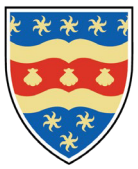

UNIVERSITY OF
PLYMOUTH

EXPLORING AND UNDERSTANDING PATTERNS OF EMOTIONS IN THE OVERALL SOUND ENERGY OF THE HUMAN VOICE IN A NATURAL ENVIRONMENT WITH AND THROUGH AN INTERACTIVE INSTALLATION AND VR IMMERSIVE VIDEOS

by

PAOLA LOPREIATO

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Scusa se il nostro ultimo natale insieme ho sprecato tempo leggendo Chalmers

Author's Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Doctoral College Quality Sub-Committee.

Work submitted for this research degree at the University of Plymouth has not formed part of any other degree either at the University of Plymouth or at another establishment.

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7th-17th December 2018
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Artistic residency - Work on installations: Sounding Out & Seams

20th/21st June 2018 - Le murate - Florence –
Exhibit of installations: Sounding Out and Seams

9th April 2018 - Conservatory of Cesena -
exhibit installation: Seams

15th -20th March 2016 – Il corpo la luce il suono festival- teatro affratellamento - Florence
exhibit installation: Pieces and parts

9th April 2016 Conservatory of Cesena
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26th August/12th September 2015 -
Artistic residency at OBRAS Foundation, Estremoz, Portugal
Working on Pieces and parts

Presentations at conferences:

19-29 November 2017 - Beijing China
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Abstract

In today's era we can say that human reality is often reliant on or intersected with computers. The need of improved communication with devices in a natural way has arisen and led to development of interactive systems. The new channel for detecting emotions presented in this thesis is not so much important for humans as it is for computers that still don't have human capabilities of recognising emotions.

The vision that drives this research project is of an interactive kind of art through which it is possible to implement and enhance our knowledge of emotions in relation to sound, assisted by new technologies.

My research concerns the relation between sound[1] and emotions. This research was carried out within two art installations.

Research goals

- Discover and outline the patterns in the overall sound energy of the human voice, set in a natural environment, that reflect one or more basic emotion (I.e. anger, happiness, sadness);
- Use artistic instruments and environment (interactive installation) to carry out this research; and
- Represent the collected data and results of the research using virtual reality (VR[2]).

My original contribution to knowledge lies, on the one hand, within the function that both *Sounding Out* and *Seams* have on a person's ability to gain a better understanding of

[1] From now on the terms sound, sound energy, human voice and speech are used interchangeably. for a detailed explanation of the use of the term go to chapter 1 "Key terms", p. 23.

[2] From now on the terms "virtual reality", "VR" and "360° video" are used interchangeably, for a detailed explanation of the use of the term see chapter 1 "Key terms", p. 23.

how emotions reflect on sound energy and how sound energy analysis makes the computer able to recognise what we are feeling without understanding the contents we are expressing. On the other hand, this thesis forms a valuable tool of analysis, as well as the installations that I created: *Sounding Out* is an effective setting for the live detection of emotions, it allows the use of normal persons instead of trained ones. The innovative contribution to the research in the field is making the process of analysis faster and the recognition of emotions in a real-life setting is possible. The installation *Seams* is innovative in the way it is used to present academic research data. *Seams* is original in its intentions as it aims to make data more accessible and intuitive and particularly disseminate the study not only to researchers but to a broader audience.

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General introduction

The current study seeks to investigate emotions and their correlation with sound and to do so I analysed online sources and created an immersive responsive art installation *Sounding Out*, incorporating a tool that analyses emotions in people speeches, detecting inner states by how emotions influence the distribution of energy in the audio signal. I also designed a second installation, *Seams*, to exemplify the process of analysing and detecting each emotion. I examined the physical features of emotions (body and environment, acoustic and psychoacoustic) as sites where the interior and exterior meet, all combined in the process of being and becoming. Through data analysis (Soundingout) and visualization (*Seams*) I made perceivable events that go beyond human senses. To be precise the emotions in speech are recognisable with normal sense, but the fact that they change sound energy is not something you can understand through our usual communication channels. The direct and obvious way in which we detect emotions is via the speech contents and the tone of voice, breath emission, speed of speech, volume or pitch. Investigating how *sound energy* is shaped influenced by our inner states and reflects into our voice on the energy that we emit (i.e. not only on the qualitative features of voice) is less obvious using our natural senses or better impossible to perceive. This difference is important as for computers and automatic emotions recognition systems is easier to analyse difference in just one parameter (energy) than using all physical and psychological factors and capabilities that we human naturally use and which are much more complex. Addressing the physical world and taking a phenomenological approach is important not only to create an automatized

system for emotion recognition but also more in general is important in my artistic research as I believe in the fact that what we experience through our body is the substrate for the appearance of our feelings, emotions and thoughts[3] therefore is also in the physical world that we should search the traces of our emotions.

My investigation originates from the idea that body, environment and cognition are connected, and that inner states are not a product of our mind or brain but a seamless relation between body, mind and environment. Starting from the assumption that inner states are not explainable (not yet) only by studying physiological data (and might never be explained only on this basis), it is also true and evident that physical events and causes are related to the arousal of the inner state and emotions. Based on this, I try to investigate the correspondences between acoustic physical processes and emotional reactions or changes, similarities and shared patterns between the manifestations of both.

Moreover, I have always struggled with the idea of art as a process in which people are referred to as just passive receivers as much as I have never believed that the role of art should only be to explain or describe something. So, I created interactive installations in which people could be part of my research process both as makers and receivers. Art since the nineteen-sixties has been process-oriented and a big part of its staging includes triggering action and responses

[3] Damasio A., *Self comes to Mind,* Pantheon Books, New York, 2010, p. 75-76: The combination of old flesh and neural probe constitutes a body border. Signals hailing from the world must cross that border in order to enter the brain. They cannot simply enter the brain directly. Because of this curious arrangement the representation of the world external to the body can come into the brain only via the body itself, namely via its surface. The body and the surrounding environment interact with each other, and the changes caused in the body by that interaction are mapped in the brain. It is certainly true that the mind learns of the outside world via the brain, but it is equally true that the brain can be informed only via the body. The second special consequence of the brain's body aboutness is no less notable: by mapping its body in an integrated manner, the brain manages to create the critical component of what will become the self. We shall see that body mapping is a key to the elucidation of the problem of consciousness. Finally, as if the above facts were not quite extraordinary, the close relationships of body and brain are essential to understanding something else that is central to our lives: spontaneous bodily feelings, emotions, and feelings.

from the public and encouraging an interior dialogue[4]. Through action and perception my installation investigates emotions; the transformative action of the technological tools in my installation and the reaction of people, is used for detecting different ways in which emotions manifest themselves within sound. The choice to create installations and conduct my own research into emotions through this particular medium was guided by the fact that I am a multimedia artist and this project would enable me to draw on my experience and expertise. Moreover, it was determined by the nature of the research topic itself, which straddles the concrete and the ephemeral. Expanding the awareness of changes in emotional states across the relationship between communication, perception, feelings and decision-making inherently leads to the need for a practice to support this intent, as these relationships all occur in a physical reality (including the brain as the body part in which mental processes take place). As a result, I designed an art practice using technological tools in order to make visible and hearable how emotions reflect on and shape sound energy. Not being a scientist or a psychologist, I concentrated on the artistic practices available to me, although I was inspired by my reading of the practice implemented by Damasio in the field of emotions and decision-making and by Jung in the field of images and symbols (objects, mandalas or rituals) used to investigate interiority and to search for what already exists in our inner states[5]. Emotion categorisation is one

[4] Ascott R., *The Cybernetic Stance, Leonardo, Vol. 1, No. 2 (Apr. 1968), pp. 105-112*: My Process and Purpose: We have undoubtedly become process-oriented that was deal with objects. For my part this must be so. […] Artefacts on an intimate scale are essentially triggers. They contain nothing but the possibility of future action; that is to say they exist only in so far as the spectator or participates in their evolution by, on the one hand, interacting with other people within a complex social situation, and on the other hand my conducting a private interior dialogue.

[5] Jung C.G., L'UOMO E I SUOI SIMBOLI, Tascabili Editori Associati, Milano 1991, original Title "Man and his Symbols". Copyright © 1967 by Aldus Books Limited, London, Traduzione di Roberto Tettucci, Edizione su licenza della Longanesi & CI: In these remarks, there are two equally important aspects of the symbolism of the mandala. The mandala artwork to keep close - exactly in order to restore a previous order. But it also has the creative aim of giving expression and shape to something that to this day doesn't exist, something new and

of the most interesting undertakings in speech signal processing, as sound is an important vehicle for interaction, which can be used to recognize the speaker, speech and even emotions. Current research and knowledge in this field is based on the conviction that our comprehension and consequent response to other's emotions is due to our ability to judge the content of a speech, its loudness and frequency or time rate of speech, hyper nasal resonance[6] and breath emission. But my research led me to find that emotions also change the overall energy of the sound we emit, which is an invisible mechanism as compared to more accessible physical information such as pitch and amplitude. To outline the emotional states in sound during my installations I needed a tool able to detect emotions in voices in real time. But as soon as I came across current studies in this field and the tools and methods they applied, I realised that they were not suitable for my artistic research process. In fact, analysis of contents, breath emission and detection of peaks was time consuming and could be done after the recording. So, not only was it not possible to carry out the analysis in real time, but the existing methods often did not consider the detection and analysis of emotion in a natural fluent environment which was the one issue I was interested in as an interactive audio-visual artist. Hence, I thought of a parameter and a tool that did not depend on the person's ability to express emotions (in a definite way like actors), the situation or the equipment I was using. The parameter I outlined was energy distribution in sound, specifically in human voice

unique. The second aspect is even more important than the first but does not contradict it. Because, in most cases, what is to restore the old order, involves simultaneously some new creative element.

[6] Davletcharovaa A., Sugathanb S., Abrahamc B., Pappachen Jamesa A., *Procedia Computer Science, (2015)* , Detection an analysis process in speech recognition.

emission. I[7] designed a program in Max/MSP software which I called “energy band analyser[8]” that examines the different energy distributions in speech signals in an emotional situation. The different distributions are related to the different emotional states of the speaker. There is an absence of investigation in sound energy distribution. It has never really been considered a key factor for detecting emotions in sound. Whereas extracting the information on energy distribution in speech, the “energy band analyser” has proved to be a reliable tool to deduce the emotional state of the speaker without relying on the contents or the environment of the footage, moreover the signal’s quality does not influence the results. I first worked in my studio using the “energy band analyser” in Max/MSP to examine recorded sound samples, producing a series of graphs. The data confirmed that there were coherences between the energy distribution in the voice and the emotional state of the person. Based on these findings I then included the patch into my installation so that I could detect emotions in real time. The installation can be figuratively understood as a way to see the unseen. In the installations, the “energy band analyser” detects the participant’s emotions analysing in real time her/his voice and provides the participant a coherent visual response to show that the system recognises the inner states (mind) in the shape of energy (body and environment). I also designed a second installation including the use of virtual reality in order to give an immersive representation of the processes and contents of my research. My contribution to knowledge stands in

[7] *Sounding Out* project and installation is a solo project, but the patch used in the project is made in collaboration with prof. Alfonso Belfiore. So, when I talk about the max/Msp patch and I mention myself I mean “me and prof. Belfiore” as this patch was created re-arranging the one of the project Quanta of Sound.

[8] For full description of the patch see chapter 5, p. 95

art experiences that explore new relationships between emotional states and sound (analysing energy distribution instead of the usual parameters) and that have led to the creation of a new tracking/display system for outlining these relationships and open up new scenarios in the production of dynamic interactive art that reacts to the perceived emotions.

