage of material like; Carrara marble, crystal, gold, bronze and jade, amongst others. All production portrays a mixture of images extruded from the entire history of our Western civilisation. He then sunk it, retrieved it, exhibited it and made us believe it. To a certain extent his show is going through the same process of a fantasy Hollywood movie, but on a real-life 3D scale, and he is his own producer of it. In fact, I do not agree that the sculptures are lifeless, but have a similar aesthetic and spirit of a CGI fantastical avatar instead. The matter that he can afford to invest that enormous amount of money in his own solo exhibition, shows a new business oriented artist-figure who is on top of the established gallery system, collectors, museums, and art festivals like the Venice Biennale itself; all facilitated through contemporary technological production. At the same time, maybe this operation is also reminiscent of the capitalist modernity of the last two decades Crary mentions when explaining our constantly changing perceptive means, which some sometimes claim as being a state of crisis (Crary, 1999, p. 13).

Figure 53: Installation shot of Damien Hirst's *Treasures from the Wreck of the Unbelievable* at Punta della Dogana. Venice Biennale 2017. (Cumming, 2017)

Figure 54: *After ALife Ahead.* Pierre Huyghe. Ongoing work situated inside a disused ice rink in the German city of Münster. (McDermott, 2017)

Technology has been easing production since the beginning of the industrial revolution, and exhibitions like Damien Hirst's fully exploit the possibility of a huge-scale fabrication, alongside an artistic concept. In other contexts, technology and art can create an environment of a less product-like nature, and of a more explorative perception. *After ALife Ahead,* by artist Pierre Huyghe, is an ongoing work situated inside a disused ice rink in the small German city of Münster (Figure 54). Huyghe has created an internal environment, with a chain reaction of 'evolutionary' events. Inside the arena he placed algae, bees, peacocks and cancer cells, turning the interior architectural space into a living thing through something resembling a post-human intervention. All is animated (not controlled) through an augmented reality app of pyramids being virtually born and dying as sections from the ceiling occasionally open and close according to the sound produced from a musical score, allowing-in natural elements such as light, wind and water. The playing sound is a changing musical score which is the translation of naturally forming shells inside a visible aquarium, while at the same time, several unnoticed mini sensors are placed throughout the space registering the present animals' movements, bacteria levels, and CO2 amount. This data is in turn used by an algorithm to calculate an average verve inside the atmosphere, which information is then transferred to the cancer cell incubator influencing their rate of reproduction. The design system is such that the technology involved does not control nature, but on the contrary the present algorithms were written in a way to adapt as the conditions of the environment (space) follow their course; "It's not a program written to be fixed, (but) rather changing operations contaminated by other languages… agents react and vary according to external factors" (McDermott, 2017). To some extent, *After ALife Ahead*, is therefore a system mimicking natural evolution on a small scale, inside a biotech based ecosystem. The technology acting upon the environment, does interfere with the biodiversities changes, but cannot control it. *After ALife Ahead* gives us an observatory type of perception inside a mini-model of life itself, which metaphorically talks to us about our contemporary lives; through our present technology of many forms, we interfere with the environment around us influencing a series of related events which go beyond our total control. As much as it may seem, the mini-model presented is however not a scientific undertaking; it remains in its artistic realm while aided by science and technology. Philosophically, the technology being employed by Huyghe is of no difference from the charcoal inside the prehistoric men's cave; nevertheless, its means developed significantly.

Because of its quest for efficiency, technology can sometimes seem as a detriment to deal within an artistic context. Sol LeWitt himself once stated the following in an interview; "New materials are one of the great afflictions of contemporary art. Some artists confuse new materials with new ideas" (Elderfield, 1991). Sol LeWitt is right with respect to the times where artistic practice employed the use of contemporary technology for technology's own sake, and not for a primarily artistic purpose. To some extent, good art has always made use of the available contemporary technologies and geared their scientific function into a track satisfying the artistic practice's needs. In his essay *The Open Work in the Visual Arts*, Eco (1989) mentions this pivotal issue concerning the arts and scientific media, and states that; "the uncritical use of scientific categories to characterise an artistic attitude is often dangerous" (p. 87). At the same time, he defends the critical use of "scientific categories" in the arts, as:

> …those who are shocked by the use, in aesthetics or elsewhere, of terms such as 'indeterminacy,' 'statistical distribution,' 'information,' 'entropy.' and so forth, and who fear for the purity of philosophical discourse, forget that both philosophy and traditional aesthetics have often relied on terms (such as 'form,' 'power,' 'germ,' etc.) that once belonged to physics and cosmology." (Eco, 1989, p. 88)

In a similar stance to Sol LeWitt's claim, Eco (1989) acknowledges that the importation of scientific means into the artistic (philosophical) realm necessitates verification in its employment, not to result in an obscene operation, whereas at the same time, if successful, the metaphorical implications of it can be of great importance to the development of research in both disciplines.

It is also here that we must define a problem found in the technologies employed by our contemporary Western world. According to some scholars like Poster (2011) the tool-making technology (mechanical technology) is often confused with the recent phenomenon of media technology (pp. x - xi). It is probably true that any technology involved in digital media emerged from the affects of the ongoing mechanical technological revolution throughout the past century, especially in its last three decades. However, media machines (information machines) processing text, sounds and images as data, are essentially distinct from the mechanical technology manipulating physical materials, which have a diverse significance in our lives. Consequently, information technology is somewhat closer to us humans, as its development directly acts upon our

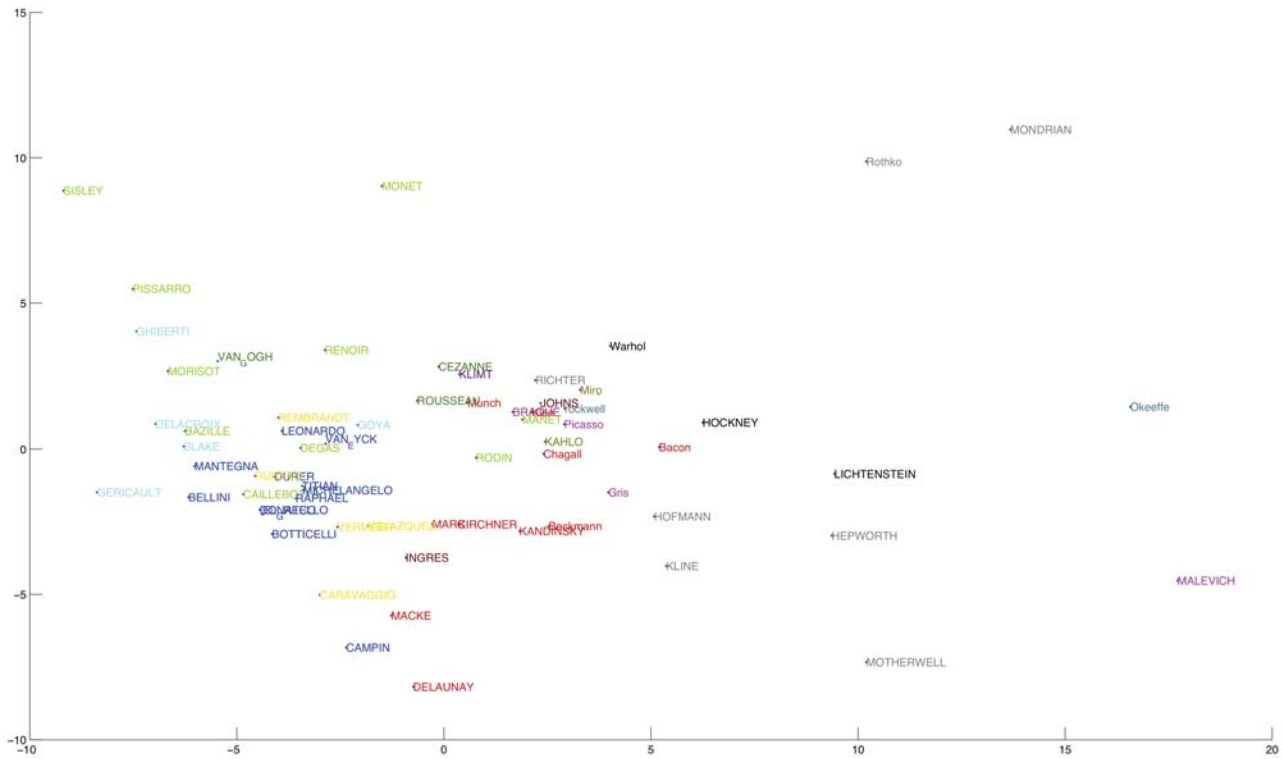


Figure 55: An algorithmic mapping attempt of artists' influences. (Saleh et al., 2014)

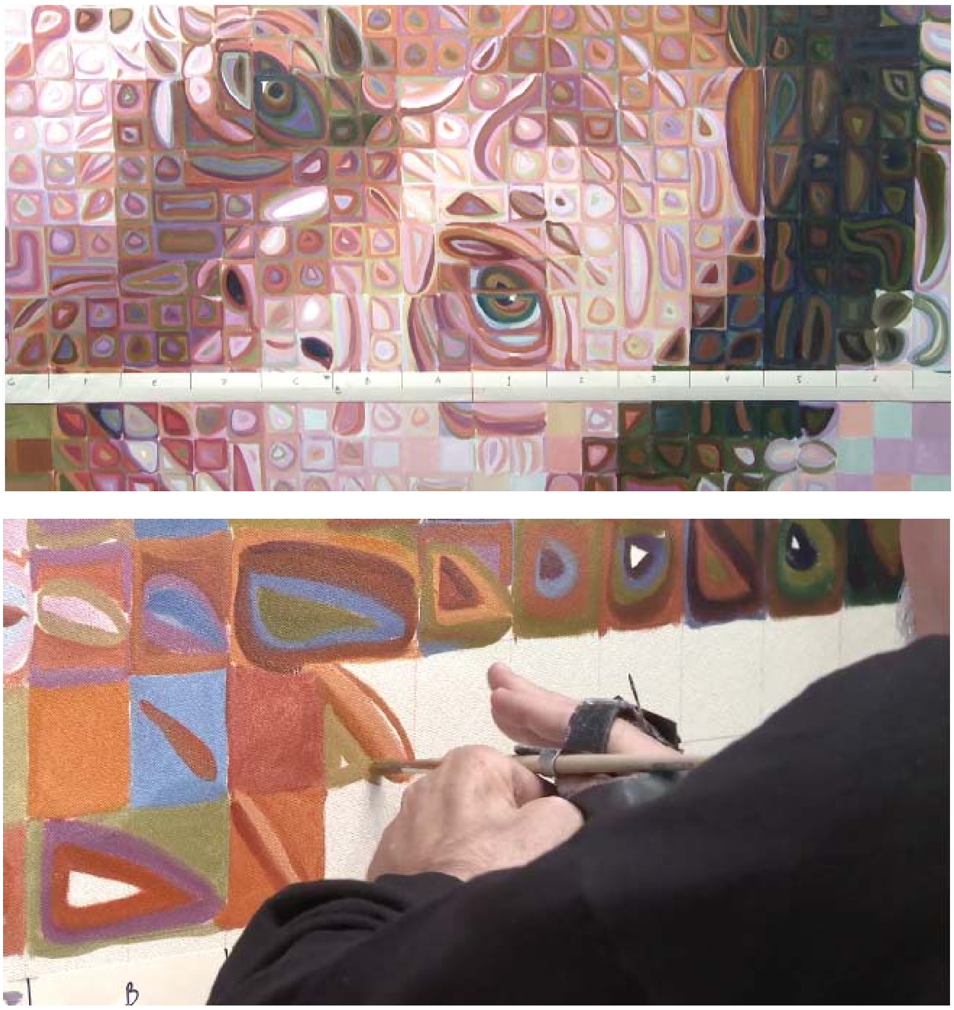


Figure 56: Chuck Close's method. Still-frames. (Cube, 2017)

culture (Poster, 2011, pp. x - xi). An implicit aspect acting upon our Western culture today through information technology is the process of datafication. Locked into our screens as individuals, we constantly produce collective data as millions of users through Google searches, Facebook, Instagram, YouTube and others. Application programming interfaces (APIs) make chunks of this generated data available to third parties, and a new vast business industry has emerged dealing from trading data to analysing it for market research and mass surveillance purposes (Schafer & van Es, 2017, p. 14). On the other hand, the humanities should be critically interested in how this technology is affecting and changing our perception of knowledge (Schafer & van Es, 2017, p. 14). One example of considerable resonance of this transformation can be found in the paper, *Toward Automated Discovery of Artistic Influence*, with the objective to create an algorithm capable of measuring artistic influence through paintings (Saleh, Abe, Singh Arora & Elgammal, 2014). A comparative study was initially performed which dealt with the "classification problem" looking at methodologies employed by the art historian, after which the question of who influenced the artist in question through given algorithmic parameters (such as pictorial distances) resulting in a mapping attempt of artists' influences (Figure 55). Probably, more time and scholarly research from the humanities is needed in order to understand what the implications of such possibilities are on our perception. The algorithmic element gives the possibility for the discovery of more comparisons than a human beholder is naturally able to come up with considering the huge database of artworks that exist, whereas on the other hand the loss of the primarily human critical judgement may prove to be dangerous and superficial.

On a different note, I mentioned earlier that a digital image appearing on our screen is essentially thousands of bits of electronic data (pixels) forming a whole (see p. 79). When one talks about the influence of data and information technology on the arts and culture, one needs not solely expect to be confronted with art of an electronic nature and technology. Chuck Close is the ultimate example of an artist working within the duality of the acceptance of a world saturated and conditioned by pixels, algorithms and computer machinery, and the manual and thinking process behind the execution of an artwork (Figure 56). Prior to the digital boom, Close (suffering from face blindness) created his own algorithms of splitting a portrait image into bits, into data, into some form of pixels coming from the head and therefore from his perception. He thus flattened out reality (the depicted photograph) into a conglomerate of squares and shapes, which he then painted bit by bit onto a canvas reassembling the whole. His process appears as being mechanical, but not entirely. It has more of a methodological nature. His 'algorithm' is not that of a computer, even though; "what I [he] do [does] is very similar to what a computer does, which is average everything in the same area" (Cube, 2017). The difference lies in the moment and way of execution. Close gets tired and bored of what he does, unlike computers and machines, and therefore he automatically does not paint the "squares" all in the same way because unlike the machine he is both understanding and perceiving what he is creating (Cube, 2017). In order to obtain change in a computerised algorithm, it needs to be inputted as a variable instructing program, which in turn can only understand within the limits of the inputted instructions (even though there have recently been significant advances in this technology). This is very evident in a mathematical paper which dealt with the creation of a number of algorithms and digitally transformed portrait photographs into a 'Chuck Close' stylistic representation (Aboufadel, Boyenger & Madsen, 2010). The context of living through the eve of the Information Age to today's Digital Age is evidently an important force acting on the development of Close's work, however one must not ignore the aspect that a painting can be described as a unified product resulting from numerous components of not only an idea, but also the individual's (artist's) capacity to subjectively deal with problem-solving, visual perception, spatial perception, reasoning, memory, and also sensory deficits amongst others (Zaidel, 2005, p. 7). In "*A note to younger self*" interview, Close himself states that virtually everything he's developed was influenced by his disabilities; prosopagnosia particularly determined him to bind portraits of friends and family to memory by flatting them out in order to remember them better (CBS This Morning, 2012).

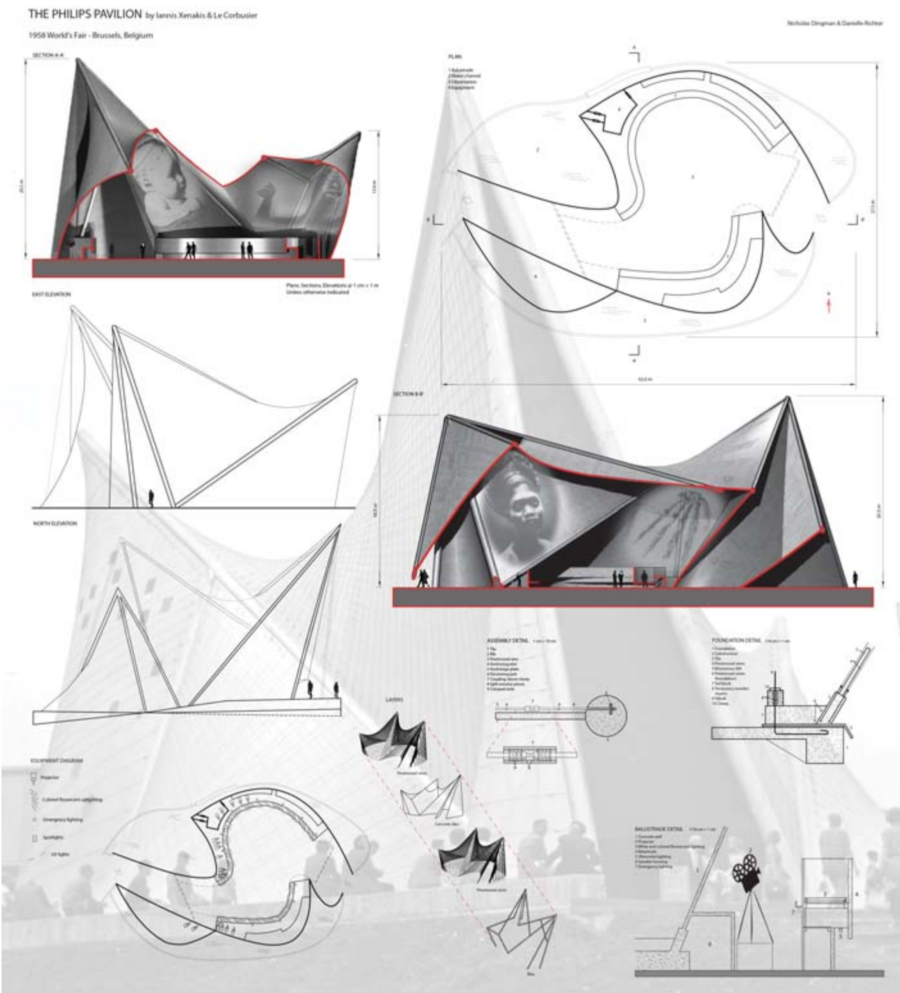


Figure 57: The Philips Pavilion at the Brussels Expo ’58. (Lopez, 2011)

The use of algorithms (in an archaic form) as a tool for artistic production, goes back to the Medieval times and is principally found in music (Uricchio, 2017, p. 129). It has definitely left its mark since the rise of the computer which is in itself an information machine processing automated algorithms. The Philips Pavilion at the Brussels Expo ’58 (Figure 57), is somehow a precursor of Huyghe’s contemporary project in its use of technology as a reactionary chain (not in its inclusion of the natural element). Le Corbusier had been approached to take in hand the final commission of the pavilion by the Philips electronics company, who in turn left the exterior design in the hands of Iannis Xenakis, both a designer and experimental composer. The pavilion took shape through a simple algorithm, with a resulting *Poem Electronique* merging light projections, images, architecture and sound into a full electro-spatial interactive surrounding (Lopez, 2011). In the same artistic research spirit, the exhibition *Cybernetic Serendipity* opened in 1968. The spirit of the show highlighted the new creative opportunities aroused by technology, and put in evidence the new links between the arbitrary freedom employed by artists, composers and poets, and the employment of cybernetic devices (Reichardt, 1968). The exhibition brought with it two innovative aspects to both fields. Firstly, in front of every work, no visitor could perceive whether it was the creation of an artist, architect, engineer, or scientist, while the other aspect was the introduction of new media such as plastics and visual music notations, which altered the artistic format itself (Reichardt, 1968). The spirit of these works (and others stemming from the same category of both aesthetics and research) have the "openness" referred to in *The Open Work of Art*. Eco (1989) argues that our culture's attitude persuades us to perceive the world as possibility (p. 104.), and it is this recurring issue that the critical contemporary artistic process saw in information technology.

In 2013 The New York Times commissioned Jonathan Harris to issue a small manifesto about the promises and dangers of data. Harris designed a number of questions in one single, justified paragraph, where all text fits a perfect rectangle (Figure 58). The font's colour goes through the RGB palette with its gradient effect, while white is represented by the first word; "*Data*", and black lies in its background. Electronically, the full text is not text, but it was uploaded as an image; the manifesto text is made up of tiny pixels organised next to each other for us to read. If one zooms, the image pixelates. At the beginning of the 20th century, Marinetti had presented the Futurist manifesto in Paris, publishing it on *Le Figaro*, because Paris was at the time the city of change; the platform where the perception of the future was taking shape. Harris published it online. This is our platform in our datafied times. All depicted questions have the same format of a dualistic nature, and they relate to anything which is or will be affected by data, showing a positive truth followed by a hard question of uncertainty. Some are philosophical, some are practical, and some are both. Perhaps one of the truest and at the same time hardest ones is the following; "It will help us uncover the facts, but will it help us be wise?" (Figure 58). This can be applied throughout various contexts, but in the context of this research (in the context of an artistic practice) the facts consist in what results technology provides us with (data), whereas how will this be used wisely for the validity of art?

Figure 58: *Data will help us*. Jonathan Harris. 2013. www.datawillhelp.us

Moreover, there seems to be another promise and peril in the domain of this work itself. Harris named his project, "Data will help us", which is in itself a positive promise. However, when one looks at it through a cynic's lens, it can be interpreted as ironic. This latter point is subjective, whereas what's more interesting is the domain itself which is intended to refer to the title of the piece; www.datawillhelp.us. Is Harris here referring to the harsh truth Ritchin (2009) mentions in his introduction of *After Photography,* that while in 2007, 250 billion digital photos were made from nearly a billion camera phones, billions of people of the global population still have no access to internet (pp. 11 - 12)? Data is useless to these populations as their primary worry concerns physical survival. Therefore, the pronoun "us" is substituted by ".us" referring to the United States of America, symbol of the Western world. Data will help us; only us residing in the developed parts of the world.

Figure 59: *Network Effect*. Jonathan Harris. Screenshot from http://networkeffect.io/

Harris is a digital artist working on projects which merge elements from anthropology, digital storytelling, computer science, visual arts, data and statistics amongst others. Like Pierre Huyghe his contemporary artistic practice has an interdisciplinary research approach with the difference that Harris' exhibition space is the internet. His *Network Effect* project (Figure 59) sums his critical perception of the internet, evidencing his concern with how online data affects our lives as human beings. The internet is of an infinite nature with its ever growing data points which are impossible to calculate, let alone experience in one lifetime. *Network Effect* conceptually and technically deals with this issue in relation to our human psychological perception of time and technology. The website http://networkeffect.io/ presents the beholder with an experience mimicking that of internet browsing. The project includes millions of singular data points, visual statistics, tweets, news headlines, 10,000 streamed video clips, and 10,000 uttered sentences; all categorised in alphabetical order through hundreds of keywords. This streaming experience has a daily time-limit, which varies according to the beholder's country average life-expectancy (data which is automatically calculated through one's I.P. address), triggering in the beholder some kind of frustration and urgency not to miss out on content. Throughout the allowed browsing time, endless videos, texts, data facts, and sounds overlap, as one search word leads the beholder into another. The content behind each keyword is in itself as vast as the amount of data present in the project. This contemporary project deals with everything just like the internet does. Surfing the web is the newly efficient way of holding onto our attention (in fact the internet now entered the television screen), and therefore the average seven minutes pass instantly. At the very end the project reminds us that our "internet" time is up and we should go do something else, reminiscent of Harris' words that; "the deepest truths cannot be found by searching (browsing)—and you will not find them in data, in videos, or in images of other people's lives" (Harris, 2015).

Other data artists work instead from self-recorded tracking, instead of the endless video and image data found on the internet. Laurie Frick's art analysis our human nature through self-recording apps to create patterns of behaviour which then take shape inside room-sized environments. *Mood+Quantify*, 2011 - 2013 (Figure 60) is for example a wall-sized installation of a colourful pattern resulting from the digital tracking of mood changes. An app was used to keep track of the mood changes by assigning colours to different feelings, after which data was then physically developed into a patterned wall using 3D printers and laser-cutters. Frick describes these works as; "Human data portraits" and believes that through the resulting visual design she's able "to anticipate the condition of our daily-selves" (Frick, 2013). Frick states that the Western world is at a point where society is not worried about who's tracking its data anymore, and in this context she prefers to take her data back and turn it into something meaningful. She also designed a free app, *Frickbits*, evidencing this attitude of turning self-tracking data into personalised art, creating a "data-selfie" (Urist, 2015).

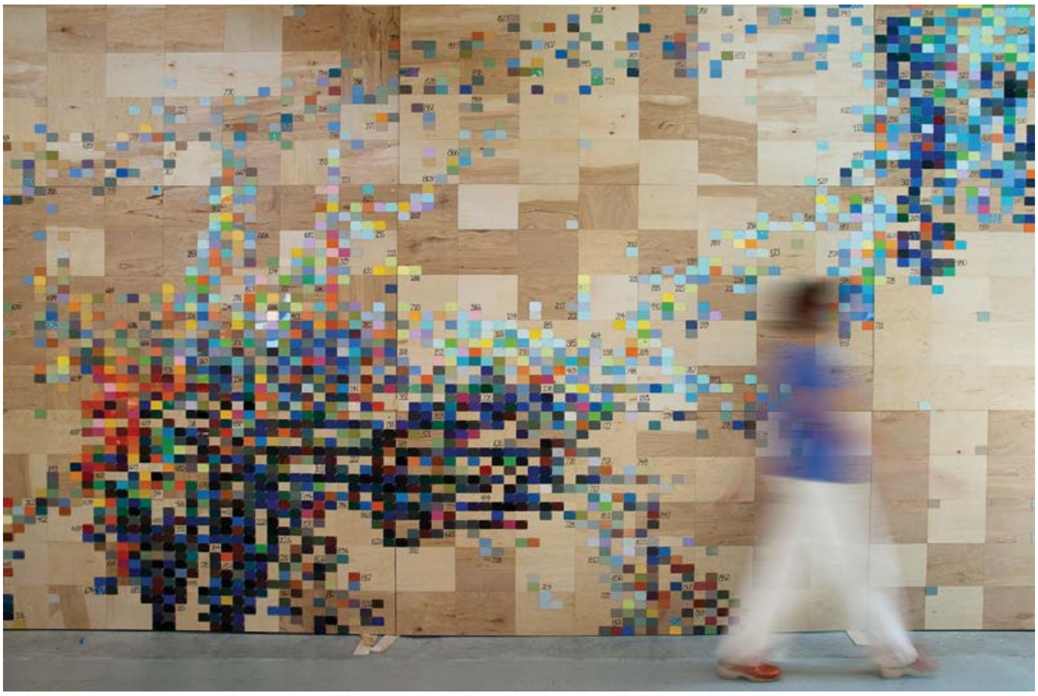


Figure 60: *Mood+Quantify.* Laurie Frick. 2011-2013. (Frick, 2013)

It can be argued that data art is a current phenomenon, however, its roots can be traced as far back as the 1960s. Works such as Robert Morris'. *Self-Portrait (EEG)*, 1963 (Figure 61), was one of the first contemporary works which combined existential questions about one's self and subjective experience, with a technological device (Krauss, 2013, p. 78 - 87). Morris was ironically dealing with the hard question of the mind/body problem through this work, as his brain scan lasted as long as it was needed to register a line which was as long as his body (Krauss, 2013, pp. 78 - 87). Another important point, is the fact that he dealt with the self as subject of this operation, which was conditioned by two factors. Primarily, the electroencephalogram itself is a device created for registering the activity of an individual's mind, and automatically falls into the category of a subjective experience. Secondly, as reported by Morris himself in his writings, it is true that the

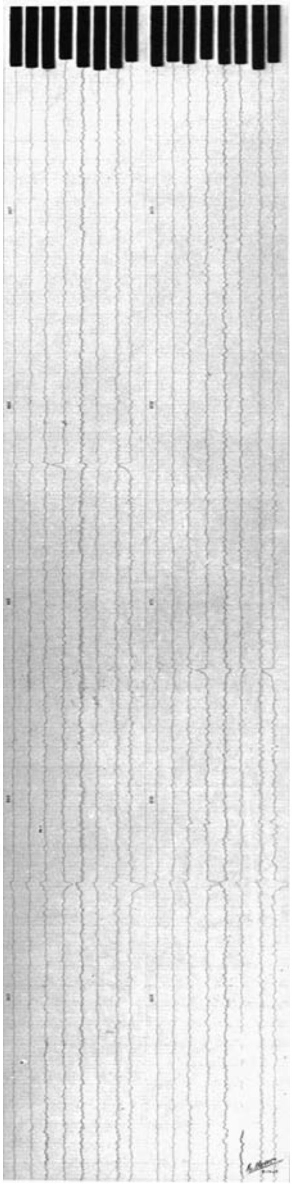


Figure 61: *Self-Portrait (EEG)*. Robert Morris. 1963. (Krauss, 2013)

obsession with the self exists since the first self-portraits, but in the post-War era there was a significant difference in its attitude; the self's space became discontinuous with the rest of the world unlike previous periods (Morris, 1993, p.160). Reminiscent of his Minimalist background, while the scan took place he tried to "think about" himself in order for a more honest representation to be recorded, but ironically the representation shows no imagery of his thoughts or himself (Krauss, 2013, pp. 78 - 87). The 'self' lies in the linear wave; a representation of a specific time period evidencing that Morris' brain was active. If he wouldn't have 'thought of himself' during his performance, this work would still have had the right to be titled as a 'self-portrait', for the simple reason that the brain activity would have still happened inside Morris' head and nobody else's could replicate it.

Morris' work is a very archaic form of data art. His approach was more concerned with adapting the necessary technology from the empirical discipline for the accomplishment of a conceptual artistic act. Since technology itself vastly developed from when *Self-Portrait (EEG)* was made, so did its employment by the arts. To a certain extent data art has developed through pragmatic visual techniques where it visually presents us with what is usually non-visible (akin to what photography revolutionised in perception), which in turn is often accompanied by a sense of irony and critical look towards our contemporary society (Grugier, 2016).

Our Gaze and Eye-Tracking Technology

As discussed in the previous chapters, the main human visual exploration of the real world is done through our eyes, notwithstanding the cerebral process and mental imagery. The eye gaze is therefore a crucial process attracting our attention and guiding our perception throughout the world around us. Because of this, cognitive science has been developing technology and paradigms to use our gaze to study our cognitive processes, while other applications of eye-tracking technology include advertising, marketing, medical research and Human-Computer-Interaction; which for example focuses on replacing inputs such as the mouse pointer with the human gaze (K. Wang, S. Wang & Ji, 2016). Essentially eye-tracking technology provides us with data concerned with the eye's point of regard in the space of our visual axis. Nowadays, research is developing 3D model-based approaches, where a 3D geometric eye model is built from which an estimation of the 3D eye features' gaze direction (like the pupil and cornea) is computed (Wang et al., 2016.). Considering that both creation and perception of visual art are determined by the artists' or beholders' respective gaze, how can such data influence the course of contemporary art processes?

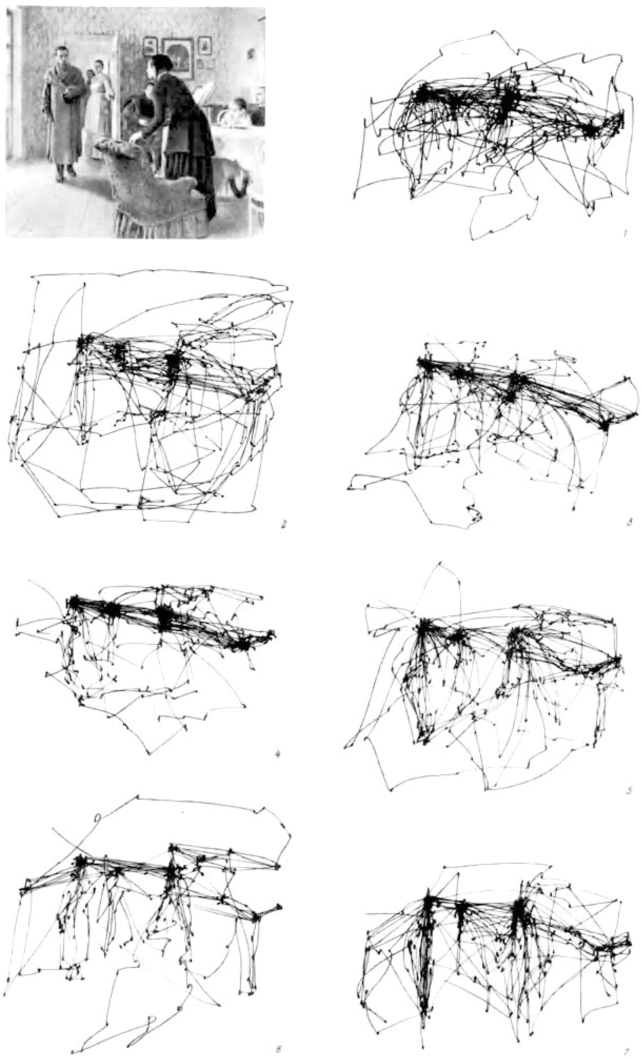


Figure 62: Yarbus's results after asking his subjects to freely gaze at Ilya Repin's painting, *An Unexpected Visitor*, for 3 minutes. (Yarbus, 1967, p. 173)

One of the first eye-tracking analysis' interest was executed in front of paintings, being considered as objects offering a complex perceptive system. Yarbus' (1967) research is one of the most notable ones, and was amongst the first to prove that when gazing at complex visuals, our human eye can only fixate on certain elements; resting much longer on specific ones while others get no attention at all (pp. 171 - 196). Such early eye-movement studies also raised doubts on Gestalt theories that recognition is attained as a whole and that vision has a natural impulse of grouping objects (Duchowski, 2007, p. 8). Yarbus firstly asked his subjects to freely gaze at Ilya Repin's painting, *An Unexpected Visitor* for 3 minutes, resulting in very similar scan-paths (Figure 62). Subsequently, in the following experiments the subjects were asked particular questions before gazing at the same painting, again for three minutes (Figure 63), which produced distinctive tracking patterns. Participants were influenced by statements such as; “give the ages of the people”, or “remember the position of the people and objects in the room” (Yarbus, 1967, p. 174), and their perceptive gaze seemed to be pre-conditioned by a “research objective” differing from the more intuitive attitude during the free 3-minute exploration (Figure 62). Museum research is nowadays also starting to engage eye-tracking technology in understanding their visitors’ perception inside the galleries (Fantoni, Jaebker, Bauer & Stofer, 2013).

