

Bio Mind and Techno Nature in the Performance of Memory: Arts-Based-Research and Human Enhancement

Maria Manuela Lopes 

Universidade do Porto, IBMC - Instituto de Biologia Molecular e Celular,
i3S - Instituto de Investigação e Inovação em Saúde.
ID+ - Instituto de Investigação em Design Media e Cultura,
NIAM - Núcleo de Investigação em Artes e Multimédia.

maria.lopes@i3s.up.pt

ABSTRACT

This paper intends to examine two recent projects *Enhancing the Mind's I* and *Emerging Self* that address notions of self-identity, the desire for freedom of form and the greater cognitive capacities promised by neuro-enhancement technologies. It is a bid on critical evaluation of the production of the artworks; departing from an understanding that the observer is not independent of reality and that observation and experience are constructed. Consciousness is considered as resulting from the organism capacities to understand its emotions and interacting context, thus the research explores the possibilities that memory and knowledge do not reflect a real exterior world, but a concrete interior world attempting to play with possibilities to generate affect and empathy in the audiences. The text reflects on the ethical side of Human Enhancement (i.e. the potentiation of biological characteristics of Human Body) and the technologies, such as Brain Computer Interaction (BCI) or digital tattoos (tattoos that have technological interactive properties), promising a refinement of nature by technology. It raises questions surrounding memory and identity through art installation. It explores whether is it possible to translate one's emotions directly into matter, as a memory. The result is the opening of a critical gap between the way sciences produce knowledge about the subject and the affect produced by the experience of the viewer on the installation artworks.

KEYWORDS

Arts-based Research; Neuroscience; Memory Enhancement; Consciousness; Performance; Affect; Empathy; Embodied observation.

1 | INTRODUCTION

Digital technology has been altering ways in which memory and knowledge are produced, stored, connected and shared (Lopes, 2013), forging new domains, tools and artefacts (Lopes, 2015). New cultural practices derived from the technologies and

gadgets we use, alter the ways in which we remember, and how memory is stored and processed, resulting in new concepts of personal memory/identity and related rituals (e.g. digital social networks). In scientific laboratories and through artistic production the author explores varied approaches to the concept of memory (e.g. biological memory, data as process memory, memory as protocols to procedures, memory as identity, and other forms of acquiring, encoding, storage, retrieve or re-enact actions and thoughts). Memory has become entangled with digital materialization and neuroenhancement technologies (i.e. technologies that are used to the potentiation of cognitive capacities), and the author is curious on how mediated memories as 'traces' and 'institutional texts' are socially shaped (van Dijck, 2007).

In this moment in time, Mankind curiosity and technical possibilities (alongside some anxiety and fears, such as the fear of the use of medication to maintain attention or electrical brain stimulation to enhance cognitive capacity) are propelling us to move from using the created techniques to restore our bodies to "normal" functioning (e.g. after an impairment due to an accident), to using them to increase our innate abilities (e.g. needing less sleep in some professional fields). Conceivably, technology may add new body and mind capacities, as the author tried to survey in the development of the performance *Enhancing the Minds I*, when she went through an intense training in *Neurofeedback* [i.e. a kind of biofeedback, which teaches self-control of brain functions to subjects by measuring brain waves and providing a feedback signal in audio and video (Marzbani et al 2016)].

This paper is an exploration of questions raised on the development of two artistic projects during the course of the author's Postdoc research, when in residency at a molecular biology institute - dealing with distinct studies and scales on memory (functioning and enhancement). The artworks are ultimately about the fragile and contingent nature of memory, its relation to

identity and consciousness (Lopes, 2013) and human futures, attempting to investigate perceptions of memory through performative practices mediated by technological processes. The performances invite the audiences to ponder the different dimensions, costs and unintended consequences of neuro enhancement. This reflection is a bid on critical evaluation of the production of the artworks; departing from an understanding that the observer is not independent of reality (Maturana & Varela, 1980) and that observation and experience are constructed (Latour, 1999). Antonio Damásio (2000) recognizes consciousness as resulting from the organism capacities to understand its emotions and the surrounding to interact with them. In line with these stances memory and knowledge do not reflect a real exterior world, but a real interior world and the author attempts explore these potentials to play with possibilities to create, through art, empathy and affect in the audiences.