New knowledge

The present study is novel because it shows that through the use of a music programming technology it is possible to identify the emotions of the human voice in real time and in a natural environment. The investigation was carried out using material from online sources spontaneously provided by users.

After an analysis carried out in my art studio the research has been carried out within an interactive art installation in which emotional feedbacks were encouraged in the participants (participants were asked to interact with and experiment the emotion analysis process provided by the computer). For this second trial I took inspiration from one of the few scientific studies that involves free natural speech, which was carried out in an ordinary bedroom and using a mobile phone for recording (Davletcharovaa et al., 2015) [9] and from an online project from Affectiva called Emotion Api for speech[10].

Apart from these few examples, current research in this field is usually based on the analysis of sound in a controlled and artificial environment. The studies are based on parameters such as the analysis of content, breath emission, detection

[9] Davletcharovaa A., Sugathanb S., Abrahamc B., Pappachen Jamesa A., *Procedia Computer Science, (2015),* Detection an analysis process in speech recognition.

[10] https://blog.affectiva.com/introducing-affectivas-emotion-recognition-through-speech, accessed March 2018.

of peaks in soundwave, pitch, duration, voice quality and spectral information. To use these parameters, researchers rely on trained participants and on specific sentences to be repeated, specific equipment and an acoustically isolated space (laboratory) instead of ordinary environments[11].

In my research project, the detection of emotion during a spontaneous situation was possible due to the use of a new analysing process. Instead of the standard parameters my investigation relies on the analysis of the overall sound energy[12] distribution. With the use of music programming software only the distribution of energy and its accumulation was taken into consideration, which is not influenced by the methodology of sound capturing and by the way that people speak. These elements allow this research to be employed in normal conditions thus giving it uniqueness.

Research and development

Even if research studies in this field claim they have demonstrated that it is possible to detect emotions in human voices, because most of the experiments were carried out in a lab setting it is not yet certain that these tools and this methodology would work in a natural setting and if they can be applied to real life. As the psychologists Patrik N. Juslin and Klaus R. Scherer say, most studies have used emotion portrayals by professional actors so they underline the crucial question of to what degree such portrayals differ from natural expressions and if

[11] Some articles in which is described the use of this kind of setting and tools are: Guzman M., Correa S., Munoz D., Mayerhoff R., et al, Michigan Petrushin "Influence on Spectral Energy Distribution of Emotional Expression" V.A:, EMOTION RECOGNITION IN SPEECH SIGNAL: EXPERIMENTAL STUDY, DEVELOPMENT, AND APPLICATION (ICSLP 2000); EmoVoice - Real-time emotion recognition from speech https://www.informatik.uni-augsburg.de/lehrstuehle/hcm/projects/tools/emovoice/ accessed 18/may/2018, Sezgin M.C., Gunsel B.* and Karabulut Kurt B., Perceptual audio features for emotion detection Article in EURASIP Journal on Audio Speech and Music Processing · December 2012;

[12] For the definition of sound energy go to paragraph "Key terms", p. 23.

the same tools for the analysis of professional's speech can be used for natural ones. As they state *"The jury is still out because few attempts have been made to directly compare the two types of speech samples. […]. Hence, much of the pertinent work on emotion differentiation in the voice remains to be done"*[13].

As emotions occur in real life their research should take in consideration emotion spontaneously expressed and desirably in a natural environment, which by the way is a constitutive element of the arousal of emotions. In this study, I demonstrated that detecting emotions in a natural environment is possible and I used an artistic tool, spontaneous video (provided by people online) and artistic environment (my installation *Sounding Out*) to prove it. My research in the first place confirms that real life situations allow for the detection of emotions (through sound analysis), and secondly that art and music tools are as well valid vehicles for such research.

Method

I used a music programming software (Max/MSP[14] software) to develop a system for analysing sound and to outline the patterns in speech that are influenced by emotions. I outlined the patterns in recorded speech and subsequently used this software within an interactive installation to be used as a live environment. Therefore, the first step of my investigation was to use Max/MSP to analyse the recordings of live events (videos that people posted online to share their

[13] Juslin N. and Scherer K. R. *Speech emotion analysis*, (2008), Scholarpedia, 3(10):4240. doi:10.4249/scholarpedia.4240

[14] https://www.music.mcgill.ca/~gary/306/week1/max.html, accessed 30 July 2018: Max/MSP is a standard tool used in the music technology field for composition, music control, and various other tasks. It provides a graphical interface and paradigm for modular programming.

experiences). Once that the software and process of analysis proved to be effective, I tried this analysis tool within an art installation in which the software was used to detect emotion in live conversations (namely participants of the installation talking freely and expressing their emotions in front of a microphone). The installation (*Sounding Out*) was both a tool and a research goal as it was a setting for producing data and demonstrating that is possible to detect the emergence of sound patterns during live situations.

Foundation and Inspiration

As an artist I am interested in exploring the human nature and my curiosity has always been directed towards the mechanisms that make emotions arise and how they are triggered. My research was driven by the curiosity about how we understand feelings and the channels through which we can recognise other people's emotions. Being a composer, I looked at sound as a natural first way to explore emotions. I took inspiration from my readings on art, technology and consciousness (Ascott: 2000) and specifically Robert Pepperell's papers where he states that, according to what is understood about reality at the sub-atomic level, it is plausible to think of everything in the known universe as energy in various states of manifestation and transformation[15]. In art practise, my reference point were interactive installations based on sound and inner realm (Grant: 2008; Viola: 1987; La Belle: 2015).

[15] Pepperell R., The Posthuman Conception of Consciousness: A 10-point Guide, Art, Technology, Consciousness, mind@large

My interest in energy expression and analysis also derives from a previous work of mine *Quanta of Sound* (Lopreiato, Belfiore: 2015) in which I used the analysis of sound energy to manipulate matter. In *Quanta of Sound,* we created a Max/MSP patch that analysed sound coming from a microphone and after the analysis returns the sound transformed in time, strength and location in space. Starting from this kind of analysis, we used the same 25 filters employed in this project and placed them in a new patch. Nevertheless, in *Sounding Out* the analysis was used to detect differences in the distribution of energy determined by the emotional state of the person that was speaking. In fact, while in *Quanta of sound* people could make any sound or talk about any topic, in *Sounding Out* the participant was asked to express an emotional content. The analysis that took place was similar but the focus in the first installation was the manipulation of the acoustic event per se and its material representation while in *Sounding Out* it was used to look for the correlation of emotions in human voices during an acoustic live event. *Quanta of Sound* demonstrated that the patch was a valuable tool for live analysis of sound and from this positive experience came the idea of using it also on a specific target such as emotion detection. In the *Sounding Out* project the system of analysis proved again to be valid and the computer was able to outline the correlation between modifications in sound energy and changes in the emotional state during speech, in a live setting. As a consequence, by using this specific kind of sound analysis the computer could recognise the speaker's emotional state. Starting from this evidence, I implemented my work by virtue of immersive video to visualize the collected data of sound analysis. This research has led to the development of a second installation called *Seams*, which is

original in its intentions as it aims to make data more accessible and intuitive and disseminate the study not only to researchers but to a broader audience.

These installations allow me to examine the physical features of emotions through data analysis (Sounding Out) and visualization (*Seams*). In this way, I was able to make observable events not reachable by our senses.

Noteworthy, the emotions in speech are recognisable with normal sense but investigating how sound energy is shaped influenced by our inner states is relevant to computers. In fact, automatic emotions recognition systems work better with defined parameters (i.e., energy) than using the multiple physical and psychological human capabilities.

Conclusion

This thesis, trough the installations that I created, is a valuable tool for emotion recognition by computerised system. The innovative contribution of my research in the field is to simplify the process of analysis by evaluating and visualizing the overall energy of audio signals instead of the several voice features used in other research. In the future, this study could be a useful starting point for neuroscientists and artists whose main goal is the study of cognitive and emotional processes applied to human and artificial intelligence.

1. Key Terms / Glossary

As stated in the introduction, my research pivots on several key concepts: emotions, consciousness, perception, memory, multimedia, and others. It is not in my intention to create or provide new definitions of these concepts, because defining them is too great task for this project and because my research method is to start from practise and to then go back to theory. The installation addresses everyone not just experts and is also designed for first-person practical investigation into awareness and analysis of the data. As those terms are part of a PhD project, I felt the need to enquire into how these concepts have previously been understood and explored across diverse academic disciplines and to outline from them my own understanding. This research was crucial in driving and shaping my artistic research as well as functioning as an instrument to shape methodology and artistic content. Below, are the key concepts which were important for the design of my installations and my understanding of them is outlined. These terms are: sound and sound energy, VR, emotions,

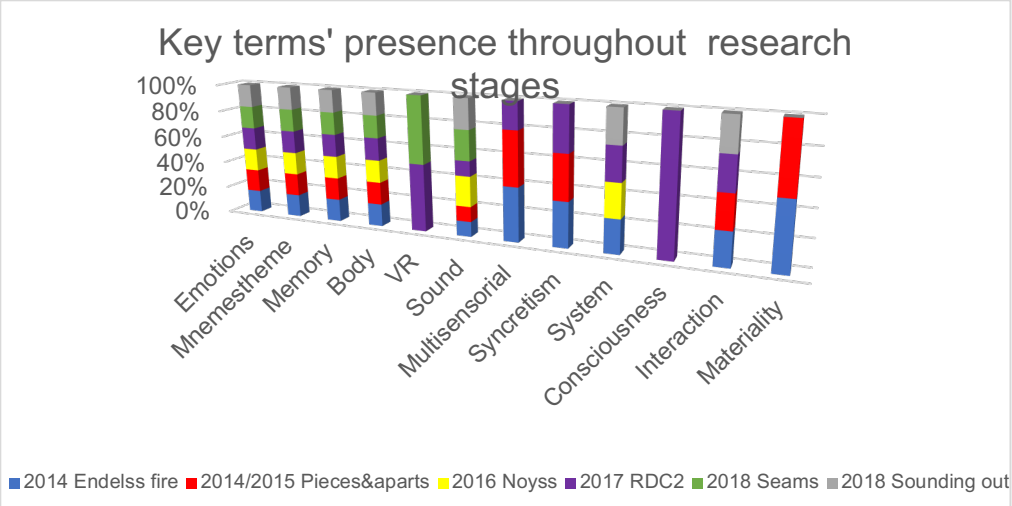

Fig. 1 chart explaining the presence of key concepts for the duration of the research process

mnemestheme, consciousness, perception, memory and remembrance, syncretism, system, interaction, materiality and process, multisensoriality.

Sound and sound energy

Using Douglas Kahn words “sound, rather than being a destination, has been a potent and necessary

means for accessing and understanding the world”[16].

In a physic sense the definition of it could be “when a vibrating body creates in the surrounding air the propagation of a pressure wave, in the same manner that to agitate an object on a surface of water provokes the propagation of wavelets. This is the physical reality of sound, the variation of acoustic pressure over time and this reality is unique ; It can, nevertheless, be represented in ways according to the information that one wishes to emphasize”[17] . Another definition is related to the power of sound, in fact the total sound energy produced by a source per unit time is the sound power, W, which is measured in watts. It is defined as the total sound energy radiated by the source in the specified frequency band over a certain time interval divided by the interval (Colin H Hansen: 2019)[18].

Virtual reality (VR)

By virtual reality we may intend many different things. One definition can be:

[16] Sterne J., Chapter “introduction” in the book “the sound study readers”, 2012 by Routledge, 2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN, p.6

[17] Pressnitzer D., McAdams S., Acoustics, psychoacoustics and spectral music, Contemporary Music Review 2000, Vol. 19, Part 2, p. 33-59, p.37.

