

# Ulysses Pact: Metagenomic Entanglements

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## Abstract

This paper aims at presenting and discussing the work 'Ulysses Pact' (2016) produced by the author – a bioart interactive sound installation that metaphorically evokes the ancient myth of Ulysses (Odysseus) and the pact he made with his crew as they approached the Sirens. The reference to the myth is a dramatic invitation to reflect on the constitution of our viscerally chaotic plurisystemic selves – myriads of Complex Adaptive Systems' (CAS) conglomerates, resembling a noisy metropolis build up of *microbiomic* conversations. As it is envisaged by the author, in an isolated wall at one of the ISEA 2016 collective exhibition venues, one individual a time is challenged to have a seat in an object that resembles an old restraint apparatus – a reference to the Benjamin Rush's (1749-1813) 'tranquilizer chair' designed for psychiatric patients, to which a circuit of sensors and piezoelectric generators is integrated. Seduced by its own curiosity, or by the apparatus' weirdness itself, this individual will find her/himself immersed in a vibrational whole body experience. Starting from a personal interest in investigating potential links between schizophrenia and the human microbiota, in 'Ulysses Pact' the author dedicated to the production of a sonification project using raw data from a study where the 'composition, taxonomy and functional diversity of the oropharynx microbiome in individuals with schizophrenia and controls' was investigated. 'Ulysses Pact' is the first emergence of a new series of works produced by the author as an attempt to investigate plurisystemic conversations within our body from a cross scalar perspective considering the phenomena of quantum entanglement as the main communicational strategy that allows to understand our bodies as CAFFS - Complex Affective Systems (a term coined by the author) and consciousness as an emergence from this self organizing structure.

## Plurisystemic Selves

"In general, we may ask, why has not everything a soul, since everything either is an element, or is formed out of one or several or all of the elements? Each must certainly know one or several or all." [1]

We were just informed that [2], from the 100 trillion cells the human body contains only one in ten of those cells approximately is actually human. These Complex Adaptive Systems (CAS) we understand and recognize as 'individuals' can be seen, from a microscopic point of view, as a plurisystemic structure that shows some integrity and emerges from subtle cross scalar informational processes. This understanding is essential when we propose to consider a continuity between the body cells and the microbiome of a given organism. Systems that can be described as having a characteristic that couples with its adaptive qualities – affectiveness.

From this perspective they can be understood as Complex Affective System (CAFFS) – a term coined by the author to describe and discuss certain Complex Adaptive Systems (CAS) focusing on affectiveness as the main bond between the systems' elements, the bond that is responsible for its integrity.



Fig 1. *Ulysses Pact*, 2016, Clarissa Ribeiro, bioart interactive sound installation, 3D model produced by the author evidencing the intimidating weirdness of the apparatus (image by the author)

This aspect of system's interconnectedness and the ability its elements have of nonlocal communicating can be linked to the phenomena of quantum entanglement. In fact, far from a reductionist understanding of our organism as strategically isolated from the environment, running a unified genetic program that encapsulates ancestor's informational history and dictates all the development steps and metamorphosis from mammalian sperm-egg interaction to death, we can actually picture ourselves as something resembling a metropolis build up of *microbiomic* conversations. As in any Complex Adaptive System (CAS), the relations between the microscopic sub-systems are so instable, transitory, easily disturbed by different noise sources, that the AI (Artificial Intelligence) challenge (the long term cybernetics' goal) to design an equivalent of a human mind in its plenitude sounds more like a childhood dream, as reductionist as Heron of Alexandria's [3], automata or miracles (thaumata).

## All Watched Over by Organic Post-Humans

It was just recently that, for the first time in science history, a consortium of researchers organized by the

U.S. National Institutes of Health (NIH) Common Fund, Data Analysis and Coordination Center (DACC), got involved in the challenge of mapping the normal microbial composition of healthy humans supporting the Human Microbiome Project (HMP). According to the researchers “the aim of the HMP is to characterize microbial communities found at multiple human body sites and to look for correlations between changes in the microbiome and human health.” [2]. The consortium clarifies that, “[...] the majority of microbial species present in the human body have never been isolated, cultured or sequenced, mainly due to the inability to reproduce necessary growth conditions in the laboratories.” [2]

The HMP is using 16S rRNA and metagenomic sequencing to characterize the complexity of the human microbiome collecting tissues from 15 body sites in men and 18 body sites in women – what complements sequencing and analysis of reference genomes isolate from human body sites and, according to the team, “[...] generating unprecedented amounts of data about the complexity of the human microbiome, and providing a baseline for further research into the impacts of the microbiome on human health and disease.” [2] The researchers consortium collected up to three samples from each volunteer at sites such as the mouth, nose, skin (two behind each ear and each inner elbow), and lower intestine (stool), and three vaginal sites in women.