The intention is to question how technology intervenes in the process of memory and how the concept of memory and consciousness is being thought about, leading the author to investigate these through arts-based research. The author artistic performances on/of memory search ways to consider mind, not only as a biological entity but as a technologically mediated concept and the natural body as techno enhanced device.

Enhancing the Mind's I is a performance on/of memory incorporating drawing, video, *Neurofeedback* and brain computer interaction, multiplying ways in which memories become embodied and externalized, by using the artist's brainwaves [i.e. electrical signals neurons produce and the oscillation of groups of neurons in specific frequencies (Tapan, 2017)] as tools for a new humanistic arts based-approach.

Emerging Self explores the sensorium of surrounding space through innovative approaches (ultimately body digital tattoos that are perceived differently according to the body reactions to the surrounding space). Body perception, emotions and memory are expressed in/through skin – allowing differing selves to emerge.

Both artworks attempt to expand on Foucault (2003) and Varela's (1993) challenge of surpassing the 'limits of representation' by allowing the mind that remembers to observe itself in the act of remembering.

Bruno Latour (1999) observed that science exists as an environment of social and cultural relationships. Accordingly, science is created in the overlapping of heterogeneous elements – colleagues, texts, experiments, presentations, etc. – which must be continually managed in a continual reconstruction of social and cultural contexts. The author's artistic projects are created using a method of overlapping of ideas, materials, discourses, texts, workshops, experiments, symposiums, festivals, etc. continually

and simultaneously constructing/acting and re-enacting social and cultural contexts.

Thus, the research methodology is dynamic as it networks and negotiates bodies, social places, objects, data, agendas and fields of memory studies.

2 | BIOTECHNOLOGY AS CONTEXT

Molecular biology/bioengineering laboratorial work reminds the author of the recent understanding of life's molecular architecture and the ability to control its workings, adding a subtle promise to the understanding and control of memory and emotions and extension of the body timeframe. Since polymerase chain reaction (PCR) discovery and the readings of the genetic codes of living systems that scientists can read, alter, copy, edit and splice the genes bringing with it the panoply of dreams for reshaping the world we live in (internally and externally).

The biotechniques are nowadays used to human applications in numerous forms such as genetic diagnostics, assisted conception, tissue engineering, and regenerative medicine, bringing about a new genre of human body repair or enhancement through technological assistance. If in the near future, neural implants could improve our ability to perform physically and mentally, at present researches are exploring ways to improve athletes' performance with gene doping (e.g. enhancing performance by adding or modifying genes), creative surgical enhancements (e.g. using skin grafts to create webbing between a competitive swimmer's fingers and toes) and mechanical prosthetics (e.g. the prosthetic legs used by double-amputee, athlete and top model Aimee Mullins). With the concomitant advances in the digital domains, the increasing number of artificial, synthetic and biological extensions and processes are used to rebuild dysfunctional organs, to reconstruct damaged ones and to enhance others. The biological laboratory presents a labor-intensive (craft like) and visual world, with the guesses, hints or concepts and principles being translated into designed protocols that when followed reveal the abstract domain that preceded all the synthesizing, apparatus, labor, instruments and, as Latour mentioned (1987), 'inscriptions'. The author asserts that biotechnology is reshaping concepts such as identity, memory and body and claims that it is important that art reflects on that stance.

2 | DIGITAL SMART

It is quite evident that the city is indeed constructed thanks to and by means of intricate networks and relationships, encounters and multispecies exchanges. However, recent portraits describe it using a much less complicated – yet definitely more futuristic – set of computing metaphors: the city, the popular view contends, is an information-processing machine, with its social structure compared to a software and infrastructures and transportation

systems to its hardware (Livni 2018). Techno-assumptions (both utopian or dystopian, depending on the approach and the type of critique employed) typically overemphasize the role of technologies in shaping the city. Technologies appear to achieve the same goal: to make the city more efficient. For instance, the ubiquitous presence of mobile, surveillance and signaling technologies is said to have transformed the city into a programmed and programmable entity, a machinery, whose behavior can be predicted, controlled and modulated according to the principles established by some well-intentioned technocrat. AI, the latest obsession of technologists, infrastructure experts, and urban planners alike is said to make cities smart(er).