[18] Hansen C., Fundamental of acoustics, 2019,

> Virtual Reality (VR) is the use of computer technology to create a simulated environment. Unlike traditional user interfaces, VR places the user inside an experience. Instead of viewing a screen in front of them, users are immersed and able to interact with 3D worlds. By simulating as many senses as possible, such as vision, hearing, touch, even smell, the computer is transformed into a gatekeeper to this artificial world[19].

One example of VR is a completely virtual environment in which everything you see is computer-generated. Another kind of VR is one in which virtual spaces are used in real spaces, for example in military training or in holographic technology where a virtual environment is juxtaposed with reality or with data coming from a camera on a head-mounted device (mixed reality – MR). Another form is cinematic VR, which is when situations or places are shot and screened in HMD in a seamless panoramic form. With this technique it is possible to navigate places or to see things that one cannot realise in reality, but that are nonetheless real (this is usually for educational, advertising or preservation purposes). Examples are the projects developed by Google (Google street view, exploration and Google earth) with which it is possible to visit places all over the world. Indeed, I am using the latter (cinematic VR) for my installation.

Emotions

"Everyone knows what an emotion is until they are asked to define it"

(Fehr, Russell, 1984)

The word emotion usually calls to mind one of the six so-called primary or universal emotions: happiness, sadness, fear, anger, surprise, or disgust. It is important to remind that there are numerous other behaviours that are called

[19] www.marxentlabs.com/what-is-virtual-reality-definition-and-examples/ Accessed 1/3/2017

secondary "emotion" such as embarrassment, jealousy, guilt, or pride. Following Damasio definition all emotions occur in the body and influence our physical states and brain landscape.

In its interpretation emotions are due to chemicals and neural connection and responses while the feeling of emotions is when those physiological changes become neural patterns[20]. In some way the definition of William James is similar in the sense that for the philosopher emotions are not mind staff that is a consequence or reaction to physical causes, but emotion and inner states, they are one thing all together with body and flesh: our body reaction and our emotion are unseparated constitutive elements of our feelings[21].

All my thesis is based on the idea that inner state and body, spiritual and matter are not separate and that the patterns of one reflects on the other in an overlapping process. It was not my intention to describe or discover which triggers first, if the flesh or the mind, also because it is my opinion that inner and outer states are not definite and separated but in a fluid relation with no certain borders.

Definition: Emotions, feelings and moods: words commonly used as synonyms,

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[20] Damasio A., *The feeling of what happens*, New York: Harcourt Brace & Company 1999, p.35: The mention of the word emotion usually calls to mind one of the six so-called primary or universal emotions: happiness, sadness, fear, anger, surprise, or disgust. Thinking about the primary emotions makes the discussion of the problem easier, but it is important to note that there are numerous other behaviours to which the label "emotion" has been attached. They include so-called secondary or social emotions, such as embarrassment, jealousy, guilt, or pride; and what I call background emotions, such as well-being or malaise, calm or tension. The label emotion has also been attached to drives and motivations and to the states of pain and pleasure. Emotions are complicated collections of chemical and neural responses, forming a pattern; all emotions have some kind of regulatory role to play, leading in one way or another to the creation of circumstances advantageous to the organism exhibiting the phenomenon; emotions are about the life of an organism, its body to be precise, and their role is to assist the organism in maintaining life. [..] All emotions use the body as their theatre (internal milieu, visceral, vestibular and musculoskeletal systems), but emotions also affect the mode of operation of numerous brain circuits: the variety of the emotional responses is responsible for profound changes in both the body landscape and the brain landscape. The collection of these changes constitutes the substrate for the neural patterns which eventually become feelings of emotion.

[21] James W., *what is an Emotion?,* First published in Mind(1884),, 9, 188-205., from Classics in the History of Psychology, An internet resource developed by Christopher D. Green, York University, Toronto, Ontario accessed 13/4///2014: I say that for us, emotion dissociated from all bodily feeling is inconceivable. The more closely I scrutinise my states, the more persuaded I become, that whatever moods, affections, and passions I have, are in very truth constituted by, and made up of, those bodily changes we ordinarily call their expression or consequence; and the more it seems to me that if I were to become corporeally anaesthetic, I should be excluded from the life of the affections, harsh and tender alike, and drag out an existence of merely cognitive or intellectual form. Such an existence, although it seems to have been the ideal of ancient sages, is too apathetic to be keenly sought after by those born after the revival of the worship of sensibility, a few generations ago

but which recall different aspects of the affective dispositions with which we approach the world; those words seem interchangeable terms, yet this is not the case. We deal with our emotional life on a daily basis; however, it is not always easy to clarify and identify the different components.

Emotion: can be defined as intense affective reactions, with acute onset and of short duration determined by an internal or external stimulus, pleasant or unpleasant, the appearance of which causes changes on a somatic, psychic, vegetative level. Emotions are not all the same, generally we distinguish some basic primary emotions - such as fear, anger, disgust, joy and sadness - and some secondary emotions. Primary emotions represent innate reactions with which we react to stimuli and are present from birth. Secondary emotions, on the other hand, represent more complex reactions that appear in later moments of psychological development.

Feelings: are generally referred to in psychology to allude to the person's ability to be aware of the emotion he is experiencing. Feelings implicate a cognitive activity whether an emotion is a psychophysiological reaction immediate and independent of thought; to have a feeling instead means being aware of a certain emotional state.

Moods: for moods we refer to almost stable and recurring emotional traits resulting from our temperament and our personality characteristics. Moods are not punctual reactions and defined stimuli, they also do not refer to a specific episode and stimulus, but represent, in fact, affective dispositions without a specific motivation for action.

Historical references: the psychological analysis of emotion finds its roots in the philosophical discussion that initially took place in the context of rhetoric (Aristotle) and ethics (Tommaso D'Aquino, Summa theologica). Only during the seventeenth century did the considerations of the natural sciences begin to be included in those discussions (Descartes, Les passions de l'âme, 1649; Spinoza, Ethica, 1677) and in the analyses elaborated in the broader context within which the aim was to clarify social processes (Hobbes, Leviathan, 1651). The central aspect of emotions, in all the discussions of this early period, was their motivational side, their passionate character, their ability to determine behaviour. Efforts made in the eighteenth century to bring mental processes back into the natural sciences led to an analytical approach to these processes, in the search for the elements of the mind. Emotions were considered states of consciousness consisting of a type of sensation (Hume, Treatise of human nature, 1739), a point of view that dominated the theories of emotions in the eighteenth and nineteenth centuries (A. Bain, The emotions and the will, 1859).

In the early days of scientific psychology, the theory of emotions followed this line, interpreting emotions as a particular type of elements of consciousness (W. Wundt, Grundzüge der physiologischen Psychologie, 1873-1874), or as bodily sensation (W. James, Principles of psychology, 1890).

The sensist approach was attacked, in the early twentieth century, by the intentionalist perspective of phenomenological philosophy (Brentano). According to this perspective, emotions are intentional phenomena, that is, modalities of the subject-object relationship and perceptions of meanings (Scheler, Sartre). Until the 1960s, the sensory positions dominated scientific psychology; since then,

although such positions have continued to contribute to research and theoretical elaboration, the theory of emotions has begun to move towards the so-called cognitive approach, in a synthesis that incorporates the views of phenomenologists and those of previous philosophy. In the same period, a completely different line of thinking developed, centred on emotional behaviour rather than emotional experience; this line, which exercised considerable influence above all through Darwin's comparative study, The expression of emotions in man and animals (1872), was adopted by ethology - the study of animal behaviour - and by behaviourism in its most recent formulation (OH Mowrer).

These two approaches share a functional perspective: innate emotional behaviour, of which facial expression is part, may have developed over the course of evolution only by virtue of its functional value for adaptation. Even learned behaviour survives only when it is functional to obtaining rewards. The functional perspective is also important in current cognitive science, in which models of emotional processes are built with the computer (see Pfeifer, in Hamilton et al., 1988).

Mnemestheme

Mnemestheme and mnemesthetic reaction, is the moment in which we live some emotional and cognitive states through art. My installation is a way to help people replay their past experiences using a new, empowering approach; in fact, the difference between a simple recollection and a mnemestheme depends on the

artistic tool engaged in the experience. That of Mueller, which I will quote in full here, closely informs my understanding of mnemestheme:

> It occurred to me that the unique quality of art is that it enables us to 'replay' past experiences, happenings or imaginings vividly in our personal consciousness. An artist has the gift and skill to weave valuable human consciousness experiences into an art form (…). Since the activities of the human consciousness include a vast array of thoughts, feelings, cognitions and emotions, mnemestheme contribute both to our emotional world and to our thought processes; but to be clear about them, we must try to separate out how they differ from other emotive and cognitive responses and show how they apply specifically to works of art. The ancient Greeks awarded all of the arts to the goddess of memory, Mnemosyne, who was the mother of the nine Muses. The reason I borrow her name and suggest the term 'Mnemesthetics' is that I think what classically has been called the aesthetic experience is a more general experience than one that applies only to art (Robert Dixon, "Aesthetics: A Cognitive Account", Leonardo 19, No. 3, 237-240, 1986). For example, one can have an aesthetic experience when viewing aspects of nature (sunsets, children, flowers) or when reacting to elegant human performances (especially virtuosi in action), brilliant chess moves or mathematical ideas. But as I define it, a mnemesthetic reaction applies only to art. The mnemesthetic experience of art differs from normal consciousness because it is powerfully enhanced and vividly repeatable. The enhancement is due to the creative abilities of artists, and the repeatability is due to the peculiar nature of art. Although we move our conscious attention about as we go through our waking life, when we bring it to bear on a work of art something unusual happens. This unusualness, the mnemesthetic reaction, results because of the media of art and how they are developed by artists. Although each of us has a private consciousness, forever separate and unique, art defies this unconnectability. The mnemesthetic reaction to art is a sharable consciousness event[22].

Consciousness

If we look in a dictionary, we discover that consciousness can be defined as being the awareness of the mind of itself and the world[23].

[22] Mueller R.E., Mnemesthetics: Art as the Revivification of Significant Consciousness Events, Leonardo, Vol. 21, No. 2 (1988), pp. 191-194, The MIT Press, http://www.jstor.org/stable/1578558, Accessed: 07-02-2017 09:51 UTC, p. 2

[23] http://www.oxforddictionaries.com/definition/english/consciousness accessed 15/4/2016

However, what I take into consideration in my own research is a concept of consciousness as a process or flow. It is important for me not to misunderstand it as a thing, or in the words of William James, an "entity"[24]. Besides being a process, consciousness is also something that we participate in actively and not only something that happens to us passively. Noe provides an enlightening metaphor for this concept saying that 'consciousness is not something that happens inside us, 'it is something we achieve….is more like dancing than it is like digestion[25]. Indeed, I consider consciousness a function in its performative sense, in agreement with artist Robert Pepperell, who states that 'consciousness is the function of an organism, not an organ[26]. This processual, active and functional understanding of consciousness is a key tenet of my practice-as-research. As Pepperell explain consciousness is made up of many components and conditions that must somehow combine to make consciousness emerge. It is difficult to separate consciousness from the conditions and components that come into play in its emergence and in our awareness of states of consciousness. Some of these may be memories, emotions, sensations, and feeling but, despite the intuition that we might have that all these elements are parts of the process of being conscious and aware of consciousness states, all that can be sensed is their interconnection and interdependence[27]. Therefore, as Chalmers states, any

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[24] James W., Does `Consciousness' Exist? Source: *The Journal of Philosophy, Psychology and Scientific Methods*, Vol. 1, No. 18 (Sep.1, 1904), pp. 477-491 Published by: Journal of Philosophy, Inc. Stable URL: http://www.jstor.org/stable/2011942 Accessed: 16-04-2016 13:32 UTC: Consciousness is nothing joined; it flows. A 'river' or a 'stream' is the metaphor by which it is most naturally described. For twenty years past I have mistrusted 'consciousness' as an entity. To deny plumply that 'consciousness' exists seems so absurd [...] I mean only to deny that the word stands for an entity, but to insist most emphatically that it does stand for a function