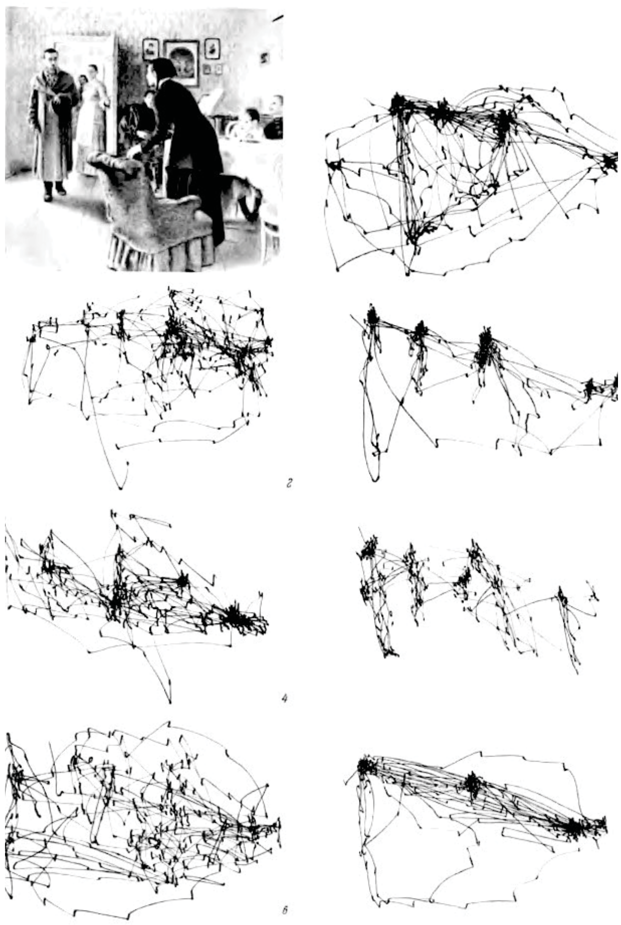


Figure 63: Yarbus’s results after asking his subjects specific questions before gazing at Ilya Repin’s painting, *An Unexpected Visitor*, for 3 minutes. (Yarbus, 1967, p. 174)

Eye-tracking technology has nowadays developed into much more portable and efficient devices from Yarbus’ times in the late 60s. A case in point is the *Pupil* device (Figure 64) which has been recently developed as open source by Pupil Labs, Berlin. It consists in a portable and versatile device which has its eye-tracking technology attached onto a spectacles-looking frame. This technology will be further discussed in the coming Methodology chapters as it will be a primary device used for the implementation of this research question. What is worth noting in order to link to the previous mention, is a very recent experiment which was held at the Van Gogh Museum where the primary data was collected through a *Pupil* eye-tracker (Pupil Labs, 2016). The department of Experimental and Applied psychology at the VU Amsterdam invited volunteers to observe a number of paintings by Van Gogh both before and after they listened to a verbal description of the painting. The results were produced in visual heat-map charts of the several gazes which gave the opportunity to a comparison of how much the descriptions influenced the viewer's eye-gaze.

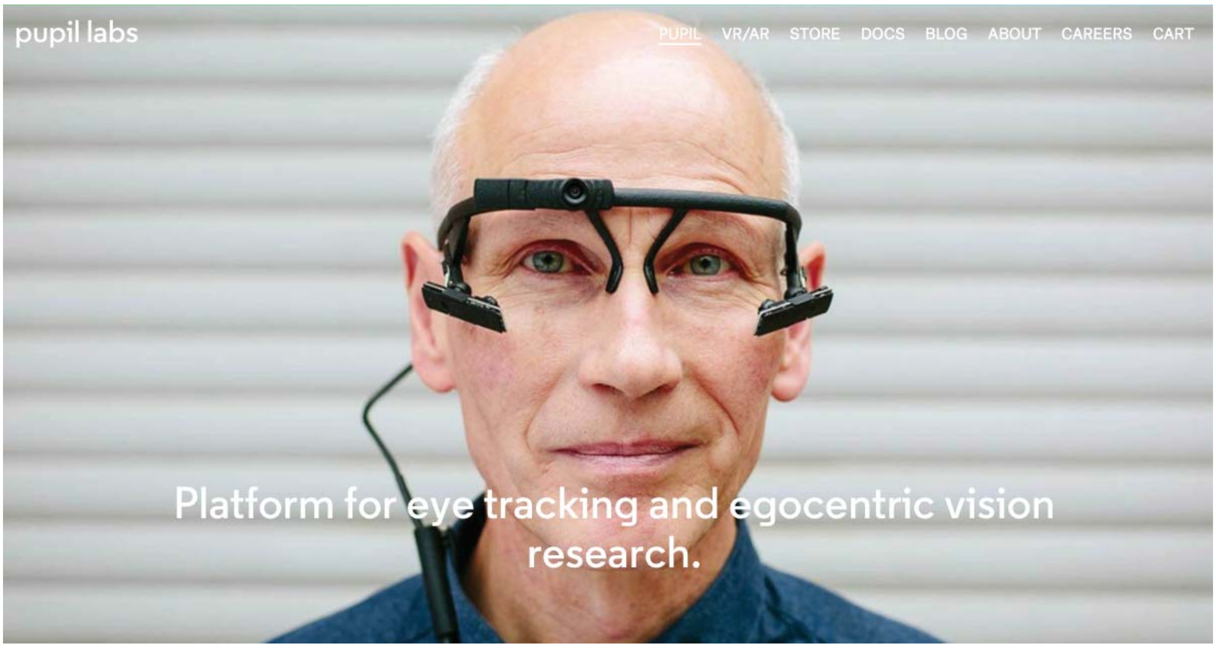


Figure 64: *Pupil* headset. (Pupil Labs, 2016)

Heat-maps resulting from eye-tracking technology are very popular at the moment in the implementation of marketing strategies. Companies such as *RealEye* are developing systems which allow their clients to test online content such as adverts, websites or company videos prior to publishing (Figure 65). The eye-tracking happens through an approximation of the viewer's gaze recorded from his or her respective computer, smart phone or tablet camera, giving the opportunity of an instant evaluation of how effective the marketing graphic order is with respect to the viewer's attention.

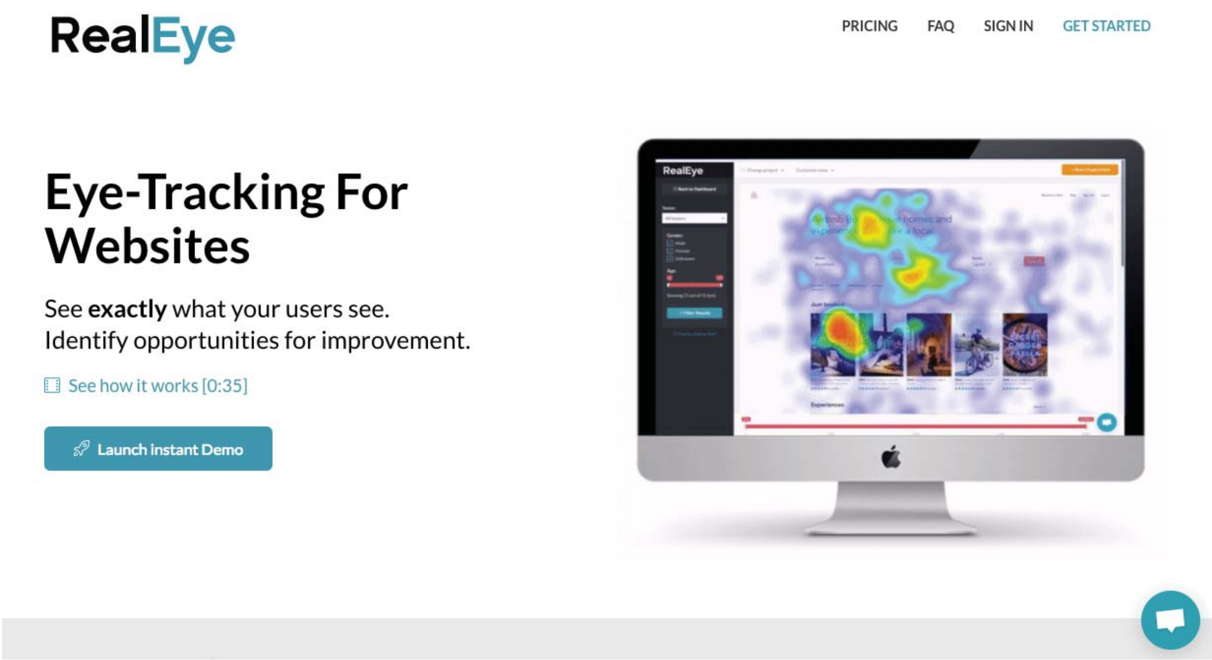


Figure 65: *RealEye* website. Screenshot. (RealEye, 2017)

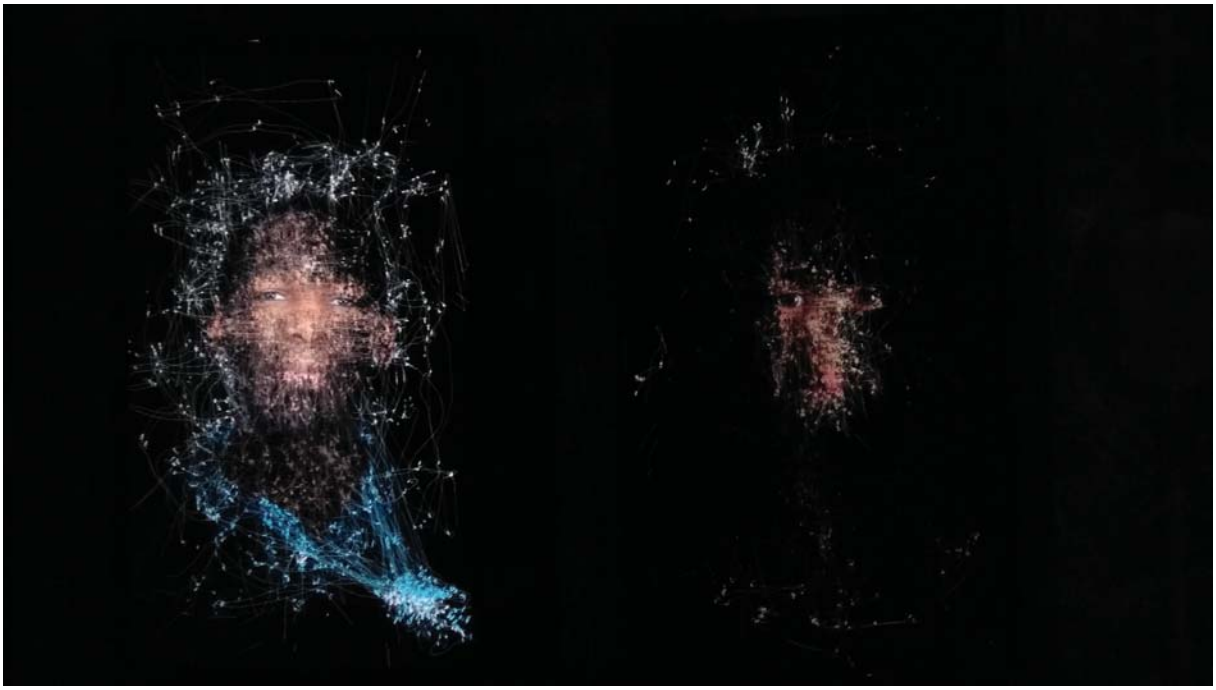


Figure 66: *200 gazes looking around them.* Mariano Sardón and Mariano Sigman. 2011. Still-frame from video. Own photograph, Venice. 2017.

Contemporary artists have also started to explore the possibility of implementing data from the eye-tracking technology into their artistic process. Mariano Sardón and Mariano Sigman's collaboration for *200 gazes looking around them*, 2011, is a comment on our daily gazes towards 'the other' through the dualistic engagement of concealment and revelation (Figure 66). 200 people were eye-tracked while gazing at portraits, which data was stored and then edited together sequentially into an HD video sequence. As eye-tracking technology practically makes visible what is usually invisible, like most of the technology concerned with vision discussed earlier, *200 gazes looking around them* resulted in an intriguing conceptual video where the more gazes were illustrated, the more they overlapped with the portrait image, concealing it from the beholder's vision.

The following *Methodology* chapters will deal with the testing and experiments of the attempt at substituting the hand-eye coordination perceptive process present in artistic activities like drawing, solely with our eye-gaze. Through the use of eye-tracking technology the objective is to 'phenomenologically' trace/draw the perceived real world, which recorded data will then be exported and implemented in a contemporary artistic process. Butades' daughter's technology of the chalk used to trace the shadow will now be replaced with the data representing the 'eye-tracing' of an object.

CHAPTER 3

METHODOLOGY

Going About an Artistic-Practice Methodology

Before going into the details of the practice behind this research question, I would like to give a brief overview of the advantages and difficulties behind artistic-based methodologies and how these were tackled with respect to the methodology of this practice-based dissertation. In 1993, Gray and Malins published a research paper dealing with the theme of research processes and methodology for artists and designers, starting with a very clear dictionary definition of what “method” and “methodology” mean and ending it with Figure 67; a vignette illustrating the difficulty in describing an artistic methodology through a clear definition, which therefore leaves it as an open question (Gray & Malins, 1993). A quarter of a century ago, the challenge was to establish and correct meticulous methodology approaches which were both on a par with the ‘scientific method’, as well as flexible for the appropriation of the needs in an artistic research (Gray & Malins, 1993). Artistic practice-led research was (and to a certain degree still is) relatively new when compared to other scientific disciplines. Apart from this fact, practice-based research in the arts is also different in character from the scientific model for other reasons. In the previous Literature Review, a sub-chapter was dedicated to a discussion between art and science, where Kandel’s description of both disciplines presenting a reductive model of the world in their own right was cited (see pp. 9 - 13). It has also been shown how science is more preoccupied with reaching an objective model of the world, and in order to attain this its methodology has rigorously developed throughout a considerable span of time. Because of its discipline characteristics, the employed research model is based on testing which can also be confirmed and demonstrated by others; a method which tends to clash with artistic research (Gray & Malins, 1993). A close examination of Figure 67 makes us realise that terms like ‘anarchic’, ‘private’, ‘divergent’ and ‘debatable’ amongst others, are all surrounding the phrase ‘Artistic Methodology’ and illustrated as valid methodology options; which even if differing in nature from one another can still be used for any particular artistic research question when applied accordingly. This is specifically the reason why artistic-research clashes with a confirmed method, as elements like chance, chaos and every method which seems to be related to an “anti-method” can arguably become a methodology in its own right. In view of this, the authors of the previously mentioned paper state that since it is not in the nature of artists (and designers) to exteriorise their process, their methodology consequentially results in being “unarticulated” (Gray & Malins, 1993).

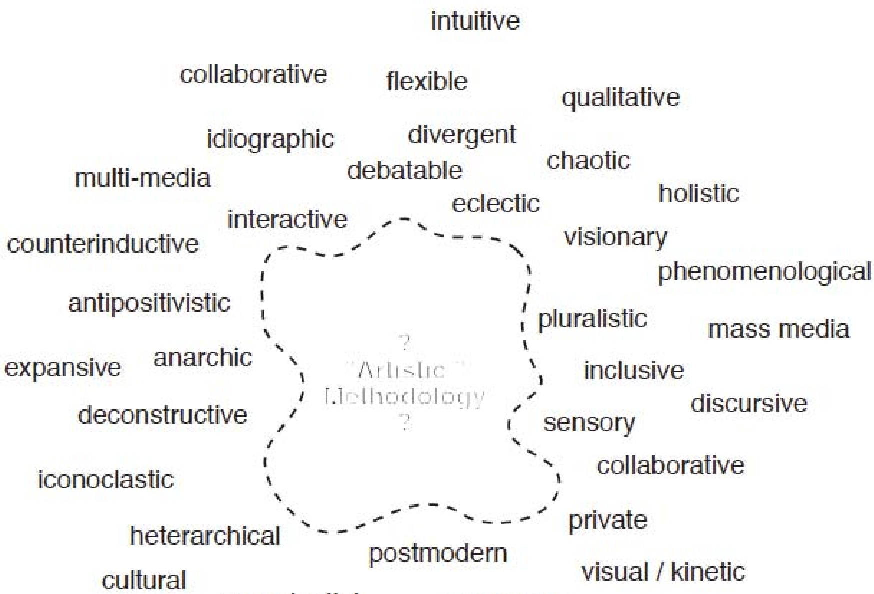


Figure 67: Artistic Methodology. (Gray & Malins, 1993)

As a practicing-artist myself, I completely agree with the fact that an “anti-method” can be transformed into a suitable methodology during an artistic research, but I do not acknowledge the general assumption that artists have difficulty in ‘exteriorising’ their process for a simple reason. In most cases the exteriorisation of the meaning of the research question can be strongly evident in the resulting work itself when this is artistically successful. At the same time, one must be aware that what a work of art communicates, does not necessarily equal research communication (Trimingham, 2002). There are many points to consider here with respect to methodology itself, starting with the experimentation or fieldwork process. It has been stated that experimentation tends to be culturally associated with the realm of scientific disciplines, which, through its discoveries about the world, alters our existence and place within this same world (Gere, 2010). However, science is not the only discipline doing this and another facet of this culture is art itself. Gere, (2010) illustrates as example how artists in the mid-20th century regarded their work as a series of experiments, and mentions the group *Experiments in Arts and Technology* from the U.S.A of 1966 in support of this. The author also adds a note specifying that experiments in art are not implemented as some excuse to gain academic respect and privileges sciences automatically experience, but are instead a great necessity to the discipline as it is only through experimentation that the resulting work can surpass what is usually defined as art (Gere, 2010). This way of approaching experimentation is more adequate to the nature of artistic research. For an artistic process to be successful, the researcher cannot know what the end will consist of in advance. This is where the earlier mentioned scientific confirmation model fails with respect to art, and this was evident in the course of this practice-based dissertation.

The upcoming chapters describing the development of this research question through experimentation will illustrate how results from different tests led the directional development of the research question itself. In order for art to healthily evolve, it cannot anticipate a final answer to a research question and test it through it's methodology, but instead has to develop its answer/s through an experiential process. Perhaps this is why McNiff (2008) starts his study entitled *Art-Based Research* with a quote from Pablo Picasso stating that he never made a work of art, but it always consisted in a matter of research instead. It has however also been pointed out that the term “all practice is research” should not be mistaken with the idea that all practice contributes to research, but at the same time it is relevant to it (Trimingham, 2002). In view of this, for a research methodology to be meaningful, the selected processes and the nature of the evolving exploration must be critical of itself, rigorous and understandable (Gray & Malins, 1993).

Gray and Malins (2004) published *Visualising Research*, following up on the previously mentioned study (1993), aimed at being a guiding textbook for post-graduate practice-based research. Its introduction by Mike Press, illustrated two crucial points about art and design research practice: in our times it is both exciting, and deeply challenging (Press, 2004, pp. x-xiii). The excitement lies in the fact that adapted methodologies allow art-practice researchers to also engage with other disciplines during their experiential discovery, while at the same time all is made challenging as unknown territories can easily mislead us into “a rabbit hole” (Press, 2004, pp. x-xiii). I find the following quote from the same published book to paraphrase the same concept by using different words, focusing more on a description of the characteristics behind practice-based research:

> Unlike many other disciplines, where formal logic and serial thinking are predominant, artists and designers are usually visual, lateral thinkers. In our domain we know that there are no certainties, no ‘right’ answers, no simple solutions, no absolute objectivity. All views are admissible, many interpretations are possible, different ‘ways of seeing’ are encouraged – indeed, one might say that the ambiguity of visual language is its strength and fascination, and one reason for the persistence of visual practices. (Gray & Malins, 2004, p. 39)

The freedom of expression permitted by the nature of this discipline is notably intriguing and as Press (2004) described above, “exciting”. However, if not handled critically and with a systematic decision-making approach along the several stages of the research advancements, the results can be catastrophic. It is safe to state that there are no 'right' and 'simple solutions' in artistic-based research, but what is misguided and uninteresting can be (and has to be) immediately put in evidence and analysed through critical thinking. It has to be said that the rigour in artistic methodology should lie in its decision-making capabilities taken during several instances during the 'free' experiential experimentation necessary to the directing of the research question. In a way artists have been doing this on an intuitive level throughout art history, and Picasso's earlier mentioned research quote can fit this example. Another artistic research example coming from the history of contemporary art which emphasises specific rigour in its practice is Roman Opalka's. The development of his work is a perfect match to the build-up of this argument. In his pre-1965 artistic activity, he vastly experimented in his painting with the intention of trying to represent time on a canvas (which for the sake of this argument is being assimilated with his research question). His experiments varied widely through the developments of what he called *Chronomes* (Figure 68), which consisted of paintings meticulously showing the passing of time rather than time through a literal sense. All of this experimentation brought him closer to his crucial life-time decision of 1965; that of representing time through painting numbers from 1 towards ∞ (Figure 69). He and his research metaphorically became one, and his practice embarked on a logical direction that would only stop when he passed-away (2011). As he stated in his own words:

> Nothing can disturb the logic of my practice since I do not find myself in the necessity to daily come up with a new project anymore. I instead use my time to give body to my *Détails* and to explore their implications. (Opalka, 2011, p. 39)

From an artistic-research point of view, Opalka's work done prior his *Opalka 1965/1-* ∞ project is as important as the last painting he worked on. Opalka's obsession of questioning the representation of time was an experiential methodology throughout his whole oeuvre as an artist, and his *Détails*

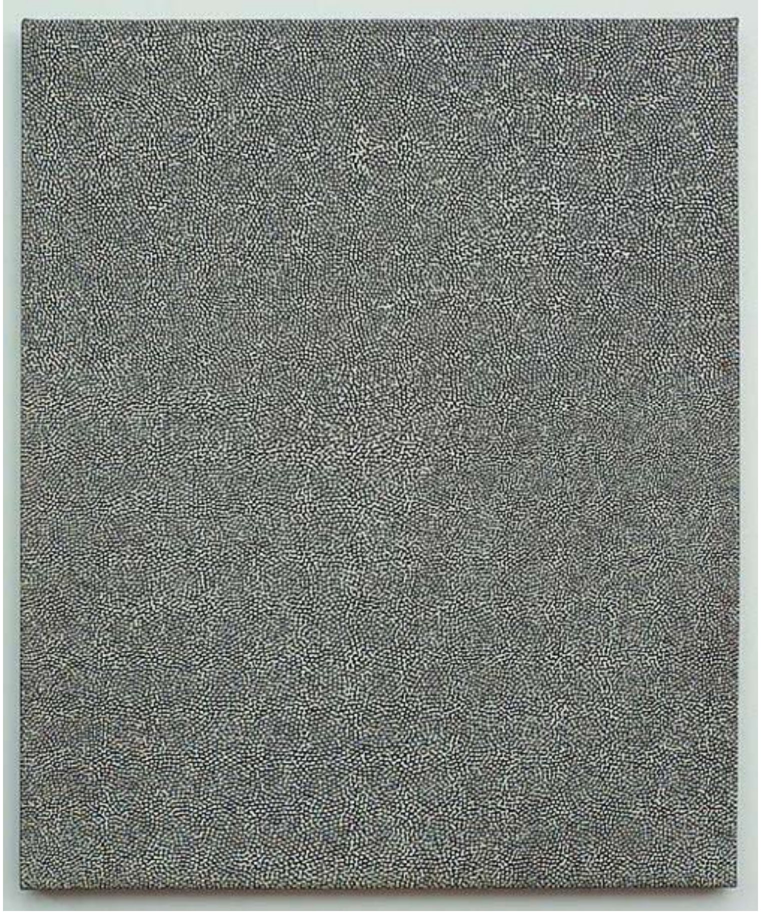


Figure 68: *Chronome No. 4.* Opalka. 1963. Tempera on canvas. 73.5 x 61 cm. Retrieved from https://www.levygorvy.com/exhibitions/roman-opalka-painting/

Figure 69: Detail shot of *OPALKA 1965/1 - ∞ | Détail 5175778 - 5193062.* Opalka. Acrylic on canvas. 196 × 135 cm. Own photograph taken March 2017.

would not exist without the *Chronomes*. Furthermore, once he reached the *Détails* solution to his question problem, further questions arose within the practice of the *Détails* themselves, as proven by his above citation. Thus, he for example started realising that by ‘painting time’ he was automatically also painting his current psychological states and moods; his practice as a human activity became assimilated with time and vice versa. Within the *Détails* research itself he developed the practice through for example the capturing of a daily self-portrait and the recording of his voice. Using Opalka’s research example gives the opportunity to refer to the following artistic methodology theories, which were constantly present during the development of this thesis’ research practice.

Opalka’s research process can be linked to the concept of a ‘reflective practitioner’, consisting in the figure of a researcher seeking to solve problems placed by him in the world through his professional environment. Reflection behind a practice is divided into two types; “reflection-on-action” and “reflection-in-action”, where the professional practitioner either reflects upon his practice during an evaluation of it, or directly re-thinks the course of his oeuvre while practising it (Gray & Malins, 2004, p. 22). Both methods are crucial for the critical understanding of the developing work itself. While arguing on this point, Gray and Malins (2004), compare research-practice to an elephant, citing a Hindu story where since this particular animal is so large and full of interesting elements in their own right such as texture, scale and movement amongst others, a group of blind men could only describe a partial experience of what the animal consisted of, thus failing to grasp the entirety of the elephant because of its complexity (p. 25). Perhaps, in practical terms the elephant in Opalka’s case is time, which he interpreted through the paintings and self-portraits developed during his research process. But time as a subject/research topic is not explicit to Opalka, and other practitioners interpreted the same ‘elephant’ through other elements within their own research practices. For example, Christian Marclay interpreted time in *The Clock* presented at the 2012 Venice Biennale; a 24-hour movie collage of clips from popular movies

Figure 70: Detail shots of *The Clock*. Christian Marclay. 2012.
Retrieved from https://www.newyorker.com/culture/culture-desk/night-shift-with-the-clock

Figure 71: *One-Year Performance*. Tehchin Hsieh. 1980-81.
Retrieved from http://www.skny.com/artists/tehching-hsieh

showing time, while being constantly synchronised to the real time of the day (Figure 70). Another specific example comes from 1980, where Tehchin Hsieh accomplished a one-year performance photographing himself punching-in to work on the hour, every hour, twenty-four hours a day (Figure 71). The examples can be numerous, and the point here is that through an adequate artistic methodology, there is the potential for several resulting interpretations to the same problem or research question. The intentions behind making a work can be as varied as the possible resulting work itself, and in most cases this takes shape because of the action and engagement with the physical materials, giving space for exposing the unexpected (Duxbury, 2008, p. 19).

An interesting concept of how to attempt an understanding of the methodology behind an art-based research is to regard it as a product of knowledge or “philosophy in action” (Barrett, 2007, p. 1). This brings to the spotlight the experiential value of the material itself—and therefore Heidegger’s concept of ‘handlability’—as artistic research can be proof that knowledge can be directly derived from doing; action (Barrett, 2007, p. 1). Heidegger’s notion suggests that our primary experience in the world is acquired through the things we deal with, and therefore it is not a simple perceptual understanding (Bolt, 2014, p. 1). This praxical knowledge is thus apprehended through practice, from which theory and concepts are then derived (contrary to other disciplines’ methodology approaches), and since such processes depend upon the tacit and the doing across time, their exact procedure cannot be listed beforehand (Barrett, 2007, p. 6). This methodological approach allows us also to manipulate whatever is available to us (material, tools and interdisciplinary knowledge amongst others) in order to be put to use in an innovative way.

This shifts our attention to another methodological concern in research practice; the tools and technology themselves. These can range from a pencil to scientific instruments and new media, and experimental tradition revolves around their utilisation. Regarding the rise of digital technology as a tool for artistic practice, Gere (2010) makes an interesting observation that:

> The technology used by a blogging teen or a member of MySpace, or a net.artist, is more or less the same as that used by a journalist working for a newspaper or, perhaps most importantly, a scientist working on DNA, or artificial life or whatever. (p. 5)

This point is important because it adds complexity to the challenge art practice faces when utilising such technologies as means within its process. Since the system of doing something through a digital method is quite standardised within its platform (as shown by the previous citation), an artistic process needs to be further encouraged to look for different ways of the appropriation of the digital world and new media in order not to risk falling into naive or banal solutions. This feeds into the argument brought up by Graham (2010) in his essay *Tools, Methods, Practice, Process… and Curation*, where she starts by emphasising the power of tools with respect to how they influence our perception. Regarding this she cites artist Jon Winet who started perceiving everything as "a document" after researching at Xerox Parc, a case which makes us reflect on the fact that there are times where artistic methodologies need to recreate an entire way of dealing with technological tools (including the tools' functions themselves). On the other hand, there can be times where the good old "hammer" is more than sufficient for the research's goal (Graham, 2010). In contrast, Gere (2010) stated that more powerful tools give the option for better experiments resulting in more relevant research. This is true in the scientific model, as the function of most utilised tools regards their precision and accuracy of their results, but it might not always be the case within an artistic methodology. On certain occasions the artistic research directs the practitioner into necessitating powerful tools for specific results, but in other cases such powerful tools might be blinding for the research purpose itself. As will be mentioned in the coming chapter, during my research practice of this dissertation, I myself discarded the initial idea of using an EEG in order to accumulate data as its power proved risky and would have deviated my research focus.

Tools and technology in artistic methodology can therefore prove to be both an important necessity and a drawback. Through some discussions on practice-based research it might sometimes appear that all that seems suitable can be accepted within an artistic methodology, but this intuition needs to be acknowledged with caution. Tools become a liability when they overshadow the focus of the research question itself, de-routing the practitioner's attention towards their function other than the research's development. This is why it is also crucial that an art-based researcher familiarises with the utilisation of tools and technology implemented in the practical element of the research, especially when these form part of the equipment aimed at other disciplines. The familiarisation with such, needs to be approached from an artistic methodology point of view in order for the practitioner to be able to widen the utility options of the tools themselves. Perhaps such attitude also aids in eliminating the "anxiety of interdisciplinary" complexities mentioned in the previously cited essay (Graham, 2010). An art-based research practitioner needs to acknowledge that when 'borrowing' tools and methods from other disciplines, it does not give him/her the expertise of that discipline or technology, but a technique of how to get closer to an artistic research's answer instead. This technique has the freedom to vary and adapt according to the development-by-doing necessities, and can range in results from ironic statements to precise and accurate testing. Perhaps, it is sometimes beneficial to assume that the experimental testing in an artistic research does not confirm a theory or conceptual model, but analysis whether surrounding things from our real world can become part of an artistic practice. This approach is similar to how I treated appropriated tools from other disciplines into my dissertation; as will be described in the coming chapters with respect to the usage of an eye-tracking device.

In this view, Gray and Malins (2004), argue that through our contemporary technology's capacities, broad amounts of collected data can be converted and reinterpreted into valuable material which can be taken advantage of by research methodologies (p. 95). It is through this appropriation of cultural contexts that present methods can be expanded and new research tools for artistic practice invented (p. 95). This links to what practitioner Smith (2016) stated in her essay when challenging a fixed methodology through the inclusion of art-doing. She argued from the point of view of a Deleuzian action research, mainly because of Deleuze's interests in understanding what something does and how it does it, other than focusing on its meaning (Smith, 2016). Smith also added that this concept is not an approach, but the capacity of the combination of practice and theory instead. For new research methods to be found, one has to therefore think about what a particular tool does before appropriating it into a specific context. By focusing on how the tool works, a new conclusion for its meaning can be arrived at. Should one start researching by solely focusing on a tool's meaning (without having a particular necessity to do so), the research's experimentation can be immediately limited and hence compromised. In addition to this, I would like to add a comment on how Barrett (2007) uses Richard Dawkins' teachings on evolution to further emphasise the importance of differing from traditional points of view in both theory and practice. She believes that this should also help us understand why art practices are consequentially modified over time; "Dawkins tells us that evolution occurs through the differential survival of replicating entities. The implication here, is that evolution occurs through change as an adaptation to the demands of the environment" (Barrett, 2007, pp. 159 - 163). In order for artistic research to develop, it therefore needs to evolve, and in order for this to happen a series of changes (tests) occur at the time of experimentation. The differences in these changes become crucial for an interesting evolution when critical thinking is used for the evaluation of the experimentation results, determining the best way/s forward, and to a certain extent this will be proven by the evolution of this practice-based research's results.

In conclusion to this critical introduction to artistic-based methodologies, the latter point on evolution can also help avoid what McNiff (2008) describes as "ineffective" art-based researches due to their exceedingly personal or multi-complex overtones. The idea of an evolving art-based research, may seem also appropriate to the elimination of the problems posed by 'more rigid' scientific methodologies which do not entirely apply to art-practice, while at the same time the critical evolution itself gives crucial control over the risk of dispersive total freedom.

The Initial Hunch of this Research Question

A practice by research inquiry is usually carved out of these three essential questions *what?*, *why?* and *how?*, which as discussed above can be modified according to the artistic practice needs (Gray & Malins, 2004, p. 12). The *what?* starts with a proposition, which is then turned into a feasible research question, while the *why?* allows for the application of a context to the research objectives. The *how?* is then about generating and analysing data evolving from the research question itself (Gray & Malins, 2004, p. 12). When adapted to an art-based research practice, this section does not include a "right way" of doing analysis, and its exploration in methodical techniques vastly vary in nature striving to be both creative and meticulous (Gray & Malins, 2004, p. 132).

The *what?* in this study came after a series of practical works developed over the span of the last five years, which dealt with the exploration of representing drawing through space by distributing line along an environment for the beholder to cerebrally discover and perceive. On the occasion of the solo exhibition *In Between the Lines*, Conti (2013) described this research practice as follows; "A fundamental component of Attard's installation is the loss of the drawing's linearity, broken in the moment of execution, in the perceptive dynamics, in its regularities and discontinuity of space". The beholder's cerebral involvement is hence of critical importance to the perceptual experience of the artworks in subject, as each individual creates his/her own subjective itinerary depending on the individual's cognitive contexts. The works in subject deal with the representation of human figures, mainly exploring the contemporary notion of the pose ranging from advertisement manifestos to selfies uploaded on social media platforms (Figure 72). A beholder's brain therefore works its way through its object recognition abilities while exploring the changing forms offered by the unlimited possible views, until the occurrence of the visual shift from abstract compositions to the recognition of the temporarily (as the figure representation breaks down when the beholder changes his viewpoint) visible familiar poses. The concept behind this body of work is however not solely mechanical as Pinton (2014) notes in a critical review of the work:

> On the one hand Matthew Attard shows us the mechanics of vision, the perceptual and physiological components, the neurophysiological dimension while, on the other hand, in asking us to participate in the construction of an image, he demonstrates its cultural – that is social – component, that which acts to correct, to order what you are looking at and that leads to perception of the form, of the figure. (Pinton, 2014)

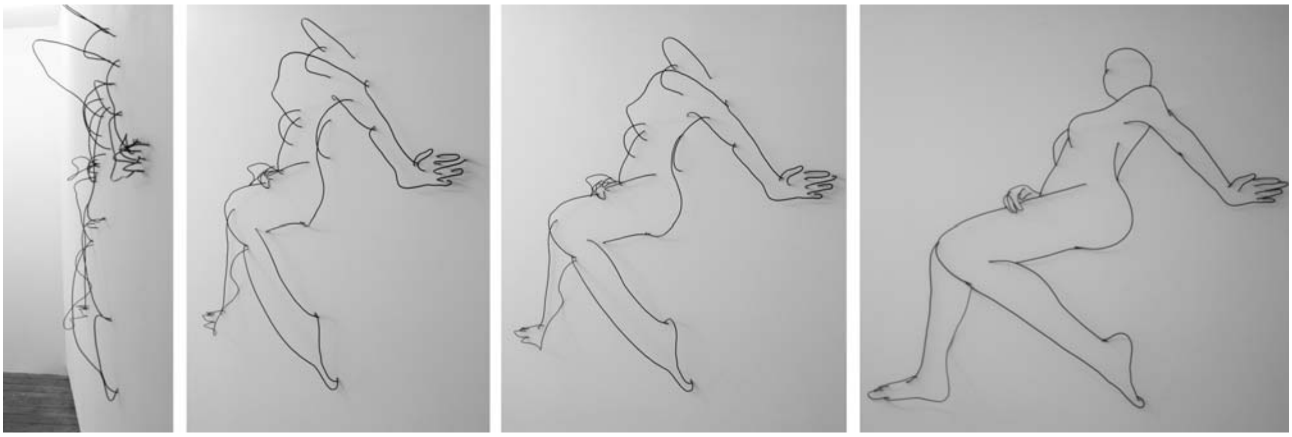


Figure 72: *Untitled (You are a Poser!).* Multiple views. Own work and photo. 2014.
Black wire, wall. Exhibited at Canal|05, Brussels.