A lot of ink has been spilled to theorize, criticize, imagine how AI will enhance cities in the not-too-distant future. However, little has been spent to reflect on what exactly smart means and who/what makes something smart (or, the case of many recent projects to modernize and optimize the city, Smart). Shannon Mattern, responding to this matter argues: “..We’re transforming the idealized topology of the open web and Internet of Things into urban form.” This means that “..If you believe the marketing hype, we’re on the cusp of an urban future in which embedded sensors, ubiquitous cameras and beacons, networked smartphones, and the operating systems that link them all together, will produce unprecedented efficiency, connectivity, and social harmony (Mattern, 2017)”.

This approach places a disproportional faith in technological innovation. For the techno-enthusiasts and the techno-obsessed, the Smart City is brought about by a combination of sensors, automatized systems, and surveillance technologies, all placed to measure the city’s patterns, to monitor its flow and its functioning and to eventually predict how it should work in order to run smoothly. Surveillance cameras and monitoring systems do not seem to be associated with any negative connotation at all: rather than being a potential threatening force (as in the best science fiction dystopia tradition) that can be used as a form of oppression, but a series of useful regulating engine put in place to improve safety and efficiency. Even for the scholar in urban planning and architecture, this rhetoric is difficult to shake off: in a recent conference (to which, ironically Mattern was invited to chime in) at the University of Toronto Faculty of Architecture, critical commentaries on self-driving cars and automated systems inhibited any discussion that might have been generated from thinking past the city as a Smart City of technology (“Urban IQ Test,” 2019).

Think tanks and the big tech industry are all focused on how technologies can improve the city. If they could, they would build an entire city from scratch (Mattern, 2016). Cities built with technologies in mind are already a reality: for instance, Songdo, in South Korea, one of the most prominent example of what Orit Halpern calls *Testbed Urbanism* (Halpern, 2015),

was billed as the smartest city, featuring an “efficient trash system, an abundance of parks, as well as a vibrant international community—all wrapped in a walkable, sensor-laden showpiece of 21st century urban design (Poon, 2019)”. Although newer cities built from scratch or almost are the most desirable, other earlier cities, with their aging infrastructures, can be good candidate. In fact, old infrastructures are somewhat marginal: the Smart City lives in the present and is projected in the future.

The current rhetoric about the Smart City has reduced it to an easily measurable, quantifiable, modular object. This approach not only translates the city into a digitized and digitizable module, but it also purports a notion of technology as predominantly digital. But technology is not just digital. It comprises a number of analog devices and old mechanical infrastructures that were implemented at least since the industrial revolution. This conception also neglects important aspects of the city that actively contribute to or are complementary to its functioning. Animals, human beings and microorganisms and plant systems acting as infrastructures, tend to be dismissed as marginal, uncontrollable and incalculable. However, they do serve the city in many meaningful ways, intersecting with, affecting and facilitating the work of those very technologies that we mistakenly consider as the sole protagonists. Interpreted from this angle, the city is a sort of *tabula rasa*, as if before digital technologies were put in place, urban conglomerates were inefficient, wasteful and incapable of functioning correctly.

It is with the above assumptions that my class on technology and society started. When asked: how can you define a smart city? Students were naturally driven to technologies, inspired by the above rhetoric circulated across mainstream media, science fiction stories and a visionary cinematic imaginary dreaming of flying cars and media sensory overload. Coupled with today’s increasing peruse of apps to find direction and places and leave reviews, such standardized response to questions about the city are quite expected.

3 | RESULTS



Figure 1 | *Enhancing the Mind's I*. Detail; Laboratory research, Porto, (Portugal). (The author, in collaboration with Bastos, Marques & Teixeira, 2015) Source: The author, 2015

If a preserved memory is intended to be passed on to others, it needs to be extracted from one's own mind and presented in a way that would make it accessible for others to perceive. The author explores whether it is possible to translate one's emotions and memories directly into an object as a memory of a certain moment. The idea behind *Enhancing the Mind's I* (Figure 1), is to design with the mind (both metaphorically and literally!) multiplying ways in which memories become embodied and externalized, by using the author's brainwaves as tools.