[25] Noe A., Out of our head, Hill and Wang, New York, 2009, p.xii

[26] Pepperell R The Posthuman Conception of Consciousness: A 10-point Guide, Art, Technology, Consciousness, mind@large

[27] Ibidem: Consciousness can only be considered as an emergent property that arises from the coincidence of a number of complex events. In this sense, it is like boiling. Given sufficient heat, gravity and air pressure the water in a kettle will start to boil. We can see what boiling is, we can recognise it as something to which we give a name. We do not consider it mysterious, yet we cannot isolate it from the conditions that produced it. We cannot isolate consciousness from the conditions that produce it any more than we can isolate boiling. Consciousness is a property that emerges from a given set of conditions

experience that involves consciousness also involves feelings, memories and emotions and can be seen as a process, not as a thing. But 'at the same time, you may be feeling some emotions and forming some thoughts. Together such experiences make up consciousness: the subjective, inner life of the mind'

Perception

Understood in its usual sense, perception is the ability to see, hear, or become aware of something through the senses. But perceiving is a complex system that involves our body as a whole, and our knowledge of the relationship between sensorial changes and bodily experience of these changes are, as Noë remarks, the activity of perceiving[28]. Furthermore, perception is not only about the material world, and substances we observe. Rather it is a whole in which everything participates. As Merleau-Ponty says, it is a setting or a field for both thoughts and sensations at the same time[29]. This idea has influenced the understanding of perception in my work, which views the concept of perception as encompassing both the material and the ephemeral, and as related to the full spectrum of bodily changes and responses, and awareness of these changes.

Memory and remembrance

[28] Noe A, Concept Pluralism, Direct Perception, and the Fragility of Presence,p.1, https://open-mind.net/papers/@@chapters?nr=27, Accessed 09 AGOUST 2017: Perception is the activity of exploring the environment making use of knowledge of sensorimotor contingencies. Sensorimotor contingencies are understood to be patterns of dependence of sensory change on movement. The proposal, then, is that we make use of this knowledge of the way our own movement gives rise to sensory change to explore the world. This knowledge-based or skilful activity is perceiving

[29] Merleau-Ponty M., Phenomenology of Perception, Routledge & Kgan Paul, the humanities press, London, 1962, pp. x-xi: Perception is not a science of the world, it is not even an act, a deliberate taking up of a position; it is the background from which all acts stand out, and is presupposed by them: The world is not an object such that I have in my possession the law of its making; it is the natural setting of, and field for, all my thoughts and all my explicit perceptions

This quote from Stanford encyclopaedia, attentively tells the general understanding of memory:

> 'Memory' labels a diverse set of cognitive capacities by which we retain information and reconstruct past experiences, usually for present purposes. Memory is one of the most important ways by which our histories animate our current actions and experiences. Most notably, the human ability to conjure up long-gone but specific episodes of our lives is both familiar and puzzling and is a key aspect of personal identity. Memory seems to be a source of knowledge. We remember experiences and events which are not happening now, so memory differs from perception. We remember events which really happened, so memory is unlike pure imagination. Yet, in practice, there can be close interactions between remembering, perceiving, and imagining. Remembering is often suffused with emotion and is closely involved in both extended affective states such as love and grief, and socially significant practices such as promising and commemorating. It is essential for much reasoning and decision-making, both individual and collective. It is connected in obscure ways with dreaming. Some memories are shaped by language, others by imagery[30].

This standard definition is helpful in the sense that it includes the idea that memory has an unintelligible relationship with perception, cognition and emotions, together with decision-making and self-awareness. Starting from this simple definition my studies are marked by an understanding of memory that follows the Proustian aesthetic, for which remembering is observing memories or the reinforcement and renewal of emotions and sensations of what was happening rather than pure recalling of faded images of events which retain nothing of the experience's richness. So, what I intend when I talk about memory and remembrance is what Proust calls 'involuntary memory': a recollection of an entire connection of sensations, thoughts, and impressions from the past. Memory when is involuntary recovers not only perceptual and spatial information,

[30] Stanford Encyclopaedia of Philosophy, First published Tue Mar 11, 2003; substantive revision Wed Feb 3, 2010, http://plato.stanford.edu/entries/memory/accessed 19/02/2017

but also the whole intertwined web of sensory, emotional experiences that made up these earlier moments in time as well as a sense of fulfilment for how all these experiences fit together into a coherent whole[31].

Syncretism

Syncretism is the fusion of two or more originally different inflectional forms, but in this dissertation, refers more often to the combination of different sensations and/or physical and mental stimulation that are not necessarily related or similar but that coexist in one system or situation. Syncretism in the sense of mixing or association can reach and add a force to disparate and diverse elements that in a syncretic context not only coexist but support and enhance one another. A syncretic approach is very helpful because, unlike purely binary opposition, it leaves open the possibility of, as explained by Ascott, the elements in play maintaining their own characteristics ("being both")[32]. Adopting a syncretic approach will thus disable the usual dynamic of perception and understanding,

[31] Epstein R. Consciousness, art, and the brain: Lessons from Marcel Proust, Department of Psychology and Centre for Cognitive Neuroscience, University of Pennsylvania, Philadelphia, February 2003, p.5: According to Proust, involuntary memories re-instantiate a moment in the past as it actually occurred— ''a fragment of time in the pure state'' (905). Voluntary memories, in contrast, instantiate a worked-over interpretation of the past that is not equivalent to re-experiencing the event. We do not usually notice that voluntary memories are insufficient reproductions of the past only because we are not usually aware of what experience is really like. (…) One striking aspect of the involuntary memories recalled by Proust in the Guermantes mansion is that all of them involve recollection of an entire nexus of sensations, thoughts, and impressions from the past. Proust recovers not only perceptual and spatial information, but also the whole tangled web of sensory, emotional, and appetitive experiences that made up these earlier moments in time as well as an appreciation for how all these experiences fit together into a coherent whole. These experiences contrast with the ''snapshots'' of voluntary memory, which represent individual sensory events that have been abstracted from their contexts and can be recalled at will. In contrast, the process of recollection for involuntary memories is guided by the relationships between previously-experienced events rather than by current goals. According to Proust, it is precisely this surrender to the seemingly illogical structure of an event that makes involuntary memory so vivid, because by surrendering to this structure one becomes aware of it. Each episode is a unique conjunction of sensations, goals, and desires which are related to each other largely by contingency. These contingent relationships are what give an episode from the past its distinct ''savour:'' Voluntary memory does not recall the experience itself; it recalls the experience as reworked by intelligence and at least partially translated into concepts. Our intellect is not interested in the details of individual episodes except insofar as they provide generalizable knowledge about the world that allows us to predict the consequences of current action. However, something important is lost in this reworking of the original episode: the ''color, scent, and temperature'' that gave the episode its unique feel. Instead, this is replaced by ''a uniform depiction of life'' that ''make[s] varied patterns out of elements that were homogeneous'' (906) (i.e., concepts), elements whose ''reality [the will] still further reduces by preserving of them only what is suitable for the utilitarian, narrowly human purpose for which it intends them'' (905). Such a depiction gets the facts right, but not the feel.

[32] Ascott R., Syncretic Reality: art, process, and potentiality, Intellect Books, 2000, Bristol UK accessible link http://www.drainmag.com/contentNOVEMBER/FEATURE_ESSAY/Syncretic_Reality.htm accessed 03/04/2016: In the syncretic context, extreme differences are upheld but aligned such that likeness is found amongst unlike things, the power of each element enriching the power of all others within the array of their differences. Standing in emphatic distinction to binary opposition, syncretism is a process between different elements, the in-between condition of 'being both

placing new inputs and meanings together to dismantle the linear approach that we use in everyday life, and will thus encourage awareness.

System

A system is an organised or established procedure, arrangement or pattern. In this dissertation, it also has a specific artistic connotation and refers to the installation itself. System is not a synonym for installation; rather it constitutes one part of the installation. The system refers to the predetermined parts designed and constructed by the author, whereas the installation includes both the system and the responses of the public to it, which act as variables. The system is therefore a part of the installation, which remains open and is completed by the contribution of participants. The system can therefore be described as a tool offered to investigate the research topic.

Interaction

In the context of this research, interaction is understood in terms of sensorial and behavioural triggers. I am more interested in the participants than in the work itself, or at least the work is designed to be finalised by the participants. This interest in people and not in the art object is much of our time and implies the involvement of all our senses and the sensorimotor system (Ascott 1968:107)[33]. My investigations are targeted towards the design of a new set of associations

[33] Ascott R. 'The cybernetic stance', (1968) Pergamon press, Leonardo, vol.1: Responses constitute an art situation. Where the artist is interested less in his own behaviour than in the behaviour of the spectator work maybe seen specifically as a behaviour trigger. This tendency, so much of our time, implies total behavioural involvement in which all our senses are brought into play, not simply visual, but postural, tactile and including the sense of hearing and even of taste and smell. The artwork or event is matrix between two sets of behaviour, which through it become one, continuous and interrelated. Inevitably a state of perfect feedback will emerge, where we all both initiate and involve ourselves in total creative situations

and new understanding of perceptive processes; helped by technology I create an imaginative topography of interaction between perception, feelings, emotions, memories and consciousness. The aim is to observe how new paths of sensitivity, in the confusion and syncretism of what we feel and recall, will bring to light new layers of consciousness. Maintaining a strong link with research on the senses and on the mechanisms of perception and how memory works, my research is reflection on and an investigation into the reactions and mechanisms of perceptive syncretism, designed to achieve a metaphysical whole by drawing new trajectories in consciousness. This investigation has as its methodology the art work itself and is thus proposed as both an effect and something being affected at the same time, reflecting the inside outside feedback. The installation process itself is under analysis, including the activation of the work process and activation of the stimulation and responses of the people taking part in the work; it is in fact an unending and embodied consideration.

Art since the nineteen-sixties has been process-oriented and triggering action and responses is a big part of its staging and conducting an interior dialogue (Ascott 1968:107)[34]. Through action and perception, the social or private negotiation can be seen as a new way of investigating awareness; the transformative action of the system and people at the same time is used in the perspective of becoming a mechanism for the emergence of new routes of awareness.

[34] Ascott R. 'The cybernetic stance', (1968) Pergamon press, Leonardo, vol.1.: We have undoubtedly become process-oriented that was deal with objects. For my part this must be so. […] Artefacts on an inti
mate scale are essentially triggers. They contain nothing but the possibility of future action; that is to say they exist only in so far as the spectator or participates in their evolution by, on the one hand, interacting with other people within a complex social situation, and on the other hand my conducting a private interior dialogue.

Materiality and process (ubiquity of sound, virtual and real objects in the installations)

The word materiality generally means the quality or state of being material, something that is material. But as well as the physical connotation when I use the term, I also intend another meaning as described in this definition:

> Measure of the estimated effect that the presence or absence of an item of information may have on the accuracy or validity of a statement. Materiality is judged in terms of its inherent nature, impact (influence) value, use value, and the circumstances (context) in which it occurs. Opposite of triviality. See also material fact [35].