In view of this, my initial intent was to explore the possibilities of developing this same body of work inside the cognitive science lab, by treating the sculptures as a test for cognitive experiments. However, it was not long before further insight into the previous Literature Review research—'the *why?*'—gave me a clearer understanding of how tools used inside the cognitive science lab can actually be directly used in an artistic process through the implementation of their recorded data. Attendance during two study-units offered by the cognitive science department at the beginning of my research also proved to be of utmost importance, as they enriched my research study by offering knowledge about how we visually experience the world from another discipline's point of view, of which knowledge I was then able to integrate and appropriate during both the Literature Review, as well as the eventual experiments and artistic practice developments. These studies also helped me familiarise myself with scientific papers and reports concerning the discipline in question.

During this research question, the *what?*, *why?* and *how?* constantly fed each other towards the evolution of this dissertation, and this was critical to the methodology itself. The initial intention of 'testing' the sculptural body of work mentioned above inside the cognitive science lab was to generate data from the beholder's visual experience. Through this data accumulation, the idea was to open doors for development opportunities embarking on the Data Art approaches mentioned earlier in the Literature Review (see pp. 80 - 98). Cognitive science devices such as the eye-tracker and the EEG were planned to be used throughout this research's methodology, but after the first tests and further insight on how our brain perceives the world (both from an empirical and phenomenological point of view), the interest of this research question shifted its focus to the strong ties between how we mentally perceive the world, the collected data from an eye-tracker and drawing itself.

The very first tentative experiments linked to the initial objective were done online, through a marketing website designed to utilise the webcam of its subscribed users' personal computer as an eye-tracker (RealEye, 2016). Through the availability of the now-standard HD Camera fitted on all modern day laptops, RealEye designed a software which, through face-tracking algorithms, is capable of detecting the position of the eyes with an accuracy of ~ 64px, equivalent to about 1 cm, and therefore with a margin of error of about 4 of our visual angle (RealEye, 2016). RealEye solely operates through their website platform and their business offer is to let their clients upload advertisements or websites for an analysis of their visual effectiveness upon the viewer. The results of these visuals are obtained from the viewing of testers logged-in onto the online platform who agree to calibrate their computer camera to the RealEye's website and then view the presentation uploaded by the client, after which a heat-map of the main visual areas of interest is generated. In my case I uploaded several case studies varying between drawings and the previously mentioned sculptures, but for the sake of clarity in the development of this practice-based methodology I will focus on an uploaded slide show which included a drawing, a frontal-view of a sculpture I had done as development of the same drawing and a side-view of the same sculpture which seemingly results in an abstract composition (Figure 73). The online experiment consisted of a paradigm-style format, where the drawing was shown for three consecutive times, followed by the sculptural frontal-view and side-view subsequently. Viewing time was set at 4000 [ms] and the in-between relax time at 1500 [ms], and Figures 74 - 76 were received as heat-map results of the average tester viewers (12 testers in total, who were anonymously provided by the website and therefore it is not known whether they had an artistic background). By no means this was aimed at being an empirical study. The ready format and ease of access offered by RealEye provided the opportunity for a curious visual experiment, which coincidentally resembled scientific lab paradigms in format. Figures 74 - 76 are the obtained averaged results of the concerned uploaded images, showing the generated heat-maps after 2000 [ms] and 4000 [ms] of viewing for each image. In an artistic research, the meaning of these heat-maps differ from that of an empirical one, and the immediate and apparent note to grasp from such results is the fact that the images acquired a temporal value through the technology used in this experiment.

The two-dimensional images (including the uploaded photos of the sculpture) went through a temporal phase during their creation; the drawing can be itself associated with a metaphorical journey of the seen, imagined and remembered (as in John Berger's earlier citation, see p. 1), while the photographs had a temporal value during the process of framing and capturing the respective compositions. However, through the technology offered by RealEye, a new kind of information is made visible which was previously invisible, in the same line of thought with my discussion in earlier sub-chapters (see pp. 47 - 66) and Gleick's citation as published by Gray and Malins (2004, p. 95). To be more exact, the images now acquired an illustrated temporal value of the averaging of 12 gazes lasting 4000 [ms] each, and when over-layered with the heat-map each and every image changed its original purpose. It becomes a subjective testimony of the individuals' looking and perceiving represented by data, and the represented image as a whole falls into second place.

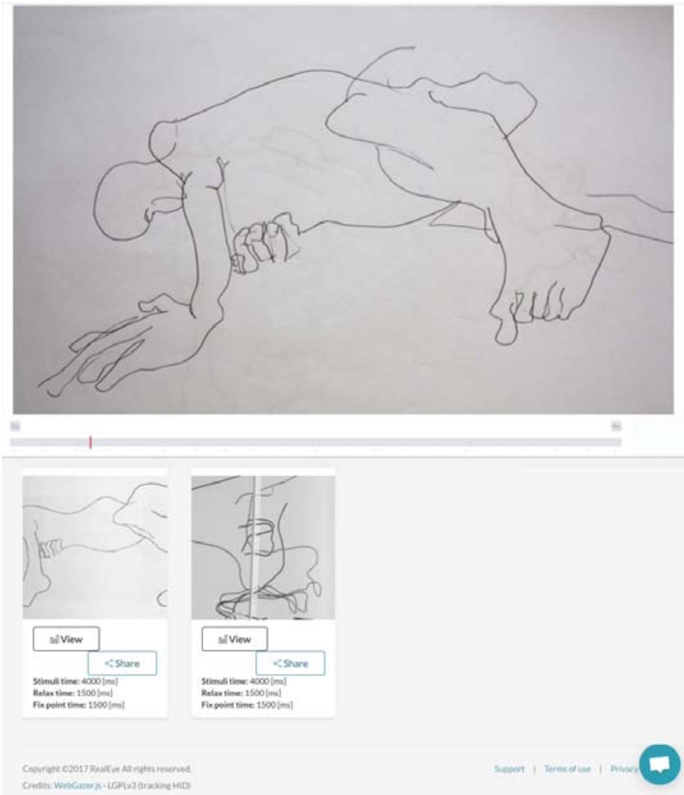


Figure 73: Uploaded images on https://www.realeye.io for testing. The upper image consists of a blind drawing, whereas the lower two thumbnails are different views of a sculpture which had been developed from the same drawing.

The idea of uploading the same drawing to be gazed at for three times in a row was to test whether there would be changes to the viewing patterns of identical images. Experimentation at this stage was very preliminary, and a platform designed for marketing purposes (RealEye) was being used for exploratory purposes in order to find a developmental link towards Data Art. It is therefore being mentioned in order to provide a clear view of how this initial 'hunch' developed into the later described concept of eye drawing. The figure represented in the analysed drawing (Figure 73) is not of a naturalistic nature. It is the product of the mind involving an exaggeration of key body features

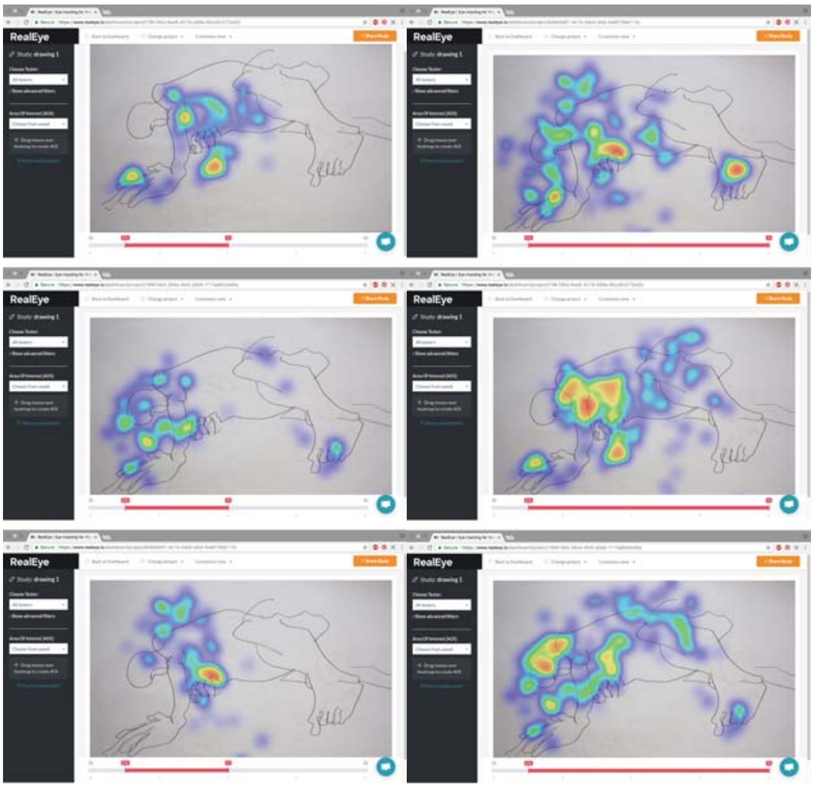


Figure 74: Heatmap results obtained from https://www.realeye.io with respect to the uploaded drawing. The left column shows data after 2000 [ms] and the right column after 4000 [ms].

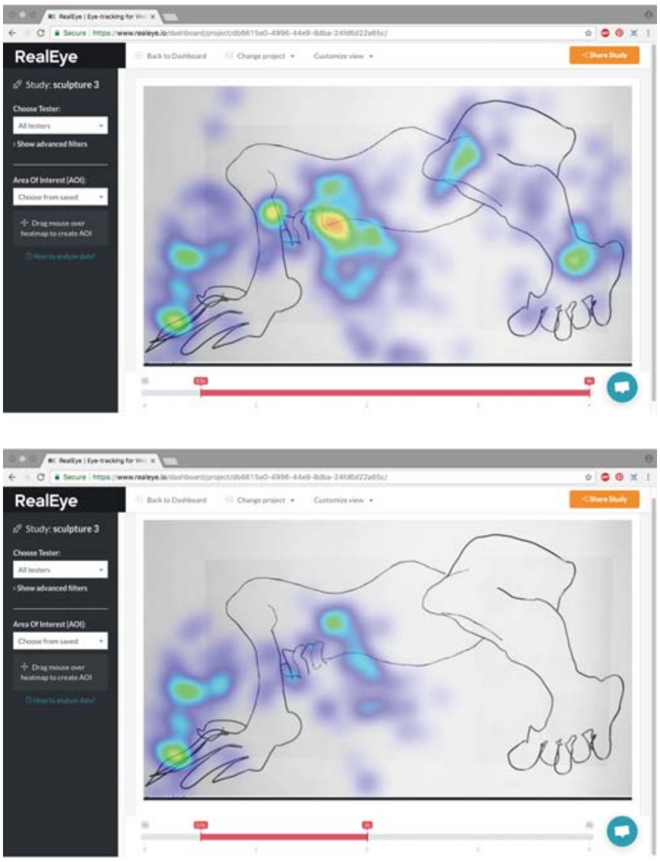


Figure 75: Heatmap results obtained from https://www.realeye.io with respect to the uploaded frontal view of the sculpture. The upper screenshot shows data after 4000 [ms] and the lower screenshot after 2000 [ms].

such as the hands and feet, and its representational values might trigger hazy resemblances (not in a literal sense) between a human figure and animal creatures, depending of course on the viewer’s perceptual contextual background (including memory and other cognitive abilities). What I find interesting is the fact that apart from the acquired temporal nature, Figures 74 - 76 also deconstruct the original sense of the image’s entirety in representation, and the resulting data from the website testers seems to focus on details instead. The data between the viewing time of the three identical slides is strikingly similar at face value, where even if viewed in repetition, the viewing starting point seems to always have been from the left side; somewhere in between the head and hand (compare Figures 74 - 75). There are of course minor changes between one session and another, but the main visual area of interest seems to have revolved around the head, hands and upper-body area.

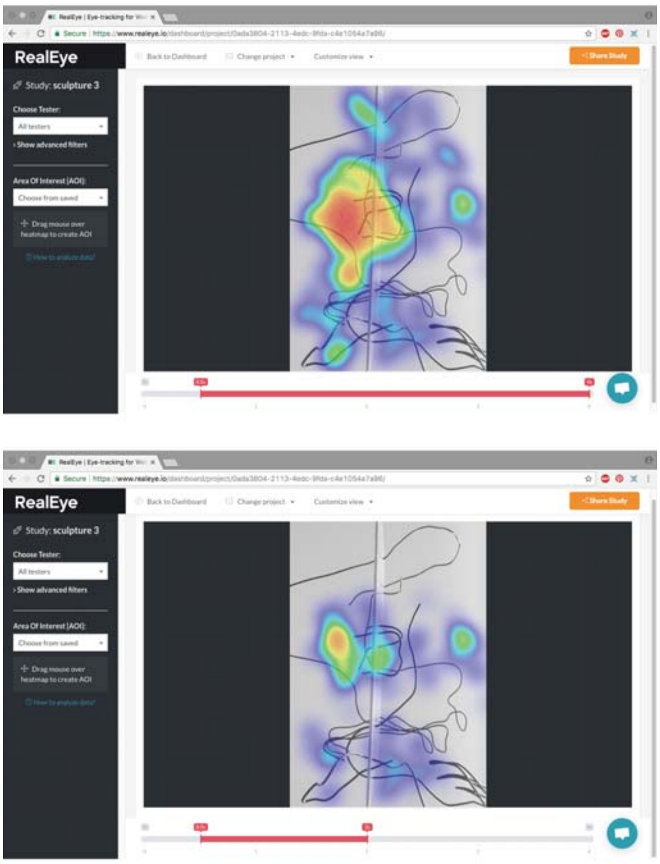


Figure 76: Heatmap results obtained from https://www.realeye.io with respect to the uploaded side view of the sculpture. The upper screenshot shows data after 4000 [ms] and the lower screenshot after 2000 [ms].

There wasn't much difference in the sculpture's photograph (Figure 75), where the main focus of interest remained the left part of the composition. In the sculpture's development, the head was omitted from the represented imagery, and the visual attention seemed to focus around the figure's right hand attached to the torso. Coincidentally, this also happened in the side-view slide of the same sculpture (Figure 76), even though the concerned area which attracted most gazes was far from the real representation of a hand. Some viewers of the 12 earlier mentioned testers might have intuitively understood that it was the same 'hand' which had been previously observed, but some others might have simply been attracted by the particular abstract design this area created. Another interpretation for this might be the fact that the concerned area happens to be at the centre of the whole composition, and therefore, because of its abstract nature it was a more intuitive starting point for the viewers' gazing.

There are two important points to extract here regarding the development of this research study. The first being that once both drawing and sculpture had been completed prior to this research, I perceived them as a whole; as an image with an identity, contrary to the process of making them (which still concerns a sense of discovery). On the other hand, a simple data analysis shows that during the very initial seconds of viewing these images, the eye/brain of a third party beholder enter a 'searching mode' in the attempt to arrive at a good level of perception of the representation. Attention is crucial for the beholder while perceiving a work of art, and this particular case links back to what has been discussed about the bottom-up processes acting upon our perception while trying to make sense of the world (see pp. 20 - 35). It also brings to mind James' quote that:

> Everyone knows what attention is. It is the taking possession of the mind, in clear and vivid form, of one out of what seems several simultaneous possible objects or trains of thought.

> Focalization, concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others… (James, 1890, p. 256)

This aspect in relation to the world of art has also been discussed by Arnheim (1974) where he stated that an area in an image can hold the viewer’s attention either because of a particular subject matter or because of complex intrinsic values within the composition (p. 24). These visual complexities, described by him as “outstanding features” also then act upon both the identity of the perceived subject matter as well as its completeness (p. 44).

The second important point is the fact that the above mentioned experiments would not have been sufficient for argumentation in an empirical research methodology. Further experiments would have had to be considered and validated, together with different conditions of testing (amongst others). For this practice-based research they instead proved to be crucial for the development of an initial hunch; that of implementing recorded data into an artistic process. Further experiments with eye-tracking technology led to a clearer focus of directly using this data as a substitution to the ‘traditional’ way of drawing. The following chapters will discuss this specific development.

The Eye Tribe

The next series of experiments during this dissertation where done using *The Eye Tribe* eye-tracking device (Figure 77). This device is known to have been the smallest and most affordable eye-tracker to have ever been produced, as of 2017; measuring 20 x 1.9 x 1.9 cm and costing as low as $99. *The Eye Tribe* company used to sell the eye-tracker with a simple open source developing kit programmed in C++, Java and C#, but it ceased to be produced during the duration of this study as it has been now acquired by the *Oculus* company for development inside the virtual reality headset (Constine, 2016).

Figure 77: *The Eye Tribe* eye-tracker.

The Eye Tribe eye-tracker connects to most computers and tablets through its USB 3.0 plug and its principal hardware is a camera working together with a high-resolution infrared LED, capable of recording the pupil's movements with sub-millimetre precision having a visual angle accuracy of 0.5 degrees after a 9, 12 or 16-point calibration. At this stage of this research, the objective of the following experiments was to attempt to use this device to start exploring the possibilities for 'drawing' through the eye movements, initially by 'tracing' along the edges of photographs and images shown on a computer screen. The drawings would result from the rendering of the recorded data in the form of scanpaths, and from now onwards this activity will be referred to as eye drawing for clarity purposes. This exercise had to involve a different way of looking at the world than our usual unconscious daily free movement of the eyes, and the results were expected to be different from Yarbus' analyses of various scanpath experiments from the late 1960s (Yarbus, 1967, pp. 171 - 210). In a way the intention was closer to what had been anticipated in a study from 1969, where through the technology of Electro-Oculography, Coss attempted to draw a car with his eyes (Figure 78) which led him to the conclusion that through developments in technology and further research, artists might be able to quickly record lines at the same instance when imagining them (Coss, 1969). *The Eye Tribe* eye-tracker undoubtedly offered a much higher recording technology, but a software for both recording and processing of these experiments had to be written as no off-the-shelf solution existed.

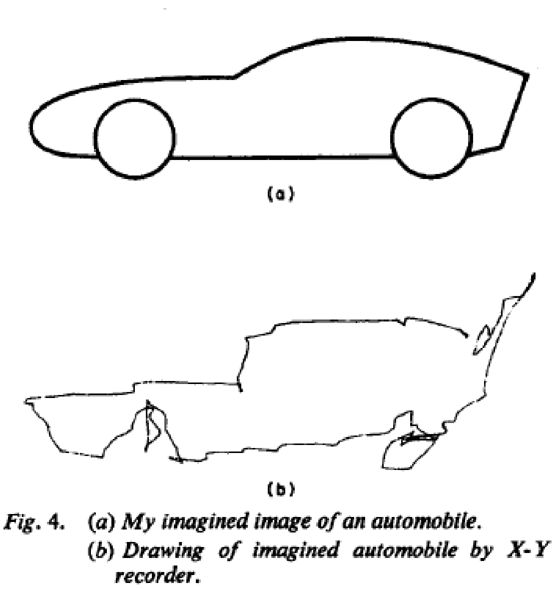


Figure 78: Eye drawing of a car. (Coss, 1969)

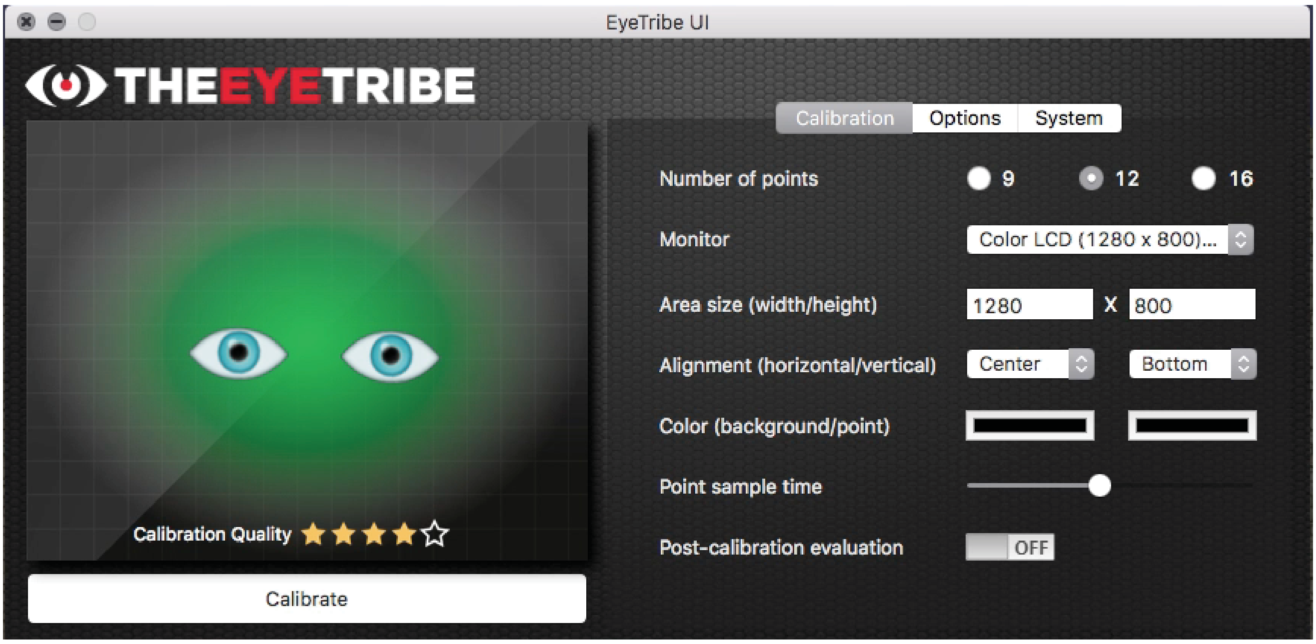


Figure 79: *The Eye Tribe* software.

The starting point for this was *The Eye Tribe* software package itself, which once installed allowed for calibration and also featured an API console (Figure 79). This gave the opportunity to communicate the live-streaming data of the active eye-tracker with the specifically developed JAVA platform, which was in turn developed from an open source program retrieved from GitHub (Sradevski, 2016). The developed programme runs through Google Chrome where it creates a local host (Figure 80) which connects to *The Eye Tribe* API console (this has to be activated and calibrated through its own software). A simple virtual room was created inside the local host JAVA server with the help of an IT programmer. The virtual room consisted of three walls, where two of them included a total of four picture frames hosting uploaded images in .jpeg format to be eye drawn. After the start of *The Eye Tribe* server, the JAVA server and the local host server, the virtual room can be loaded through *localhost:8080* and the first step is to calibrate the eye-tracker in order for the Chrome page to synchronise with the previously done *Eye Tribe* calibration (Figure 81). The eye-drawing exercises can then follow, where the camera view automatically moves from one frame (uploaded image) to another allowing 20 seconds of viewing, hence eye drawing (see Appendix B).

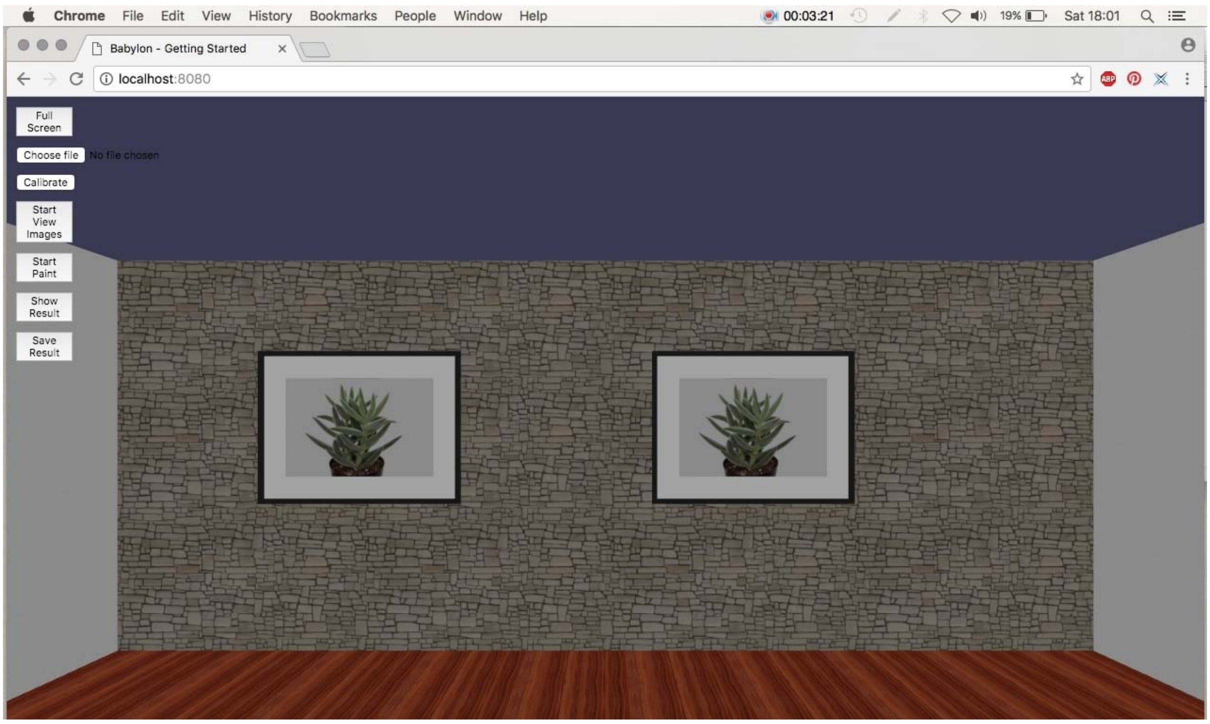


Figure 80: Virtual room designed with JAVA server on Chrome local host.

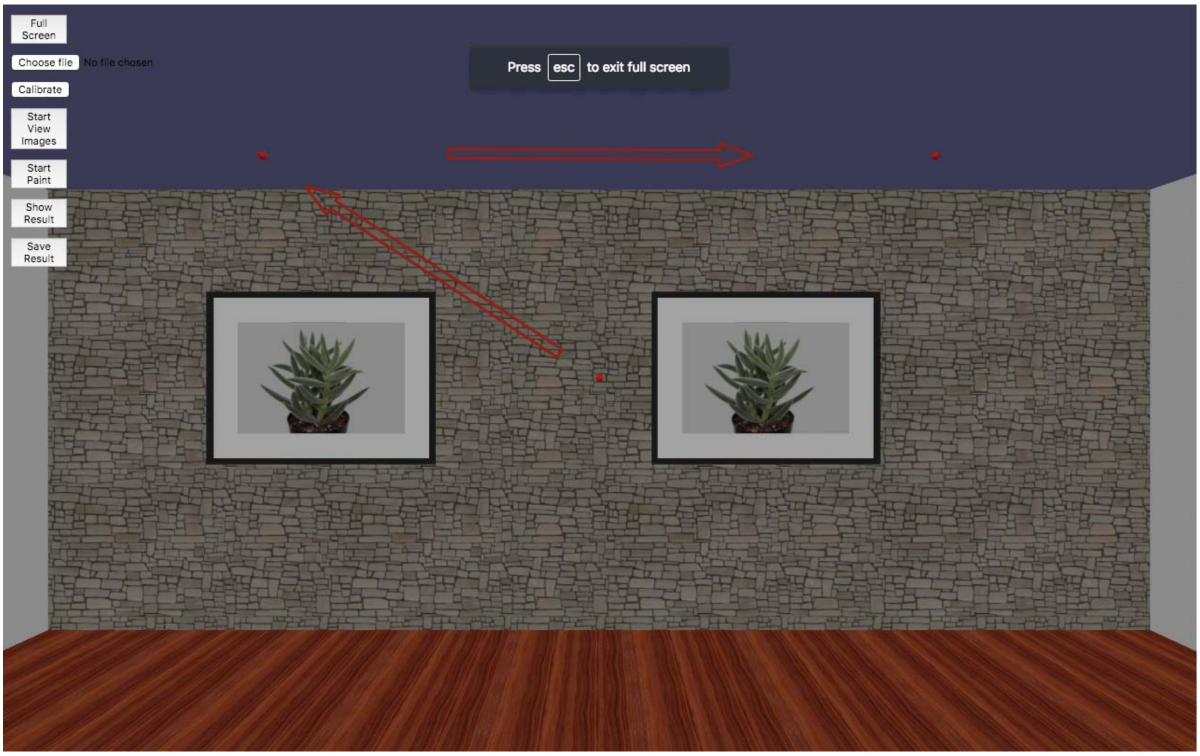


Figure 81: Eye movement calibration of the virtual room with *The Eye Tribe* API. The red arrows have been added to the screenshot for the purpose to illustrate the movement of the red dots which have to be followed by the eyes in order to calibrate.

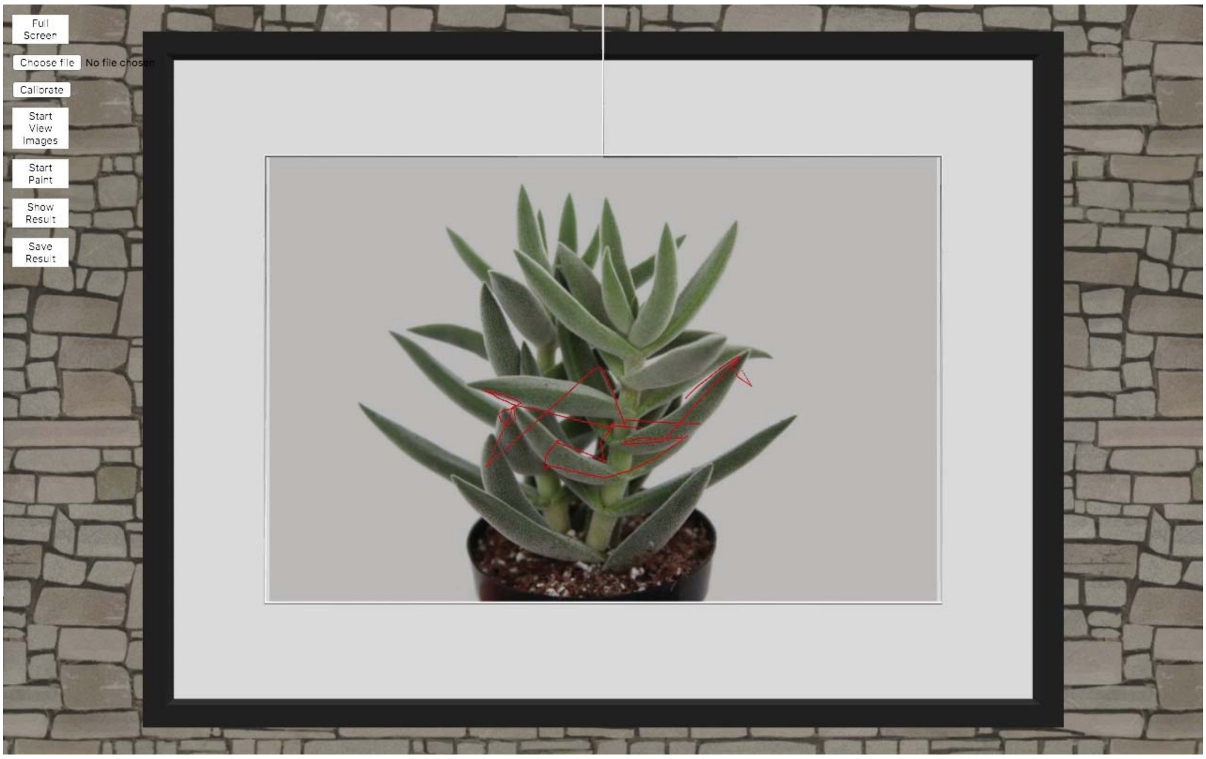


Figure 82: Red scanpath illustrating the recorded eye movements during a 20-second viewing time.

After each camera shift, the scanpaths were automatically traced by the JAVA platform through the coordinate data of the recorded eye movements and are illustrated in red (Figure 82). These results are then available for download in both a portable network graphics format (.png) and as comma-separated values representing the concerned coordinates (.csv), giving the possibility of importing the data into a 3D modelling software for further development. Therefore, the developed steps for eye drawing using *The Eye Tribe* are as illustrated in Figure 83.

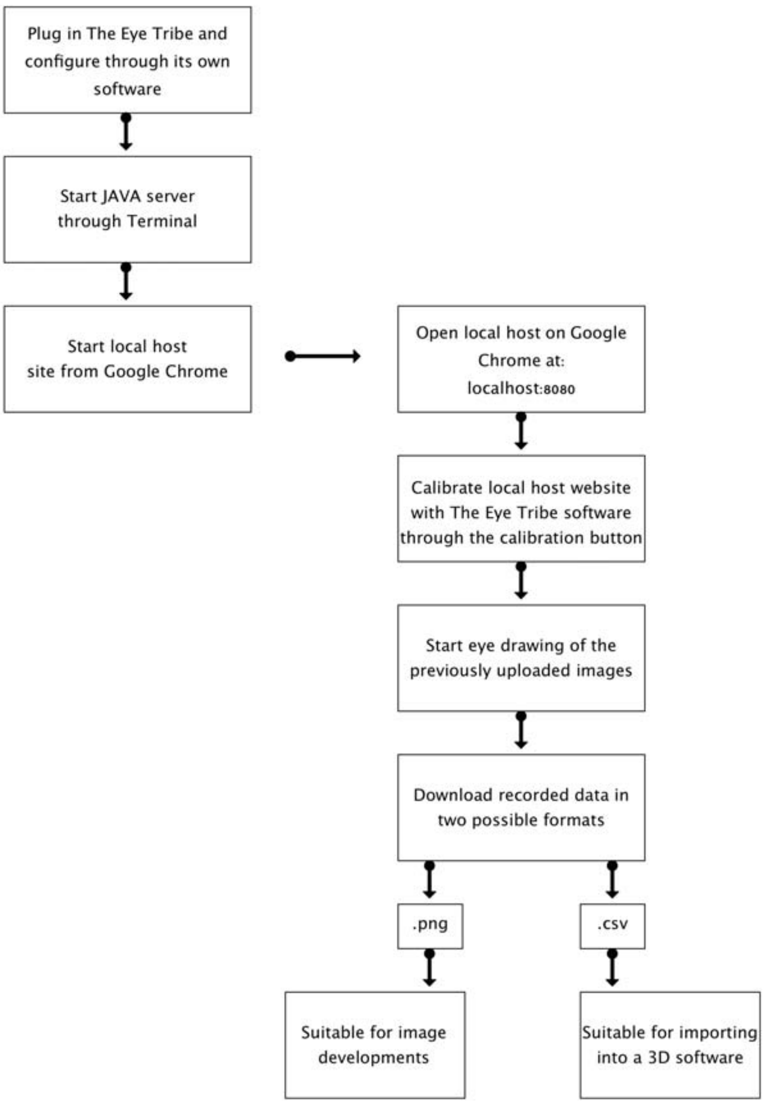


Figure 83: The developed steps for eye drawing using *The Eye Tribe.*

The Eye Tribe Results

During the initial stage of this series of experiments, the previously mentioned drawing (Figure 73) was the first image to be uploaded and eye drawn. Three chosen results of these tests are published in Figure 84, while Figure 85 shows one of the initial eye drawing results of a photo of fish in an aquarium. An analysis of the eye drawings stemming from these tests and sequential developments will follow in the discussion below. After the first eye drawing trials were completed, it was immediately understood what type of relearning had to be involved in the process of looking, in order for the achievement of more successful results. We do not naturally observe the world by mentally thinking about how to draw it, and therefore eye drawing proved to be an imposing act on the usual eye movements. As brought up in a conversation with Caesar Attard, we do not even trace along contours with our sight whilst hand drawing, as we tend to observe our subject in spatial areas and refer back to the paper (Appendix A, lines 85 - 89).