The author on participating as witness in several clinical neurological assessments (Lopes, 2013), found visual plasticity and conceptual challenge on the relationship established between the complexity of the functioning of memory and the personal and constant construction of identity and also the strategies used by different fields of research to explore this entwined relationship. In neuroscience research, specifically in neuropsychology assessment (Lopes, 2013) patients have to write about their identity and own self-perception. The author wonders if own's self-perception is to be projected onto a material to be assessed by others what is really being judged? The communication skills, the capacity to lie and perform as expected by the viewer, the speed on which the task is performed, the imagination or the embedded memory?

In the performances (Figure 2) the author produces a series of drawings following a neuroscientific/psychological guideline for psychological assessment on identity and sense of self (i.e. The TST – twenty statements test protocol is to complete the 20 times in a row the sentence 'I am ...'). The drawings are constructed by writing, in graphite, sentences starting by 'I am'. After 20 sentences there is an interruption in the flow and the artist erases partially the resulted drawing. Immediately after that effacing action the author counteracts enacting the procedure of writing another set of 20 sentences. Each event is performed after sessions of *Neurofeedback* for cognitive enhancement (memory and creativity stimulation) and while having the author's brain being sensed for the different waves it produces. Electroencephalogram (i.e. EEG, a test that detects electrical activity in one's brain using small electrodes attached to one's scalp) measures frequencies of the author's brain activity (alpha, beta, delta, gamma, theta) relating to her state of 'consciousness' while wearing it. The data collected from EEG is translated in real-time to the computer that uses software to detect the brain waves and then transforms that information into data sending it to another computer which performs further actions (such as sending information into Processing or Arduino, which is linked with Max/MSP to receive data and generate sound or video or even controlling several printing and embroidering machines that produce further drawings). The EEG records the 'drawings' that her brain is producing while thinking 'who she is' (i.e. who 'am I') and the production of the drawing is

recorded in real time video. That video file is fed into the computer that edits it accordingly with the coordinates dictated by the performer brainwaves while drawing. The audience has access to the performance scenario and also to the video images of the brain waves captured by the first computer and furthers the projection of the final edited video. The drawings will endure until exhaustion of the material surface, her memory or other unpredictable enforcement.



Figure 2 | *Enhancing the Mind's I*. Detail of a performance setting.
Source: the author, 2016

Questions kept arriving. Departing from a notion that spaces, places and objects hold presences, experiences, wishes and memories that are constantly reshaped; And that we conceptualize our memories, verbalize them and confine them to the boundaries of a narrative (or several and in distinct moments, contexts and materials). Is art able to hold memories without deforming them by rationalization? Is BCI and EEG able to confirm that if as an artist the author is able to externalize her memories whilst remaining faithful to their own fleeting emotions, paradoxical, liminal and conflicting feelings, sorrows and joys, all those irreducible inner events that constitute the nature and identity of a person.

Exploring 'drawing with the mind' (through the body action and possibly factually through thought and memory) by using the performer/artist's memory/emotions brainwaves as tools for live edition of images, is driven by and propels several questions, such as;

- Is it possible to measure something intangible as memory and creativity?
- What can we learn from what brainwaves show us?
- Does wearing an EEG device influence the drawing process?
- Will/Does clinical neuro-enhancing through *Neurofeedback* expand the drawing capacity?
- Can one translate one's emotions/memories directly into an object as a memory of a certain moment/place?
- Can new technologies allow us to observe the acts of remembrance and memory while forming new memories of that experience?

4 | EMERGING SELF

In *Emerging Self* the materials that in biotechnology are used to mark a specific gene or any other technique used to investigate the inner workings of human bodies are turned to reveal the boundary surface presenting in the skin the internal reaction to an inside or outside trigger. The performance *Emerging Self* (Figure 3) was created for the FACTT Festival of Trans-disciplinary and Trans-National Art and Science with the theme "Repetition and Difference", namely for the subfield of 'norm and mutation' and had the collaboration of two other artists (Paulo Bernardino Bastos and Horacio Tomé Marques). It is grounded in the understanding that in differing fields (as memory) the skin is understood as something particular to that field. In immunology the skin is considered as a biome of protective functions and as a negotiating agent between zones of differentiation, in physiology is understood as moving matter in a continuous migration of cells setting boundaries between being surface (self) and the world (other); in embryology the ectoderm is a permanent and direct connection between the nervous system and the skin.