My interest in this term is rooted in sound, with its materiality and its ubiquity, and draws on my musical background as a musician and electro-acoustic music composer and on my performative experience. But how and why does my research start from the concept of matter and materiality? During my PhD studies, I taught acoustics and through this experience I expanded my approach to include music, deepening my knowledge of physics and vibratory phenomena. Having to explain the behaviour of matter and energy behind music and composition to students, has given me different ideas, which during the last few years became part of the design process of my artworks. The beauty and the struggle of discussing this subject lies in the fact that sound is in one place and at the same time everywhere and somewhere else, is something physical although intangible. What most fascinated me, and still strikes me, is the ubiquity of sound; the vibrational motion and orientation of the particles, regardless of their

[35] http://www.businessdictionary.com/definition/materiality.html, accessed 4th September 2018

manifestation, exist in open spaces, architectures, objects or bodies. The ubiquity that is implicit in sound inspired me to find a physical way to express the immateriality (apparent or not) of the evolution and emergence of emotions. Not being in one place and not being stimulated by a single factor, the emergence of feelings is like sound: everywhere in the sense that is matter and mind at the same time, not in a dichotomy but in a relationship. What Labelle expresses in his book "Background noise" in relation to sound is, in my opinion, also attributable to the evolution of inner states. Specifically, our awareness, like vibration and sound, inevitably happens in the presence of matter and necessarily evolves over time and in space[36]. Objects, whether they are sounds, solids or smells, with their materiality, their shape, pattern, volume, texture are all tools for structuring and defining my installation, both in terms of their physical features and their non-physical elements. Indeed, the materiality of things stimulates our senses and have an engaging capacity to drive people to interact (physically or emotionally) with the virtual or real environment in which they are immersed. They are thus what will drive people to effectively live and experience the installation and so become part of it. Furthermore, the materiality of objects and sounds that have been part of my installations and which interact with people have another power, that of being evocative. In other words, the objects relate to memories and feelings and together with sensorial responses and stimulation will contribute to

[36] La belle B., Background Noise, Second Edition: Perspectives on Sound Art, 2015, kindle edition: Sound thus performs with and through space: it navigates geographically, reverberates acoustically, and structures socially, for a sound amplifies and silences, contorts, distorts, and pushes against architecture; it escapes rooms, vibrates walls, disrupts conversation; it expands and contracts space by accumulating reverberation, relocating place beyond itself, carrying it in its waves, and inhabiting always more than one place; it misplaces and displaces; like a car speaker blasting too much music, sound overflows borders. It is boundless on the one hand, and site-specific on the other.

achieving greater awareness of our own state, thus enabling participation[37]. This quality of "being evocative" is crucial because the materiality of things not only connects and engages people to the physical space and environment, but also connects people to the non-physical part of the work. In fact, as much as matters main characteristic is materiality, they also have non-physical aspects. They inherently have and refer to meanings, ideas, and rules. It can be the use of old and new tv monitors to represent the fact that emotions are something that were always important for humanity no matter which era we consider or can be pieces of puzzles that represent our story or parts of our life[38], but whatever object I used in my work they all have more than one meaning and provoke more than one physical and emotional reaction. The things I use in the installations are so important for my research, both technologically wired or not, I use them as what Henderson (in relation to computers) describes as *'network-organizing devices, individual and interactive thinking tools, and organizers of interdisciplinary communication'*[39].

Multisensoriality

My current art practice and research started from music and sound, later on encountering new media and telematic art. Over the years my theoretical and practical interest has shifted from music to performance, to finally arrive at an art

[37] Jacucci G., Wagner I., "Performative roles of materiality for Collective Creativity", Helsinki Institute of Information Technology, Helsinki University of Technology and University of Helsinki / Institute of Design and Assessment of Technology, Vienna University of Technology, 2007 pp. 73: Materiality is a crucial aspect of the representation, giving participants clues about all sorts of conceptual and material aspects of the work. Again, other artefacts (a wall, the odd object lying around, etc.) may be just "evocative", aspects of the environment that stimulate, remind, constrain. One of the virtues of these tangible artefacts (within a space that itself has material qualities) is their engaging capacity. They ask us to experience through seeing, touching, smelling, and maybe also gesturing, heaving and moving. Involving all the senses is to do with the richness of "informal cues". More importantly, materiality supports intuitive and simultaneous manipulation, mobilizing our tacit knowledge and enabling participation.

[38] See Pieces and Parts p. 130.

[39] Henderson, K. the visual culture of engineers. The cultures of computing, S. Star Blackwell, 1995, 197-218

in which the audience was not only the receiver, but where the dialogue was an exchange rather than a one-way process. My interest has increasingly developed towards obtaining people's deep emotional as well as physical participation. My interest in the multi-sensory started to form during the years when my work concerned multimedia performance. In an effort to encourage and stimulate consciousness and the emotional response of the viewer, I realised and immediately felt the need to appeal to all the spectator's senses. Greater involvement or a higher inclusive force could not be separated from the body of the spectator, or at least could not merely rely on vision and hearing. Thus, I created multimedia works such as *The garden in the brain* and *Mediterranean moods*[40]. In these performances, I inserted multiple visual stimuli in an attempt to stimulate a non-linear logic, to bring the symbolism and dreamlike visions, which would pass through different screens in order to depart from a linear narrative. My artistic effort stretched to the inclusion of taste, smell and touch, as well as listening (already present in my electroacoustic works).

However, in these works the unidirectional component was still present; as far as I was able to force myself to break up the usual visual and auditory dynamics, and although I tried the expedient of getting off the stage in order to use a different point of view to contact the public and stimulate different senses, the audience remained the receiver. It was not possible for people attending to move onto a more profound level of participation. From these exchanges with the audience of my performances, I learned that there was a strong emotional response to them,

[40] For more details and documentation visit the website www.paolalopreiato.it

and that the symbolism and abandonment of the usual linear dynamics helped people to indulge in a more free and uninhibited perception/reception, although it still remained passive. This, although fulfilling, was not my end point. As a performer I understood the experience of immersion in the work by testing it myself during the show.

This practice in the immersive multisensory environment of the performance inspired me to enable people to experience the situation for themselves as participants. In a way, I wanted to share the performing potentialities of the artwork. My intentions are therefore to elicit the participants in many ways: visually, with flicker, images, spatial ambiguity, and by physically changing their postural response and making the artwork become what Ascott calls “a matrix” between two sets: the participants and the environment[41]. However, audience involvement in the action was not my only aim; I want the audience to participate at a deep level, and especially at the level of perception, in the direction of a different use of senses and body.

In this way, the artwork would work towards a new grammar that would lead to a syncretic, psychophysical experience, since as Chalmers argues our experience of everything in life and of life itself is made up of an indivisible union and the overlap of what is sensed, perceived, thought, felt, and presumed[42].

2. Theoretical foundations of research

[41] Ascott R., ‘The cybernetic stance’, (1968) Pergamon press, Leonardo, vol.1, p.107: *As for the spectator, he no longer expects to receive a ready-made experience, or the expression of an experience, but rather to participate at a deep level, either it in his consciousness or, more physically, by immediate action*, p.106

[42] James. W. (1904), Does `Consciousness' Exist?, The Journal of Philosophy, Psychology and Scientific Methods, Vol. 1, No. 1, pp. 477-491 - p.13; Sensations and apperceptive ideas fuse here so intimately that you can no more tell where one begins and the other ends, than you can tell, in those cunning circular panoramas that have lately been exhibited, where the real fore- ground and the painted canvas join together

I identified three concepts on which to base the interactive installations:

a) Three orders of judgement
b) Patterns of similarity and difference
c) Mnemesthemes

a) The concept of the three orders of judgment is introduced by Chalmer in his book "The conscious mind". According to the philosopher, people can have three degrees of judgment and understanding of experience, but not everyone experiences them during their lifetime.

The first order of judgment is plain perceiving and learning about one thing, for example the colour red. The second way to experience conscious reality is to realise that you are having a sensation and perception of the colour red and the third order of judgment of an experience is to understand how complex and obscure it is that we ourselves fail to be aware that we are conscious of an event or an experience[43].

In *Sounding Out* we have the first order of judgement in the sense that people are present in first person and are excited to be in an installation and get excited when they receive the affective answer from the computer. The second order occurs when participants reflect on the emotions and therefore on themselves,

[43] Chalmers, D.J., The Conscious Mind: In Search of a Fundamental Theory, 1996, Oxford University Press, New York pp. 174-176: Judgements related to conscious experience fall into at least three groups. There what I call *first-order, second-order* and *third-order* phenomenal judgements […]. *First-order* judgements are the judgements that go along with conscious experiences, concerning not in the experience itself but the *object* of the experience […]. These judgements are not strictly about consciousness. Rather, they are *parallel* to consciousness and generally *about* objects and properties in the environment, or even in the head […].*Second-order* judgements are more straightforwardly judgements about conscious experiences. When I have a red sensation, I sometimes notice that I am having a red sensation […]. In general, it seems that for any conscious experience, if one possesses the relevant conceptual resources, then one at least has the capacity to judge that one is having that experience […]. Second-order judgement also include judgements about particular *kinds* of conscious experiences, as when one notes that some drug producers particularly intense sensations, or that the tingle one gets before a sneeze is particularly pleasurable. What I will call third-order judgements are judgments about conscious experiences as a type. These go beyond judgements about particular experiences. We make third-order judgements when we reflect on the fact that we have conscious experiences in the first place, and when we reflect on their nature. I have been making third-order judgements throughout this work. A typical third-order judgement might be, "consciousness is baffling; I don't see how it could be reductively explained" (…). To help keep the distinction in mind, the various kind of judgements related to consciousness can be represented by the following: First-order judgement: *that's red!*; Second-order judgement: *I'm having a red sensation now*.; Third-order judgement: *sensations are mysterious*

the third order takes place when they discover how it works and the mystery behind the sound analysis and how the emotions imprint changes in sound.

In *Seams*, on the other hand, the first order of judgment arises when the person is immersed in the images and understands what is around her/him (‘*That’s red’*), then there is the second order when s/he understands the story and the feelings of others in the video and finally the third when s/he follows the flow of the video in its climax and gets captured the symbolic representation of the mysteriousness of what is behind the sound and emotions. The challenge is to see if indeed installations help people go from a first to second and third-order judgement. I cannot be sure if in *Seams* and *Sounding Out* people gained any new knowledge about the emotion that they are looking at or talking about, but they probably had a different order of judgment on the relation between sound and emotions, a changed understanding of the multifaced and hidden net of connection between our inner word and how is penetrating matter (the environment) conveyed through our body. These two artistic projects support the statement that virtual reality and audio-visual immersion, along with sound analysis, can change our level of awareness of actual experience as well as contributing to the academic literature on the related fields.

b) The other concept on which the research is based is “the patterns of similarity and difference between experiences”[44].Though today's theories about inner states based only on physical phenomena are not exhaustive, they nevertheless point out that physical events play an important role in the emergence of

[44] Chalmers, D.J., The Conscious Mind: In Search of a Fundamental Theory, 1996, Oxford University Press, New York pp. 174-176

emotional states and in studying this area. My investigation started from the phenomenological aspects of sound (related to perception and feelings) in connection with the stimulation of emotional states and memory of them. During the artistic experiences described above, I collected audio-visual data in order to analyse the patterns of similarity and difference between participants' experiences.

c) The third element is mnemestheme and mnemesthetic reaction, which is the moment in which we live some emotional and cognitive states through art. My installation is a way to help people replay their past experiences using a new, empowering approach; in fact, the difference between a simple recollection and a mnemestheme depends on the artistic tool engaged in the experience. The intensity of the recollection of an emotional state during my installation is due to the use of multimedia interaction, HMD and the audio-visual immersion of the audience[45].

