Brain: the ultimate enactive interface?

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Abstract. *Eshofuni@TheAbyss* is a multidisciplinary project/performance embracing art, communication design and programming, that proposes an approach towards real-time representation of brain phenomena in performative art contexts using brain-computer interface. This paper discusses the project within the context of live interfaces purposes but introducing a transdisciplinary approach to the brain phenomena addressing a multi-level of aspects that are fundamental to comprehend it and, consequently, the project. Firstly we briefly discuss the definition of interface; then we introduce the brain as a neurophysical electric complex system and propose it as a candidate as the ultimate dynamic interface, beyond technical inventions (brain-computer-interfaces); then we correlate the system with the performative live art event(s); then we explain *Eshofuni@TheAbyss's* representational conceptual approach and strategy; finally we discuss the implications of this approach and propose insights on the subject.

Keywords: Brain, Interface, Environment, Enaction, Brain-computer interface, Art

1 Introduction

On writing about the seminal book *Endophysics: The World As An Interface* by Otto Rössler, Ichiro Tsuda (2002, 213-214) proposes, in his conclusions, that "Endophysics tells us that reality only exists at interfaces. By perturbing the interface slightly, we can have different senses of reality". Interestingly, Peter Weibel (1996, 343) addresses questions about the (same) theme saying that "The world changes as our interfaces do. The boundaries of the world are the boundaries of our interface. We do not interact with the world — only with the interface to the world." Finally, Manovich (n/a) on his essay *The Interface as a New Aeshetic Category* postulates that "Content and interface merge into one entity, and no longer can be taken apart".

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2 The interface dilemma

Is there a proper definition for interface? Interface definitions could make reference to functionalities and/or characteristics, could be considered iconic, symbolic or ecological. In *Computers as Theatre*, Laurel writes (1991, p.4) "interface is not simply the means whereby a person and a computer represent themselves to one another; rather it is a shared context for action in which both are agents". An interface based on action-perception paradigm — integrating multiple modalities (e.g., vision, sense of touch, sound) — can be considered as enactive (Fukuda, 2011, p.77). If we consult reference dictionaries about interface definition we have multiple entries, some variations of the theme, some variants related to the field where it relates to but at the most basic level, there is a common denominator which can be taken as the definition itself — (Interface is) ": the place or area at which different things meet and communicate with or affect each other" (www.merriam-webster.com), "A point where two systems, subjects, organizations, etc. meet and interact:" (www.oxforddictionaries.com).

We propose that: Interface is whatever, whenever or wherever entities of different systems establish contact that opens and promotes the possibility of data transducing and transfer between them (data here should be understood in a broad sense, i.e., from physical to conceptual, e.g., electric energy, a virus, words in the mind, a graphic form).

3 Brain basics

The human brain is a very complex multi-system whose architecture is based on multiple layers and systems (e.g., groups of neurons devoted to certain routines or functions, such the auditory system) that are networked and permanently communicating with each other (e.g., through electrical phenomena) (Sporns, 2011).

It is a system of extraordinary sets of circuits that allows itself to detect and evaluate the relevance of myriads of physical energies in the environment and plan and execute appropriate reactions to them. It provides us with numerous functional schemas such as basic senses (i.e., sensing, detecting features of the external and internal environments — olfaction, sight, touch, hearing, taste, etc.), and basic integrated postural and locomotor movement sequences (Buzsáki, 2006). Through sensing, perception and cognition allows us to be aware of the environment not only relative to the environment itself but also aware of ourselves (Buzsáki, 2006; Wilson and Foglia, 2011).

3.1 A priori versus a posteriori

As a system the brain is by itself a universe with a priori characteristics.

According to scientific evidence a brain can live isolated (Llinás and Paré, 1991) — and kept living as an isolated system as far as proper energy (e.g., glucose) feeds its basic functions (Bohlen and Halbach, 1999). However many of that same empirical findings also postulate that although a brain could "live" isolated, it does not produce useful constituents (e.g., data) to itself without environmental interactivity (Buzsáki, 2006). Most interestingly, not only to itself but also not to the entity(ies) that could have a relationship whit it (e.g, the human-body that hosts it or other enti-

ties that interact with it, e.g., other humans). Or better saying, it could not develop if isolated of a dynamic context (Buzsáki, 2006; Wilson and Foglia, 2011). Tsakiris and his colleagues postulate that "coherent experience (…) depends on the integration of efferent information with afferent information in action contexts."(2006).

3.2 Remarks on quantitative brain's phenomena (electric, oscillatory)

Brains generate electromagnetic oscillations that have been being recorded in the form of waves. Certain characteristics of the brain electric phenomena (e.g., asynchrony of certain bands such as alpha within frontal lobes) may denote emotional processes (Trochidis and Bigand, 2012), whilst others — e.g., progression of spectral power before onset of a movement — may denote a voluntary self-initiation of movement (limbic), or rather, a kind of preparatory processing that precedes the actual action (Jo et al., 2014). Brain electric phenomena could, as such, be seen as a kind of global mirror of its functions, namely in temporal frameworks, that could denote aspects such as environmental interaction.