Figure 3 | *Emerging Self* Performance Festival FACTT Lisbon MATT. Source: the author, 2017

The performance presents a play between the characteristics of the skin (viscosity, color, elasticity, shape, density, etc.) and an attentive look at the mutation of the surface (skin of self-body), all mediated in a sequence of actions ranging from stamping (digitizing) digits into memory / archive surfaces (old books about nature, body, skin, and memory). Several designs are built in space that are wrapped with paper and space support. The actions that constitute the performance, such as, dissecting, stamping, drawing, copying, walking are monitored emotionally by a galvanic conductance reader who, by reading the emotions (in varying electric current on the performer skin), sonifies them, constructing a soundtrack of norm and mutation, difference and repetition.

Skin and touch, although primordial, are often undermined and veiled with conventions and taboos, but humans need touch to prosper psychologically and maintain health, although we are illiterate in terms of haptic memory and touching vocabulary, that

even the proximity gestures invading personal space engender, sometimes, social awkwardness. The skin as a self-expression canvas through the medium of decorative, protective, religious or medicinal tattoos dates far back and evidence of its instruments has been found from the Paleolithic Period (Gilbert, 2005) with tattooed human bodies recovered from the Neolithic period (Dickson, 2003). Traditional tattoo methods inscribe permanently the marks in the skin limiting future interventions and the reversal of the process. New experiences and technologies provide ground for, in a similar way to the laboratorial apparatus, our own skins to become the inscriptive devices as well as matter that will allow narratives to unfold. As tattoos and scars are conceived as traces of emotional experiences, the expectation of the project is to produce tattoos that react according to environment conditions (interior or exterior variations), transforming the user body in a visible dynamic network organism. This is a concept of 'Dynamic Tattoo' (Bitarello & Queiróz, 2014). In the version still under development in the laboratory, the author explores the idea of a biosensitive and dynamic tattoo, based on research like Bandodkar et al. (2014) a proof of concept of a temporary glucose sensor based on tattoos as non-invasive blood glucose control; the DuoSkin developed by Mit Lab and Microsoft Research (Kao, et al., 2016) creating a user interface on the skin using gold foil that is commonly found in craft stores, and that it is a leading material; or the 2017 novelty in terms of MIT lab research towards the bioresponssives - Dermal Abyss. The emerging self tattoo might not only help diabetics read their sugar levels without a needle but will expand the possibility of alteration in the tattoo as synonymous of modifications in the physiological/emotional states of the body (conscious awareness).

5 | DISCUSSION

The embodied approach, taken by Chilean researchers Humberto Maturana, and Francisco Varela (1980) or Herbert Dreyfus (1972) deeply re-evaluates the role that subjective experience plays in the construction and expression of cognition and knowledge; following that it adjusts the research interests and methodologies useful to investigate the so-called embodied mind, the mind that is ontologically expressed by the connection with the body and the environment, the mind that has an ontological first-person dimension. It is the switch in the paradigm from a behavioral and computational one, towards an holistic and 'ecological' one (able to consider the central question for the science of the mind: the problem of 'Who', the subject and the subjective perception of the world and the introduction of the term 'experience'), that inspires this empirical and explorative search.

From the embodied perspective, as well as in Merleau-Ponty (2002), cognition is not considered only as the results of a series of cerebral functions

that somehow somewhere interface with the body of the thinking subject. Instead, it is seen as the result of the constant and structural interface activity with the body and the environment, the result of the sensory-motor information that create the background from which the mind can emerge and the horizon to which the mind can watch. The organic and biological body constitutes the cognition itself, it generates it, and it is its phylogenetic and ontological matrix.

Thus memory, consciousness, self-identity, all may be said according to Gallagher (2005) to emerge both evolutionarily and biographically from the relationship of the mental and bodily aspects of the human nature, and with the environment, creating the lived experience. To know an object, (Varela, 1993) is to know the moment that generates the knowledge, being the mind of the knower in the process of knowing. One needs to go out of oneself to observe oneself in the act of knowing or observing, or as the performances show maybe there are novel ways to reach that. Subject and object co-specify and modulate each other. Knowledge depends on being at/on the world on the enactment of subjects in the world, upon the material, on its embodied condition. In this line of thoughts, consciousness might be considered as the awareness of what is happening in a specific context in a specific moment: Then what are we precisely aware of? The body is the first object of our perceptions. Even when we don't intentionally pay attention to the kinetic sensations, the sensorimotor system creates what Damásio calls the proto-self (2000). The body gives us the autobiographical memory continuity, or the common sense of self; the awareness of being the person we are, the same person of the day before, in a certain environment in a certain moment.