Eye drawing differs from the normal act of drawing for two main reasons. Firstly, the hand (as representative of the artist's body) is removed from its cognitive equation. As explained in the introduction of the previously mentioned Cross (1969) study:

> Drawing with the hand is coordinated through the visual impressions transmitted to the eyes and interpreted by the brain. During the making of a drawing, three major events form a closed loop. First of all, the eyes perceive the orientation of the hand in relation to the paper's surface. The second event is the brain's decision to move the hand in a particular manner. The third event comprises the actual hand movement, which marks the paper. (Cross 1969)

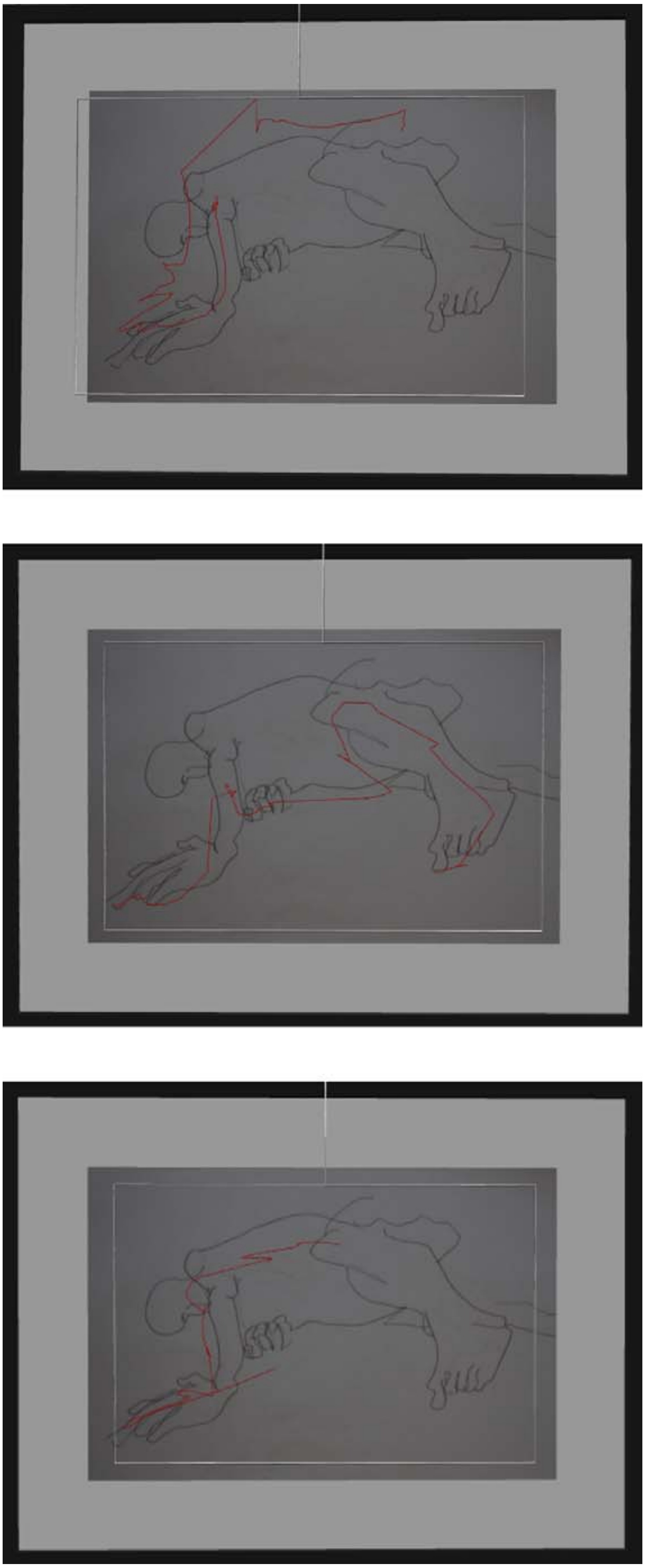


Figure 84: Selected eye drawings of the initially uploaded drawing.

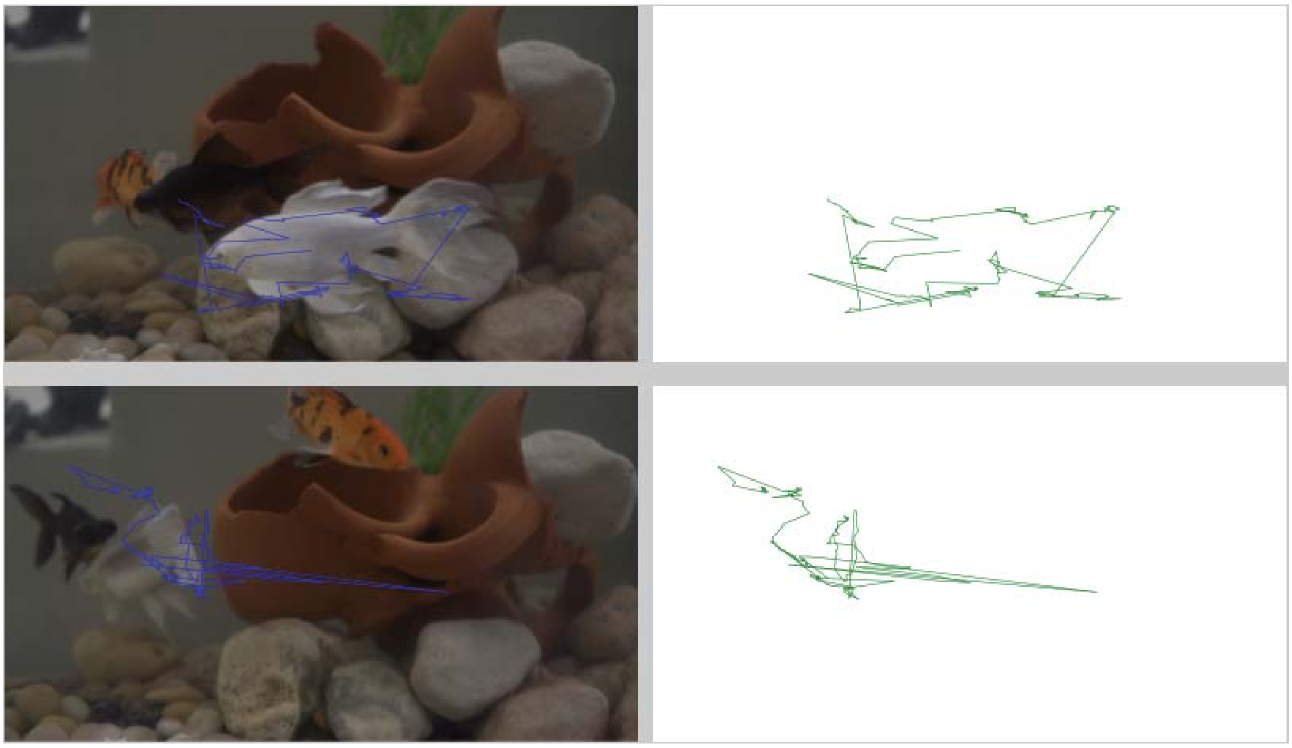


Figure 85: Selected results of the first attempts at eye drawing from a real world view.

This was the introduction to Cross' study, after which he theorised that should an artist remove the hand from this loop, the immediate communication between the eyes and the brain would cancel some of the restraints present during the 'traditional' way of drawing. In a way, I feel that during eye drawing the entire opposite of this takes place, mainly because in my drawing practice I never associated the act of drawing with any type of limitation (unless voluntarily). After the first testing of eye drawing, I felt that as a drawing practitioner I had to abandon the usual mode of looking and suppress the impulse of moving the hand (or any other part of the body mimicking the trace) accordingly to what was being looked at. This greatly felt like a limitation within itself, while time and practice were needed to get used to a new method of drawing. The feeling was similar to when an individual who is used to driving a manual car, suddenly changes to an automatic version and a propulsive action is subtracted from the mental script for driving. Therefore, it results in the constant need to suppress the impulse of using the left hand and foot for manually changing the gears. During eye drawing, this overthrow acts on the hand.

The second main difference from the traditional way of drawing lies in the containment and attempt at controlling the eye movements themselves. As explained earlier by citing Graham-Dixon's experiment (see p. 35), it has been suggested that the eye movements during the act of drawing do not have a holistic approach, but fixations happen in details which are immediately transcribed (and made physical/tangible) on paper through the hand's response. Therefore, there is a constant back-and-forth between specific fixations towards the real world and added detail in a drawing. This process cannot exist during eye drawing, as there is no physical drawing to refer leading the way towards the next specific fixation. During the recording stage of eye drawing, the drawing is still just data being inputted inside a computer and is therefore not tangible or visible during the process. During eye drawing the eye movements are hence "forced" to follow a created path dictated by the brain, which is based on a real worldview. This path can only be cross-referenced with memory; short-term memory to be more precise. In Graham-Dixon's experiment, fixations were also shown to happen in details as spatial relations of the concerned subject were being measured by the artist while drawing, and this way of perceiving distances was also eliminated in the process of eye drawing as the eye movements decided upon contours to follow along the observed real world.

In practical terms, I find the process of eye drawing closer to the common drawing exercise of blind contouring. It is a drawing exercise developed from the Surrealists' era as part of their automatism research, categorising it as a direct product of the unconscious. After Breton became acquainted with Sigmund Freud's psychoanalytical writings about the unconscious, he rapidly adapted them to the development of automatic writing techniques together with his friends (Hopkins, p. 17). "Automatic" techniques were promptly appropriated by artists because of their natural way of creating accidental instances through their element of chance, and blind drawing fitted this equation. Specific artists, like Max Ernst, also appropriated from the Dadaist implications of chance, and modified them to respond to the Surrealist unconscious objectives (Hopkins, p. 79).

The Surrealists wanted to negate the "self", and to a certain extent this was possible through the suppression of the conscious ego present in our collective mind by introducing what they called "an objective chance" (Baugh, p. 57). Blind contouring then developed in what is now a common exercise implemented in Art Education through a specific rule; that of drawing without looking at the paper surface. Several art teachers and drawing practitioners employ this method for different reasons. In a conversation with local artist Caesar Attard, my experimentation with eye drawing reminded him of a participatory project he had done in the 1970s called, *The Artist as Model*, where participants attempted blind drawings of the artist and were later asked to identify their work and sign it (see Appendix A, lines 73 - 83). In different examples, Naves (2012) discusses the reaction of one of his students after trying this exercise for the very first time by attempting to blind contour a meat-grinder, where according to the student in the end he wasn't drawing it but experiencing it. It also became a good exercise associated with helping artists break their own convention of drawing, and as Anderson (2015) describes it can be the most suitable cure to 'perfectionism', as the construct of a perfect rendering of the real world is discarded the minute one decides to blind contour the real world, and in reality the accident lies in the surprising occasions of resulting accomplished details. It is a type of drawing which makes us see what we look at by triumphing on the visual chaos in front of us other than simplifying it as our brain perception does during our daily routine (Anderson, 2015). In this view, blind drawing is already close in nature to eye drawing; both impose an 'unnatural' physical imposition of how to look at the world. In both activities the creator (who in turn also becomes a viewer) experiences seeing the real world other than simply looking at it, as the perceptual complexity offered by our visual environments are intricately interpreted through eye gestures echoed by imaginary traces in the brain. This all happens during the act of seeing i.e., before uncovering the hidden paper—or in the case of this research before processing the recorded data into scanpaths—but there's more to this to take into account.

Nicolaïdes (1969) described the exercise of blind contouring in accurate detail in his textbook about drawing by affirming that blind drawing should start by focusing the eyes on any point along the model’s contour while a pencil (or any other drawing medium) is placed on paper (Nicolaïdes, 1941, p. 9). The successful handling of blind contouring involves two important considerations. Firstly, it is important that one pictures the pencil tip as if it were brushing against the model’s contour instead of the paper’s surface (Nicolaïdes, 1969, pp. 9 - 10). To a certain extent, this makes the observer (artist) mentally embody, and consequentially sense the spatial dimensions concerning the model in front of him or her. Therefore, the observed view stops being a mere vision of the world and becomes a perceived discovery instead. Secondly, the speed of the eye movements has to be in synchrony with that of the hand’s response, and therefore the pencil’s motion is literally equivalent to that of the eyes (Nicolaïdes, 1969, pp. 9 - 10). This point goes hand-in-hand with the previous one, as through the implementation of both, the time concerned with perceiving a worldview is slowed down. In fact, the exercise has been paralleled to the act of climbing (and therefore experiencing) a mountain as opposed to looking at it from an aeroplane (Nicolaïdes, 1969, p. 11). However, how is this comparable to the process of eye drawing?

After the first eye drawing attempts, it quickly became evident that the needed patience while looking and the control of the eye movements are extremely similar to what has been described above with respect to blind contouring. Eye drawing too changes the process of looking into seeing, hence into a specific way of perceiving. Its process also starts by fixating on any point of the model’s contour, from which the eye movements are then drawn to follow a contour path. Again, as in blind drawing, there is no possibility for a real-time visual information update due to the constant comparison between the rendering of a drawing and the observation of the real world. In this view, it has been suggested that during blind contouring the resulting drawing is not affected by a-priori concepts. The hand can never be directed to systematically fix a drawing through the influence of existent constructs of the involved representation, and therefore the top-down domination present in cognitive literature when describing the act of drawing, is obliterated (Tchalenko, Nam, Ladanga and Miall, 2014). This same argument should likewise apply to the process of eye drawing as not only the drawing cannot be consulted during the eye-tracking process, but also there is no hand movement to be directed during the 'rendering' of the real world. Research also suggests that blind drawing also happens during the normal act of drawing from observation, and that during difficult tasks, artists were more prone to employ this method as it allowed the hand to respond to the direct gazes towards the original subject (Tchalenko et al., 2014). In Figure 84's case, the attempt was to eye draw an already accomplished linear drawing, and therefore the flow of the eye movements while deciding on a drawing path felt quite natural. This proved to be different when the uploaded drawing was replaced with a photograph of the real world such as Figure 85. Following are some main points to consider in relation to the evolution of this argument.

Firstly, when eye drawing from an image of the real world the eyes have to decide which 'imaginary' line to follow in order to invent a contour representing the concerned worldview (in Figure 85's case; a fish). It has been observed that since the very young age of two and a half years, our eyes are already capable of following pre-existent simple lines and in turn guide the hand's motion into an attempt at copying it; a process known as target locking, where the hand follows an imaginary future point dictated by the eyes (Tchalenko, 2013). This differed in nature from when the same two-and-a-half-year-old subject was observed while drawing from imagination on a blank piece of paper, in which scenario the hand led the eye during the process of image-making (Tchalenko, 2013). By eye drawing Figure 85, the eye movements were following a path as dictated by various cognitive processes, happening mostly inside the visual cortex, in order to best describe a suitable rendered line representative of the scene. At the same time there was no hand movement to communicate to. The first eye drawings of the concerned photograph (Figure 85) were less successful than those of the previous linear drawing (Figure 84). I felt there was missing information and experience on how to tackle this problem, and as shown by the results in Figure 85, the eye movements appear to have been a mix of saccadic movements as happening under normal viewing circumstances and short intervals where they followed some sort of rational contouring.

These intervals are predominantly the traces of controlled and guided eye movements, but involuntary movements are naturally inevitable, and also of utmost interest for this research. To a certain extent, the saccadic movements present in the eye drawings of Figure 85 resemble those analysed by Yarbus (1967, pp. 172 - 173). Saccades also consist of a number of unconscious movements which are not perceived by us while observing the real world, and their principal function is to shift our fixation points towards specific motifs of interest in our perceived scene, while refining our visual experience of it (Yarbus, 1967, p. 129). Already in the late 1960s, empirical research had shown that even large saccadic movements of up to 15 - 20° can occur unconsciously to the individual (Yarbus, 1967, p. 105). Moreover, further research from the 1970s suggested that saccadic movements intuitively shifted from evident areas of interest during the perception of an object (e.g., the corners when looking at a square), which movements were also quite variable and subjective between different observers (Duchowski, 2007, p. 8). In addition to this, empirical eye-tracking studies have to assume that attention is a direct result of the foveal fixation points since the technology only captures the overt eye movements, while in reality there is sufficient research to also suggest that even through peripheral vision, elements of the observed worldview are perceived (Duchowski, 2007, p. 12). In order to put this theory into a practical context, it is interesting to note that while reading, research suggests that due to the swift nature of the saccades no valuable information is obtained during movement and on average one saccade measures eight or nine letter characters (Rayner, 1995, p. 4). The eye gathers suitable information for processing through the foveal region, which consists of a one degree angle of vision from both left and right of each fixation point (Rayner, 1995, p. 5). It is therefore this eye region which concerns eye drawing, and for a successful scanpath rendering, this region's movements have to be as controlled as possible along the worldview's contours. There has to be the attempt at capturing visual information during the slow movements of the eyes along a directional path. The natural saccades have to be contained and merged with the usually much longer fixation points, as the eye movements perceive information while mimicking the imagined contours.

Figure 86: Eye drawing (in red) of two fish superimposed on top of the original world view.

Figure 86 shows one of the earliest satisfactory eye drawings, which showed a practical advancement in the theory described above. When compared with Figure 85, Figure 86 shows a drawn scanpath which proves to be the result of much better controlled and more conscious eye movements. At several instances of the latter eye drawing, the shape is very close to the concerned worldview, and this draws us to a final comparison with the act of blind contouring. It has been observed that the scaling of the blind-drawn object can greatly vary from the original object being drawn, differing from the shape recognition which can be highly accurate (Tchalenko, 2013). This proves also true to the resulting eye drawing shown in Figure 86, where while a difference in scale is evident (also through the shifted positioning of the eye drawing when compared to the original scene), the rendering detail concerning object recognition resulted to be very accurate and interesting for artistic purposes.

Figure 87: Selected eye drawing of a dog’s face.

Results like Figure 86 were very encouraging for the purpose of this research and paved the way to further development and experimentation using *The Eye Tribe*. Different photographs were uploaded and tested such as Figure 87, concerning an original photography of a dog looking straight at the camera. The main difference between the latter and Figure 86 lies in the scaling of the concerned object. The eye drawn fish inside the aquarium was much smaller when compared to the entire composition the dog’s face occupies. This would call for slower and more focused eye movements as the contours prove to be longer. Since the designed JAVA software in connection with *The Eye Tribe* allowed a viewing time of 20 seconds for eye drawing, and since the virtual room allowed the upload of four images which were viewed sequentially, images like Figure 87 were uploaded in all four possible frames in order to be repeatedly eye-drawn during the same session. The 20-second viewing time was set up in view of the fact that this particular eye-tracking device seemed to occasionally disconnect when over-heated, and this controlled it. Even though these intervals might initially appear as hindering the practice of this research, they resulted in giving crucial breaks to the eye movements after eye-drawing, which were therefore constructed in layers. Apart from illustrating a chronological evolution of the concerned eye drawings, this also created interesting comparable results which could be layered into the same eye drawing image during post-production. Figure 88 is such a case scenario where a total of twelve eye drawings were super imposed after being downloaded as .png images, imported into *Pixelmator* and exported as single images. On the other hand, Figure 89 is an image composed of three superimposed eye drawings which were also included in Figure 88, and Figure 90 is an image illustrating a single eye drawing. This meant that apart from resulting in a drawing which phenomenologically represented the direct experience engaged by the eye as one tries to express the world through drawn lines, images from different chronological instances could also be created and manipulated.

Figure 88: 12 superimposed eye drawings of the image in Figure 87.

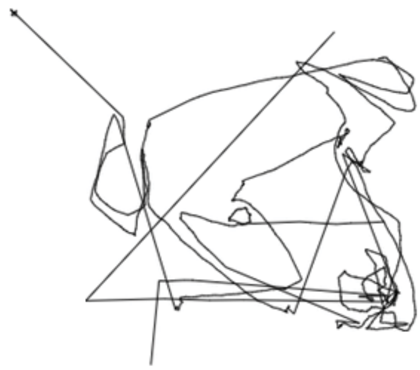


Figure 89: 3 superimposed eye drawings of the image in Figure 87.

Figure 90: An eye drawing of the image in Figure 87.

The forthcoming chapter will discuss and show how the post-processing of the recorded eye-tracking data was dealt with, together with possible ways of representation. In conclusion to this chapter I would like to mention two other selected typologies of eye drawing results using *The Eye Tribe*. Figure 91 is an eye drawing of a Facebook window. Since we nowadays practically live and perceive huge parts of our lives through our technological devices' screens—and specifically through social media platforms—it made sense to me that with a technological tool such as *The Eye Tribe* I attempt to eye draw a series of common scenes perceived on a daily routine by a huge percentage of the western population. The subject is not simply a view from the real world anymore, but a collage of photographs, text, sound, animation and adverts. Eye-tracking on websites is usually used for marketing purposes in order to assess the best spots in a particular design which attract most attention. When it came to eye drawing, the interest was different and Figure 91 illustrates a juxtaposing of visual information between virtual images and text bounded by a screen.

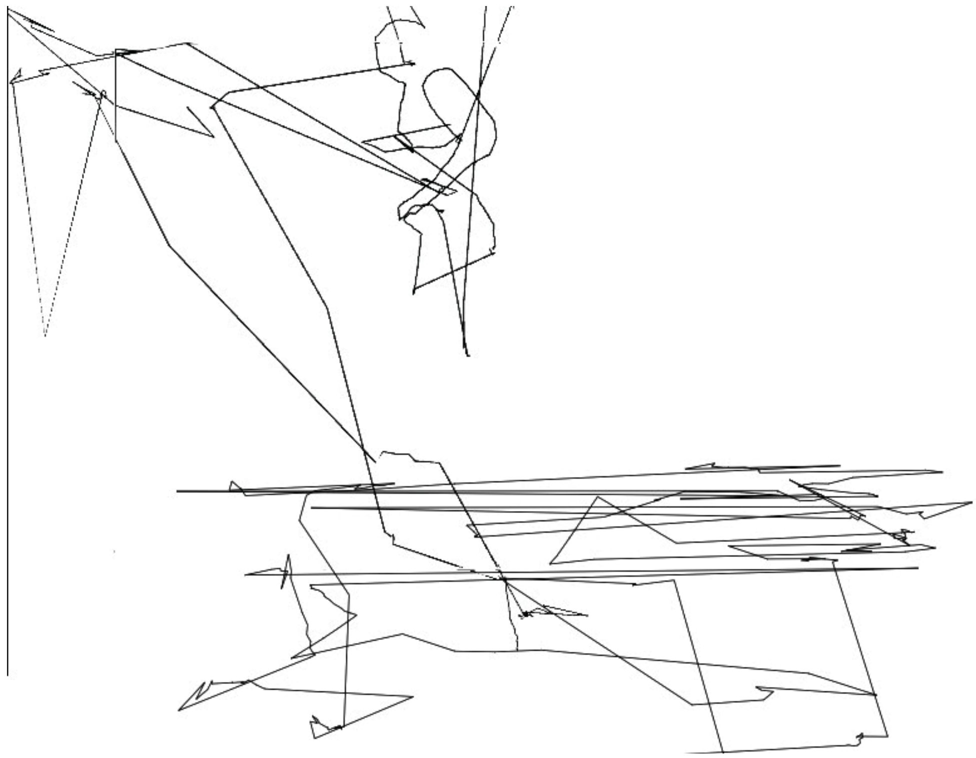


Figure 91: An eye drawing of a Facebook screenshot.

One last notable mention is the fact that inside the virtual room on *Google Chrome*, the possibility to have a blank canvas had also been designed. This permitted me to draw from memory by using the computer mouse (while the eye-tracker still recorded data), or to directly eye-draw by staring at the blank canvas. Figures 92 - 93 are two eye drawings resulting from such exercises respectively. Figure 92 is a superimposed image of drawn contour lines from memory by using a computer mouse (red lines) and its resulting eye drawn data (blue lines). Although the scaling and positioning is different, the shape is strikingly similar at first glance. Visual differences lie mostly at particular tight corners of the mouse-drawn contours, which resulted in being more acute and sharp in the eye drawing. This is mainly due to the difference in the nature of the movements between the eyes and the hand, where the first is straight-oriented due to the saccades' high velocity while the latter is of a more curvilinear characteristic. A saccade has also been recorded towards the centre of the eye drawn composition which does not appear in the mouse drawing. This was probably the result of an involuntary eye movement while cross-checking the red drawing itself, and again, such phenomenological instances prove to be of utmost interest to this research question. On the other hand, Figure 93 is the portrayal of an eye drawing from memory. Once the eye drawing depicted in red was completed, an eye drawing of it was instantly attempted. Both contours were super-imposed as in Figure 93 during post-production, and nothing was visible during the eye drawing process of the black contour (the eye drawing from memory). Again, this proved to be of great interest as parts of the eye drawing from memory are strikingly similar to the previously eye-drawn fish, while other parts are the result of a free interpretation combined with saccadic movements. For a selected number of eye drawings done using *The Eye Tribe*, please refer to Appendix C.

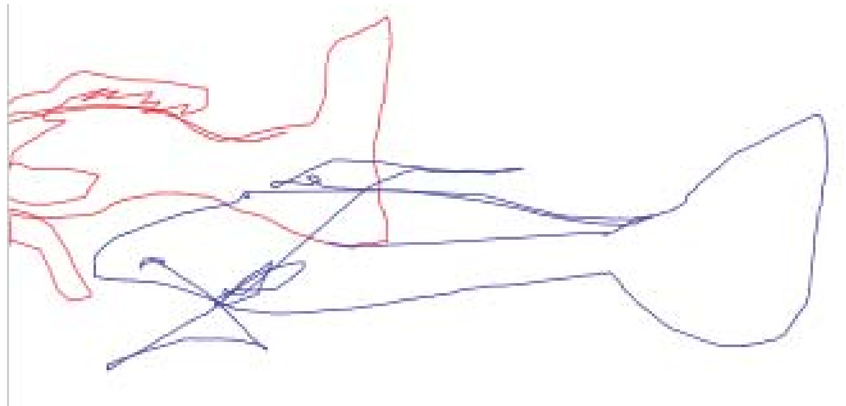


Figure 92: A memory drawing of a fish using the computer mouse (red lines) and the resulting eye drawing of it (blue lines).

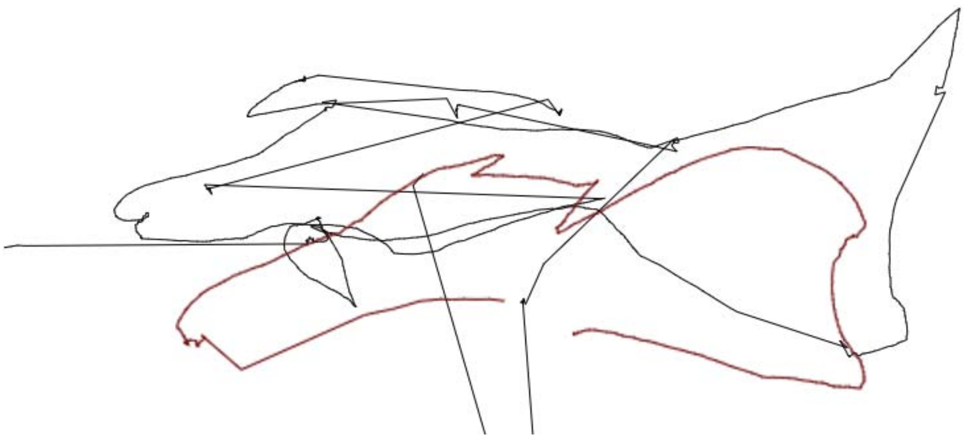


Figure 93: An eye drawing of a fish from memory (black lines) done right after the completion of the fish eye drawing from a real world view (red lines).

Processing *The Eye Tribe* Results

Through these experiments it became evident that recorded data from an eye-tracking device in the form of eye drawing, could successfully find a place in an artistic process and the subsequent steps in this practice-led methodology were stimulating for the extension of this process into a variety of possible implications. Once results such as Figures 84 - 93 were obtained, the next logical question within the artistic process itself was to inquire what to do with it and how to visually externalise it. The challenges here were many, but essentially, the hardest task involved the decision-making within the evolution of the artistic process itself, which I tried to influence through its own rational procedures other than by visualising a finalised product; a similar approach taken by SenseLab, at the Concordia University in Montreal (Massumi & Manning, 2015). As both these authors underline in one of their publications, experimental practice manifests techniques able to create procedures of which properties cannot be anticipated; this concept of creating within a research process permits one to find new ideas in-the-making, therefore being a pragmatic future-oriented practice (Massumi & Manning, 2014, p. 89).

When reflecting upon results such as the selected Figures 84 - 93, it became apparent that these were not simply eye drawings, but also traces of the invisible. The medium being used was essentially a scientific device (a machine), and this inevitably added an empirical aesthetic to the resulting visuals. This interested me due to the fact that the same scientific visual appeal was contemporarily defied by the unnatural subjective input of the eye drawing itself. I found them to be very close to several descriptions Manning (2009) wrote in a chapter dedicated to Étienne-Jules Marey, where in principal she described Marey's research as being invested in the experiential on the frontline of the very processes of perception itself, through the tracing of existent imperceptible movement (pp. 83 - 111). A noticeable explanation from the same chapter, talks about how the process of seeing is not merely an act of recomposing form, but a process which puts in evidence that to see is to generate through the feeling of motions taking shape (Manning, 2009, p. 85). In the case of my research, these motions were controlled eye movements, changing the act of unconscious seeing into a deliberate search while giving shape to a usually imperceptible trace. In this view, the important notion of eliminating the artist's body from the 'drawing' equation had to also be given a strong importance and focus.

Furthermore, one could say that the eye drawing results have artistic value within themselves. The first logical action was to therefore print them and present them as actual drawings. This was possible due to the previously mentioned option of downloading a .png image file of the traced eye movements. The images were imported into *Pixelmator*, scaled accordingly and printed with a high quality ink-jet Canon photo printer on a 250gsm cotton paper. The images were printed in series, which also included superimpositions of different eye drawings as shown in Appendix D. These superimpositions visually represented a number of eye drawings of the same subject (photograph) done in different instances onto a single two-dimensional paper plane, and in order to enhance this sense of time-difference between each layer, different layers were given different colour gradations following their own chronological logic (Figure 94). Essentially, this method of digital printing was the most direct way of representing the concerned eye drawings, following their own nature of being digital data in the form of X and Y coordinates.

Figure 94: Superimposed fish eye drawings with different chromatic values representing different moments in time.

Another materialising experiment for the representation of these two-dimensional *Eye Tribe* eye drawings, attempted the combination of both the digital techniques (the resulting digital data) and the traditional (analogue) way of printing, relating to the dry-point etching method. The traditional dry-point technique involves the process of manually engraving a drawing onto a metal plate, from which the prints are then obtained through the use of a high-pressure printing press. In this case I did not want to manually interfere with the resulting drawings, as this would have compromised the logic of the eye drawings themselves by re-introducing the 'hand ability' discourse concerning drawing. Therefore, the .csv X and Y coordinate data files where plotted into a Drawing Exchange Format (.dxf) file which could be imported into a CNC milling machine. As shown in Appendix D, the digitally engraved (etched) copper plate was then inked and printed in the traditional way at the Etching Department of The Malta School of Arts.

Relating to a Three-Dimensional Space

The processes mentioned above strictly concern two-dimensional representations, which to a certain extent also matched the coherence of how the eye drawings were created. Until now, the processing of the eye drawing experiments did not concern the three-dimensional space, and could only be produced specifically in front of a computer screen by gazing at uploaded drawings, photos, or virtual windows such as browser pages like Facebook amongst others. Still, I wished to test whether it was possible to project three-dimensional results, which would also link back to my previously mentioned interest in the beholder's perceptive processes while engaging with linear sculptural elements (see pp. 116 - 124). It is here opportune to again quote from Manning (2009), where when discussing Marey's sculptural rendition in bronze of his captured seagull's movement in flight (Figure 95), the scientist was using; "experimentation as a necessary tool for the production of quantifiable results" (p. 98). Manning (2009) argues that should Marey only have had an interest in quantifying his results, there would have never been the need for him to come up with visual approaches such as a bronze sculpture, which the author identifies as ‘movement machines’ fuelling innovation and encouraging more experimentation (p. 99). Throughout the practice of this dissertation, I could strongly relate to this latter concept. While my research interest was not the same ‘movement’ as observed by Marey in his experiments, extending the previously mentioned eye drawing results into the three-dimensional realm offered new takes on the experiments to follow, especially through new perceptions which were previously not possible (see Appendix D for selected work proposals developed from *The Eye Tribe* eye drawings).

Figure 95: *Décomposition du vol d’un goéland*. Marey. 1887. Bronze. Marey Museum. Beaune, France. (Manning, 2009, p. 98)

The Pupil Headset

The next breakthrough of experimenting with eye drawing was in looking for a method permitting one to eye-draw from the real world, with the least possible intrusion from the device being used. This would break free the limitations presented by *The Eye Tribe* of solely eye drawing in front of a computer screen, and would take the testing to a new level by attempting an eye drawing while fully perceiving real world contexts. In this view a research of commercially available mobile eye trackers was conducted, and the most suitable for the purpose of this dissertation seemed to be the *Pupil Headset* (Pupil Labs). This was acquired by the Cognitive Science Department within the Department of Digital Arts' same Faculty of Media and Knowledge Sciences in June 2017 for me to utilise during this dissertation.

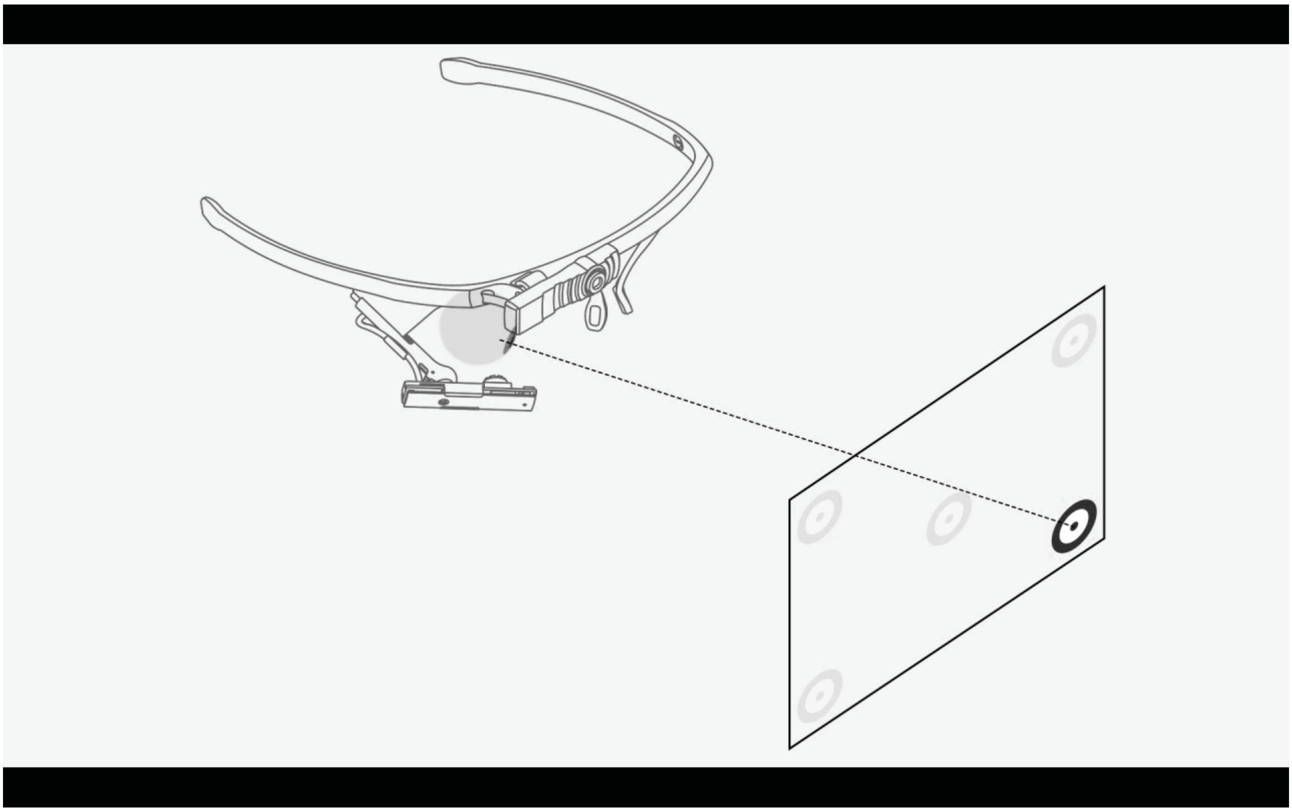


Figure 96: Calibration illustration of the *Pupil Headset*.