3.3 Am I speaking to myself?

Damásio (2010) proposes that the brain has the ability to create the self that emerges from sensing our own physiology, but also the consciousness, which is based on a self-referential layer — where autobiographical phenomenon is one of the most important aspects — that allows us to build complex sense of ourselves in relation to ourselves, in relation to the others and in relation to the environment. It could have been a consequence of a layered evolution and its necessities and strategies and has a very peculiar characteristic: conceptualize the future, beyond reasoning the present and retrieving the past.

Consciousness is, however, a puzzling concept and not consensual among neither philosophers neither scientists, between each other or among themselves. There are approaches that reduce it to mechanistic ontological models (Zeman, 2001) but others (one of which is Descartes *dualism*) "regard at least some aspects of consciousness as falling outside the realm of the physical". (Gulick, 2014)

4 Interfacing

From this frameset of theories, we can propose that the brain is, in a broad sense, a point of contact — an interface — between the *I* as a matter-less entity that is aware of its bodiless existence (at least conceptually), but, simultaneously, the *Am* as a physical object empowered with mechanisms that could impact the reality when operating (via efferent data sent to the host mechanic system). Or between *I* and *Do*[1], whereas I, through my will, will behave based on afferent information brought by the body sensors and central nervous system (CNS) to the brain and processed by it.

[1] without going to deep on aristotelian on kantian discussionsmaybe we should formulate the *I*

5 Synergy of interaction dynamics

An artistic performative live act, one with performer(s) and audience (the entities that share the act), is a participatory multi-contributive event, where both parts share and feed a simultaneous set of interlinked events. Where constituents — e.g., visual, sonic, olfactive — trigger interactive processes of analysis, perception, appreciation, feedback and co-processing between the involved entities (e.g., performers and audience), creating a dynamic and complex process of aesthetic experience, reasoning and emotions. Interestingly, art forms such as music are so powerful that can activate nearly every known area of the brain and the deepest systems generators of emotions (Levitin, 2007) and also recruit involuntary behavior perhaps even by coercion (Sacks, 2006).

However most of us can only guess what is going on inside performer's mind.

6 Transcoding and translating brain's phenomena

Both sciences and arts have been using technological apparatus that may record the brain's electric activity and transcode it into discrete objects (e.g., brain computer interfaces, specialized algorithms) (Vidal, 1973), and representational ways to denote and characterize both constituents, namely using representational methodologies based upon different strategies, conventions and purposes, e.g., topographic visualization, i.e., the possibility to denote specific occurrences within specific regions of the brain's geography — event(s) and place(s) of a phenomenon —, uses (pseudo)color coding schemas to denote and characterize both constituents (Shankar and Ramakrishnan, 1951; Teplan, 2002).

6.1 Representations and assumed paradigms

There are many electroencephalography approaches — both representational and technological — but many are restricted by auto-regulation paradigms, i.e. although they may allow reconceptualization and evolution, they replicate the conventions and theoretical frameworks from which they depend upon. They also embrace laboratory presets and aseptic paradigms in detriment of ecological contexts.

7 *Eshofuni*

Eshofuni[2] (Tomé-Marques et al., 2014) is a multidisciplinary project embracing art, communication design and programming, that proposes an approach towards real-time representation of brain data using a virtual physics engine — built fundamentally in the Max programming environment — and real-time Emotiv EEG BCI signal on

[2] Eshō-funi is a japanese Buddhist term: esho is a compound of shoho, meaning life or a living being, and eho, its environment. Funi, meaning "not two," indicates oneness or non-duality. It is short for nini-funi, which means "two (in phenomena) but not two (in essence)." Ho of shoho and eho means reward or effect. At the most fundamental level of life itself, there is no separation between ourselves and the environment.

performative contexts. Started in 2013 as a research project to propose and repurpose representational approaches, in real-time and in creative ways, but with objective empirical criteria and support, it evolved to *EshoFuni@TheAbyss*, a step forward on brain data representation going through a new approach inserting it in ecological contexts — now both literally as metaphorically.

7.1 Eshofuni@theabyss, chapter II

The Abyss is an ecologic system inhabited by entities and constituents with graphic and sonic forms — inspired by creatures that form the plankton phenomenon (e.g., zoids[3]) — that interact between themselves and with *Eshofuni* qua performer´s avatar allowing the set to denote the performer's brain processes generated and conditioned within this environment by realtime and longitudinal statistics (e.g., real-time retrieving iterated with analysis, segregation and cumulation) applying filtering (band and multiple order) and Fast Fourier Transforms (FFT).