The utopian scenarios promised by neuro-enhancement or transhumanism may be encountered in technoetic arts where digital technologies continue to evolve as digital connective, ubiquitous and pervasive spaces, as the embodied relation to memory fields extend further into the material world as we know it. However, the concept of the extension of human faculty and the questions surrounding this topic remain, as new digital materiality change forms and limits, whilst extending human abilities and possibilities for remembering (Garde-Hansen 2009; van Dijck 2007). This can often be seen through the creation of new embodied digital memory practices where human memory converges with "silicon memory" (Garde-Hansen, Hoskins & Reading 2009, p.13), where the symbolic body merges with the subjective body. These change relations to data storage and the acts of memory, leading to the development of new memory habits, rituals and customs set in the cultural imaginary, often in response to the fear of the technological 'error' and 'loss in mediation'. As Garde-Hansen, Hoskins & Reading (2009) assert, tracking, recording, retrieving, stockpiling, archiving, backing-up and saving are

deferring one of our greatest current fears, which is the loss of information. The digital technologies place remembering in an even larger multilayered performance where, individuals, groups, collectives, institutions and corporations navigate between dimensions (e.g. artefact, hardware, imagined, digital space), between bodies (e.g. human, semi living, silicon), and between spaces (e.g. physical, imaginary, digital), one overlapping the other, each of them always connected. Technology and many prosthetic devices (even simple ones as glasses) appear to be considered as an extension of the body, altered to embody connectivity in which connective silicon and human memory merge and create new forms of traces of memory with notions of personal and collective memory.

To Varela and Maturana (1980), context is not independent of the subject but a background to intrinsic facts, therefore it is not objective and may not be conceived and understood independent from the ontogenesis of organisms. The environment and experience shape the mind; the thought, as Merleau-Ponty (2002) not merely relate to the body as an object of the outside world but is made from it, it does not results solely from the interactions in the brain, which is a specific organ, but in person, that is the organism. Foucault (2003) demonstrated that the knowing subject is the result of historical and social constructions, emerging from a set of rules and relationships that work in his/her body. The self is then not a determined or specific entity but an emerging result of the body enactment in/through the world (to the author the self is co-constructed by memory).

The performances departed from the authors previous background and referred assumptions but were also grounded on Roy Ascott's (2000) concept of cyberperception and aimed to explore perceptions of memory through space/time performative practices mediated by technological processes. Thus, based on a personal reflective practice as an artist aiming to promote new experiences within consciousness, the author became aware of the dichotomy between perceptions and processes present in the techno mediated environments of the performance / installation practices discussed. Puzzlement and curiosity about such contrasting approaches to and understandings of interactive hybrid environments led the author to explore the gap between theory and practice, perceptions and processes, involved in Human-Computer Interactions (HCI) or Brain Computer Interaction (BCI) and the need for a holistic original methodology to facilitate the analysis of such environments. HCI/BCI is considered a multidisciplinary area, and according to Wania, Atwood & McCain (2007), it combines theories and practices from a number of fields (e.g. computer science, cognitive and behavioral psychology, ergonomics, anthropology, sociology, design, etc.). Despite the multimodality of the intertwined fields they incorporate sometimes conflicting intellectual

approaches (Harrison, Tatar & Sengers, 2017) commonly dissociated from one another in their methodology, terminology and final products. For instance, if one looks at BCI through the lens of computer science to analyze memory and learning, the language and methods available for such analysis reduce, limit or even ignore the phenomenological, cultural and biological aspects of human perception. Artistic practice technologically assisted (or in Ascott's terminology technoethic arts) may be viewed as a non-reductionist interdisciplinary view of knowledge, that allows different kinds of perception to interact in a non-ideological way to grasp the complexity of memory.

In the *Enhancing the Mind's I* the author explores unpretentious ideas of enhancement, such as the invention of the writing itself, as a development that simultaneously extended and impaired human memory, by providing an externalized written record but diminishing people's ability to memorize by removing the necessity of learning by heart. Andreas Husseyn (2000) inquiries about the consequences of writing for human memory and further on the role technologies impact on our natural skills providing examples for contemporary discussions around human enhancement through technology and how external memory aids and other new technologies such as brain computer interfaces, are always double-edged, extending or fixing certain powers while eroding traditional skills.