Conventional sequencing is based on a culture of identical cells as a source of DNA. Back in the 1990s, the early metagenomics studies revealed that there are probably large groups of microorganisms in numerous environments that cannot be cultured and consequently cannot be sequenced. These early studies focused on 16S ribosomal RNA sequences revealed that cultivation based methods find less than 1% of the actual existing microbiome in a sample, showing that the huge majority of microorganisms had previously gone unnoticed by previous sequencing methods. This for a long time unnoticed eclectic microbial population that is in fact a majority in what we consider a human body, can be considered a key knowledge and the starting point of born strategies that can essentially conduct our species to the point we can call ourselves post-humans – not by coupling with artificial prosthesis or nano robots but by mastering ways of managing, altering, engineering our natural microbiomes.

This population of micro-organisms within our body secretes a large number of neurochemicals, including dopamine, serotonin, and gamma-aminobutyric acid (GABA) – the same chemicals our neurons use to communicate and that regulates mood. Recent experiments has examined the possible immunomodulatory effects of probiotic supplementation in chronic schizophrenia patients, based on the fact that probiotics – taken as beneficial micro-organisms –, modulate the immune response of the host by affecting the composition of gut microbiota. Several probiotic species have been tested in series of experiments for health benefits, including the gram-positive anaerobic

genres *Lactobacillus* and *Bifidobacterium*. According to Jakub Tomasik and his collaborators, these experiments “[...] have shown beneficial effects on systemic inflammatory cytokine levels, neurotransmitter and neurotrophic factor production, intestinal permeability, and oxidative stress in animal models.” [4]. Tomasik explains that in humans, oral administration of probiotics is known to restore normal inflammatory status, increase systemic antioxidant capacity, change the activity of brain regions responsible for processing of emotion and sensation, and reduce anxiety. In addition, improved brain function after probiotic supplementation has been attributed to the gut-brain axis – “[...] multiple ways of communication between bacteria inhabiting the human intestine and the central nervous system. For example, probiotic microorganisms interact with the innate immune system, affecting secretion of pro- and anti-inflammatory.” [4]

### An Overabundant Perception

“[...] what we subjectively term efficacious volition is certainly bound to the persistence of exceptional fluctuations affecting the physical systems which we term organisms and their surroundings, including both the appearance of these fluctuations and their destruction under the pressure of the environment.” [5]

In a paper published in *Schizophrenia Bulletin*, Vol. 29, No. 3, 2003, Doctors Louis Sass and Josef Parnasin propose to characterize schizophrenia as a self-disorder or, an ipseity (Latin word for ‘self’ or ‘itself’) disturbance that has, according to the researchers, two fundamental and complementary aspects or components. The one that brings to the scene one of the most fascinating aspects of schizophrenia is hyperreflexivity, referring to forms of “[...] exaggerated self-consciousness in which a subject or agent experiences itself, or what would normally be inhabited as an aspect or feature of itself, as a kind of external object.” [6] The peculiarity of schizophrenia as a state of consciousness potentially emerging from gut-brain psychobiome integrations is that it can lead to an augmented perception of the plurisystemic nature of the self and its integration with the surroundings that is evidently terrifying and destabilizing.

In the above quoted work, the researchers mention a valuable first-person descriptions of schizophrenic ‘negative symptoms’ – the autobiographical descriptions of the writer Antonin Artaud [7] where he describes a consciousness invaded by experiences of the body-subject where the hyperreflexive awareness leads to a sense of ‘shifting vertigo, a sort of oblique bewilderment’ [7]. According to Osborne Wiggins and Michael Schwartz, Artaud can be seen as one of the rare examples of individuals that, “[...] with the onset of schizophrenia is liberated from the structures and norms that powerfully govern normal human experience.” [8] Nevertheless, the researchers

were not focusing on examine “[...] the creativity that may – albeit rarely – issue from schizophrenic mental life” [9], focusing on analyzing the more common forms of schizophrenia that brings “[...] severe suffering and hardship without the compensation of greater originality.” [8]