The mnemesthemes[46], this cognitive-emotional event, will make a strong contribution to the transition from a first-order judgement of reality (when people experience or express an emotion) to a second-order judgement (when they understand and learn about that emotion and reflect on how their or other

[45] Mueller R.E., Mnemesthetics: Art as the Revivification of Significant Consciousness Events, Leonardo, Vol. 21, No. 2 (1988), pp. 191-194, The MIT Press, http://www.jstor.org/stable/1578558, Accessed: 07-02-2017 09:51 UTC, pg. 2-3: a mnemestheme is that personal, cognitive-emotional event a person has when optimally participating in the experience of a work of art. A particular work of art gives rise to a particular mnemestheme, which is enriched and enhanced with each exposure to the artwork, until it becomes, if the art is important to us, nearly hypnotic in its intensity. Since the activities of the human consciousness include a vast array of thoughts, feelings, cognitions and emotions, mnemesthemes contribute both to our emotional world and to our thought processes; […] A mnemestheme can be compared to what Noam Chomsky calls an 'organ' of human cognition that applies to art (Chomsky 1980:3); but it must perforce have a real-world generative force to call it into being. Mnemesthemes differ from other mental organs, or constructs. They also differ from simple memory recollections in that mnemesthemes are concretized, tense, almost transcendent reflections of experiences, generating the most vivid and therefore some of the most unusual and important consciousness events of the mind.

[46] See chapter 1 p. 23 for an in-depth description of mnemestheme

people's inner states are related to sound and matter) to finally the third order when they understand symbolically (360° videos) and also through the experience of the analysis process how concealed the relations and patterns that emotions imprint in sound are; people will be able to peek the mystery of emotions and sound through the crack that technology and art have opened for them. The installations that I propose are a way of navigating among straightforward sensitivity, reflection on experiences, tense emotions, thoughts, memories, understanding of the environment and of the self, and analysing the relationship among them. Understanding these connections between physical and mental states represents (not divided but an ongoing process of appearance and disappearance) a step towards a better vision of the emotional experience and can help understand to what extent a machine can be trained on what we know about inner states.

3. Research context

My research methods can be divided into two distinct but interconnected strands. As a practice-based project part of my investigation took the form of artistic practice. However, the project is also the product of academic and practical research which contextualised and informed my artistic practice. This research consisted of two complementary areas of inquiry, which are detailed below. Firstly, I conducted a survey of academic literature on emotions, perception, sound and other relevant topics. This literature was primarily drawn from the fields of (i) neuroscience, (ii) philosophy and psychology, since inner states are a

significant area of inquiry for these disciplines, but I also investigated (iii) acoustic studies and (iv) literary works addressing this and similar issues.

My second area of research was to examine works by other artists exploring similar themes and/or using similar methods or media; their work provided comparative models which have helped with the development and explanation of my own practice-as-research.

a) First area of research: Literature Review

Although emotions and related issues have long interested philosophers and psychologists, they are still regarded as too intangible, with the exception of interest in the subject within neuroscience. I therefore conducted an extensive review of publications of research on emotions (and its relation to sound when available) from the fields of neuroscience and neuro-aesthetics, philosophy and psychology as well as from sound studies, art and literature. In doing so it was not my intention to define what emotion is, because it is too wide an issue to address within the scope of my thesis. However, drawing on definitions and reflections from experts on the subject across differing disciplines enabled me to better frame the concept, providing me with a starting point for my artistic research and guiding the direction of my practice.

(i) In terms of neuroscience, Antonio Damasio's work (*Self comes to mind: constructing the conscious brain*) was particularly useful for understanding the correlation between brain activity and awareness. His work was also very important to my practice in terms of deepening my understanding of the

mind/body problem and relationships between emotions, behaviour and decision-making[47].

The best expressions of the connection between philosophy and neuroscience I have found were the publications of Francisco Varela and Humberto Marturana (*Autopoiesis and Cognition: The Realization of the Living*; *The Tree of Knowledge: The Biological Roots of Human Understanding)* who treat the intersection between awareness and bodily responses, cognition and experience of reality, from a scientific and philosophical point of view. In terms of philosophy, I explored the work of Evan Thomson *(Article: Empathy and Consciousness; with* Francisco Varela, and Eleanor Rosch: *The Embodied Mind: Cognitive Science and Human Experience).* Philosopher Alva Noë helped me define precisely the concept of perception, which is specifically linked to the concept of self and reality as it appears (*Out of our heads; Action in perception*). Also essential in shaping my thinking more generally have been Henry Bergson, Maurice Merleau-Ponty and Edmund Husserl.

(ii) Examining the intersection of psychology with philosophy, William James and Carl Gustav Jung were among others those who drove my investigation on self and environment, and on the liminal space between outside and inside. More than this, they inspired me to search for practical means to address topics that might seem purely ephemeral. They pushed me to look for the possibility of action, to bring out the practical outcomes of ideas and statements, and to take a pragmatic approach, which is not however pure empiricism or objective

[47] Damasio A.R. (1994) L'errore di Cartesio, Adelphi, Milano 1994, original title: Descartes' Error: Emotion, Reason, and the Human Brain

experiments. Jung, for example, used mandala as an investigative tool, exemplifying the idea of practical research and providing a model for my own practice.

(iii) In the field of sound and acoustics, the academic work of anthropologist and musician Georgina Born has been a point of reference and her papers gave me a global but precise view of the role of acoustics and psychoacoustics in twentieth century musical research. Her analysis of the generation of researchers such as Schaeffer, Risset, Xenakis, Berio and others, helped me understand not only the importance of perception and acoustics to inform music, but also the controversial uses and outcomes of this kind of research. From these studies I could draw my own conclusions on what is useful and meaningful in this kind of research. I kept what I identified with, I left out what I thought it was incompatible with my research and aesthetic. Another cornerstone of my research, especially for the installation *Seams* and the sonification, was Jacques Attali[48] . From his writings on noise I learned the importance of sound as a tool for understanding music and how to talk through music. His work on establishing a relation between the history of people and the economy through noise evolution was inspiring in the sense that I clearly could understand that sound is not only a consequence or a subsidiary or aesthetic element. I understood that sound and music can actually take the place of a concept and not only describe it. Hence the choice of sonifying the data collected in *Sounding Out* to create the soundtrack for *Seams.* Brandon La Belle was also very important for reminding me of the relation between body,

[48] Sterne J., Chapter "noise: the political economy of music" in the book "the sound study readers", 2012 by Routledge, 2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN.

physicality and sound. His book “background noise” has given me an overview of other artists using sound for its materiality and power of being social. La Belle’s point of view on the sociality of sound and its power to be material and immaterial at the same time, directed me towards the idea of focusing on the materiality of sound but also on the fact that materiality (energy in my case) was also a way to convey other meanings and was one of the elements that lay at the basis of social communication (expressing feelings to others, telling our stories).

(iv) Finally, turning to the field of literature I discovered Virginia Woolf’s writing on deconstructing the self in an attempt to outline the concept of emergence, and how the self arises through a process and not in a place. Her prose, which, unlike that in Joyce’s *Ulysses* for example, is neither a self-conscious transcription nor an objective description of perception and feeling[49], supports my belief that art can lead people to investigate the emergence of the self and its inner states, and thus provided inspiration and a parallel for my own artistic practice in a different medium. While my research into this broad range of theoretical publications proved invaluable in deepening my understanding of some key issues relating to emotions, it also revealed the limitations of this approach to investigating a topic for which, as stated in the introduction, collecting data is problematic. Either research, as in Woolf's case, took a 'first-person' approach, or, as in other cases, the conclusions of the research were rather limited. For example, despite the recent advances in brain imaging technology within neuroscience, the scientific community has not been able to go further than identifying a correlation between

[49] As Erich Auerbach pointed out in his work Mimesis (Auerbach, E. *Mimesis: The Representation of Reality in Western Literature.* Fiftieth Anniversary Edition. Trans. Willard Trask. Princeton: Princeton University Press, 2003.

brain activity and emotions in terms of its conclusions; cause and consequence remain unaccounted for. Therefore, to strengthen my research and my knowledge of the field and to be able to produce a more informed practice myself, in parallel to this research into the current literature on the subject, I also investigated practical techniques which aim/claim to affect emotions and perception.

b) Second area of research: artistic scaffolding

The final strand of my theoretical part of the research sought to complement the investigations described above. I conducted an examination of examples in art investigating topics of sound, perception and feelings, and/or using the same tools (installations, mediating technology) as those employed in my own practice. This included works by artists such as Bill Viola, Gary Hill, Miroslaw Balka and Jane Grant[50], all works that were also useful in providing parameters to define and shape my own practice through comparison and opposition. Identifying and building on the similarities and differences between these works and my own proposed installation helped me to develop the latter. Adequately describing a prototype of a three-dimensional, multi-sensorial, immersive experience is not a simple task and for this reason I will draw here on several examples of installations constructed by other artists including Olivier, Jane Grant, Youssef Kashef, Abdelrahman N. Mahmoud and Rana el Kaliouby, Henrik Lörstad, Mark d'Inverno, and John Eacott, each of whose works are described in

[50] Et al

the following. Since my installation addresses issues relating to emotion, (technologically mediated) interaction and perception, the examples I detail below all deal with one or more of these aspects.

For this purpose, I have divided these installations into four key types for examination: installations whose purpose is to highlight the mediation of the technology employed; installations which seek to explore emotions; installations whose goal is to produce an artwork and installations that focus thematically on scientific research where artistic knowledge is generated concerning science.

i. *Installations with the mediation of technology as their ultimate goal.*

In this type of installation, a person activates something (e.g. a sound, images); the sensor or software that captures and manipulates data can be explored by that person, who can move and provoke different situations and thereby understand how the sensor/software works in a set situation (performance or installation) The objective of the artwork is therefore the medium and mediation. An example of this is *The Artvertiser*:

> "The Artvertiser" (2008) is a software platform for replacing billboard advertisements with art in real-time. This project, by Julian Oliver and Damian Stewart, works by teaching computers to 'recognise' individual advertisements so they can be easily replaced with alternative content, like images and video"[51].

This artwork is designed for people to use a special device to look at what is around them and to detect advertisement billboards that they can consequently chose to substitute with other images through software implemented in the

[51] The Artvertiser — V2_Institute for the Unstable Media, 11:36 - http://v2.nl/archive/works/the-artvertiser, accessed 12/06/16

device. The result is not as engaging and primary as the concept of mediation itself; in this improved reality situation (as the artists call it) the device and its mediation are the aim and main concern. During the live presentation of the project (in Berlin as part of *Transmediale 2010*, Brussels for the *Europe wide Media Facades Festival* and Rotterdam's *Image Festival*) how and what the software was doing through the device was exhibited, rather than what people chose to put on the billboard. People's choices and actions are thus simply the exemplification of the software in this case.

ii. Installations exploring emotions.

In this kind of installation, the aim is to explore emotions created by the effect of people's actions and reactions; the situation in which the reactions that emerge from the person, triggering the system, is a way for the person inside the installation to explore the emotional world. An example of this is *The Chameleon Project* (2008-2010) by Youssef Kashef, Abdelrahman N. Mahmoud and Rana el Kaliouby. In their article *The Chameleon Project: An Art Installation Exploring Emotional Contagion* they explain how they tried to explore emotional contagion and emergence through art practice. They outline the installation as follows:

> The participants will enter a defined space. Three screens are connected to three computers. Each screen will be displaying a digital portrait of an everyday person showing expressions that can be classified within six emotional states (happy, neutral, sad, angry, disgusted, surprised). The digital portraits are programmed to wait in the background until the emotional face reading system senses a participant's face. After sensing the emotional expression of a participant's face, the video portrait will walk forward to address the participant, attempting to begin an emotional dialogue with the participant that would be perceived as emotionally congruent to the participant's emotional expression. The video portrait will

> attempt to stimulate the participants in such a way as to elicit an emotional facial expression from them that is recognized by the emotion face reading system. The system constantly monitors the facial expression of the participant, selecting video portrait segments that aim to respond to the audience in an 'emotionally intelligent' way, in order to build an emotional bond with the audience. The work can interact with three people at a time. If the system finds that one participant has a particularly strong emotional expression, the emotion is propagated to all three monitors. People can leave and enter as they wish[52].