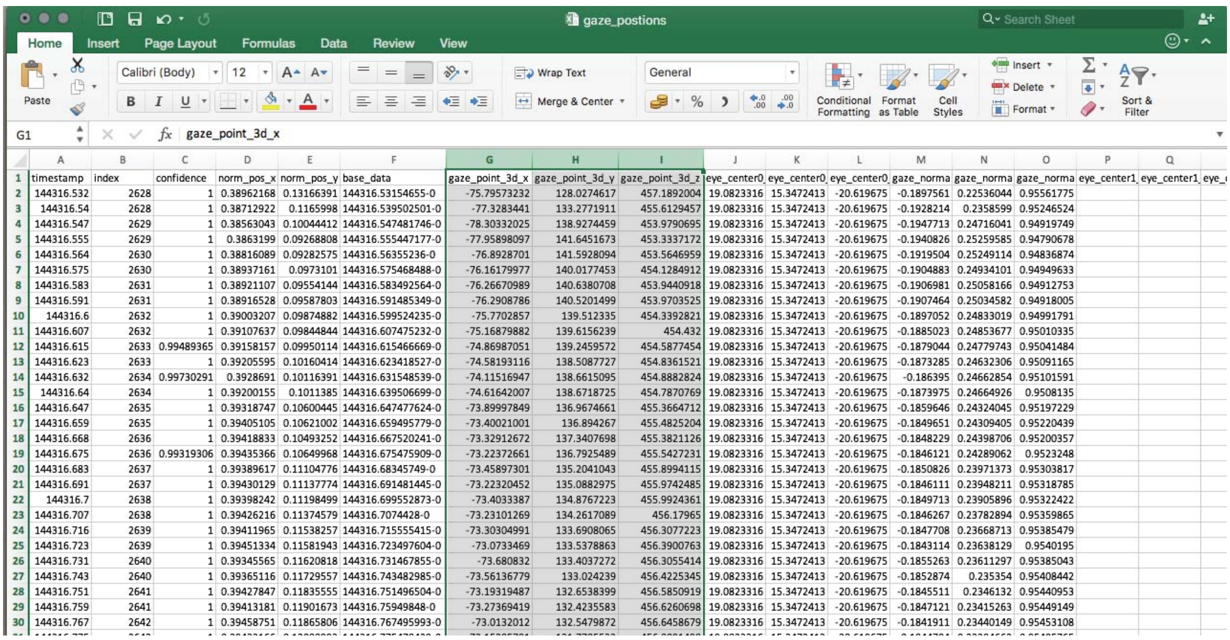
The *Pupil Headset* consists in a wearable headset which is a plug-and-play USB device designed to be lightweight, unobtrusive, and easy to use (Pupil Labs). It was launched as an extensible open source platform, and also includes a downloadable user interface for playback, video visualisation and gaze data exportation, while recording includes; "state-of-the-art algorithms" for precise gaze detection and accurate estimation (Kassner, Patera & Bulling, 2014). The mobility during eye-tracking is possible through two different recordings from the HD high-speed world view camera and the 120hz camera recording the eye's movements. The acquired *Pupil Headset* was the monocular version. Apart from the crucial difference with *The Eye Tribe* of permitting eye drawing experiments while looking at the real world, the *Pupil Headset* also offered much more accurate results with a certified 0.08 degree precision against the 0.5 offered by *The Eye Tribe*.

To operate, the *Pupil Headset* needed the download of two free apps offered by the company for the respective recording and processing of data. *Pupil Capture* and *Pupil Player* were downloaded via https://github.com/pupil-labs/pupil/releases/tag/v1.1 and installed. Once the headset was worn and plugged in through a USB port, *Pupil Capture* was loaded. Both world view and eye cameras were put in focus and calibration followed through *Pupil Capture* (Figure 96).

Eye Drawing Results from *The Pupil Headset*

One of the first *Pupil Headset* experiments, was to track my gaze during the practice of object drawing. I wore the headset while drawing a cement figurative sculpture of a model in a sleeping position (Appendix E). As expected, the visual result of the eye-tracking (Figure 97) resembles the concepts described earlier through Graham-Dixon's experiment (see pp. 35 - 37), where the eye scan-paths followed a strict logic between the observed object areas and the hand drawing. The results were obtained by exporting the raw data from the eye-tracked recording through the device's own software *Pupil Player*. This saved a .csv file, which included data such as time, frame index, X gaze-position, Y gaze-position and eye-centre positions amongst others (Figure 98). The .csv file was cleaned of unnecessary data, keeping the X and Y coordinates, which were then imported into *Blender*, an open source 3D computer graphics software. The coordinates where here plotted and exported as image (Figure 97). Essentially, this methodology of visualising the recorded data was applied to all respective *Pupil Headset* experiments from this point onwards (Appendix E). Two points are here worth noting. Firstly, this eye-tracking device not only permitted the tracking of a three dimensional space, but also exported Z-coordinate data which represented the variation in gaze-distances, which could range from 50 cm to 200 cm. Also, once any respective data was imported into *Blender* (or any other 3D computer graphics software), the opportunity for artistic developments towards the creation of tangible works stemming from the eye drawings (such as sculpture) was immense as shown in Appendices E and F, and techniques will continue to further develop after the submission of this research for the purpose of exteriorising the respective findings.

Figure 97: Diagram showing the eye scanpaths following a strict logic between the observed object areas and the hand drawing.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	timestamp	index	confidence	norm_pos_x	norm_pos_y	base_data	gaze_point_3d_x	gaze_point_3d_y	gaze_point_3d_z	eye_center0_	eye_center0_	eye_center0_	gaze_norma	gaze_norma	gaze_norma	eye_center1_	eye_center1_
2	144316.532	2628	1	0.38962168	0.13166391	144316.53154655-0	-75.79573232	128.0274617	457.1892004	19.0823316	15.3472413	-20.619675	-0.1897561	0.22536044	0.95561775		
3	144316.54	2628	1	0.38712922	0.1165998	144316.539502501-0	-77.3283441	133.2771911	455.6129457	19.0823316	15.3472413	-20.619675	-0.1928214	0.2358599	0.95246524		
4	144316.547	2629	1	0.38563043	0.10044412	144316.547481746-0	-78.30332025	138.9274459	453.9790695	19.0823316	15.3472413	-20.619675	-0.1947713	0.24716041	0.94919749		
5	144316.555	2629	1	0.3863199	0.09268808	144316.555447177-0	-77.95898097	141.6451673	453.3337172	19.0823316	15.3472413	-20.619675	-0.1940826	0.25259585	0.94790678		
6	144316.564	2630	1	0.38816089	0.09282575	144316.56355236-0	-76.8928701	141.5928094	453.5646959	19.0823316	15.3472413	-20.619675	-0.1919504	0.25249114	0.94836874		
7	144316.575	2630	1	0.38937161	0.0973101	144316.575468488-0	-76.16179977	140.0177453	454.1284912	19.0823316	15.3472413	-20.619675	-0.1904883	0.24934101	0.94949633		
8	144316.583	2631	1	0.38921107	0.09554144	144316.583492564-0	-76.26670989	140.6380708	453.9440918	19.0823316	15.3472413	-20.619675	-0.1906981	0.25058166	0.94912753		
9	144316.591	2631	1	0.38916528	0.09587803	144316.591485349-0	-76.2908786	140.5201499	453.9703525	19.0823316	15.3472413	-20.619675	-0.1907464	0.25034582	0.94918005		
10	144316.6	2632	1	0.39003207	0.09874882	144316.599524235-0	-75.7702857	139.512335	454.3392821	19.0823316	15.3472413	-20.619675	-0.1897052	0.24833019	0.94991791		
11	144316.607	2632	1	0.39107637	0.09844844	144316.607475232-0	-75.16879882	139.6156239	454.432	19.0823316	15.3472413	-20.619675	-0.1885023	0.24853677	0.95010335		
12	144316.615	2633	0.99489365	0.39158157	0.09950114	144316.615466669-0	-74.86987051	139.2459572	454.5877454	19.0823316	15.3472413	-20.619675	-0.1879044	0.24779743	0.95041484		
13	144316.623	2633	1	0.39205595	0.10160414	144316.623418527-0	-74.58193116	138.5087727	454.8361521	19.0823316	15.3472413	-20.619675	-0.1873285	0.24632306	0.95091165		
14	144316.632	2634	0.99730291	0.3928691	0.10116391	144316.631548539-0	-74.11516947	138.6615095	454.8882824	19.0823316	15.3472413	-20.619675	-0.186395	0.24662854	0.95101591		
15	144316.64	2634	1	0.39200155	0.1011385	144316.639506699-0	-74.61642007	138.6718725	454.7870769	19.0823316	15.3472413	-20.619675	-0.1873975	0.24664926	0.9508135		
16	144316.647	2635	1	0.39318747	0.10600445	144316.647477624-0	-73.89997849	136.9674661	455.3664712	19.0823316	15.3472413	-20.619675	-0.1859646	0.24324045	0.95197229		
17	144316.659	2635	1	0.39405105	0.10621002	144316.659495779-0	-73.40021001	136.894267	455.4825204	19.0823316	15.3472413	-20.619675	-0.1849651	0.24309405	0.95220439		
18	144316.668	2636	1	0.39418833	0.10493252	144316.667520241-0	-73.32912672	137.3407698	455.3821126	19.0823316	15.3472413	-20.619675	-0.1848229	0.24398706	0.95200357		
19	144316.675	2636	0.99319306	0.39435366	0.10649968	144316.675475909-0	-73.22372661	136.7925489	455.5427231	19.0823316	15.3472413	-20.619675	-0.1846121	0.24289062	0.9523248		
20	144316.683	2637	1	0.39389617	0.11104776	144316.68345749-0	-73.45897301	135.2041043	455.8994115	19.0823316	15.3472413	-20.619675	-0.1850826	0.23971373	0.95303817		
21	144316.691	2637	1	0.39430129	0.11137774	144316.691481445-0	-73.22320452	135.0882975	455.9742485	19.0823316	15.3472413	-20.619675	-0.1846111	0.23948211	0.95318785		
22	144316.7	2638	1	0.39398242	0.11198499	144316.699552873-0	-73.4033387	134.8767223	455.9924361	19.0823316	15.3472413	-20.619675	-0.1849713	0.23905896	0.95322422		
23	144316.707	2638	1	0.39426216	0.11374579	144316.7074428-0	-73.23101269	134.2617089	456.17965	19.0823316	15.3472413	-20.619675	-0.1846267	0.23782894	0.95359865		
24	144316.716	2639	1	0.39411965	0.11538257	144316.715555415-0	-73.30304991	133.6908065	456.3077223	19.0823316	15.3472413	-20.619675	-0.1847708	0.23668713	0.95385479		
25	144316.723	2639	1	0.39451334	0.11581943	144316.723497604-0	-73.0733469	133.5378863	456.3900763	19.0823316	15.3472413	-20.619675	-0.1843114	0.23638129	0.9540195		
26	144316.731	2640	1	0.39345565	0.11620818	144316.731467855-0	-73.680832	133.4037272	456.3055414	19.0823316	15.3472413	-20.619675	-0.1855263	0.23611297	0.95385043		
27	144316.743	2640	1	0.39365116	0.11729557	144316.743482985-0	-73.56136779	133.024239	456.4225345	19.0823316	15.3472413	-20.619675	-0.1852874	0.235354	0.95408442		
28	144316.751	2641	1	0.39427847	0.11835555	144316.751496504-0	-73.19319487	132.6538399	456.5850919	19.0823316	15.3472413	-20.619675	-0.1845511	0.2346132	0.95440953		
29	144316.759	2641	1	0.39413181	0.11901673	144316.75949848-0	-73.27369419	132.4235583	456.6260698	19.0823316	15.3472413	-20.619675	-0.1847121	0.23415263	0.95449149		
30	144316.767	2642	1	0.39458751	0.11865806	144316.767495993-0	-73.0132012	132.5479872	456.6458679	19.0823316	15.3472413	-20.619675	-0.1841911	0.23440149	0.95453108		

Figure 98: Exported raw data in coordinates from *Pupil Player*.

The next *Pupil Headset* experiments consisted in testing it in similar conditions to where the *Eye Tribe* device had already been used in the earlier mentioned experiments (pp. 129 - 147). Images were eye-drawn while looking at webpages through a computer screen, such as Figure 99, which involves the eye drawing of a photograph of a baby elephant found on *The Guardian* photo story section (Appendix E). The superior quality from the previous *Eye Tribe* results is evident, while the clarity of execution might also be partially attributed to my eye drawing training since the beginning of this research. Another noticeable difference is the quality of line of the rendered output itself, as through the addition of values in the Z coordinates, the eye drawing now acquired an interesting representation of depth, which does not obey the rules of perspective or traditional representational values but is instead a direct result of the eye movements.

Figure 99: Eye drawing of a baby elephant and superimposed photograph found on *The Guardian* photo story section. (Appendix E)

At this point, the *Pupil Headset* became both my ‘pen’ and ‘drawing pad’. A number of eye drawing experiments were made in order to familiarise myself with the empirical device and discover its adaptation into an artistic methodology. Also, similar to an artist’s skill acquisition in a normal drawing practice, the more eye drawings I attempted the more I learnt about different possible outcomes; both with respect to the linear eye drawing results and to the possibility of further development within this artistic practice. A selected array of experiments can be found throughout Appendices E - H, and I will here discuss chosen pivotal ones which best describe the development towards the final communal eye drawing experiment (pp. 160 - 186). The latter experiment was to be the climax of this dissertation as since the first hunch of attempting an eye drawing through the use of an eye-tracking device, great importance has been given to the concept of the elimination of the artist's hand (body), and a communal experiment including participants who never attempted eye drawing would give further insight into this. As had been brought up in the conversation with Caesar Attard, through this method I was testing a strict brain-eye relationship away from the usual brain-eye-hand coordination present in most drawing practices (Appendix A, lines 119 - 128).

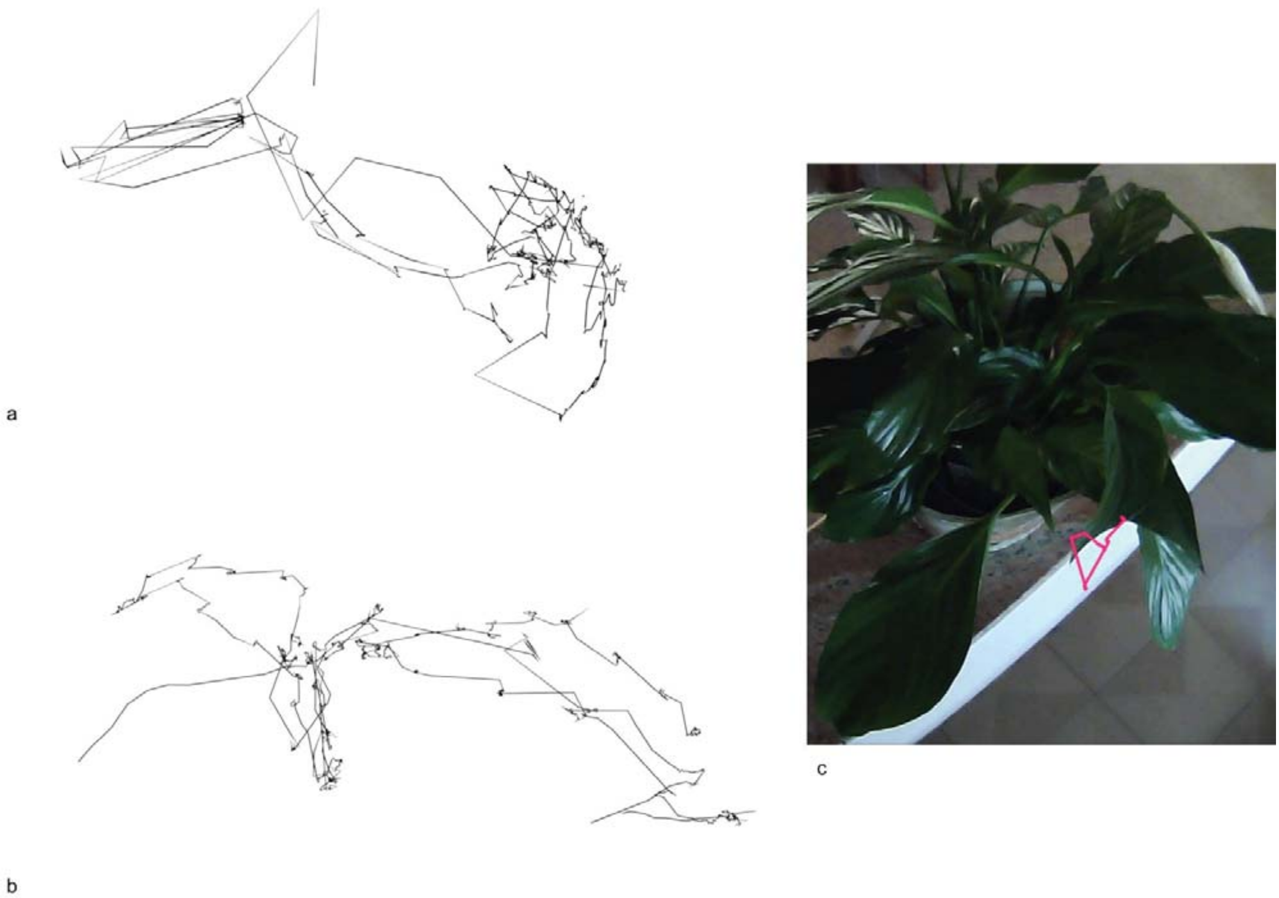


Figure 100: Eye drawings of the same plant at different gazing speeds.

A recurring practice at this stage was the eye drawing of plants. Plants provided an interesting practice due to their natural organic forms, and hence good training for attention to detail. They also aided in an understanding of possible curvilinear eye movements during eye drawing. By eye drawing plants, I was also able to test different gaze distances as well as eye movements' speed. Figure 100 shows such example where both eye drawings (a) and (b) concern the same plant (c), with the difference that image (a) was eye drawn at a gaze distance of 20 cm and a fast tracing method was utilised. Through the latter technique, less coordinates were created as the eye movements shifted rapidly around the designated contours. This point is clearly illustrated when comparing Figure 100 (a) with Figure 100 (b), where the latter is the eye drawing result of slower, and more controlled eye movements. More points are therefore created along the drawing's contour, and consequentially these same points are individualised inside the 3D computer graphic software. This eye drawing also shows more leaves as it was eye drawn at a gaze distance of 90 cm. By going through this experimentation, I wasn't necessarily trying to figure out how to achieve a successful eye drawing, but my intentions regarded the testing of different conditions in order to be applied accordingly during future projects. I therefore cannot judge whether Figure 100 (a) is a better eye drawing than Figure 100 (b), or vice versa, as this would be pointless. It is here also worth noting

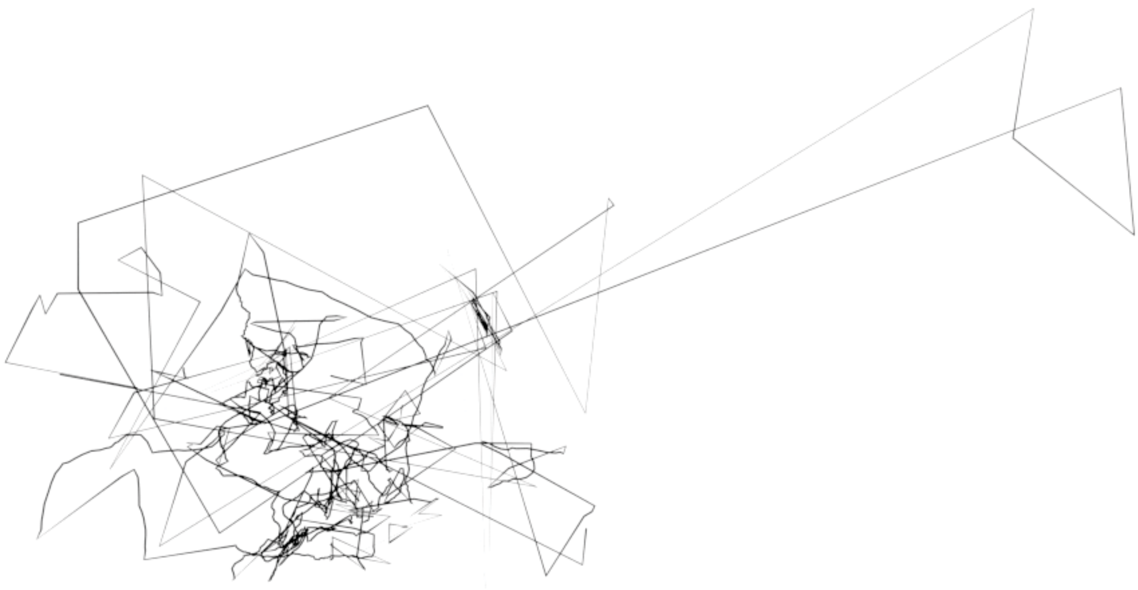


Figure 101: Eye drawing of plant while physically moving around it.

that the ‘abstract’ structure of plants facilitated elements of recognition during eye drawing, even in cases like Figure 101, which eye drawing is the result of physically moving around the plant while trying to also eye-trace along designated contours. The interesting outcome shows a mix of recognisable leaf details, moving gestures and unconscious saccades like the prominent ones protruding towards the top right corner. The next logical step in this practice development was then to attempt eye drawings of the human body.

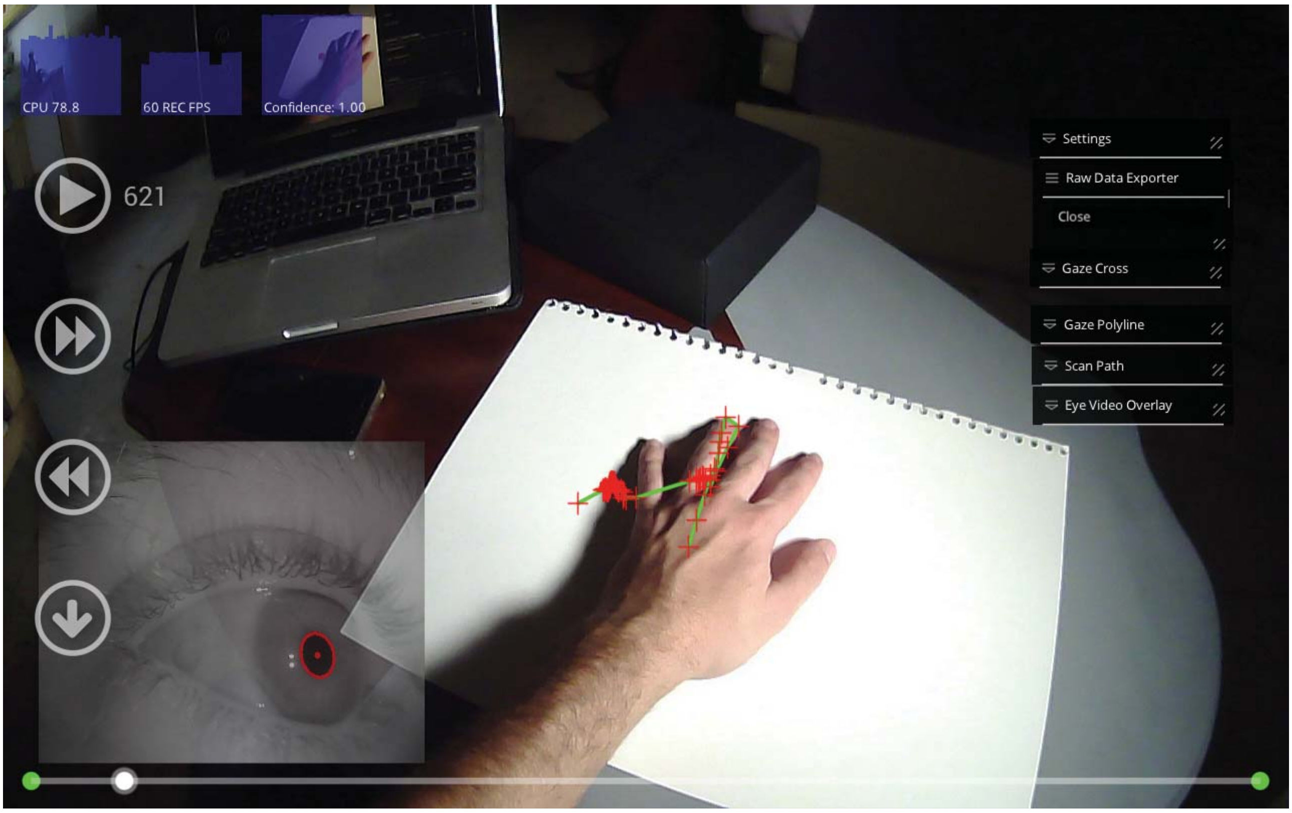


Figure 102: Screenshot from *Pupil Player* of a video of an eye drawing of a hand.

A feature which came with the introduction of the *Pupil Headset* into this research, and is worthy of a small parenthesis, is the possibility of exporting a video with several visualisation layers in the form of scanpaths, fixations and cross-markers amongst others. This video exportation is again possible through the previously mentioned software, *Pupil Player*, and Figure 102 represents a screenshot example from an exported video including the following overlays; gaze cross, gaze polyline, scanpath and eye video. This video data itself could be interesting grounds for several artistic processes, but since the development of this research concerned eye drawing, these waters were not explored. In relation to eye drawing, video data was instead utilised for the production of hand drawings such as Figure 103. The exported video was cleaned of all the unnecessary registered data through the use of Final Cut video editing software, except for the gaze cross filter (Appendix F). The video speed was also edited into a slow-motion modality, and the computer screen was then practically turned into a light box by covering it with a tracing paper as the slowed down gaze cross filter was followed with a pencil. A drawing using a technique similar to what Tchalenko (2013) describes as target-locking was therefore produced; not as a result of memory or object drawing, but as a result of tracing along a recorded eye-scanpath.

Figure 103: A hand drawing done by tracing the path of a cross-marker visualiser.

As previously discussed, after the series of eye-drawing experiments involving plants, I started to test details from the human body in anticipation of the final communal Life Class experiment (see pp. 160 - 186). The approach and methodology used was similar to what has been described above since the introduction of the *Pupil Headset*. Results also proved to be similar as shown by Figure 104, which represents two eye drawings of the same hand at a gaze distance of 20 cm. The visual difference between both is again a result of a difference in the speed of the eye movements during the moment of execution, where the left image shows more information along its contours due to slower and more controlled eye movements. In contrast, the representation on the right is the outcome of a fast eye drawn trace, and hence different in nature similar to what has been evidenced by the plant eye drawing in Figure 100. Interestingly enough, these two examples can be akin to hand drawing in which case slower gestures may produce a more precise drawing, while faster movements tend to result in gestural drawings (notwithstanding other influencing factors such as artist's skill and training).

Figure 104: A slow (left) and a fast (right) eye drawing of the same hand.

Preparatory Experiment for a Communal Life Class using *The Pupil Headset*

All *Pupil Headset* results and possible developments proved to be very exciting and stimulating, leading up to the most important experiment within this dissertation. By this point in time, the plan to organise a communal eye drawing exercise during a Life Class had been established, and this was to be instrumental to the question of eliminating the body of the artist from the activity of drawing. In order to better plan a suitable methodology for the latter experiment (see pp. 160 - 186), I conducted a small test in my studio together with a collaborator (having no art practice experience) who volunteered to eye draw my hand from five different points of view. My collaborator was advised to opt for a slow and controlled movement of the eyes along the designated contours of my hand. The same hand and points of view were then eye drawn by myself and the results compared (Appendix G). Until now, all eye drawings presented within this dissertation had been tracked by myself, and therefore this was a very important test in preparation to the communal exercise.

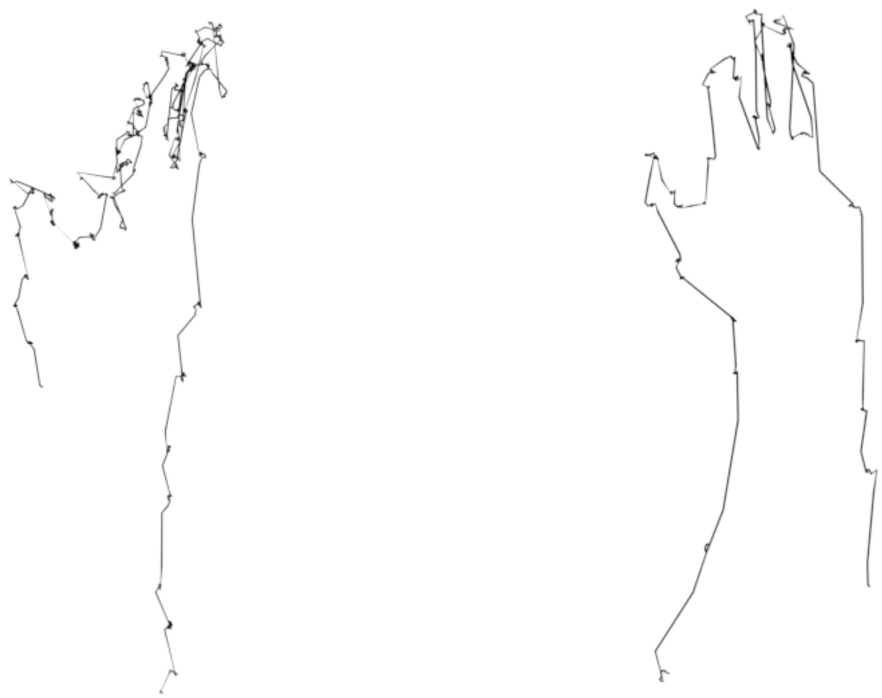


Figure 105: A comparison between a volunteer’s (left) and my (right) eye drawing of a hand.

Figure 105 illustrates two resulting eye drawings of the same hand while posing in the same position. The hand on the left was eye drawn by my collaborator, while the one on the right by myself. As stated earlier, my collaborator did not have any object drawing training prior to this test, and it was surprising and encouraging to see that both eye drawings were somehow similar in nature. One could argue that both eye drawings follow a related contour interest and the resulting differences are more typical of the activity of eye drawing itself other than our different drawing skill levels or experience, such as the evident change in scale of certain details such as the index finger in both eye drawings. At the same time, my eye drawing (right) did prove to be slightly clearer, and this can probably be attributed to my extensive use of the eye-tracking device up until this point in time.

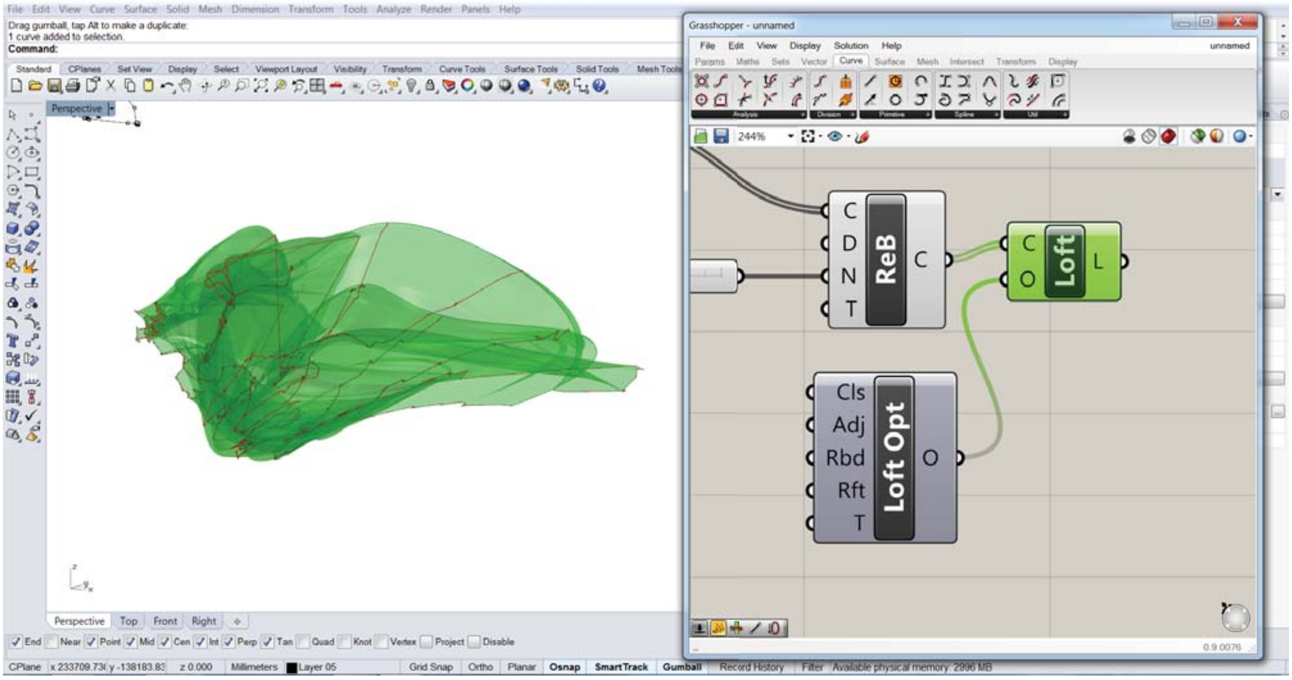


Figure 106: Screenshot from *Grasshopper* (*Rhino*'s graphical algorithm editor) showing the development of a sculptural sweep movement.

Similar to the methodology used in the development of the earlier *Eye Tribe* eye drawings (Appendix D), with the help of my collaborator Tanti (2014), all the respective ten eye drawing coordinates were imported into a Computer-Aided Drafting (CAD) system; in our case *Rhino 5*, for the testing of possible sculptural developments. All coordinates therefore were interpolated into curves appearing as plotted lines, and were arranged accordingly on the three-dimensional virtual plane. Two possible methods of compositional arrangements were identified on the basis of representing all eye drawings in relation to time; one which rotated the different scans of the same hand on one axis (potentially producing a three-dimensional representation of the hand through the eye drawn scans), and another composition included a sweep from one scan to another (representing a direction in time of the respective scans). In both cases, a surface was created between the curves through a lofting method, resulting in a mathematical representation of three-dimensional geometry known as Non-Uniform Rational B-Splines (NURBS). This method gave the facility to proportionally divide the iso curves into desired amounts along the V direction through the use of *Grasshopper* (*Rhino*'s graphical algorithm editor), which was the same direction of the sweep, movement, time or rotation in the respective models (Figure 106). To a certain extent, the reasoning behind the creation of these sculptural proposals (Figures 107 & 108) can find an analogy in the lofting process used in the building of boats. They too therefore have the option of being fabricated into any material.

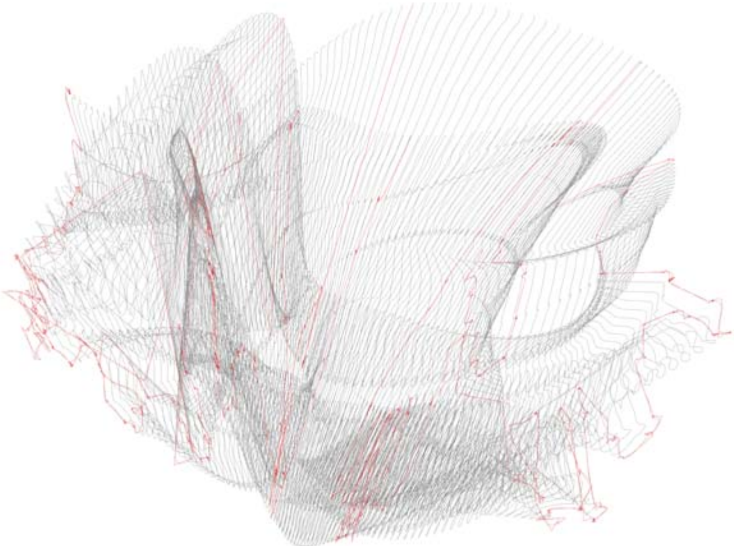


Figure 107: A top-view of the lofted model resulting from Figure 106. The red lines represent the five hand eye drawings.