To discuss ‘A Phenomenological Anthropology of Schizophrenia in its Beginnings: The Overwhelming Complexity of Reality’, the authors recall different pioneering works on philosophical anthropology as the one of Max Scheler [10] claiming that human beings are inherently ‘world-open’, and posterior correlated approaches as the one of Arnold Gehlen, according to whom “Human beings are exposed to an excess of stimulation towards which they remain world-open” [11], specifying that these stimuli “[...] may be either internal or external ones; i.e., they may issue from within the individual’s body or mind, for example, in inner urges or thoughts ,or they may consist of sensory data coming from the external world.” [8] The reduction of the complexity of internal and external stimuli consists in the achievement of automatic syntheses. During the early stages of schizophrenia, this mechanism is broken and it is observed a weakening of the automatic synthesis and, as a resultant, an overabundance of perceived stimuli. In a report of patient diagnosed with schizophrenia published by James Chapman, defending that the clinical data presented in his studies support the view that schizophrenia is an organic psychosis, the weakening of the automatic synthesis becomes intriguingly evident – “What I’m worried about is that I might get myself so controlled that I will cease to be a person. I find it difficult to cope with these situations that get out of control and I can’t differentiate myself from other people when this comes on.” [12]

### Metastable Equilibriums

“We have just seen life destroy or create metastable equilibriums in the same way that a hydraulic engineer drains a mountain lake or dams a torrent. Indeed, an entire network of distribution of negative entropy is represented by a living organism, and also by the evolutionary line which has produced it. How could this extremely complex network, whose very existence represents a negative entropy, have been created at the expense of the natural tendency towards dissipation of energy?” [5]

The microbiome of schizophrenia patients has not yet been extensively investigated, as attested by reviews run by several research groups as showed in a paper where Dinan, Borre and Cryan [13] explore the view that the genomic analysis of schizophrenia to date has been far too limited, and fails to capture the true genomic diversity of the human body. Nevertheless, several studies as the one presented by Severance, Yolken and Eaton [14], show consistent investigations on how autoimmunity, gastrointestinal (GI) disorders and

schizophrenia have been associated with one another for a long time.

Considering the challenge of conceiving an installation that invites the audience for an immersive reflection on how subtle is the equilibrium that gives our body integrity and how sensitive to internal and external cross scalar informational processes this adaptive organization could be, the author searched for studies where a possible interconnection between our microbiome and schizophrenia was considered.

The intention was to integrate available raw data from metagenomic sequence analysis, from studies were the above mentioned connections between microbiome and schizophrenia was investigated, in the design of a semi-material apparatus that was to be the core of the art work.

The selected study from where the raw data was selected proposes that “the oropharyngeal microbiome may be associated with or contribute to an altered immune state consistent with findings in schizophrenia” [15] The strategy of the team was to “characterize the schizophrenia microbiome by interrogating the oropharyngeal microbiome structure regarding its taxonomic and functional diversity” [15], focusing on the complete microbiome that means to include virus, bacteria and fungi populations. This study just recently published, is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, reproduction and adaptation in any medium and for any purpose provided that it is properly attributed. To make raw data for unrestricted use has been a common posture adopted by several research projects involving metagenomic sequencing, being the Human Microbiome Project (HMP) an important source for further explorations.

Working in a sonification project integrating available raw data from this study, it was possible to compose a sound that brings to the surface microbiome landscapes from patients diagnosed with schizophrenia. The data resultant from metagenomic sequence analysis allows investigating differentiations between the microbiome composition of control group and patients diagnosed with schizophrenia metaphorically exploring the idea of accessing somehow our plurisystemic intimacy.

How about getting immersed in a vibrational bath where our whole sensory system is reached by a sound designed to allow metaphorically navigating the microbiomic landscape of patients diagnosed with schizophrenia? Can it have the effect of a placebo-sound, giving the impression of affecting temporarily our mental equilibrium? How permeable are our vibrational structure to this sound? Can the information related to the perception of this sound be instantaneously shared in a subatomic level through all the cells that constitutes our body, including the microbiome ones?

Quantum information theory [16] deals with four main topics that are united by a common recurring theme that is the interpretation and applications of the Von Neumann entropy. First of all, it deals with

'Transmission of classical information over quantum channels'. Secondly, it deals with 'The tradeoff between acquisition of information about a quantum state and disturbance of the state. Additionally, it deals with 'Quantifying quantum entanglement' (where Von Neumann entropy plays a central role) and 'Transmission of quantum information over quantum channels.'