In *Emerging Self* (Figure 4) the author reflects on how skin and touch are often considered as minor in terms of sensing and learning. Although it may sense temperature, react to emotions and sense texture and other features conventionally attributed to vision, such as perception of different color through their electromagnetic frequencies. A reversal of the power of the understanding of the network of reactions to sensitive environment might be considered an equivalent to the enabling of a seeing gift that substitutes empathic recognition or medical inspection. The attentive gaze could be substituted for a glimpse, and that would bring about a new set of human/human and human/machine relationship paradigm. Rather than being what we produce or the results of what our body produces (such as illness symptoms or actions driven by feelings) the subjects of observation, the proposed explorative art projects with the human machine interface brings about the possibility that memory itself is the object of scrutiny literally presenting itself thought the visible reactions on the surface of the skin or the results of the performance. This unveils potential new dilemmas that are connected with culture, experience and environment rather than biological roots or racial identities if memory and feelings ought to be revealed at the surface of our actions or skins, as well as the empowering of the utopic controller of the settings that manage the coding of the interface relationship. Skin not as just a breathing organ but as a material

'membrane as liminal state of transience', as a metaphor for the exploration of what is natural or artificial, duration or memory. In contemporary life, claims Jens Hauser (2008), skin, membranes and tissues rest in a pervasive cultural position positioning as an instrument and metaphor across theory and praxis. Simultaneously skin is an organ that visibly shelves as memories the passage of time and the lived experiences, it is our interface with the outside world that contains our life but seen in detail is a biotype that houses fungi, bacteria, viruses and parasites. In the embryonic stage of our growth the neural tissue and the skin both result from the same tissue (ectoderm) and their binding allows expression of the emotions in the skin (Adler, 2017). When we become scared or ashamed, excited or angry, we feel pleasure or anguish, the temperature and humidity of the skin change because the sympathetic system, which belongs to the neurovegetative system, controls these functions. If in stressful situations, hormones such as adrenaline, noradrenaline and cortisol will cause changes in the skin, in a situation of love and stimulation by touching the hormone oxytocin leaves us with a feeling of happiness.



Figure 4 | *Emerging Self* Performance Festival FACTT Lisbon MATT. Source: the author, 2017

In the beginning of this century wearable's field of research (Tao, 2005) promised to be a revolution offering opportunities for the creation of smart clothes that could perform functions according to the body's needs and adapting to the environment. Reminders of things to carry (such as keys or wallet), performing temperature feedback and adjustments in the clothes accordingly, or wearable medical devices that could monitor body conditions, was amongst the potentials. Although research on these fields is still expanding, to the author, those investments were surpassed by the research into new materials such as e-skin or e-ink (i.e. electronic skin and electronic ink) that could transform the photonic or electronic technology that clothes/objects we transport could be made of, into something that could be made onto or under our skin and therefore be always present and not depend on the context or remembering of carrying the 'special jacket'.

In the past decade e-skin research as exponentially grown (Mallory, 2013) and the capacities and progress resemble science fiction narratives, with sensors and circuits exceeding the properties of

biological skin in many aspects (e.g. stretching further, superior spatial resolution.). The challenge still rests in its connections to the neural interface, something that the BCI is expected to solve in a near future (Mallory, 2013).

New biocompatible materials and technologies are being developed and keep surfacing in the scientific magazines and the news, some of them belong to the areas of software and electronic engineering, materials and computer science, and other to biology, nanotechnology and bioengineering. With the development of new technologies, new kinds of dynamic tattoos are envisioned, enabling new types of situated and 'embodied multimodal communication' (Bitarello, 2011) and body/machine, body/environment relationships.

The *Emerging Self* deals with the dialogical relationship between the body and its representation and how the current bio-surveillance techniques have subtly undermined the conceptual parameters of this exchange. Prior author's work (2015) claim that new technological tattoos may be considered an innovative field where cutting edge scientific and technological experimentation meets imaginative and speculative scenarios of creativity. Apart from the dynamic of mass production or even desired consumption, this biological art project presents a speculative prototype for memory and imagination consumption. However, the approach and discourse are those of arts and design in the fusion of objects, materials, social dynamics, production aspirations and the converging network of 'actors', an inquiry in the field of interaction between 'humans and nonhumans' (Latour, 1999).