Here the primary concerns are emotions and how to trigger them; people are part of this exploration through their function of triggering and because they are the element through which the result is observed. For the artists and scientists who created the work, the emergence of emotions is above all the field of exploration and the fact that people have experienced these emotions is not part of their goal. The authors state that reactions of the audience are consequences and not the subject of analysis, and that their work does not aspire to make people dwell on what they experience. What the artists need is reactions, not people reflecting on or lingering in their new mental and physical states. Due to these issues not being addressed, reports on the installation from participants were more about tools and results, and what they saw in the video; their relationship with the system (video and cameras) shadowed the relationship with their own mental and physical states. As reported by participants, what they took away from the installation was an augmented awareness of the consequences of and interaction

[52] Gonsalveshe T., Kashef Y. et al., Chameleon, Project: An Art Installation Exploring Emotional Contagion, 2009, EDT 2016, Citable Link http://hdl.handle.net/1721.1/59344, accessed Mon May 23 09:38:15

between man and machines. Changes in their consciousness and the recurrence of feeling and perception related to this were pushed aside:

> In the attempt to recreate the emotion, the feeling flooded back. I felt quite moved, this intimate relationship with a camera lens was a new experience for me and I found its scrutiny a great challenge[53].

Participants were projected outside, and their challenge was to cope with the system and emotional exchange with others, not with the flow of change and interaction between their choices, emotions and perceptions[54].

iii. Installations that have the production of an artwork as their ultimate aim

This kind of work seeks to blur the traditional distinction between the creative process and artistic tools, and between the artist and the audience. An example is *Intelligent Street* by Henrik Lörstad, Mark d'Inverno and John Eacott, in which the installation is a form of composition made by the participants triggering sensors: people can use the installation as an instrument for making music, so that they are both musicians and listeners at the same time (Herber: 2007)[55]:

> Intelligent Street was a telematic sound installation where users could compose their sound environment through SMS messages sent via mobile

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[53] Gonsalveshe T., Kashef Y. et al., Chameleon, Project: An Art Installation Exploring Emotional Contagion, 2009, EDT 2016, Citable Link http://hdl.handle.net/1721.1/59344, accessed Mon May 23 09:38:15

[54] Gonsalveshe T., Kashef Y. et al., Chameleon, Project: An Art Installation Exploring Emotional Contagion, 2009, EDT 2016, Citable Link http://hdl.handle.net/1721.1/59344, accessed Mon May 23 09:38:15: initial feedback suggests that the work is affecting, and that there is a sense of emotional interaction. When asked if the participant felt an emotional connection, one replied "...Yes, with one of them I did. And he was being quite flirtatious. The feeling I had inside was like having a connection with someone that you had met in a bar or something. We were mimicking each other..." Another participant states ".... there was a bit where I was trying to make him angry, and he was just laughing at me. And that was just making me more angry really...." (video transcript from interview at Lighthouse exhibition, March 2009).

[55] *Herber N. (2007), The Composition-Instrument: Musical Emergence and Interaction, link http://www.hz-journal.org/n9/herber.html, accessed 23 May 2017: What kinds of compositional techniques can be used to create a music that recognizes the emergence and the potential of becoming found in a digitally-based or telematic interaction with art and media? Blurring the traditionally distinct roles of composition and instrument provides one possible answer to this question. This approach allows a piece of music to play, or undergo a performance like a traditional composition. When it plays it allows listeners or users to have a musical experience of sound. But it can also be played like a conventional instrument. This treatment allows the musical output of the work to be modified by users in the course of an interaction.*

> phone. The piece was developed in 2003 by Henrik Lörstad, Mark d'Inverno, and John Eacott, with help from the Ambigence Group. Intelligent Street was situated simultaneously at the University of Westminster, London and the Interactive Institute, Piteå, Sweden via live video connection. Users at either end of the connection were able to see and hear the results of their interactions. Using freely-associated, non-musical terms such as "air" or "mellow," participants sent an SMS message to Intelligent Street, and were able to hear how their contribution impacted the overall composition[56].

The focus of the installation in this case is therefore on product, rather than process. Although each of these types of installations (and the representative examples described above) differ in terms of their approach, in each case the medium, the emotion and the product of individual action influence the awareness of the participants. However, in all these situations there is also a further step, which occurs when the participant not only feels and perceives these effects, but when these elements which influence the environment are reflected back, changing the person's state once again. There is thus a continuous process of change and reaction in the awareness of participants as they follow new paths and create new layers of experience. However, this final step is usually not considered in the types of installation described. For example, Eacott et al.'s intentions are limited to showing how music can change the mood of a physical space[57], while Gonsalves et al. focus on exploring emotional contagion[58]. The additional stage that occurs when effects turns back onto the person who caused

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[56] *Ibidem*

[57] *Herber N. (2007), The Composition-Instrument: Musical Emergence and Interaction, link http://www.hz-journal.org/n9/herber.html, accessed 23 May 2017: Simultaneously, all received messages were superimposed over the video feed to create a graphic representation of the audible sounds at any given time. Intelligent Street showed how music could be used to set the mood of a physical space through processes of cooperation and composition across groups of people in distributed environments. [20] Further information about Intelligent Street is available at John Eacott's web site (www.informal.org), Henrik Lörstad's web site (www.lorstad.se/Lorstad/musik.html), and the Interactive Institute of Sweden (www.tii.se/sonic.backup/intelligentstreet)*

[58] Gonsalveshe T., Kashef Y. et al., Chameleon, Project: An Art Installation Exploring Emotional Contagion, 2009, accessed Mon May 23 09:38:15, EDT 2016, Citable Link http://hdl.handle.net/1721.1/59344: *This demonstration allows the audience to interact with prototype 07 of the Chameleon interactive artwork installation. It is part of a project exploring emotional contagion, and communication, built by a cross disciplinary group of artists, scientists and engineers and a curator, that also includes the ACII 2009 poster presentation and paper by Iacobini, Gonsalves Berthouze, Frith, et al [5].*

them remains obscure or implied. In most experiences and in most installations or artworks, what remains and what is investigated is either the mediation of technology itself (the tools used and how they work or affect people) or the product resulting from the exposure to a given input in the installation.

iv. Installations about science or adapting scientific findings and theories

A significant example for this category is the work of Jane Grant, specifically works such as "Ghost", "Fragmented orchestra[59]", and "Threshold[60]" which were 'developed through the desire *to sonify thinking to make audible the firing patterns in the cortex'* [emphasis added] [61]. In these works, it is possible to see how neuroscientific discoveries and theories can be explored and explained through art practice.

> We hope that the project will illustrate the complexity of consciousness and create an artwork there is beautiful both in itself and in the parallels, it has with the process of the brain[62].

The artworks are an attempt to depart from a theory and to structure a work which will include people not as an experiment but as translation and enlargement of the concept. Throughout her artistic career professor Grant has tried to give voice to neuroscientific topics involving perception, memories and consciousness. As expressed in her papers she seeks to give an artistic form to the brain and its patterns:

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[59] By Jane Grant, John Matthias and Nick Ryan

[60] Composed using the Neurogranular Sampler, a digital instrument created by John Matthias at Plymouth University

[61] Grant J., Hearing things: inside outness and 'sonic ghosts', Technoetic Arts: A Journal of Speculative Research Vol. 9 Issue 2-3, p.1

[62] *Translating Consciousness into Music*, Jane Grant, John Matthias, Nick Ryan, in *New Notes,* Dec. 2008, http://cmr.soc.plymouth.ac.uk/SPNM_12_08.pdf accessed 12/12/2017

> The Fragmented Orchestra is a vast distributed sonic structure created by Jane Grant, John Matthias and Nick Ryan. It was installed in the United Kingdom between December 2008 and February 2009. It consisted of 24 fixed geographical locations, including FACT, Liverpool, University of Plymouth, Landscove Primary School, Devon, The National Portrait Gallery, London, Millennium Stadium, Cardiff and Kielder Observatory, Northumberland. At each of the locations, a 'soundbox' was installed, which consisted of a microphone, a small computer connected to the internet and a Feonic 'drive', a device that transmits audio through resonating architectural surfaces. Sound made in the spaces was transmitted across the internet to a server computer in the FACT gallery. In this computer, we ran an artificial neuronal network, *an adaptation of the Izhikevich's recently developed non-linear integrate and fire model* [emphasis added] that incorporates spatial 'axonal delays' between synapses and a spike-timing-dependent plasticity algorithm, which causes the synaptic strengths between neurons to become updated as a function of the differences in signal arrival times[63].

What inspired me in this work (apart from the topic of memories, perception and music) is the involvement of people. In my PhD research project, I am not only concerned about helping people understand some concepts or theories, but to prove it in first person. I think what I would like to keep from these examples is that an audience is an important part of the experiment and that their contribution is crucial for my project. Another fundamental example of art researching perception, memory and awareness is the work of Bill Viola.

> Viola's primary subject is the physical and mental, the connections and interplay between the outer world and the inner realm. He is concerned with exploring the interaction of his images with the viewer's memory, as well as with the subconscious and its dreams and imagination. He is particularly interested in that moment of exchange between the viewer and the artwork when energy is, released and the viewer achieves a new awareness. "In a way my work is very literal, but it has more to do with the after-experience than the actual experience in itself," he told an interviewer. "As if memory were a sort of filter, another editing process. In fact, the editing is going on all the time. Images are always being created and transformed . . . I think memory is as much about the future as it is about the past . . . I'm interested in how thought is a function of time, there is a moment when the act of

[63] *Translating Consciousness into Music*, Jane Grant, John Matthias, Nick Ryan, in *New Notes,* Dec. 2008, http://cmr.soc.plymouth.ac.uk/SPNM_12_08.pdf accessed 12/12/2017

> perception becomes conception, and that is thought. For Viola the image is merely a schematic representation of a much larger system, and the process of seeing is a complex process that involves far more than surface recognition[64].

In Viola's work as in the work of Jane Grant (John Matthias and Nick Ryan) I appreciated the care for people and the attempt to make the audience explore the concept that was proposed. While sharing some common features with these types of installations and taking inspiration from them, it is important to note that there is not always a scientific method behind artworks. As part of a PhD project my own practice will attempt to make people explore changes in awareness in relation to sound and emotions, which happen and reoccur when people are within the installation itself. In addition, people's experience is recorded and collected as research data. My installation attempts to be the culmination and meeting point for the various ideas and concepts described above. Taking lessons learnt from others' artistic practices and drawing on the diverse strands of academic and practical research, I conducted my own research into the relationships between our perception, emotions and sound via technology-mediated installations.

4. PRACTICE: the design process

I will now describe the last two artistic case studies as they are the apex of my research. In future chapters I will describe the other artistic project that led me to these two final ones and the correlations between them, analysing the strengths

[64] London B., The Museum of Modern Art, NY, NY (1987), catalogue, http://www.experimentaltvcenter.org/bill-viola-installations-and-videotapes-poetics-light-and-time, accessed March 2017

and weakness that each project had and that drove me to understand which was the focus of my thesis.

Final artistic case studies: Sounding Out and Seams

Sounding Out and *Seams*, are two separate installations that share their content using different perspectives. On the one hand *Sounding Out* has as its core the "energy band analyser"; it is a live interactive installation in which the audio signal from the participant is captured by a microphone and analysed in real time. On the other hand, *Seams* is not interactive in the sense that no live information is produced or detected (except for the movement of the head of the participant wearing the goggles[65]) but it is an immersive art experience that shows the contents of my research; this installation is a way for people to visualise the patterns of emotions in sound, a sort of phenomenological approach to my research content and findings. This second installation is meant to address the topic from a different perspective in order to give people a figurative as well as practical overview of this study.