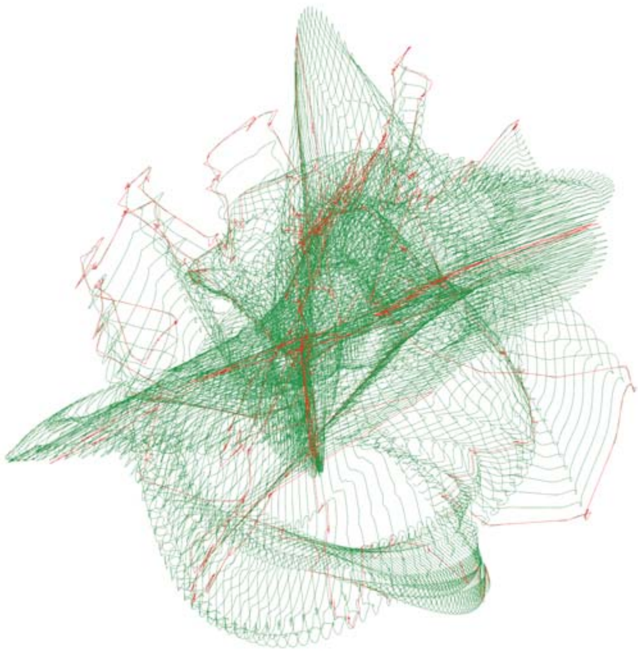


Figure 108: A top-view of a lofted model where the hand eye drawings (red lines) rotate on themselves.

This methodology of developing resulting eye drawings into three-dimensional constructions is a continuation of what had been achieved through *The Eye Tribe* eye drawings (Appendix D), and a preparation of possible developments for the outcome of the following communal experiment (see pp. 160 - 186). Marey's bronze sculpture has been earlier noted in relation to this research aspect (Figure 95), and after developments such as Figure 107 and 108, I would here also add a small note assimilating these proposals to the Constructivist techniques utilised by artists such as Naum Gabo and Antoine Pevsner in the 20th century. In a catalogue introduction of an exhibition of both artists organised by the Museum of Modern Art, New York, Read (1948) described their work as intellectually coming from the form of the physical universe as shown by modern science, while creatively constructed through a poetic application of the latter (p. 11). In a way, this is recurring in my sculptural proposals with the addition of two important factors. The first concerns the eye drawings themselves which give the essential framework for the construction processes and are essentially representations of subjective visions (and data). Last but not least, automation is introduced through *Grasshopper*'s visual scripting, which facilitate the creation and visualisation of forms which would be almost impossible to achieve manually; all is achieved within a short time-span.

Communal Eye Drawing Life Class

All of the above described practice-based methodology led to the following experiment, which can be described as pivotal for this dissertation. The experiment merged the concept of eye drawing together with communal participation and the traditional Life Class. By this point in time in my methodology, I felt I had gained enough experience in eye drawing to be able to share it with other individuals and involve them in a participatory activity. An experiment designed around the participation of others seemed also inevitable in order to test the levelling of the roles between the artist and the viewer as the ‘artistic talent’ associated with an artist’s hand (body) was supposedly obliterated through eye-drawing. For this communal experiment, I introduced the participants to my familiarisation with the technology as being appropriated as an artistic medium by sharing my findings of this study until now. At this developed point of my methodology, I also had enough experience to be able to demonstrate rigorous planning prior to organising the concerned research experiment and this proved to be of utmost importance. As Trimingham (2002) states, when involving a group of participants in research its outcome will depend on their individual creative processes, and therefore a methodology that responds to both meticulous planning and the uncontrollable aspects of the creative process is needed.

It was decided to link this experiment to that of a Life Class for two main reasons. Firstly, it is generally accepted that our visual cortex has specific prominent areas which are dedicated to the recognition of human body parts (from faces to fingers), as we look at human bodies all day throughout the variety of our daily activities (from social to personal) to the extent that we evolve to perceive certain details (such as our own skin colour) as; “uncategorisable and uncoloured” (Changizi, p. 14). Moreover, empirical eye-tracking studies suggest that when looking at figurative works of art, participants (both experts and non-experts) tend to be initially attracted into observing the entire human figure when the social context of the scene is low, whereas if the compositional context describes a social activity, the tendency is to first observe the respective faces from which information regarding the represented action is acquired (Villani et al., 2015). Perceiving a human figure therefore involves several cognitive and contextual processes. Secondly, eye-drawing during a Life Class via the use of an eye-tracking device also seemed an exciting opportunity to re-visit the highly traditional and art-historical activity from a contemporary lens. In view of this a brief historical overview of the Life Class will follow prior to the description of the experiment itself in order to immediately place the communal activity in its contextual and critical value.

The Life Class

An immediate question upon seeing a seminar title involving the activity of a Life Class, is that of why do we still practice drawing through such an activity today? In today's contemporary world, the Life Class has been somewhat classified as being obsolete and lost its place of a forerunner, and of being a mandatory training for every artistic process. The debate here can be a long one and also risks diverging from the main focus of this experiment, but my aim is to tackle this now 'conservative-regarded' activity in new light. In order for a better understanding of the project, the history and the distinctive connotations behind the Life Class will be briefly looked at, together with its drawing implications and other relevant aspects.

Two articles from last year issued respectively on *Artsy* magazine and the *Art Review* section of *The New York Times*, describe the Life Class activity as outmoded and conservative (Mendelsohn, 2016; Schwendener, 2016). Mendelsohn (2016) partly attributes this to the traditional concept that the 'likeness' rendering of the human figure is the highest artistic achievement linked to such activity. While I agree with the fact that the contemporary conceptual tendency towards the Life Class is a conservative one, I find its acquaintance with the strict practise of realistically portraying the figure on paper to be a very narrow minded view. The event of model drawing has definitely been put aside from the contemporary artistic tendencies, but still, it has never been completely obliterated and somehow resisted time by adapting for its own sake.

Small art colleges still implement the practice as part of their training, with distinctive interests between individual schools. Walker (2008) writes about the different schools of thought between individual colleges during his student years, where for example the life-drawing 'lessons' at Kingston were more 'Florentine' oriented with a special focus on the anatomy underlying the figure's skin, while at St. Martin's College, Leon Kossoff's take verged more towards the emotional, and involved the whole other than anatomical details by inviting the student to try to ‘feel’ and ‘be’ the model (p. 88). Critical thinking regarding the artistic practice of life-drawing should not be done through a contextual void of the exercise itself, and via a significant analysis of its artistic history with respect to distinctive cultural frameworks, contemporary opportunities may arise again. It is true that a ‘drawing’ can nowadays consist of a daily walk in a village, or a set of archival photos to be reflected upon in order to fit an accepted methodology (Walker, 2008), but I believe that this should not black out possible new light for an adequate inclusion of a traditional practice into a contemporary process. In view of this, I wanted this proposed experiment not to include any form of passivity, at least in its initial stages.

Life drawing as we know it today in our Western culture has basically been around since the time of the Renaissance. It became part of the accepted teaching of how to become an artist and lasted for centuries until the arrival of the Modern period; going through notable perceptive changes along distinctive contexts. The Renaissance implementation of the Life Class was of course partly debted to the re-birth of an interest in antiquity, and therefore because of this rise in humanism, the human figure became central to all taught subjects (Nead, 1992, p. 46). Some significant developments from the times of the Renaissance school of thought should here be noted. Firstly, students were initially taught how to visually approach a real-life figure through the practice of methodically drawing from classical casts. Barges (2003) included this practice in his *Drawing Course (2nd ed.)* and explained how the immobile single views of figures from antiquity gave the opportunity for a lengthy observation of a visualisation (the cast) which was widely acclaimed to have been the ideal portrayal of the human body in its precision of finish, pose and harmony in composition (pp. 18 - 21). This exercise of cast-drawing was then rebelled against around the 1850s as students absorbed by the emerging Realist school of thought declared that a statue blocked them from looking at nature attentively (Barges, 2003, pp. 18 - 21). This practice was then almost obsolete by the beginning of the 1920s. In this view, a citation by Clark (1956) is worth noting, which somehow connects Life Class practice in during the Modern and Post-Modern times with its classical roots:

> The Greeks perfected the nude in order that man might feel like a god, and in a sense this is still its function, for although we no longer suppose that God is like a beautiful man, we still feel close to divinity in those flashes of self-identification when, through our own bodies, we seem to be aware of a universal order." (p. 370)

Figure 109: *The Judgment of Paris.* Marcantonio Raimondi after Raphael. c. 1510. Print. 29.1 x 43.7 cm. Retrieved from www.metmuseum.org.

Another noteworthy development from the classical way of human idealisation happened during the High Renaissance itself. Classical antiquity largely assimilated its anatomical perfection triumph with the male figure (specifically through its study and idealisation of anatomy), where as the Renaissance progressed the female body started to predominantly take over art's interests. Clark

(1956) attributes this start to Raphael's design for the *Judgment of Paris* (Figure 109), printed by Marcantonio (p. 356). After this prevalence of the female nude, it was set to escalate for the subsequent two centuries, while the male nude was retained in art practice for the sake of loyalty towards the classical ideal (Clark, 1956, p. 356). According to the same author, this also marked an early start of a decline in the interest of portraying a perfect anatomy itself. With the female nude, the interests of the figurative artistic portrayal changed, and the female body became culture and a possible metaphor for art itself (McDonald, 2000, p. 58).

It is also interesting to here note the now common connection of the word 'nude' to art practise as opposed to the word 'naked'. Scholars like Clark and McDonald (2000) emphasise on the historical analysis that the term 'nude' finds its roots in the forced employment into the English vocabulary by the critics of the eighteenth century in order to aid in the clarification to the 'artless' sections of society that a naked body can be a subject for art (p. 61). Apart from emphasising on the social split, the addition of this term also eased distressed connotations which can be brought up by the term 'naked' (McDonald, 2000, p. 61).

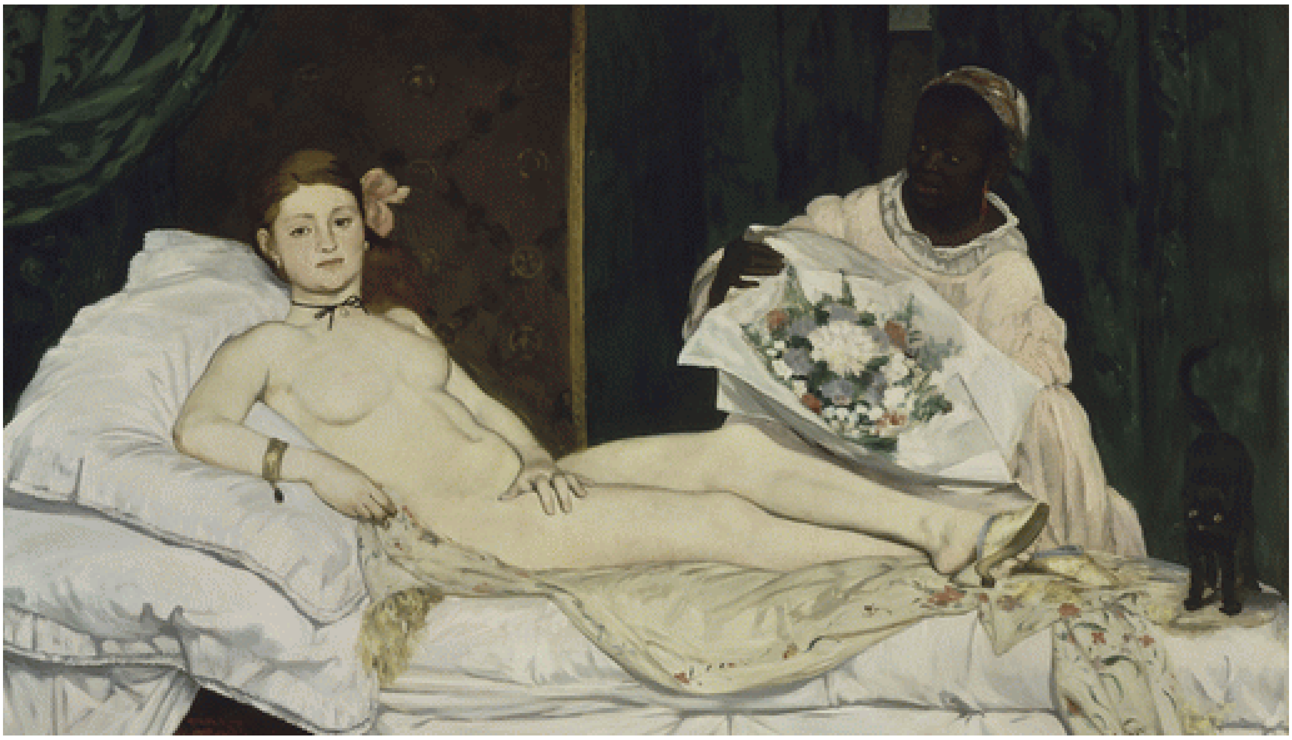


Figure 110: *Olympia*. Edouard Manet. 1863. Oil on canvas. 130 x 190 cm.
Retrieved from www.musee-orsay.fr.

Art during the Modern period developed according to society's changing attentive attitudes and new perceptual technologies as discussed in earlier chapters (see pp. 80 - 103), and as a result the artists' relation to the Life Class developed respectively. The rapport between artist, model and the art history metaphor of the nude became intricately subjective, and a difficult one to illustrate at the same time. To start with, Manet's *Olympia* (Figure 110) has been regarded as a Modernist milestone not only because of its formal artistic qualities, but also for its then shocking representation of the nude. *Olympia* is frequently compared with Titian's *Venus of Urbino* (Figure 111) as *Olympia* directly cites it, confronts its mythology, and completely breaks away from it. Nothing in its scene is harmonious anymore, and the female figure stops being a metaphor for a soft aesthetic portrayal, but becomes an analogy of discomfort instead. *Olympia*'s gaze is a Modernist one, and it made its Modernist viewers aware that she was naked and not simply nude for art's sake.

Figure 111: *Venus of Urbino*. Titian. 1534. Oil on canvas. 119 x 165 cm.
Retrieved from www.uffizi.org.

The maid's face alone has been described as being excessively sexual, while also alluding towards prostitution, obscene illness and death (McDonald, 2002, p. 69). This shock value might now sound exaggerated but maybe this is because in the century and a half that followed since *Olympia*, we have been exposed to much more nakedness, and shock value, and society's and art's perception towards the subject differs greatly.

Throughout the Modernist era, the environment of the Life Class has also been described to have developed into an iconic interpretation of masculinity and artistic identity, as heavily portrayed by Brassaï's (Figure 112) artist's portrait of Matisse and his model in his studio (Nead, 1992, p. 49). The portrayal of both is intimate, but at the same time may appear to be happening under a somewhat awkward proximity, as an aged Matisse resembling a physician squints at the female body (Nead, 1992, p. 49). This image is perhaps comparable to a similar interpretation by Picasso in a series of drawings he began towards the end of 1953 (Figure 113), which always included a desirable naked young woman being sometimes painted by an old, awkward-looking and small Picasso (at times also represented as a monkey or a cupid). Berger (2005) notes that when the model is being painted she scarcely seems to pose, but is there instead just as a reminder to us that she is nature, sex and life; which is somewhat akin to why drawing classes of a nude model are in fact called Life Classes (Berger, 2005, pp. 20 - 35). The whole series is quite satirical, but that satire is a result of some truthful torment of life. In this context, the Life Class fully developed into a subjective and personal experience—away from aesthetic forms—opening up for more expressive metaphors and personal interrogations. Both Picasso and Matisse are also two artists whose work in front of a model has been discussed by Clark (1956), where he described it as a revolt against the tradition that the; "painter should be no more than a sensitive and well-informed camera", which idea the Impressionists had somehow still implicitly utilised (p. 357). On the contrary, Picasso and Matisse distinctively unified sex and geometry through the nude/naked portrayal, which reminds us of how reminiscent the nude is to our basic notions of order and design (Clark, 1956, p. 357).

Figure 112: *Matisse and his model*. Brassaï. 1939. Gelatin silver print.
(Nead, 1992, p. 110)

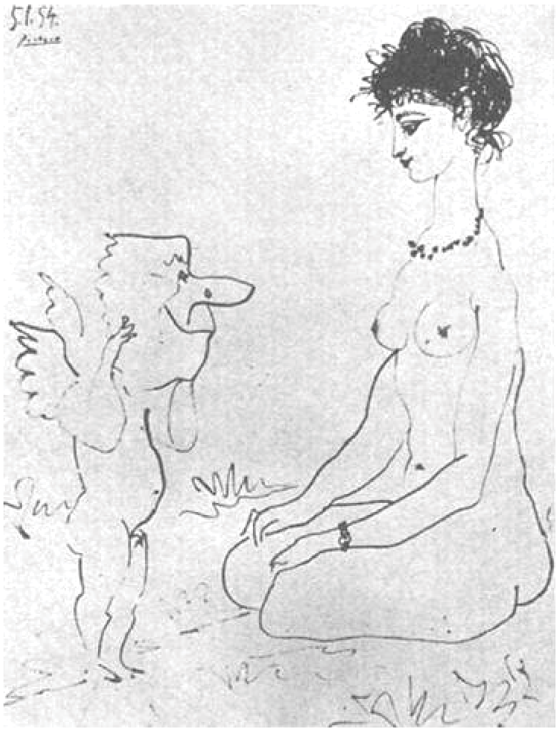


Figure 113: *Young Woman and Cupid with Mask.* Picasso. 5th January 1954. Ink on paper.
(Berger, 2005, p. 24)

However, life drawing is not solely a discipline of design, but it is primarily a drawing activity and therefore one that engages with the act of looking, and consequently individual perceptions. This was an exciting point in the consideration to decide to conduct the concerned experiment. Each decision taken during figure drawing brings us nearer to the figure itself (both in life drawing and in drawing from memory), and as Berger (2005) recounts in what seems to be a phenomenological account of a drawing experience during a Life Class, at a point it (the drawing) reaches a standard point of crisis (pp. 3 - 9). This moment is a point where the interest of what is being drawn equates that of what can be discovered, and therefore the artist begins then to draw according to the drawing’s own needs, highlighting its truths and falseness accordingly (Berger, 2005, pp. 3 - 9). Looking and seeing through drawing in a Life Class is an activity which is done differently than the way we look at the world on a daily basis. Perhaps the only order and discipline which is contemporarily present during a Life Class, lies in how through the act of looking, time is slowed down permitting us to observe the model with a searching mode other than simply a glancing approach. A fitting example is Lucian Freud’s way of working (looking) in front of a model (Figure 114). The first chapter of the first biography of the artist since his passing in 2011, was dedicated to his way of looking, entitled *The Art of Looking* (Hoban, 2014, pp. 1 - 12). His gaze has been described as ‘cruel’, and his scrutiny in looking verged the fanatical. As the author of this biography recalls, it is almost impossible not to parallel this obsession with the way his uncle,

Figure 114: *Benefits Supervisor Sleeping.* Lucian Freud. Oil on canvas.
This painting was sold for $33.6 million USD, a world record price for a work by a living artist, in 2008.
Retrieved from www.telegraph.co.uk/culture/art/art-news/8653726/Lucian-Freud-a-towering-and-uncompromising-figure-in-the-art-world.html?image=2.

Sigmund Freud, interrogated his patients; both Freuds worked in a private room, in an intimate setting, while endlessly interrogating their subject throughout repeated sessions (Hoban, 2014, pp. 1 - 12).

Figure 115: *Iggy Pop Life Class.* Jeremy Deller. 2006-2011.
(Schwendener, 2016)

In a way, it is true that Life Class practice has been deprived from its once held podium, but at the same time it is still being vastly implemented throughout the infinite plurality of today's contemporary artistic practices. Jeremy Deller directly cited this through his project *Iggy Pop Life Class* (Figure 115). Deller invited art students together with their teachers for a four-hour class, and to the student's surprise the model to be drawn was rock-icon Iggy Pop. The students ranged in age from 18 to 80, and included a military veteran, a pharmacist and psychologist amongst others (Schwendener, 2016). Deller's project is a witty one. While re-establishing the activity of the Life Class on a centre stage in a contemporary art museum, the contemporary artist himself did not draw, but created the ambience of it instead. The mythological female body has been replaced by a celebrity icon from our contemporary pop culture, who was himself a forerunner in the breaking boundaries of the 1960s sexual liberation. Above all, the artists drawing the model were not professionally known artists, but students who attended Life Class lessons as a side activity. This project is comparable in concept to David Shrigley's ongoing *Life Model* project (Figure 116). Shrigley too sets-up a Life Class scenario inside contemporary museum spaces, but instead of a model, at the focus of his class there is a mannequin which defies classical proportions and ideals. Is this a reference to our contemporary bodies? Plastic surgery and body modification interference on our bodies is an acclaimed trend, while at the same time, we tend to visualise how to dress our bodies through window-shop mannequins. Moreover, the 'artists' drawing the 'model' are random museum viewers who accept to attempt this 'Life Class', whose work is then placed on the hall's walls creating the installation piece itself. How do these contemporary projects revolving around the Life Class interact with the proposed experiment?

Figure 116: *Life Model II.* David Shrigley. 2016 (ongoing project).
Retrieved from www.brandeis.edu/rose/exhibitions/2016/davidshrigley.

The Experiment

In his interrogation on drawing, Walker (2008) refers to an advert issued by Gillotts in 1962 (Figure 117), where the image portrayed an illustration of a caveman drawing a bison on the cave wall juxtaposed with the phrase; “Times have changed…Artists in those days had to make do. Artists today have Gillott’s pens” (p. 88). The advert hints at Gillott’s pens as the new technology available to the artists of its time, but what is ours? As discussed in the previous Literature Review (see pp. 80 - 103), contemporary technology has led artists to test several technologies from our Information Age into their artistic practice, and the aim of this experiment is to analyse the activity of a communal Life Class through the several gazes of the viewers (‘artists’) surrounding the model through collected data. The hand-eye coordination while drawing is an intricate one; one feeds on the other. The gaze in sight and the gesture of the hand are entangled, while one highlights the other during the progressive action of leaving a physical trace on the given sketchpad (El-Bizri, 2014, pp. 27 - 35). My aim was to substitute this physical trace with the gathered data from the eye-tracker. As repeated throughout this dissertation, this exercise again involved a new way of looking—this time at a real life model—and the viewer had to enter a psychology of ‘tracing’ her solely via his or

Figure 117: *Gillotts Times have Changed.* Advert. 1962. (Walker, 2008, p. 79)

her eye-movements. The *Pupil* eye-tracking device was the primary tool for this experiment, and was used as follows.

The experiment took place at the Design Studio within the Faculty of Media and Knowledge Sciences on November 24th, 2017, after obtaining UREC ethics clearance. The participants in the experiment were seven first year students reading for a Masters degree in Digital Arts within the Faculty of Media and Knowledge Sciences at the University of Malta. They were a total of four female and three male students. My supervisor for this dissertation and head of department, Prof. Vince Briffa, was present during the experiment and also documented it thoroughly (see Appendix H). The experiment started with a half an-hour research seminar which briefly introduced the points mentioned above regarding eye drawing a Life Class together with the scope of my entire research. The Life Class followed and a professional art model was engaged for a three-hour sitting.

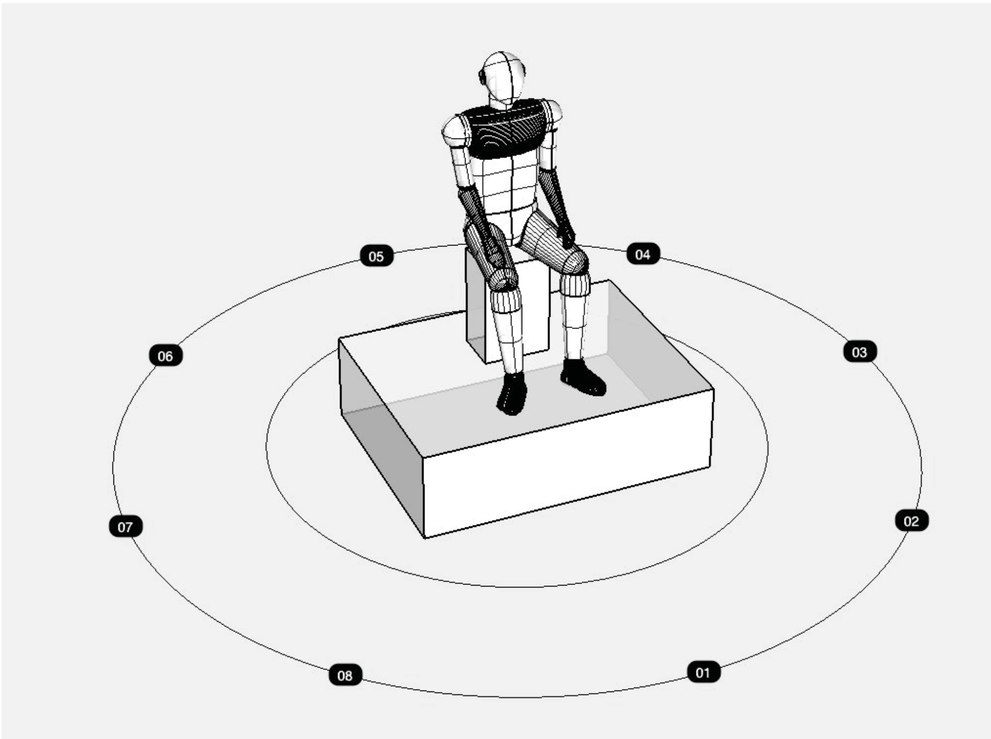


Figure 118: Perspective view of a 3D model illustrating the Life Class set-up.

The students were assigned a specific place which was numbered accordingly. The model was placed at the centre and maintained a sitting position throughout the experiment, while eight student-placements were set-up around her at a diameter distance of two metres as shown in Figure

118. The students occupied positions 1 - 7 and number eight was intentionally left empty for a specific exercise. All students started drawing in the ‘normal’ manner during a Life Class, while I engaged them one at a time to attempt the eye-drawing exercises listed below. The students were advised to approach each eye-tracking exercise with maximum attention, while trying to slowly control their eye-movements in tracing around the model’s figure. Before each eye drawing, the *Pupil* eye-tracking device was calibrated accordingly with each respective student and gaze distance. Both eye and world view cameras were put in focus and their respective recording settings were set to 640x480 at 90 frames per second and 1440x1080 at 60 frames per second. All the data was directly recorded onto a computer. The Life Class session lasted for three hours. After the session ended, the hand drawings done by the participants during this session were also collected for analysis and discussion.

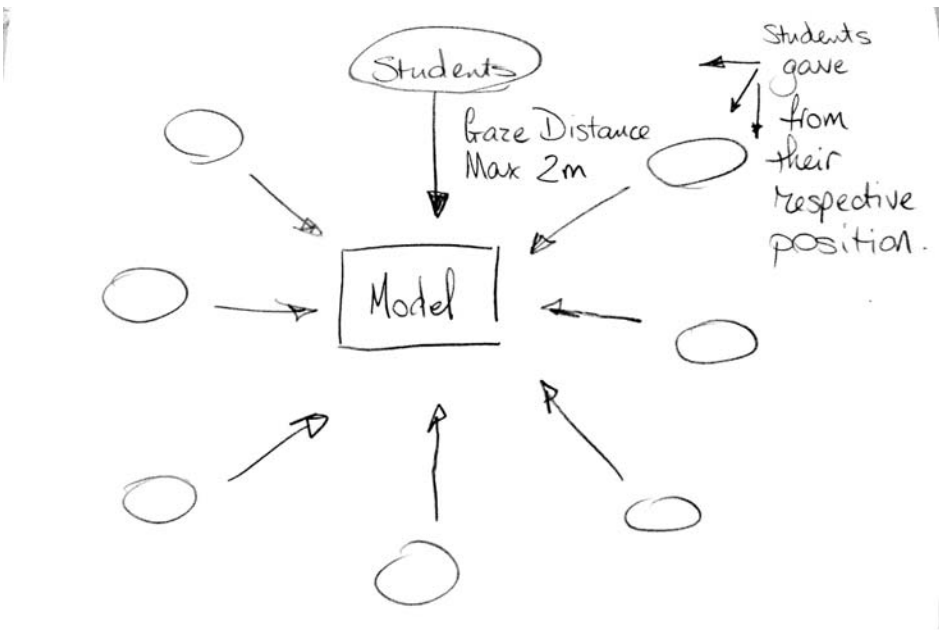


Figure 119: Slow eye-drawing at a maximum distance of 2m from the students’ respective position. (Appendix H)

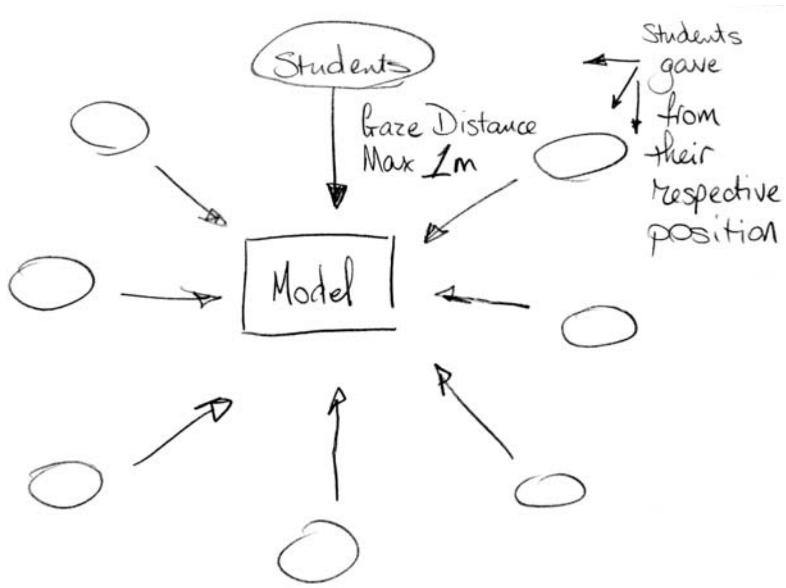


Figure 120: Slow eye-drawing at a maximum distance of 1m (repeated twice) from the students' respective position. (Appendix H)

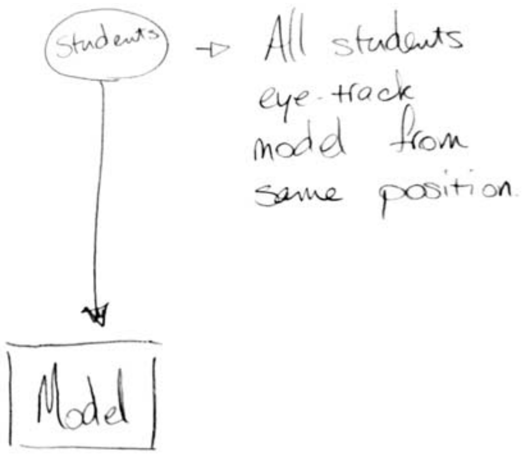


Figure 121: Slow eye-drawing at a maximum distance of 2m from position 8. (Appendix H)

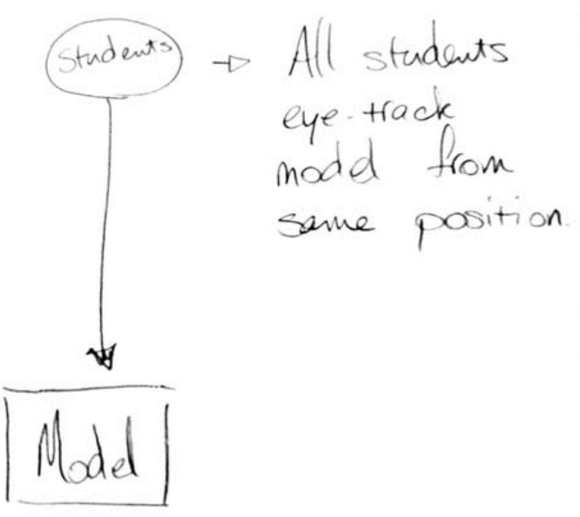


Figure 122: Slow eye-drawing at a maximum distance of 1m from position 8. (Appendix H)

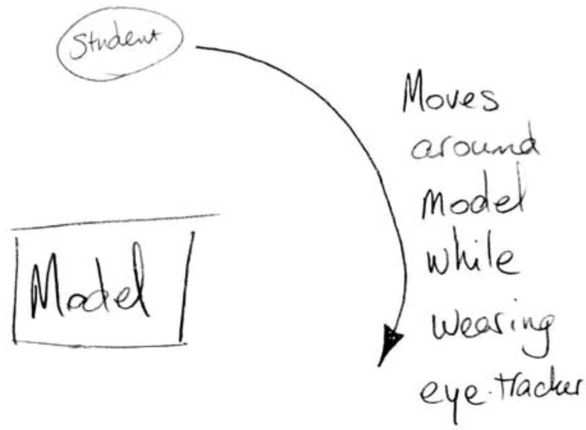


Figure 123: Eye-drawing while moving around the model. (Appendix H)

The collected eye-tracking data was then processed by utilising the same methodology as in the previous *Pupil Headset* experiments (see pp. 156 - 160) and an image of each individual eye drawing was obtained (Appendix H). These gave the opportunity for evaluation and discussion, followed by further development of the resulting data into an artistic process.

Evaluation of the Findings

All resulting eye drawings from this experiment can be seen in Appendix H, and I will here compare and discuss a selected number of them. In general, the visual results can be divided into two main types. The first concerns eye-drawing results which show a high interest and control in contouring around the model (Figures 124 - 126), while the second type show several layering of representation indicative of an interest in volume (Figure 127). Exceptions like Figure 129 resulted in both typologies, where it is evident that the participant first started the eye drawing with an interest in contouring at the left side of his composition, and changed his control of the eye movements halfway through. In general, the eye drawing results proved to have a very surprising outcome and there is here much to be discussed together with several grounds for further research.

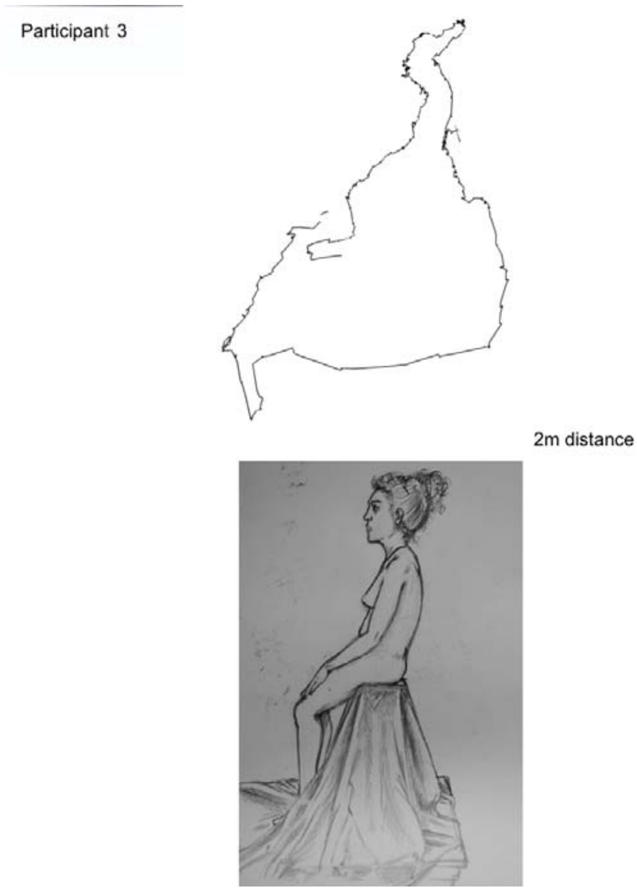


Figure 124: A selected eye drawing (top) and a selected hand drawing (bottom) from participant 3.