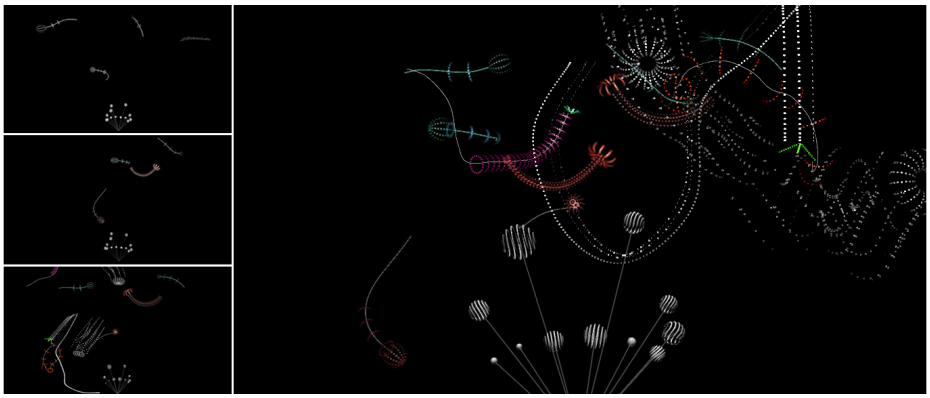

Fig. 1. *Eshofuni@theabyss*, four frames of the system.

Entities that inhabit the *Abyss* — e.g., zoids, salps — have their own *independent* and interactive life. Different entities are *connected* with different clusters of the brain metaphor (i.e., *Eshofuni* — which also is an entity that inhabits the *Abyss*). Evolution happens when specific clusters of the brain are triggered by events that happen on this ecosystem. When spectral and oscillation patterns related to brain complex specific processes — e.g., emotions — are detected the system denotes this phenomena by changes in the representation(s) (the all metaphor). This evolution can be characterized by recodification of color, changes (complexification) of forms, sounds, or whatever inventive representation we think of as far as it fulfills our purpose and criteria.

[3] Zoids are the beings that constitute the Siphonophores - The longest animals on the planet.

8 Discussion, purpose and strategies of an novel approach

When science proposes the brain has the ability to create the self from sensing one's physiology, maybe we should see it as a kind of low level computation that deals with hardware parts and details, and the consciousness as a kind of high level computation that deals with abstractions and pure concepts.

We accept that the brain can have a conscious endo-reality, one that may only communicate with the environment (exo-reality) via non haptic abstract interfacing, disassociated from any specific corporeal instance but embodied however in our hardware (i.e., human physical constitutive). This embodiment did create a complex organism with multiple sensors and sub-systems that are interdependent and fundamental to the operations it has to operate in order to live. A kind of enactive simultaneity where the entity is dependent on the system and is conditioned by it, but, at the same time, has a personal perspective and understanding of the system, its icons and symbols, and acts on it according to this understanding, meaning this that the complexities of both the environment and the entities are bi-directional and impact each other. We are also empowered with the notion of ourselves as agents that can act in coherence with the available options derived from the entity-environment dynamics but also or deny the act with respect to incoherent deliberations.

Another important aspect related to the brain is that there are brains — millions of — not *one* brain. That means that there are millions of endo-realities, and consequently millions of perspectives about the environment each one operates, i.e., there are also multiple exo-realities. Evolution, in his "chaotic" development, created heterogeneity, maybe the best strategy of the universe — understood as all the things that we are able to think and are not able to think about — to the resilience and survival of life itself.

All this aspects put huge problems on eventual objectiveness of any representational recipe.

Brain phenomena is extraordinarily complex and can be approached, studied and represented from many perspectives, methodologies and strategies, but that complexity puts unarguable problems of decoding it. Even within contexts of quantitative empirical approaches, although science has uncovered certain consensual patterns that denote brain specific brain processes, the findings are far from being secure.

Lastly, but not less important, being the performative live art act an environmental dependent participatory multi-contributive event, where the parts share and feed a simultaneous set of interlinked events — as proposed a dynamic process of aesthetic experience, reasoning and emotions — one only could infer and assess certain phenomena within the context it arises even at the risk that complexities inherited on its relative environment could compromise data comprehension.

Although there are high-tech specialized apparatus (e.g., brain-computer interfaces) that could transcode brain phenomena into discernible data the fact is that most of the solutions are far from being capable of decode the immense complexities of the brain phenomena — this is one of the most important limitations

As such the project is, beyond the quantifiable criterion, relevantly inspired and anchored on holistic ecology concepts where particles (e.g., humans, entities, agents)

and the environment interact and develop in a whole and integrated manner, where the all is more than the mere sum of the particles — like a super-organism, but one constituted by heterogeneous parts, i.e., entities that have agency and personality that could impact the course of the events in unexpected and uncontrollable ways. We strategically use metaphor, because only through metaphor we are (slightly) capable of suggest the behavior, characteristics, intricacies, complexities and synergies of the endo-exo *reality* simultaneity and the entities that operate it and within it.

Finally, of the most important aspects in this context — and as artists —, is the emergency of breaking rules and assumptions postulated and commit by reductionist and restrictive theories, assuming that breaking rules (and assuming risks) is a crucial behavior to open other and novel hypotheses to the same problems of the respective theories and, consequently, new answers — indeed even in science nothing should been taken for granted.

9 Additional Information

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9.1 Copyright Agreement

Authors declare acceptance of the copyright conditions specified therein with the submission of this paper.

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