Memory, as author mentions in previous work (2014) is so close to our actions of thought that we tend to give it for granted. The flow of time allows for a constant stimulation of our senses and, therefore, a permanent flow of messages sent to the brain. Sensory stimuli disappear very quickly, leaving a pattern of neuronal activity, that is, an impression on brain cells. The possibility of a real skin tattoo that would reflect and react to the emotional states and the environment plays on the inverted observation point that visualizing technologies in medical research have been exploring in recent decades (*i.e.* foregrounding the interior over the exterior). With dynamic settings possibly adjusted to each user the seeing through the skin process would become a malleable subjective process reversing the image process of the medical arena where expertise and converging fields are necessary to produce and interpret access to one's bodily structures and functioning's.

6 | CONCLUSION

The re-enactment of our perception process in this context is a realization that the art project, understood

as perceived through the sensory system, is always fuller than we can ever be consciously aware of. We know that conscious recognition is constructed, a process that does not distinguish between events perceived from mediation or from real life enactments. As Damásio claims (2000), what we perceive consciously is only a very small part of our whole perception. The author's art projects propose to introduce intuition into the discussion, since it enables inherent qualities of the perceived objects to be grasped and engage with the deeper layers of our conscious states.

Serving as the hermeneutical phenomenological basis for reflection and analysis of BCI and skin galvanic conductance techniques in interactive hybrid environments, this paper introduced the migration from, and connection between, practice and theory in the production of new knowledge. Deployed Varela, Ascott, Damasio to argue for a non-reductionist interdisciplinary framework to equate user, information and interface in meaning creation. Considering humans are embodied agents who are capable of creating and exploiting structures in the world, that own an agent's brain handling the controls of embodied action in the exploitation of environmental structures, which have been shaped through repeated brain-world interactions. The result of such interactions is characterized by emergence, coalescing from the agent's cognitive capabilities in the utilization and manipulation of external media, tools, technologies, but also the storage and transmission competences offered by cultural institutions. If in the biology/bioengineering laboratory the biomaterials are researched for health purposes, this project, at the interface of science, culture and technology explores the biological artefacts as well as all the surrounding dynamics of its construction encouraging new modes of engagement with the contemporary understanding of the fluctuating range of life forms and matter. The performances seemed to engage audiences in a collaborative mode of inquiring creating a sense of belonging to the holistic artworks, once the reactions of the audience were immediately sensed and acknowledged by the authors body that resulted in visual and audio changes visible back to the public. The artworks became scenarios for audiences to perceive the emotions the artist was undergoing during the performances and many viewers reported a sense of somatic or emotional empathy towards the author. Thus, the author asserts the artworks were successful in producing affect, towards the enhanced human, placing emphasis on the embodied experience acting upon the viewers mind producing responses.

In a future approach the author may focus on observing interactive hybrid environments through space-time experiences within BCI transdisciplinary contexts, defying the elements involved in interactive hybrid environments and the integration of these elements (user, data, technology and interface) as a

complex adaptive system called meta-environment departing from such experiences when integrating perceptions and processes.

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BIOGRAPHICAL INFORMATION

Maria Manuela Lopes is a visual artist whose practice is transdisciplinary, investigating relations of memory and identity informed by the biological sciences/ medical research. Her artwork presents itself as multimedia installations, drawings, performances and biological materials. Lopes studied sculpture at FBA-UP and did an MA at Goldsmiths College in London. She has a Doctorate in Fine Arts and New Media at the University of Brighton and UCA-Farnham in the UK. She has developed a Postdoctoral Art Research Project at the University of Aveiro and University of Porto – Instituto de Investigação e Inovação em Saúde, i3S. She is a researcher at i3S as co-responsible for the Cultural Outreach Art/Science interface. Maria Manuela Lopes teaches art and has curated several international exhibitions and her work has been shown and research presented nationally and internationally. She is co-founder and Deputy Director of Portuguese artistic residency programs: Ectopia - Laboratory of Artistic Experimentation and Cultivamos Cultura.

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