According to John Preskill, Professor of Theoretical Physics at the California Institute of Technology (Caltech), [...] the deep ways that quantum information differs from classical information involve the properties, implications, and uses of quantum entanglement." [17] It means that, in the subatomic world of quantum mechanics, as Preskill attests, "[...] if A and B are entangled, a measurement of A is performed and a particular outcome is known to have been obtained, then the density matrix of B does change." [17] Considering the perspective of a Quantum Information Theory, an intriguing issue comes up that is related to the questions we are pointing here when considering the ways our body actual cells and our microbiome communicate – How then does the quantum state manage to travel from A to B? According to John Preskill, "[...] we can hardly say that the two classical bits that were transmitted carried this information – the bits were random. So we are tempted to say that the shared entangled pair made the teleportation possible." [17] A and B has to be capable of nonlocal communicating.

So, considering our actual body cells are quantum entangled with the microbiome ones and, beyond using nervous systems as a communicational channel, the information is non-locally shared through this plurisystemic structure – the 'microbiome-body cells' can be considered a CAFFS – a Complex Affective System, producing our fuzzy logic and instable consciousness as an emergence from its cross scalar instantaneous conversations.

### Ulysses Pact: Microbiomic Sirens

"The faculties of the mind have been called, very happily, internal senses. They resemble the external senses in being innate, and depending wholly upon bodily impressions to produce their specific operations." [18]

The work 'Ulysses Pact: Metagenomic Entanglements' is a bioart interactive sound installation that metaphorically evokes the ancient myth of Ulysses (Odysseus) and the pact he made with his crew as they approached the Sirens. According to the myth, as the hero wanted to hear the Sirens' chant, although he knew that doing so would render one incapable of rational thought, Ulysses put wax in his men's ears so that they could not hear the Sirens and had them tie him to the mast of the ship so that he could not jump into the sea. Upon hearing the Sirens' chant, Ulysses was driven temporarily insane and struggled with all of his might to break free so that he might join the Sirens, which would have meant his death.

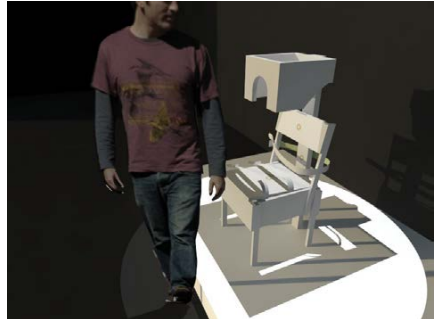


Fig 2. *Ulysses Pact*, 2016, Clarissa Ribeiro, bioart interactive sound installation, 3D model produced by the author evidencing the intimidating weirdness of the apparatus (image by the author)

In a possible conceptual link to Psychiatry, mental health advance directive, are sometimes referred to as Ulysses Pacts – contracts designed to override a present request from a legally competent patient in favor of a past request made by that patient. An example of when Ulysses Pact is invoked is when patients diagnosed with schizophrenia stop taking their medication at perceived remission times. Nevertheless, according to Puran, "Ulysses contracts also raise a number of ethical questions, including the nature of patient autonomy, competency and how to handle refusal of treatment." [19]

Considering that voice hearing is often seen as a prime symptom of psychosis and that auditory hallucinations is considered a first rank symptom of the specific psychosis of schizophrenia, to recall the ancient myth of the sirens is an artifice to build a conceptual bridge that can possibly allow for a reflection on how consciousness emerges from plurisystemic conversations involving our innate cells and our microbiome. According to Flavie Waters, "[...] it has been estimated that approximately 75% of people with schizophrenia experience auditory hallucinations." [20] Can we somehow hear the microbiome's voices embedded in our thoughts, in what we identify as consciousness?

In 'Ulysses Pact', the reference to the ancient myth is a dramatic invitation to reflect on the constitution of our viscerally chaotic plurisystemic selves – myriads of Complex Adaptive Systems' (CAS) conglomerates, resembling a noisy metropolis build up of *microbiomic* conversations. As it is envisaged by the author, in an isolated wall at the one of ISEA 2016 collective exhibition venue, one individual a time is challenged to have a seat in an restraint apparatus – an adaptation of Benjamin Rush (1749-1813) 'tranquilizer chair' designed for psychiatric patients as a strategy to calm down his patients. A few centuries ago it was common to use restrictive techniques and apparatuses to calm down psychiatric patients that could be submitted

to tough treatment including restraint bags, strapped chairs and could be placed in an isolation box or cages. The Rush belief that “[...] mental diseases were caused by irritation of the blood vessels in the brain [...]” [21], that led him to design the “tranquilizer chair” is used here as a metaphor for the conception of the material part of what can be considered a semi-material apparatus – becoming the installation an artifice to access cross scalar realities within our bodies.