Figure 125: A selected eye drawing (top) and two selected hand drawings (bottom) from participant 4.

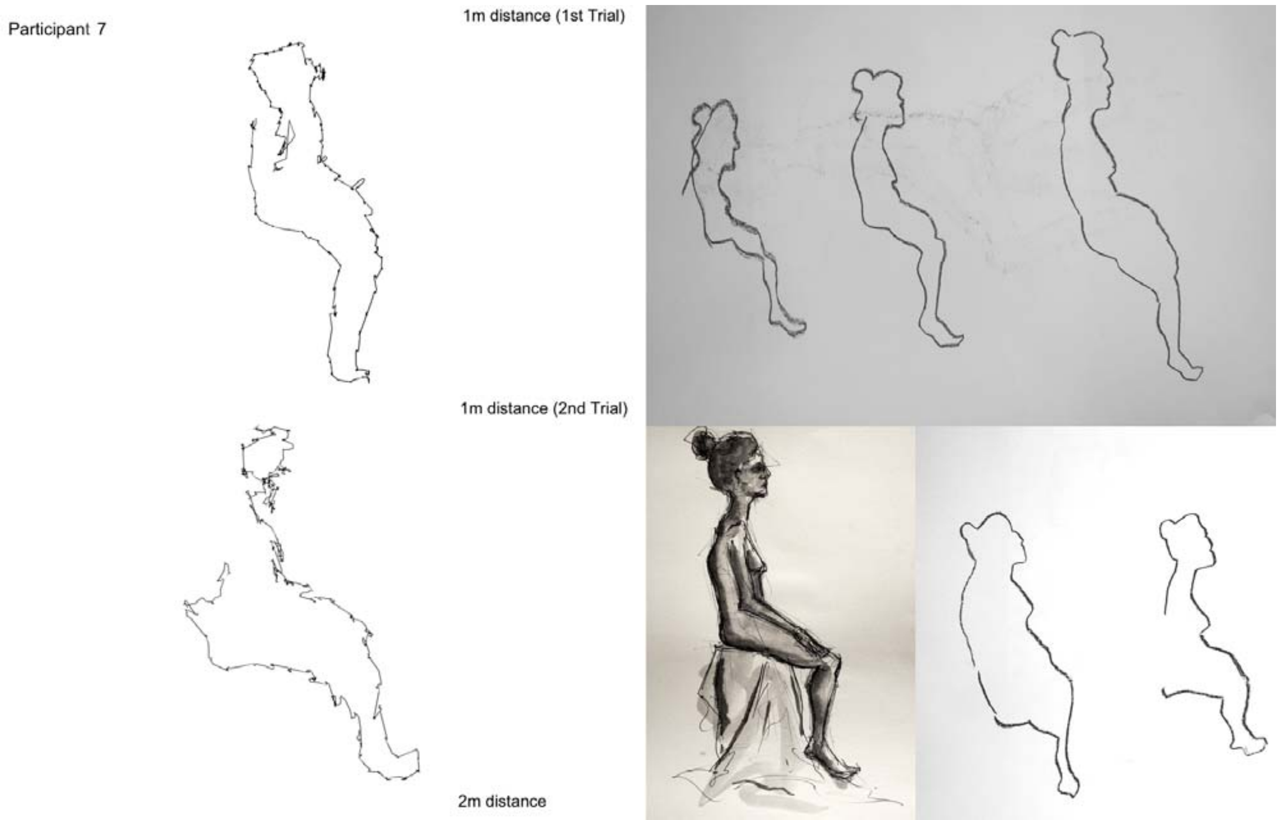


Figure 126: Selected eye drawings (left) and selected hand drawings (right) from participant 7.

One of the most notable resulting aspects is the fact that each participant's set of eye drawings has a distinctive character—an individual 'mode of expression'—when compared with each other, and this is also constant in the approach of execution throughout all of five exercises which required the participants to eye-draw from a fixed position. The level of which this occurred had not been expected. The results from the preparatory exercise which involved the comparison of a tracked hand by myself (as an art practitioner) and a non-practitioner volunteer (Appendix G), did show a degree of subjective difference but did not have the same extent as the Life Class experiment results. This might have occurred due to two main reasons. Firstly, eye drawing a hand is less challenging than an entire figure as the contours are more prominent and 'obvious'. Secondly, when eye drawing the hand it was inevitably positioned at a closer proximity to our gaze than the figure in the case of the Life Class exercises. This might have contributed in easing control on the eye movements themselves, as the sight of the concerned subject was clearer.

Such evident individual differences between the resulting eye drawings of the Life Class might also be so noticeable since they include seven subjective ‘ways of seeing’, whilst the hand experiment had only involved two. It can also be argued that since the participants had a pre-assigned position where to eye draw from, these might have created different levels of difficulty. For example, position 1 must have been more difficult to eye draw than position 5 or 6 (Figure 118), as it involved much more contour information. However, the interest of this particular argument is not to compare between which eye drawing is more realistically successful as representation, but the fact that these results suggest a ‘graphological’ element throughout the individual participants’ eye drawings. I am here applying a terminology associated with the personification of handwriting metaphorically; there is probably no other word-meaning that can better describe this point with respect to the results in discussion in view of the fact that it ironically brings back the (artist’s) hand into the picture. These eye-drawing experiments had been climaxing to the hypothesis that the artist’s body was being eliminated from the drawing equation, attempting a levelling of the ability to ‘draw’ throughout this research, but the Life Class results bring back distinctive individuality and ‘artistic skill’ into this argumentation. These grounds are similar to how one would describe a hand drawing (or a handwriting). Two other considerations have to be kept in mind before further evaluation. A condition equal to all participants was the fact that these were their very first attempts at controlling their eye movements in order to substitute hand drawing. Also, even though it can be accepted that the assigned positions provided different levels of difficulty, the results from position 8, which was equal to all, continue to evidence the ‘graphology’ interpretation (see chapter 4 for further discussion).

Even though all participants are current students of a Masters degree in Digital Arts, it does not necessarily mean that they come from an object drawing background. This could also be noted from the collected hand drawings contemporarily done during the Life Class (Appendix H). A very brief questionnaire was also e-mailed to the participants after the visual processing of all results, together with a scan of their hand drawings and a seven-page document illustrating all the respective eye drawings (each page contained all the eye drawings of one participant). The short questionnaire included seven questions (Appendix H.b), which inquired about their experience during the experiment (as well as whether they had drawn during a Life Class prior to this experiment). In one of their questions, the participants were also asked to identify which set of eye drawings they thought was theirs, and three out of four participants did so successfully. This is an interesting result which is however very difficult to interpret at this point in time as the number of tested participants is only seven. It does however bring back to mind Caesar Attard's *Artist as Model* experiment where all of his participants recognised their respective blind contoured drawings without prior viewing of them (Appendix A). Further research is needed to identify why some participants did successfully recognise their respective set of eye drawings, but one hypothetical answer may lie within a comparison with their respective hand drawings.

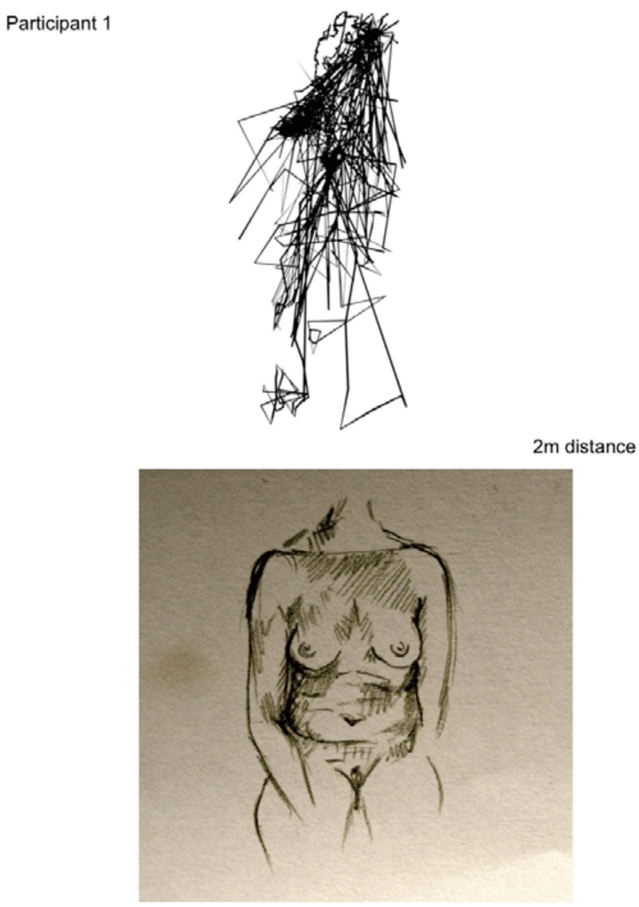


Figure 127: A selected eye drawing (top) and a selected hand drawing (bottom) from participant 1.

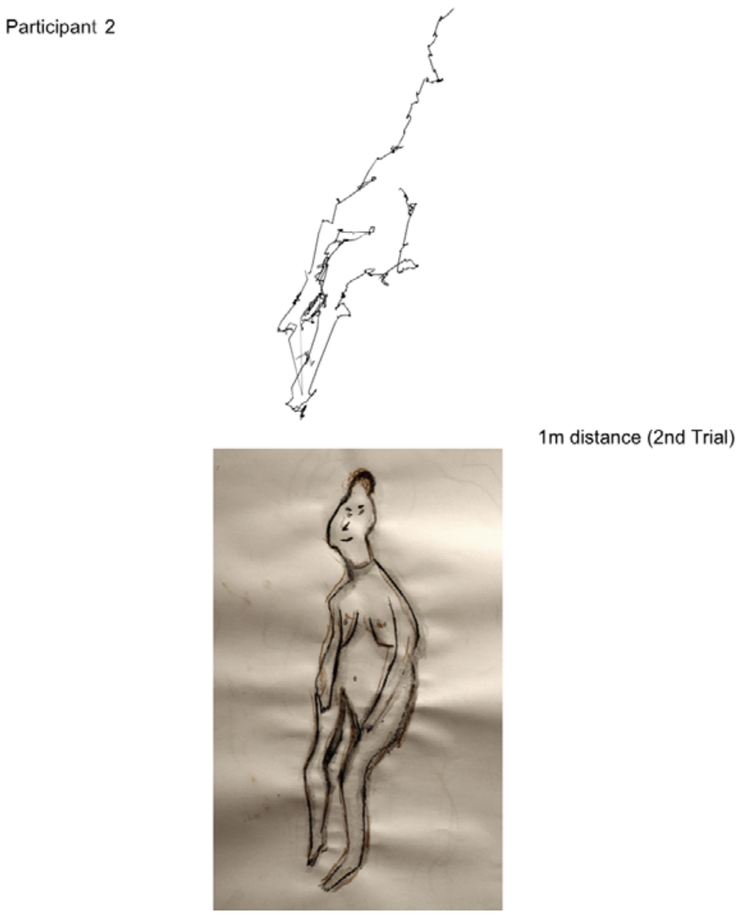


Figure 128: A selected eye drawing (top) and a selected hand drawing (bottom) from participant 2.

Selected Figures 124 - 128 show both a selected eye drawing and a selected hand drawing of different participants. Participant 3 (Figure 124) opted for a contour-driven eye drawing, and it is interesting to note the resulting suggested details (such as the profile facial feature) which vary in scale throughout the eye drawing, reminiscent of the blind contouring comparison to eye drawing discussed earlier (see pp. 133 - 138). What is also of great interest to this research is the fact that participant 3 was the only student who gave the same attentiveness to both figure and draped plinth while hand drawing, and this is also greatly reflected in the composition of the eye drawings themselves as there is no distinction between the figure’s and the plinth’s contours. Moreover, the hand drawing also shows great interest in the evidencing of an ‘outline’, and participant 3 claimed that she started the eye drawing activity in a very similar way to her hand drawing in order to have a good spatial understanding of her composition. Could this mean that eye drawing is heavily influenced by how one would actually tackle hand drawing? The same participant 3 also declared that everything felt quite unnatural while eye drawing since a personal method was restrained, and the similarity with both activities lies within the way one scrutinises the subject while drawing.

Figures 125 and 126 also show an interesting comparison between the respective hand and eye drawing results, and both participants also noted this in their questionnaire answers. Participant 4 mentioned a specific interest in the shapes representing the portrayed figure, which she tried to follow during eye drawing. This then reflected strongly in the hand-drawn interpretation from life seen in the bottom right image in Figure 125. Participant 4 recognised her eye drawings from this very visual aspect, as she stated that she felt (and attempted) to eye draw the figure through long straight lines. This is again akin of the visual representation of the mentioned interest in shapes, and even though this particular participant mentioned a difficulty in not being able to rest one's eyes during the activity of eye drawing, this difficulty seems to have not influence her eye drawing results and instead contributed to a very direct and sharp image. Figure 126 again provides a notable comparison and 'graphological' similarity between both activities especially when considering the contour hand drawings at the top and bottom right (which in the questionnaire the participant stated that they were drawn using the blind contouring technique). Participant 7 also stated that while both hand and eye activities required an attention to detail of the subject's negative space (an aspect which is visually evident in all representations in Figure 126), eye drawing needed more concentration. This was expected especially in view of the recurring mention that eye drawing implements a new way of looking (and tracing) during a forced suppression of the more natural hand-eye coordination.

A very distinctive set of resulting eye drawings was participant 1's (Figure 127). The participant did not correctly guess her eye drawing results in the sent questionnaire, and in one of her answers regarding her approach towards hand drawing, she stated that she tends to draw 'in layers', by building up volume through 'sketchy' interpretations. She probably incorrectly guessed which eye drawings were hers as she was certain that she managed to eye draw along the figure's contours contrarily to her hand drawings, but her eye drawings prove differently. This is therefore a case where the participant was sure of being able to control her respective eye movements along a contour, but was unconsciously heavily influenced by the way she usually tends to hand draw. Another significant case was that of participant 2, who claimed to have never drawn during a Life Class prior to this experiment. To a certain extent this is evident from the hand drawing illustrated in Figure 128, which shows no interest at a realistic depiction of the human figure. In her questionnaire answers she stated that she was more concerned by the movement of the body at different stages, and in fact chose a set of eye drawings which included several saccades without having a recognisable representation of the drawn figure. In contrast, the eye drawing result shown in Figure 128 shows an interest in designated contours along the upper-body and legs of the posing figure, and an interesting degree of figurative representation. This is again a very distinctive case-scenario where a participant who did not have any Life Class drawing experience prior to this experiment was convinced that her eye drawings would not result in representative contours but in 'abstract' movements, contrary to the eye-tracking evidence.

Figure 129: A selected eye drawing from participant 6.

This experiment was definitely very fruitful to this research and as stated earlier, all eye drawings and eye drawing developments from the latter can be found in Appendix H. A final worthy mention is the particular exercise where the participants were asked to trace along the contours of the seated figure while walking around the model. As expected, this proved to be quite a difficult cognitive task to undertake, and unconscious saccades referring to the surrounding context result in almost all eye drawings. Still, as shown in Figure 130, which illustrates five overlaying eye drawings from this exercise, most scan paths resulted in an interesting mix of figurative contour details and saccades indicative to the participants' motion and unconscious reference to the surrounding environment.

Figure 130: Five overlaying eye drawings.

The following chapter will describe an experiment which involved a collaboration with a student from the Artificial Intelligence department, after which a general discussion of all these the findings throughout this dissertation will be compared and analysed in the final chapter 4, alongside openings for new possible research.

Collaboration with A.I. Department in Creating a Drawing Aid Tool

Throughout this practice based research, eye-tracking technology has been tested as a new possible medium for artistic practice itself. This also put in evidence both the potentiality of the relationship between the eye and mind (imagination), as well as the eye-tracker's status of a powerful tool which through its data processing, several artistic methods and techniques can be explored. To a certain extent, the obliteration of the hand from the drawing processes mentioned above levels down the status between a 'talented' artist's hand and an untrained individual, and both would need eye drawing training for successful outcomes. As a result of this the question of whether an eye-tracking device such as the *Pupil Headset* could be used as a drawing aid tool was raised. This question differs from the approaches seen until now as it involves a variation of the processes used in the experiments above where the main preoccupation was with how to apply the recorded data from the eye drawings into an artistic process. Testing the eye-tracking device as 'a drawing aid tool' meant that the technology would be used to help and facilitate someone to draw what is being perceived, and would therefore have to correct the resulting eye drawing by interfering upon the recorded saccades which as shown above are not always obedient to our consciousness. In contrast, during the previous experiments these non regular results were always included and integrated into the artistic process itself.

Eye-tracking technology is already being used to enable individuals with speech and body movement impairments to type (and therefore communicate), control environments (such as operating doors and curtains), compose music and paint amongst other activities (Montague, 2017). While interviewing Steve Thomas, a software engineer who had been diagnosed with amyotrophic lateral sclerosis (ALS), journalist Montague (2017) reported that Steve now depends on eye-gaze technology during his daily routine as through this assistive method he manages to do anything from using Skype to playing games. Another case in point is that of

Sarah Ezekiel, who used to be a passionate painter until she was diagnosed with a definite motor neurone disease, and through the use of a *Tobii PCEye* device, started to paint again in 2012 (Ezekiel). By controlling her mouse through staring and blinking, she manages to paint digital paintings from her imagination (Figure 131) and has also been featured in numerous exhibitions both in the UK and internationally (BBC 2015).

Figure 131: One of Sarah Ezekiel's paintings representing a flower. Retrieved from http://www.bbc.com/news/uk-england-london-32573909

The Department of Artificial Intelligence within the Faculty of ICT, at the University of Malta, was approached with this idea of interfering on the device's outcome and after a series of meetings, student Mizzi (2018) adhered to this research question and took it up as his undergraduate final year project. An interdisciplinary collaboration between both departments was initiated and the scope was to attempt a realistic correction of the saccadic scanpaths resulting from the process of eye drawing with the *Pupil Headset*. In this view, an artificial intelligence research involving shape recognition concepts was made in order for Mizzi (2018) to be able to arrive at an algorithm which would average the resulting saccadic path of the eye drawing with the shape of the concerned eye-drawn objects. The *Pupil Headset* was used throughout these experiments for the simple reason that together with the data of the eye movements, it also recorded HD footage of the eye drawn objects through its world view camera. Eye drawings of a straight-edged pyramid-like sculpture (Figures 132 - 133), a wire sculpture I did representing a female figure (Figures 134 - 136) and my hand (Figure 137) were eye drawn in order for their respective results to be inputted in the created algorithm. The methodology for the processing of all of these experiments was as follows below, and Figures 132 - 137 progressively illustrate the outputs of the described stages.

The raw data of the XY coordinates concerning the eye-drawn saccadic path was exported as a comma-separated value (.csv) file through the *Pupil Headset*'s *Pupil Player* software, two columns of which were then stored in Python. By using Python's data plotting library, the XY coordinates were plotted into the respective saccadic path, which in turn was saved to file in a portable network graphics (.png) format. At this point, both the .png saccadic path, and the world view image taken from the corresponding video frame, were imported into MATLAB for processing.

Once inside MATLAB, the first processing step was to resize the image of the saccadic path in order to match that of the worldview in scale. It is here worth noting what has been mentioned earlier regarding the usual resulting scale of blind drawings and eye drawings when compared to the worldview (see pp. 133 - 138). Hence, since these very rarely match, they were resized in anticipation of the algorithm processing in order to avoid compromised results. Once both images had a matching scale, a thresholding filter was used to process the worldview frame, which essentially evidenced the photographic image of the observed object through a high black and white contrast. At this point, Mizzi (2018) applied the *Harris Corner Detection* algorithm to both saccadic path image and thresholded result of the worldview frame, which algorithm consists of a mathematical formula distinguishing features in an image. It enhances the flow of edges of thresholded images (Harris, 1988) and through its application, the corners are required to try and match the corresponding corner points of both images.

Once both images were processed into data consisting of two sets of corner points, they were differentiated by the application of the *Kernel and Nearest-Neighbour* algorithm. This is a non-parametric regression technique which is regarded as a powerful tool for parametric model building, and for data analysis involving the calculation of the mean function and its derivatives (Altman, 1992). In our context, this algorithm processed each point with respect to its neighbouring points and learnt how to discard any non-matching coordinates. This created the arrangement of the needed points for the new processed shape, which were consequently sorted by distance on the plane and then plotted. The results of this aided drawing process are all illustrated in blue contours throughout Figures 132 - 137.

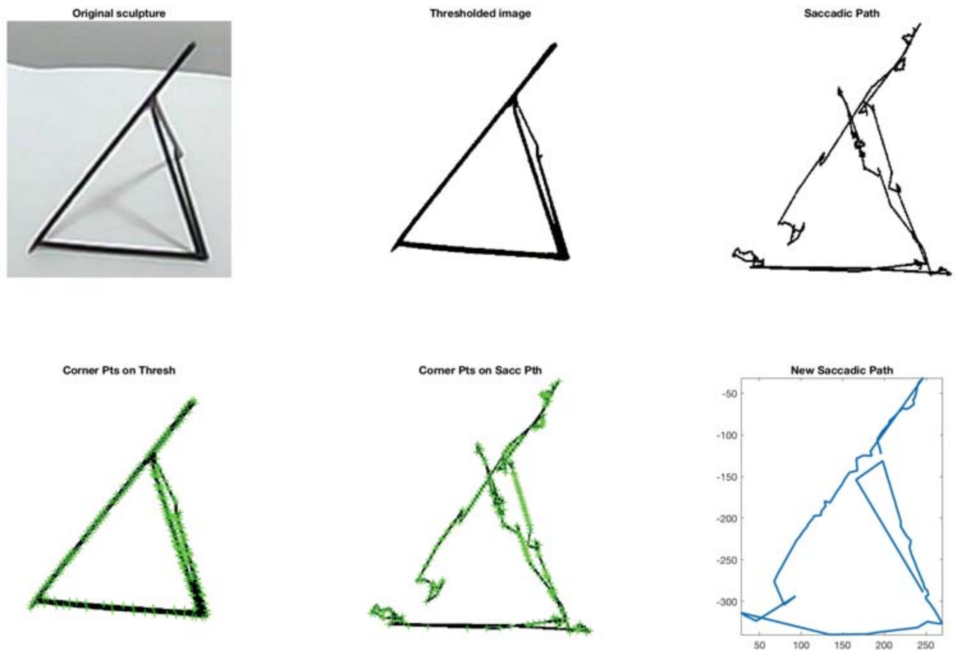


Figure 132: Experiment 1. Algorithmic correction on the output of *Pupil Headset*.

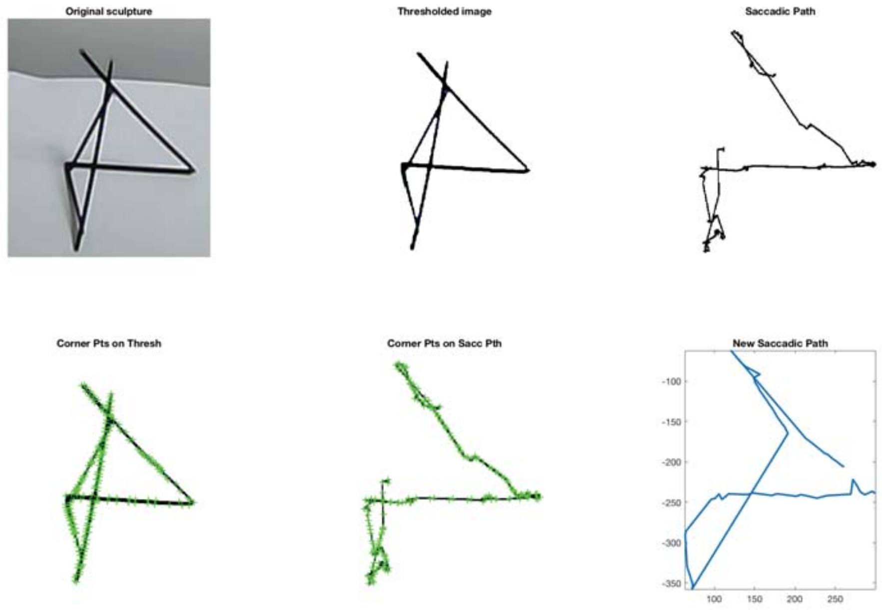


Figure 133: Experiment 2. Algorithmic correction on the output of *Pupil Headset*.

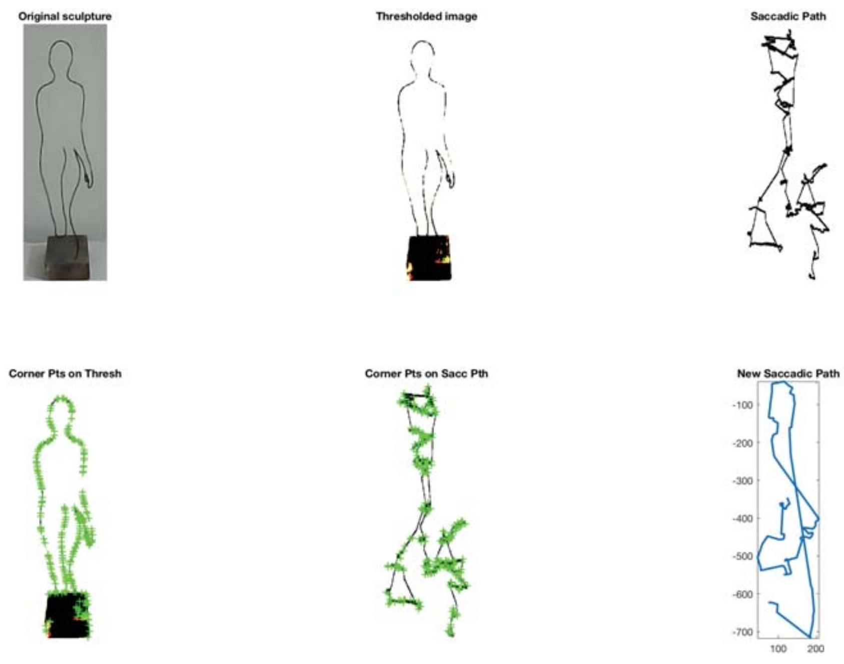


Figure 134: Experiment 3. Algorithmic correction on the output of *Pupil Headset*.

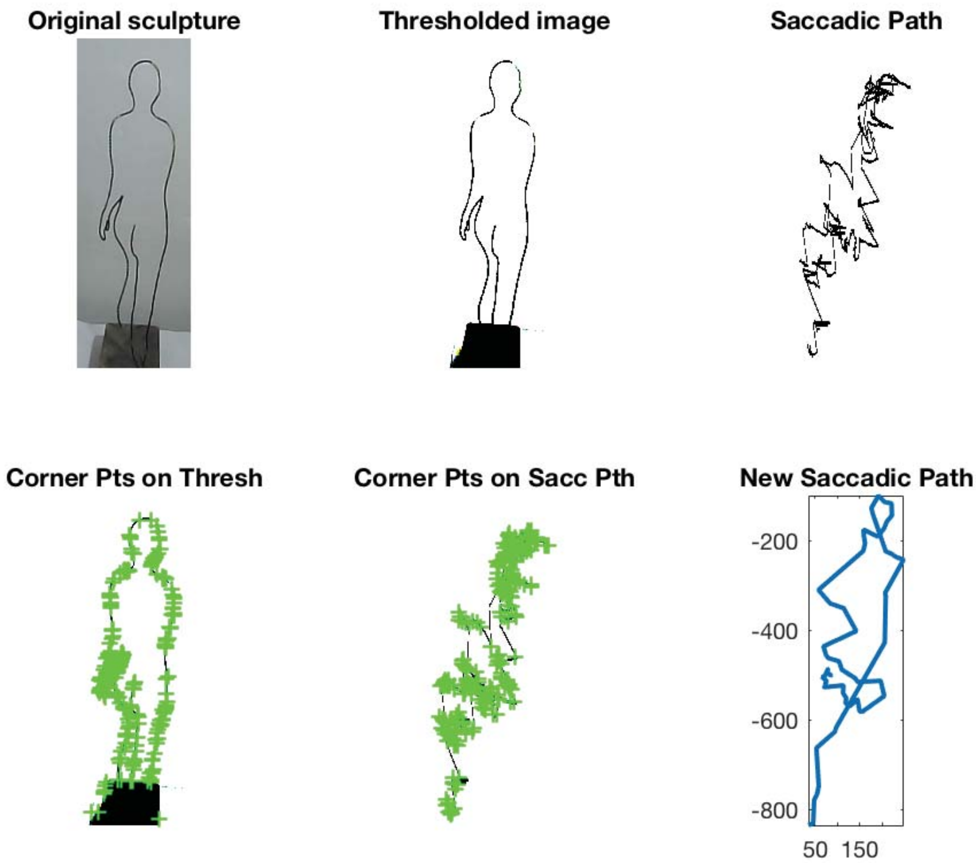


Figure 135: Experiment 4. Algorithmic correction on the output of *Pupil Headset*.

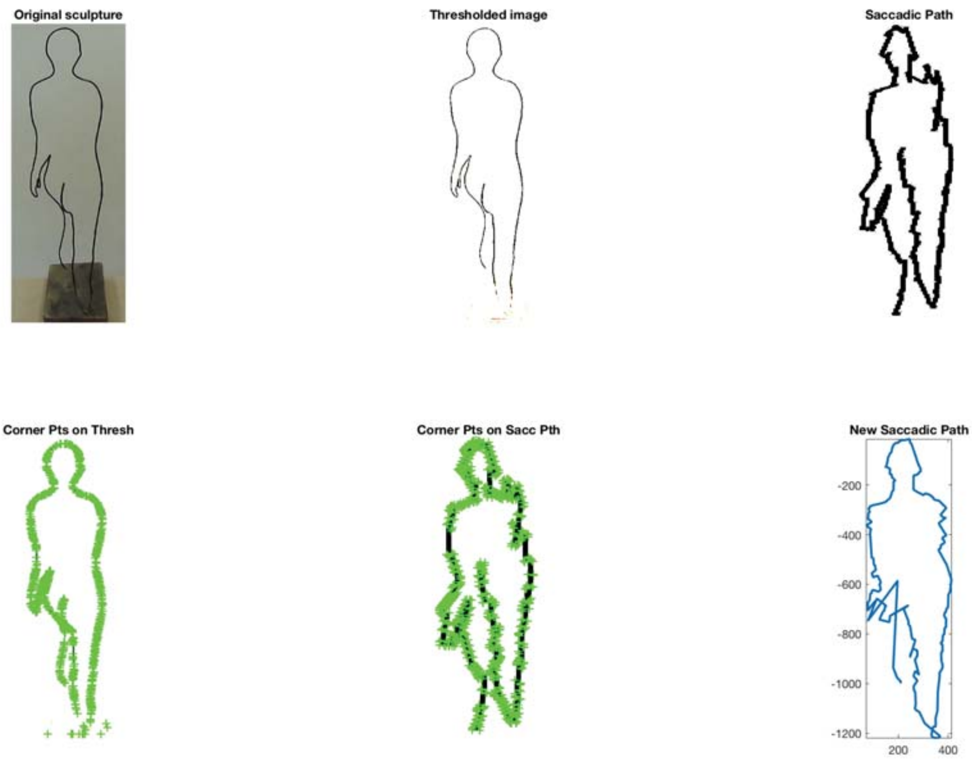


Figure 136: Experiment 5. Algorithmic correction on the output of *Pupil Headset*.

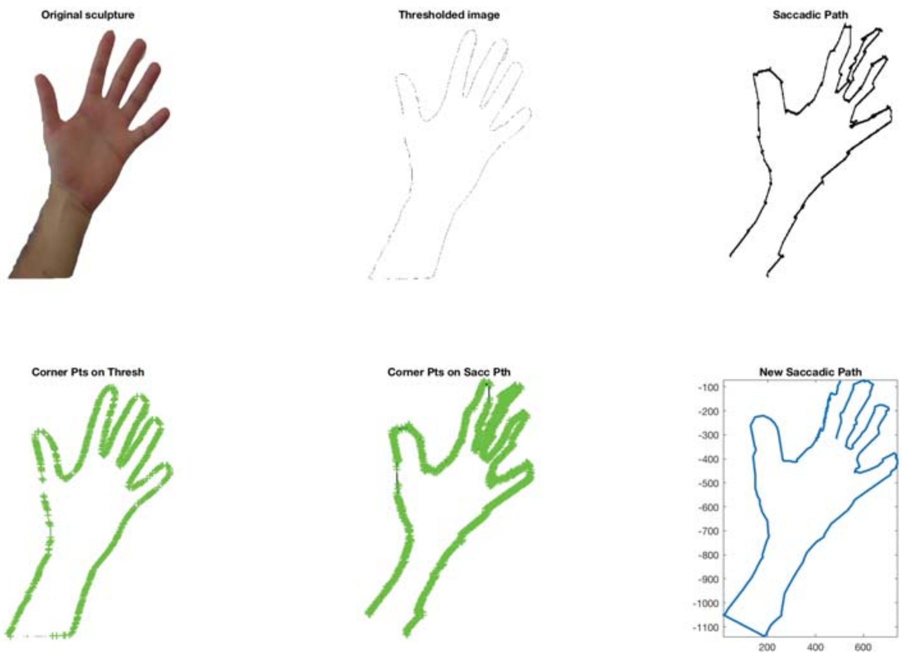


Figure 137: Experiment 6. Algorithmic correction on the output of *Pupil Headset*.

Understanding the Results

As mentioned above, these experiments had to start by tracking the contours of an object made up of straight edges for the reason of simplifying the initial recognition testing of the possible filters and algorithms, which were to be implemented throughout the processes of correcting the respective eye drawings. A straight line also resulted in a more intuitive contour to trace during eye-drawing as the natural saccadic movements are of a more linear nature. A simple pyramid-like wire structure was therefore built for this purpose and eye-drawn several times from different angles both by myself and by Mizzi (2018). Figures 132 and 133 represent two of these eye drawing experiments, where the latter was eye-tracked by Mizzi (2018) while Figure 132 by myself.

There are several points to note here regarding these first experiments. Firstly, there is not much difference between my resulting eye drawing and Mizzi (2018)'s. Both results have the same line quality with jagged turns along the straight edges, most probably echoing several unconscious saccadic movements. Another similarity lied in the scale difference between the video frame and eye-tracking scanpath, which as previously explained was re-matched during the described processing. Both eye drawings also did not linearly close the concerned shape, something which resulted to be characteristic of eye drawings as the scale of different contours usually differs. In both cases the eye drawing was also relatively close in its linear recognition to the original eye-tracked view, and as noted earlier, it is here suitable to keep in mind that straight lines tend to be easier to eye-draw due to the nature of our saccadic movements. This comparison between Mizzi's (2018) eye drawings and mine proves to be interesting especially when taking into consideration that my collaborator during these experiments never had any artistic training or drawing practice. It is however also important to note that these observations are not to be taken objectively as more research needs to be done for a scientific conclusion regarding the difference between the behaviour of artistically and non-artistically trained eyes, and this comparison was not the scope of the here concerned experiments. The objective was to understand the best processes to average an algorithmic drawing between the resulting eye drawings and the correspondent photographic frame.