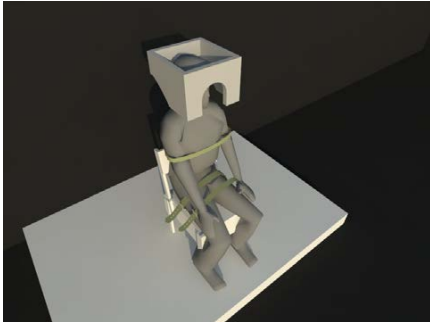


Fig 3. *Ulysses Pact*, 2016, Clarissa Ribeiro, bioart interactive sound installation, 3D model produced by the author showing a person joining the whole body vibrational experience. (image by the author)

After having a seat in the chair at the gallery, the individual finds her/himself immersed in a vibrational whole body experience unleashed by the subtlety of an input – a transducers installed in the region referent to the neck that can capture heart beats by reading differences in blood density just by having the emitter’s light reflected by the visitor’s skin surface. In correspondence to the brain intestines communication circuit, piezoelectric generators are installed along the restrictive chair’s body and the reading of the heart-beat transducers processed by an Arduino and Processing interrelated code designed by the author, makes the sonified microbiome landscape to be played louder or softly depending on the visitor’s state of relaxation or excitement. *Ulysses Pact* invites the audience for an intimate restrictive sound experience – a metaphorical meeting our own potentially schizoid sirens.

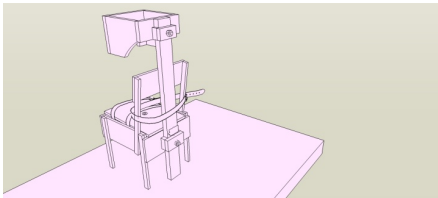


Fig 4. *Ulysses Pact*, 2016, Clarissa Ribeiro, bioart interactive sound installation, 3D model produced by the author showing the apparatus’ structure (image by the author)

Starting from a personal interest in investigating potential links between schizophrenia and the human microbiota, in ‘Ulysses Pact’ the author dedicated to the production of a sonification project using raw data from metagenomic sequencing analyses.

The study from which the author used selected raw data to produce the sonification project that integrates the installation “[...] aim to characterize the schizophrenia microbiome by interrogating the oropharyngeal microbiome structure regarding its taxonomic and functional diversity” [15], contributing to understanding the relationship between microbiome diversity and schizophrenia.

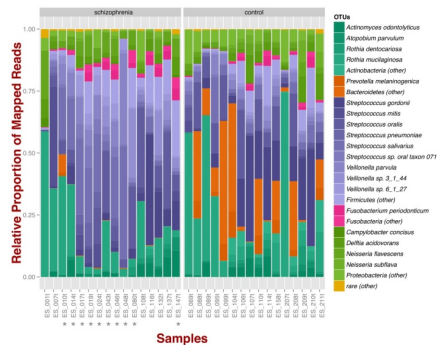


Fig 5. Oropharyngeal microbial composition at phylum and species levels exhibits different patterns for schizophrenia and control samples [15].

As reported by the team of researchers, the oropharynx microbiome was selected due to the fact it is easily accessible by non-invasive techniques. Individuals with schizophrenia were recruited from psychiatric treatment programs at a large psychiatric health system and community psychiatric programs in central Maryland. The study found out “High-level differences were evident at both the phylum and genus levels, with Proteobacteria, Firmicutes, Bacteroidetes, and Actinobacteria dominating both schizophrenia patients and controls, and Ascomycota being more abundant in schizophrenia patients than controls.” [15] Data showing these specific differentiations consist the raw material used by the author for the sonification project.

Sonification strategies were used to allow the perception of microbiome variations in the dataset from a single database table, altering different components of the sound initially generated using Audacity 2.1.1 – a free, open source, cross-platform software for sound editing and recording. As more representative specific phylum and species are considering the oropharyngeal microbial composition, the strategy was to produce equivalent increase in pitch, amplitude and tempo.

## Final Considerations

Ulysses Pact: Metagenomic Entanglements is the first emergence of a new series of works produced by the author as an attempt to investigate plurysystemic conversations within our body from a cross scalar perspective, considering the phenomena of quantum entanglement as the main communicational strategy that allows to understand our bodies as CAFFS – Complex Affective and consciousness as an emergence from this self organizing structure.

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