In the stepped-image procedures illustrated in both Figures b and c, it is evident that this latter objective visually succeeded. The development of this exercise went fairly smooth too. The steps of thresholding the video frame and the application of the *Harris Corner Detection* algorithm to it proved to be straightforward, most probably because of the clean and minimal set-up used during recording. This was taken in anticipation of the concerned image processing, and this set-up is also recurring in the other tests taken during this collaboration which will be explained below. For future research and implementation of this method, the idea is to attempt the use of trainable filters which Azzopardi and Petkov (2013) named as *Combination Of Shifted Filter Responses* (COSFIRE). These filters can learn environments with respect to keypoint detection and pattern recognition, and therefore would be more suitable for different environments from our daily contexts. This step would replace the thresholding of the camera image and therefore would be the step prior to the application of the *Kernel and Nearest-Neighbour* algorithm.

The resulting new saccadic path shape in both Figures b and c was quite successful in its target of averaging the eye-drawn path with its respective worldview. In both cases the jagged elements present in the original saccadic contours were successfully smoothened and the shapes' outlines were both completed. It is therefore safe to state that the new saccadic path of both Figures 132 and 133 is a polished drawing of the original eye-tracked scanpath, both in its linear qualities and shape scaling adjustments.

Figures 134 - 136 illustrate the same procedures applied to the eye drawing attempts of a more complex object, which included a variety of curves. This consisted in the outer contour of a walking figure as represented through a wire sculpture. In the case of the original saccadic path of Figures 134 and 135, recognition of the figure contour is very scarce and abstract. These are again the results of Mizzi (2018) and myself, respectively, and were executed in a very quick manner through fast eye movements during the eye drawing attempt. The idea behind this was to test how much can a 'scribble-like' eye drawing be corrected via the processing method described above. Both saccadic paths again had the same characteristics of jagged interferences along their contours and both resembled a vertical doodle, with Figure 134 leaning more towards the right at its top corner. As in the previous examples, the new saccadic path largely smoothened the jagged instances, and attempted an averaging of both eye drawings with the concerned threshold images. In this case a major difficulty is evident in the resulting new saccadic path, even though when considering the velocity with which the primary eye drawing was recorded, the resulting image can be assimilated to the very first seconds of a gestural drawing; both in nature and appearance (Figure 138). Perhaps something which can be enhanced through further research is the actual steps when plotting the points prior to the formation of the new saccadic path. Should this be instructed to better follow the directional movement of the original eye drawing, the final plotting of the corrected image might turn out to be of better quality in such cases.

Figure 138: A 5-second student gestural drawing. (Nicolaïdes, 1969, p. 18)

Figures 136 and 137 illustrate again Mizzi (2018)'s algorithmic process for the correction of two eye drawings, as described above. These case studies concern another eye drawing of the same sculpture mentioned in the latter two tests, and an alternative one of my own hand. Both eye drawings used in these experiments were done by me, and this time slow eye movements were utilised. In this view, the original saccadic path of Figure 136 differed greatly in shape and scale from the previously mentioned two, and it resulted in being visually much closer to the concerning viewing angle in the video frame of the sculpture. However, it again illustrated several rough disturbances along its contour and some irregularities in the scale representation. As proven by the new saccadic path in Figure 136, both of these issues where corrected through the algorithmic procedures. At the same time, the resulting processed drawing still retained crucial aspects reminiscent of the original eye drawing, which strongly differentiates the image from that of the thresholded video frame. This was very important and encouraging for this exercise, as the idea behind this assisted technology is to correct the primary scanpath in a way that original aspects of the individual's way of eye drawing are still preserved.

This same exact argument regarding Figure 136 also applies to Figure 137, which was the only eye drawing experiment done on a real feature of the human figure. As discussed in the latter example, the original eye drawing of my own hand was accomplished through slow eye movements and it featured jagged intervals and some scaling imbalance. Once again these were successfully smoothened and corrected as shown in the new saccadic path, and hence the results are encouraging for the possibility of further research into this way of processing eye-tracked drawings. Possible implementations and applications of this research are also analysed in the following chapter.

CHAPTER 4

GENERAL DISCUSSION

This dissertation started with the possible explorations of implementing data recorded by a potential empirical device into an artistic process, and developed into the concept of obliterating the hand-eye coordination taking place during drawing. This directed the attention to the question of how data from an eye-tracking device could be used for the creation of what this dissertation coined as ‘eye-drawings’. The implications and questions brought up by this method were many, and ranged from the exploration of a mind-eye relationship to an early testing of a more ‘universal’ practical application seen in the latter experiment in collaboration with the A.I. department. The practice-led methodology used throughout this dissertation also found important inputs and concepts within the Literature Review which was investigative of artistic, empirical and phenomenological approaches towards a definition of perception. This dissertation question concerning an artistic approach to data, resulted in both an important conceptual investigation with respect to the respective drawing practices, as well as a technical exploration of how to externalise the findings (Appendices B - H).

The gesture of drawing has been regarded as being both “transitive and intransitive” in nature where the hand records what is processed through the eye, while being influenced by multiple factors, in particular the artistic skill of the individual (van Alphen, 2017, p. 111). In practice, the present dissertation attempted to challenge this synthesis by eliminating the artist’s body from the gesture of drawing, and to a certain extent tried to give it more of a transitive approach by tying it directly to the eye movements. At the same time it might also be argued that such method is also intransitive in its aspect of ‘blindly’ directing the gaze according to mental perceived contours without reference to tangible gestures at the moment of execution. In general science, eye movements are considered to be part of our non-verbal body gestural communication, possibly well implanted through our human evolution, and which also form part of a universal and culture-free communication system together with facial expressions, body movements and posture amongst others (Hugill, Fink & Neave, 2010). There are therefore universal objective factors in the nature behind our gazes. The first challenge brought up by the process of eye-drawing was related to the suppression of two bodily gestural instincts; that of the moving hand (and 'artist's' body) while drawing and the unconscious freedom of our eye movements. This difficulty in eye drawing was also noted in most answers provided by the participants of the communal Life Class (pp. 172 - 184) as they noted the high need of concentration during eye drawing.

Eye drawing therefore cannot be entirely analysed in the same way we are accustomed to deal with drawing. There also needs to be the understanding that its objective is not of realistically representing our perceived world, but of giving an account of a traced subjective vision—a perceptive experience—through the establishing of the eye-tracker as an artistic medium. The challenges presented by eye drawing were equal to both art practitioners and non-practitioners, and therefore the activity levels the grounds for usage and expression, as the artist's body's skilful aspect is bypassed. Nonetheless, two main points are here to be noted. Firstly, as in hand and object drawing, the more one trains, the better one becomes at controlling the eye movements in choosing contours to trace along in a real-world environment, and in understanding how the eye-tracking device works. The notion of the machine plays an important role in this activity, as it practically 'substitutes' the pencil in a similar manner a photographic camera 'substitutes' a painting.

The second aspect to consider is the 'graphological' element which resulted in the eye drawings of the communal Life Class experiment. By eliminating the artist's body from the drawing equation, the 'characteristical' differences of the eye drawings which resulted from the communal Life Class experiment had not been expected. The hand is usually considered to be the unit which contains the artistic gesture (skill), and the exhibition *Graphology* at *The Drawing Room*, London, 2012, defined it as “a living seismograph of inner life” (Carels, 2012). Perhaps, this same artistic gesture can be related to the “self-analysing” gesture described by Flusser (2014) when describing the act of painting, where even though he specifically refers to painting (p. 64), the same auto-analysis takes place when the artist steps back from his paper and observes both drawing and subject. During the activity of eye drawing, both the gesture resulting from the artist’s hand as well as this process of life assessment do not exist, and yet, the eye drawings resulting from a communal exercise evidenced a ‘graphological’ aspect in the results of different individuals. While more research is needed to test and confirm these circumstances, these results raise the question of where does the artistic skill lie within our body, amongst others.

A study concerning differing drawing skills among art students had started by noting Berger’s comment on how drawing causes the individual to dissect the observed world in his or her mind’s eye, after which observations are reconstructed on paper (Mc Manus, Chamberlain, Loo, Rankin, Riley & Brunswick, 2010). The study also stated that it would be naive to assume that drawing skills are not achieved through hours of practice, and compares its skill acquisition to methodologies used in singing where complex tasks are broken down into simpler ones through specific exercises as happens in drawing (Mc Manus et al., 2010). This is most probably true also for eye drawing, where through different exercises, harder tasks can be tackled and one can assume more control of the respective eye movements for specific eye-drawing purposes. More research can be done in this field, with the objective to explore different exercises which could enhance one’s eye drawing practice.

The results of another study which tackled why most people cannot successfully perform in object drawing can perhaps give a hypothetical answer to why the eye drawing results of the communal Life Class experiment were so individualistic, with visual elements similar to hand drawn attributions. The study presented its participants with different exercises which tested different tasks related to drawing like hand-eye motor coordination, misperception of the work and the artists' decision-making amongst others (Cohen & Bennett, 1997). The authors' conclusion was that the major source of drawing inaccuracies did not lie within the artists' hand but was mainly caused by a misperception of the object being drawn, with delusions being a major influencing factor (Cohen & Bennett, 1997). Can such point also be affirmed within the context of eye drawing in view of the communal experiment results? Again further research including a larger number of participants and different exercises need to be conducted before any similar affirmations, but it is here opportune to note two important questions Flusser (2014) asked before his analysis on the gesture of painting; "Can you observe anything without having some kind of point of view? Don't you always see what you believe you see?" (p. 61).

Another important segment explored through this research is the experiment which included the algorithmic 'correction' of an eye drawing (see pp. 185 - 195). The attained results can be important grounds to consider for future development in the manufacturing of 'eye drawing' devices designed to give individuals with physical hand impairments the opportunity to draw from the real world through the use of their eyes. Whilst the other experiments' results opened up for philosophical and conceptual debate related to the act of drawing, this particular experiment immediately acquired a practical objective. The algorithmic 'correction' can be improved through the use of environment learning algorithms, and if successful, these can prove to be very useful to average the individual's fast scanpaths tracing along objects with the real contours of the same representations. The resulting 'corrected' eye drawings were therefore not relatable in nature to the distinctive communal Life Class results, and were instead very similar in their linear values. This is of course due to the automation intervention upon the individualistic scanpaths, which standardises the outcome parameters of an eye drawing. This is certainly a case where artistic skill would not be a primary factor influencing the outcome of an eye drawing, and would give an opportunity to describe our surrounding world through selected contours to everyone; including the physically impaired.

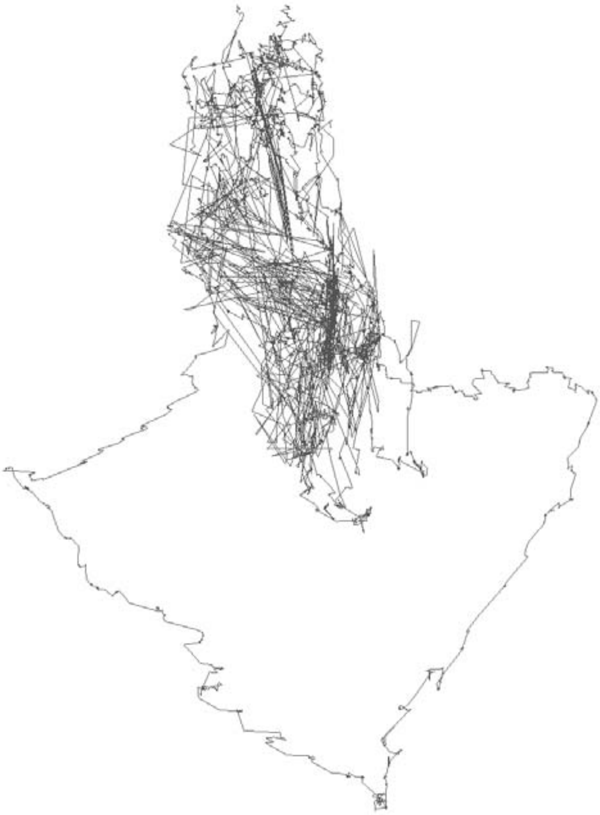


Figure 139: Seven eye drawings of a figure.

Last but not least, throughout this dissertation the artistic implications of eye drawing were constantly explored. Appendices B - H show an array of logistics and artistic developments where the recorded raw data from the eye-tracking device can be stimulating for the development of an artistic work in its own right. Eye drawing data has been practically used as a 'sketch'—or an initial study—from which the proposal of sculptures to be digitally fabricated were born (Appendices D, E, G & H). The same argument applies to digitally printed images and digital images which were developed through an analogue process (Appendix C). The solution of arranging respective eye drawings of the same subject (executed by different people and at different moments in time) into both two and three dimensional compositions harks back to a comment by Anthony Gormley which I mentioned earlier in the Literature Review, where he stated that unlike what Giacometti had done in the past century, he tries to think of representation in terms of a place other than in terms of how to portray an object (Figure 31). The artistic developments emerging from this eye drawing research somehow merges both concepts, as all data (drawing) is an outcome of a place and time, while each added eye drawing is indicative of a subjective percept within that moment. Figures 139 and 140 clearly illustrate this, and more artistic development in view of externalising this research within an exhibition will be done after the submission of this dissertation.

Whilst many exciting questions arise with the conclusion of this dissertation, the only definite answer is that the eye-tracker can have a most interesting place within artistic research as a powerful tool and medium.

Figure 140: A lofted model of three eye drawings of the same figure.

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APPENDIX A

A CONVERSATION WITH CAESAR ATTARD[1]

[Matthew Attard] What are you reading at the moment?

[Caesar Attard] I was reading Adorno (1973) and was curious about how he doesn’t accept Hegel’s dialectics of resulting in a positive (as a negative of a negative). Adorno sticks to the concept of a negative. So instead of defining what art is, it’s better to have a strategy. In fact, I came upon Adorno's “Negative Dialectics”, which is a hell of a book, when I was researching on definitions by concept negation, what in Theology is known as apophasis. However, Adorno (1973), following Socrates' method and Hegel's dialectics, was completely negative dialectically. Whereas Hegel drew out a positive from negation, Adorno sustained a negative critical stance. My interest in all this arose from my dissatisfaction with definitions because although they may serve some purpose they do so at the expense of abstracting what is being defined, something which I think Adorno complained about. If I define art, my definition will exclude others. Therefore, if I say that art is a creative activity such as painting or music or literature, I would be excluding any other possible form. If one defines art in this manner, he or she should be aware that it is subject to a continuous expansion as has been the case throughout history. And who expands it? Artists innovating the area …and the notion of art. But still, they never get to it, and that’s why there is still no definition for art.

[1] This transcript was translated from an audio recording in Maltese, and then verified by the interviewee.

[M.A.] There’s none, but there are a lot…

[C.A.] Yes, exactly! That’s why there’s none, because in the end each definition needs to extend another and open up for innovation. Therefore, I think that we should not be more concerned about the identity of art. We should instead talk about art with respect to what it is not. When describing what is not art, it does not mean that art does not exist. It means that it is always retreating towards something which is closer to you, less abstract and more particular phenomenologically. At the same time defining through negation leaves you with nothing and relieves you of everything that is not what you wanted to define. It leaves you with a hole. It is like defining beauty or God as in apophatic theology proposed by Pseudo-Dionysius for whom knowledge of God would have to be reached mystically by direct experience. However, one must beware of mystifying the art experience imagining one can experience art mystically without mediation.

[M.A.] Why?

[C.A.] How is God still a mystery? By lacking a definition! By saying that he is neither this nor that. Anything which you can mention is not him. And therefore you end up with having a transcendent God (speaking in objective terms) who is separated from us, with whom we could converse, if there be one at all. I have to re-visit Adorno’s concepts as I am suspecting that his way of dealing with negativity is more concerned with an experience. You state (in my case); ‘that is not art’ when testing whether the work Caesar did is or is not art [while pointing at one of his works] because that is only a minute fraction of art.

[M.A.] So you can say that it is not because you tested it?

[C.A.] Because I found an exception for it.

[M.A.] So it is not that mystical in the end, right?

[C.A.] Let us take as example something which is undoubtedly a work of art; Rembrandt's *Self Portrait*. If I state that it is not art, it would sound scandalous. But it is not. If I weigh the painting, measure it, analyse its shapes, etc. I cannot thereby conclude it is art. By exfoliating it as material, I would end up asking myself, why am I describing it as art? So my point is not to search for an identity definition of art, but to look for a locus — a site of art. Better to identify it with an event. What I mean by the danger of mystification is that when one always negates, then one ends up with never saying something positive. A void is therefore created.

[M.A.] But isn't negation something positive in itself?

[C.A.] The act of negating is positive but a negative definition is similar to when one digs a hole, and he takes away that which is extra. The end result is that even the hole is taken away and he ends up with nothing.

[M.A.] But do you think that we live long enough to get rid of the hole?

[C.A.] No, but that's my point. We are digging not with the objective of finding something which poses as art. That is why we throw out anything falling short of a satisfactory definition; and any definition is unsatisfactory. So let’s not concern ourselves with this, but concern ourselves with the things we usually do when confronted by or immersed in what we might even call 'Art'. We can talk about it without defining it. Most of all, we live it. I recently had a discussion with someone about art and science, where I insisted that they are not the same as they do not have the same objectives. However, if one specifically asks me what are the objectives of art, I then answer with what we have been saying so far. The canonisation of works of art is shattered through its own history, after all how can we know if something which is considered as art today will still be considered as such in the future? Or how can we be sure that if something which is not considered as art today, will one day become art? It is fluid. Our concern with the canonisation of works as Art will have nothing in common with the experience I have been talking about. The canonisation of works as Art benefits more the so called art institution with all its social and economic appendices than the experience of 'things' or 'events' which have profound meaning for us.

[M.A.] I then show Caesar one of the earliest eye drawing results.

[C.A.] This has something similar in nature with the portraiture work I had done (Figure a), as when you put participants in a position where they are in the same difficulty you might be if you draw without seeing what you are doing, and you are supposedly ‘the artist’ (Derrida, 2010).

When drawing, you of course have an eye-hand coordination, and what is natural in the hand movements are curves. Both Dennis Morris’ (1962) studies on chimps and studies observing kids have suggested that the natural way to draw involves curves and the most difficult thing to draw is a straight line.

Figure a: *The Artist as Model* – selected drawings.
Retrieved from https://caesarattard.wordpress.com/exhibitions-2/

[M.A.] What is reminding you of your participator experiment the *Artist as Model*?

[C.A.] In the *Artist as Model* the participants never saw the drawing they were producing, because I immediately took the drawing away mixing it with other drawings, and then asked the participants to go look for theirs among the rest in a bin, and sign it. All of them chose the one which they hadn't seen, which was theirs. This might bring to mind Merleau-Ponty's phenomenological accounts about our embodiment. To a certain extent this can be applied to these eye-tracking drawings, but I suspect that nobody can be able to recall automate eye movements, as we are never conscious of our saccades. But, at the same time other persons might be conscious of what we are looking at, especially if they catch us looking at them.

In this view, if I were you, I would ask participants to use an eye-tracker, print out the visual results and ask them to retrieve theirs. I think it would prove to be a very difficult task.

[M.A.] Coincidentally I will be doing this during a Life Class experiment!

[C.A.] I’d be curious to see the results. I’m also wondering whether drawing abilities can change the eye-tracking results, although we do not normally scan an object along it’s contours while drawing. For example, while drawing I tend to look at spaces, and try to relate them together. So probably if you eye-track me while I’m drawing you’ll see several criss-crosses in the resulting scanpaths showing that I compare certain spatial relationships.

[M.A.] What do you think of these Caesar? I was manually tracing a slow motion video of recorded scanpaths while using the computer monitor as a ‘light-box’.

[C.A.] I see, so this is *post-factum*. These can be very close to your previous sculptural research. This can be a good challenge for the fact that in those sculptures there is always a point of view where the beholder sees the representation as ‘resolved’. To a certain extent, this idea of a ‘single’ viewpoint harks back to the Renaissance and Baroque. To the Renaissance because of the invention of perspective. Let’s take Da Vinci’s *The Last Supper* as an obvious example; there is a specific viewpoint from where to ideally see it. During the Baroque period, this was exploited, sometimes to absurdity, and for some church ceilings the pavement was sometimes marked indicating from where best to perceive it - an ideal position. So I think what you need to challenge from your past work is the fact that when the viewer finds that ‘ideal spot’, he or she is seeing things in a coherent manner which automatically makes the other viewpoints result as being incoherent. Therefore, that ‘ideal spot’ becomes a ‘reward’. How can you overturn this? I think this ties well with what I said earlier about the insufficiency of definitions which pretend to 'resolve' the indeterminateness of whatever they define by abstract means. The perspectival resolution here analogically risks freezing the experience to a static moment by resolving all other possible moments which together constitute our dynamic experience. I would at least hope the moment would not be an end – a 'telos', but a pause?

[M.A.] I don’t know yet. This research started from there actually and now I’m at this point I’m showing you.

[C.A.] Well probably through the use of science, you can achieve something. Remember that we always associate science to something being very precise, but it’s precision is probabilistic and cannot be more precise than that. So, also remember that when viewers get to a ‘good’ point of view they would have essentially moved from an exploratory world to a conceptual fixation. That concept is final and you have to think whether you can go beyond that. If you finalise a concept, you risk that a viewer does not appreciate the transition of getting to it. I think you always need to leave a question mark.

[M.A.] I’ll show you this eye-drawing of a hand as a last quick example of where I am at in my methodology, and then we’ll talk a bit about your previous algorithmic and participatory work.

[C.A.] Yes. I see. Here you are quite in control and conscious of your eye movements. Again, I am very curious whether it would be possible to recognise one’s own eye drawing. I think that would give you a chance to compare it with the *Artist as Model* experiment. My experiment had revolved around the sociological idea of switching the role between artist and non-artist, but you can here talk beyond that. In a way this can be a ‘semi-scientific’ study, because this will give you the opportunity to compare between a mind-eye control and a mind-eye-hand coordination. And keep in mind how important the latter is to our development, especially when still kids. What’s also interesting is that when eye-tracking from a three-dimensional environment, like in the case of this hand (Figure b), you can actually also understand foreshortening! This is very controlled, and since you did it, most probably it can be the result of your training in object drawing.

Figure b: Eye drawn hand – personal screenshot

After a short break we went back to talking about Caesar’s algorithmic drawings he had done in the early 1970s.

[C.A.] I usually do not publish these. We are here going back to 1972. In 1969 I joined the Teacher's training College and in 1971 I started teaching. In 1972 I had not yet started teaching art. That happened towards the end of 1973. I was very much dissatisfied with what I had done so far [artistically]. I started looking around and researching what other [international] artists were developing, and comparing them with art history. I used to borrow *Studio International* from the University, and that exposed me to a lot of contemporary developments.

[M.A.] How would you compare contemporary happenings with art history?

[C.A.] For example, I would see an abstract painting, and doubt whether it’s abstract while trying to understand what was actually happening there. Remember also that we tend to go in and out of painting, and the market is unfortunately pivotal in this too. Over here I have some material which might give you an idea of how I worked and what the contextual background of these algorithmic drawings was.

Caesar took out his notes and sketchbooks from that period.

[C.A.] These primary notes are transcribed. I was here obsessed with the idea of angles. Angles include points, especially when they are acute.

[M.A.] How would you interpret these from today’s point of view?

[C.A.] There are elements which give me the feeling that I see these through a symbolic lens and not as a technique to create images. The angle itself could symbolise an environment.

[M.A.] Contexts?

[C.A.] Yes, and contexts. This is also clear in examples like this drawing here, which is titled as an *Angle-oriented Environment*. It looks like an observation of a hypothetical situation. This is how this series started, with an interest in angles. At this very early stage I had not introduced variables yet, and the angles were still not precisely calculated. They also became a symbol for other things as well, and this was important to me as an artist since I did not want to close myself in a technique or some kind of mechanism.

[M.A.] How did this initial interest in angles develop into algorithmic drawings?

[C.A.] I introduced the earlier mentioned variables, through a scale. So for example a scale could be made up of black, white and the gradations in-between, and would then be matched to the appropriate angles. In others, I also used a colour scheme. This was therefore my palette and the situation I had created for these images.

[M.A.] Where did this research come from?

[C.A.] Here I have a book which had interested me way back. I think I bought it in the late 1960s; *A Stepladder to Painting* (Gordon & Hayes, 1962). I had done all the exercises published in this book and it proved to be very enriching. It had exercises about the value of tracing, shadows, framing [i.e. 'composition'] and the subject amongst others. But the most influential exercise was probably this; *Memory and Colour Shorthand*. So these were exercises I would do; instead of painting I would go around and write annotations of what I saw. Even the relationship with music was important. The start of the algorithmic drawings was a kind of arbitrary arithmetic, where what we describe as science — and what we describe as art — conflate. In this case, science stops being science and becomes speculative, and therefore it is there where science can be artistic. As a parenthesis think of Einstein before his discoveries; his approach was artistic. He was visualising, imagining, concretizing and creating metaphors. So I could not say that I was doing art, but I was aware of the fact that I was doing something different. With every step I would write my reflections and descriptions. Some experiments also had an element of fractals, where a pattern could endlessly be repeated and transformed. Recursive and self-referential instructions existed at the time, but not the word ‘fractal’.

[M.A.] When was your first contact with a computer?

[C.A.] I bought this book, *Computer in Art*, by Jasia Reichardt around 1975 (Reichardt, 1971).

[M.A.] This was the time when in Europe and in the U.S. experimental exhibitions between artists, engineers and biologists amongst others were being organised right?

[C.A.] Yes, and that’s why I earlier talked about the dangers of defining art. It is much better to tackle it through conversations and discussions, and to discover how interesting it can be. It is important to ask questions like; why is this so meaningful for me? How is it affecting me? Why are we still fascinated by it after all these years? In this way we deflate a bubble revolving around art which only favours those who are (economically) enriching themselves from it.

[M.A.] Would you say that in this series you were testing your own applied rules to break them?

[C.A.] To a certain extent I would try to disrupt my own self. For example, here [pointing at his notebooks] I noted something about *The dictatorship of the shape of the frame and its containment*. I had to challenge my own rules, as I was aware of the fact that they could become mechanistic.

[M.A.] So it is as if you had bugged your ‘system’ and at the same time tried to debug.

[C.A.] Yes, I had to question myself about this ‘bug’, which was recursive and had the possibility to be translated into a formula. I had to ask where it was coming from. I had a remainder. The initial conditions when you apply a rule and a recursive procedure, never repeat themselves in a precise manner. This can also explain why as subject I had a particular interest in profiles and portraiture, as well as accidental happenings like the *Ink-Drop* experiments (Figure c).

Figure c: *Ink-Drop Experiment 4.*
Retrieved from https://caesarattard.wordpress.com/exhibitions-2/

[M.A.] But there is still a repetition of the ‘action’…

[C.A.] Yes, to be more precise there is a repetition of the rule. But, for example, try creating a polygon with enough repeated angles to make it form a circle; the ending will never be precise. There is a certain chaotic element to the practice. It is the difference between praxis and theory. A typical definition of 'chaos' in physics goes like this: the property of a complex system whose behaviour is so unpredictable as to appear random, owing to great sensitivity to small changes in conditions.

[M.A.] What other accidents did you apply?

[C.A.] I differentiated between what can be geometrical and what is non-geometrical in nature. For example, if you manually tear a paper there is no control on the resulting contour. At this stage I would try to define a geometry of the non-geometrical, by creating a number of points from which I could then extract information concerning the accidental rip.

[M.A.] So, in these cases you would be 'rationalising' upon an accident.

[C.A.] Exactly, and most of all analysing it in order to be able to use the resulting information. However, I must point out that rationalization itself is still open to challenge and can even be debunked as I had done regarding definitions. For example, the results in *Human Pantographer* (Figure d) become the trigger of a humorous debunking of the whole *mise en scène*. In view of this, I also started projecting installations, like this proposal for a cubicle constructed of doors.

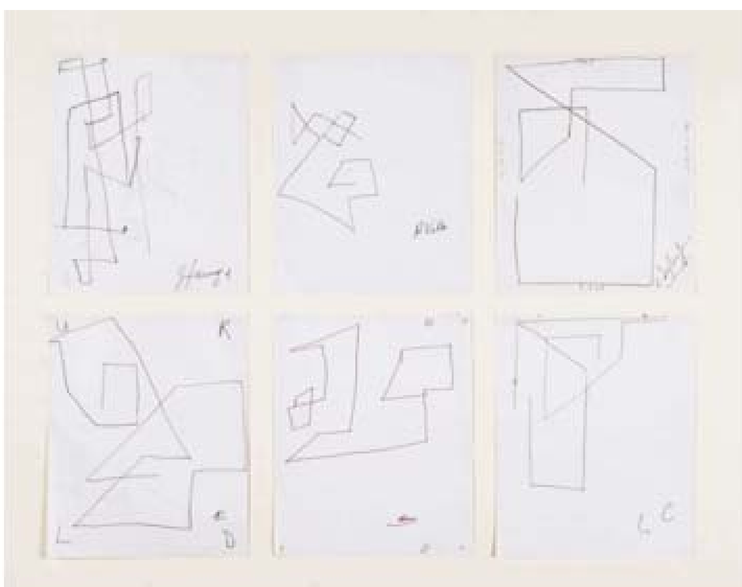


Figure d: Sample results from Human Pantographer, 1977
Collection of the artist

[M.A.] Is that its plan view?

[C.A.] Yes, you would enter the space from here and exit from somewhere. It is similar to a labyrinth, but this wouldn't be an exact description of it. Things would take place while one is moving within the cubicle space. Light sources, screens, sensors and colour tones were all designed to obey these 'algorithmic' rules. [Reading from notes] *This is a project for an angle-oriented environment. Concept: movable environment creating new space relationships through the changing of angle relationships. These new space relationships would condition the light source volume quality in much the same way as an only window in a room can be used to control the light entering the room. This environment can be constructed by means of rectangular or even other flat shapes in such a way as to guide the participant through different channels of stimulation. In fact, these elements or shapes of the environment can also be influenced physically by the participant himself. The participant can be led to behave in a manner that automatically stimulates the environment.* In a way it's similar to Acconci's *Movable Floor*, where if two participants are within the environment, they will also be influencing each other.

[M.A.] That's true.

[C.A.] So as most of you are doing today, I was trying not to solely close myself in an art world. I then also applied these concepts to painting. For example, one of them concerned a nude, which I presented to the artists of *Atelier '56*. That's what I had given them to judge whether I could form part of their group, and I was accepted! The curious thing was that they accepted something which they did not understand, and somehow still saw that worked!

[M.A.] Did the rules change from one representation to another?

[C.A.] Yes, I would decide upon these depending on different cases. For example, this started from a haphazard composition, and then again rationalised its process. I played with complimentary logic, like for example an angle of 90° would also have the opposing 270° to consider. Also, the chosen scales of the different gradations where all arbitrary, and this is probably where I (as an artist) still had a minor degree of control. At the same time keep in mind that I was also interested in notions of interpersonal art, i.e., how I am to relate with another?

[M.A.] Would you consider this array of work as being your subjective vision of that time?

[C.A.] Yes, definitely. But of course this also exists in the act of painting itself. If I apply pure red to a canvas, I do not have much control on its effect. The brush would probably be more in control than myself, while the brush mark is something the artist has to abide with. In this same way I accepted an algorithm.

[M.A.] What other variations of these experiments did you do?

[C.A.] At some point I also tested calligraphy. I would plot random calligraphies and through that plotting create an algorithm — a mental rule — which I then applied in a serial manner. Algorithms could also be applied on top of other algorithms too.

[M.A.] How complex is this?

[C.A.] Well, when I used to teach art to kids, I sometimes gave them a related exercise. They were primary school kids, and I would ask them to design tile patterns. They would have a chequered paper and all I told them was to start by marking a square, and repeating (sequentially or alternately) the same mark to all. After this procedure, (roughly speaking) more marks could be added with the simple rule that what is added to one 'tile' needed to be added to all. The visual complexities they managed to produce used to be astonishing, but the procedure behind it was a step-by-step one… almost 'stupid'. It can somehow be assimilated to the way simple programming functions today.

[M.A.] Can you please design a specific algorithm as example?

[C.A.] Yes, sure. Let us look at two algorithms used in this profile sample from the installation *Open-Ended Meta-Dimensional Field*, 1977 (Figure e.a).

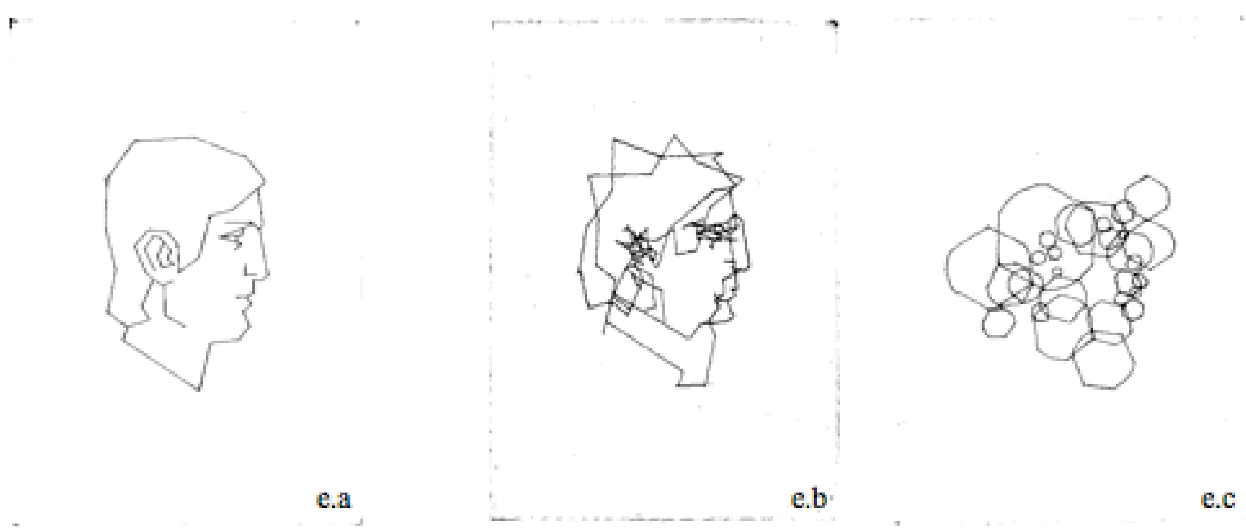
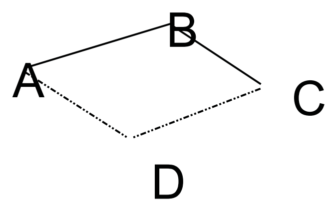


Figure e: Open-Ended Meta-Dimensional Field, 1977
Collection of the artist

Algorithm 1(Figure e.b):

For any given angle ABC

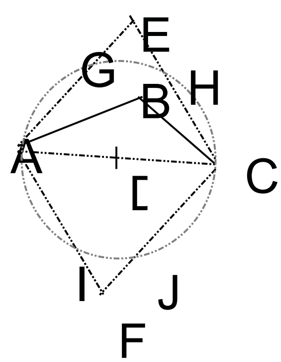


a) draw line AD parallel and equal to BC and line CD parallel and equal to BA

b) erase lines AB and BC

Algorithm 2 (Figure e.c):

For any given angle ABC



a) join A and C to form line AC

b) bisect line AC at vertex D

c) draw two equilateral triangles on opposite sides of AC with base AC and apices E and F

d) from vertex D, draw arcs GH and IJ radius DA on opposite sides of Ac intersecting sides of triangles ACE and ACF at G, H, I, J

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APPENDICES B – H

A USB flash drive is attached to this dissertation, which includes Appendices B - H. The following appendices incorporate visual documentation and results of this study’s experiments and development, which were essential throughout the practice-based methodology of this research question. Should the USB flash drive get lost, or files get corrupted, please contact the author for a new version.