4.1. ***Sounding Out***

Title

Following the definition of the dictionary *Sounding Out* means trying to find out someone's opinions, ideas, feelings etc. by talking to them[66]. By using this idiom as the title of the installation I wanted to underline that the art practise is an

[65] From now on the terms goggle, head mounted display or HMD are used interchangeably
[66] https://www.macmillandictionary.com/dictionary/british/sound-out, accessed 22-May 2018

investigation into feelings but one that actively involves the participant. The interaction and contribution from the public is a key factor and a propulsive drive of my artistic research. *Sounding Out* also has other meanings such as *to follow up* or *to look into* and these other connotations strongly reflect my intention to deepen the understanding of hidden patterns of emotions.

Getting started - preliminary stage

In this artwork, I created an inclusive framework for real-time recognition of emotions from acoustic properties of speech not using content information. I then linked these properties to a visual output to arrange an interface of the emotions. The process for the creation of this responsive artwork includes the following steps:

- Considering three basic emotions: sadness, happiness, anger

Keeping in mind the difficulties of framing emotions as they change depending on many factors, I decided to limit the number of emotions and limit my approach to just one of the three most recognised approaches to categorising emotions in psychology. The three main approaches emerged out of different schools of thought over the centuries, those that the phycologist Scherer (2009) outlined are: the basic emotion theory or categorical, the constructivist emotion theory, and the appraisal-based. As prof. Sezgin states in his paper "*Perceptual audio features for emotion detection"*, the appraisal-based theory is difficult to use because of its complicated measurements of change[67]. Sharing his opinion, I

[67] Sezgin M. C., Gunsel B., Gunes Karabulut K., *Perceptual audio features for emotion detection*, EURASIP Journal on Audio Speech and Music Processing · December 2012, p.3: *According to research in psychology, three major approaches are of concern that affect emotion modelling: categorical, dimensional, and appraisal-based approach. Since the appraisal-based approach is*

decided not to use this theory as it was not adaptable and workable within my search method. The constructivist or dimensional theory states that emotions are expressed in dimensions such as arousal and power[68] but I did not include these parameters in this study as they were too time consuming and also not adaptable as the former one. Since a computer functions by calculating numbers, it was hence necessary to reduce the quantity of variables and information to send to the software. This led me to the choice of the categorical approach, which considers the definition of diverse classes of emotions that are basic and universally popular, called basic emotions. As prof. Picard says, it is important to simplify the work for computers so that they can start from basic information[69]. So, to further simplify data processing I chose three out of the six[70] common emotions appearing in most of the studies in this field: anger, sadness and happiness (or joy). These basic categories can mix, and many other states can derive from them[71].

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not prevalently used because of its complex and sophisticated measurements of change [4], we concentrate on the mostly employed categories; the categorical and the dimensional approaches.

[68] Lugger M., Yang B., *Psychological Motivated Multi-Stage Emotion Classification Exploiting Voice Quality Features,* International Conference on Acoustics, Speech and Signal Processing, IEEE, 2008*: The second approach of psychological emotion research (Dimensional emotion approach) says that we can locate different emotions in a two- or three-dimensional space (Schlosberg, 1954). The most often used dimensions are activation (arousal), potency (power), and evaluation (pleasure).*

[69] Picard R. W., *Affective Computing*, M.I.T Media Laboratory Perceptual Computing Section Technical Report No. 321, 1995, p.6: *Diverse writers have proposed that there are from two to twenty basic or prototype emotions (for example, [33], p. 8,[4], p. 10). The most common four appearing on these lists are: fear, anger, sadness, and joy. It makes sense to simplify the possible categories of emotions for computers, so that they can start simply, recognizing the most obvious emotions.*

[70] Sezgin M. C., Gunsel B., Gunes Karabulut K., *op.cit* p.3: Categorical approach considers the definition of diverse emotion classes that are basic and popular universally, called basic emotions. Six basic emotions are defined by Ekman [17] which we are familiar with; happiness, sadness, anger, fear, surprise, and disgust.

[71] Picard R. W., *op.cit.*, p.6: *Clynes's exclusivity principle of sentic states [14] suggests that we cannot express one emotion when we are feeling another, we cannot express anger when we are feeling hope. Clynes emphasized the "purity" of the basic sentic states and suggested that all other emotional states are derived from this small set of pure states, e.g., melancholy is a mixture of love and sadness. Plutchik also maintained that one can account for any emotion by a mixture of the principal emotions [33]. However, in the same article, Plutchik postulates that emotions are rarely perceived in a pure state. The distinctions between Plutchik and Clynes appear to be a matter of intensity and expression. One might argue that intensity is enhanced when one voluntarily expresses their sentic state, a conscious, cognitive act. As one strives for purity of expression, one moves closer to a pure state. Given the human is in one sentic state, e.g. hate, then certain values of motor system observations such as a tense voice, glaring expression, or anger pressure strongly away from the body are most probable. Respiration rate and heart rate may also increase. In contrast, given feelings of joy, the voice might go up in pitch, the face reveals a smile, and the anger pressure have a slight bounce-like character. Even the more difficult to analyze "self-conscious" emotions, such as guilt and shame, exhibit marked postural differences [12] which might be observed in how you stand, walk, gesture, or otherwise behave.*

Emotional states (basic or not) alter the physical parameters of people experiencing them, and, although the software does not understand the emotion as such, it analyses the physical changes occurring depending on the participant's state. As Picard proposes, the physical features caused by those states can be used to train the computer[72]. In my installation I chose the overall energy distribution as the physical element to be observed and used in the creation of a system that recognises emotions (or better the physical changes occurring during their manifestation). Nevertheless, during the construction of my installation I kept reading article about emotion therefore some concepts from the other two theories influenced me somehow as I think they cannot be completely excluded from a study on emotions.

- Creation of a database called "corpus of emotional data"

First of all, before starting any discussion on data collection or analysis I need to state on my use of the word database. In general, and also in computer environment database is defined as an organised collection of data. The data collected in a database is organized for fast search and retrieval and therefore it is a simple collection of items. Different types of databases use different models to organize data, which can be hierarchical, network, relational and object-oriented. For instance, the records in hierarchical databases are organized in a treelike structure. Object-oriented databases store complex data structures, called "objects," which are organized into hierarchical classes that may inherit

[72] Picard R. W., *op.cit.*, p.7: *As mentioned above, the essentic form of certain motor system observations, such as anger pressure, voice, and perhaps even inspiration and expiration during breathing, will vary as a function of the different states. Its dynamics are the observations used for training and for recognition. Since an HMM can be trained on the data at hand for an individual or category of individuals, the problem of universal categories does not arise.*

properties from classes higher in the chain. One may or may not employ these highly structured database models and a large percentage of them are organised in a more basic sense. For my database I decided to collect videos (and their audio) from the web (subsequentially analysed by the Max/MSP patch[73]) in which people expressed emotions following the relational model.

Source	Duration	Gender	Category of emotion
YouTube	5 min 13 sec	Female	Anger
YouTube	3 min	Male	Anger
YouTube	2 min	Female	Happiness

Table 1. example of relational model used to collect data

In order to define and select those videos and to validate the emotional element that was the criteria for the selection I followed two procedures:

- *Validation:* I asked volunteers to listen to the selected samples and requested them to state which was the emotion they thought was expressed in the audio sample and in what percentage. Those interviews were used to validate the category of emotion which I decided to assign to each sample.
- *Patterns extraction plus building and testing of the classifier:* I tested the algorithm to select patterns in sound energy related to specific emotions, so that the software can classify the emotions in relation to sound characteristics and react accordingly.

I concentrated on internet quality speech, selecting videos from the web and then extracting voice signals from them. In this technology mediated era, internet

[73] In *Max/MSP software patches are the name of programs. They are made by arranging and connecting building-blocks of objects within the patcher that is a visual canvas.*

platforms appeared to be the best field in which to find spontaneous and personal stories. The choice to select data from the web assumes that the conversation is more genuine than the one in professional vocal performances. Free expression on the web is much more difficult to analyse due to the quality of sound and the complexity of recorded situations but it is closer to natural communication[74].

- Creation of an installation preserving a natural environment

In a second moment of my research, I focused on the use of the patch for live interaction and analysis. In this way I also expanded the "corpus of emotional data" including recordings of people attending my exhibitions and participating in the installation *Sounding Out*. As I stated in the premises, one of my research goals was to develop an interactive installation as a research method capable of outlining emotional patterns in sound energy distribution (live). The use of an installation as the environment for developing such an investigation not only falls within my expertise but is also significantly related to the fact that I wanted to analyse voices of people acting as naturally as possible. Art is a common experience for many people, particularly art experiences that include new media. Although art always keeps its mystic and surprising characteristics, it is also something that people are used to and feel comfortable with. The art environment is closer to a natural environment than a laboratory might ever be. As Gilroy et al. have proven in their article and installation "Emotionally Responsive AR Art Installation", maintaining a real-world physical environment leads to a more

[74] It is important to outline that technology mediation still has a little influence on the behaviour of who is recording so it cannot be defined purely spontaneous, although the interference can be considered minimal.

natural participant behaviour[75], which is especially important in an investigation of emotional expression. Furthermore, the mystical and surprising characteristics of an art experience, a mnemestheme[76] as Muller calls it, can be a booster rather than an impediment for the purpose of this study[77]. As Picard states, people's emotions also depend on the context in which they are stimulated[78], therefore choosing an artistic environment instead of the usual scientific laboratory is a way to keep the environment comfortable so as to make people feel free to express their emotions as close as possible to their natural way of doing it.

Artwork - In practice

The actions during the installation are arranged as follows:

- Entering the room

When the person enters the room of the installation, she/he is asked to speak in a microphone and talk freely about an emotional experience in their life (or, in alternative, about someone else's experience that they share and for which they feel empathy), trying to convey in their voice the emotion they are talking

[75] Gilroy, S. W. et. al. *'An emotionally responsive AR art installation'*, International symposium of mixed and augmented reality (ISMAR 2007), Nara, Japan. ACM, p.3: *The preservation of a real-world physical environment supports more natural user behavior, whilst the incorporation of multimodal sensors (cameras, trackers, microphones) serves as a basis for developing multimodal affective processing, such as user attitude recognition, emotional speech recognition, and a range of non-verbal behavior. Finally, as an artistic medium, AR provides both interactivity and the visual aesthetics of virtual elements. It can thus be used to experiment with "affective feedback loops", in which the experience elicits affective responses from the user, which in turn are analyzed to modify the visual presentation of the installation. Beyond their potential to support artistic installations, such systems constitute similarly privileged test-beds for the development of multimodal affective interaction.*

[76] For a full explication of the term mnemestheme see chapter 1 p. 23.

[77] Mueller R.E., *Mnemesthetics: Art as the Revivification of Significant Consciousness Events*, Leonardo, Vol. 21, No. 2 (1988), pp. 191-194, The MIT Press, http://www.jstor.org/stable/1578558, Accessed: 07-02-2017 09:51 UTC, pg. 1: *[…] a mnemestheme is that personal cognitive-emotional event a person has when optimally participating in the experience of a work of art. A particular work of art gives rise to a particular mnemestheme, which is enriched and enhances with each exposure to the artwork, until it becomes [..] nearly hypnotic in its intensity. Since the activities of the human consciousness include a vast array of thoughts, feelings, cognition and emotions, mnemesthemes contribute both to our emotional world and to our thought processes;*

[78] Picard R. W., *Affective Computing*, M.I.T Media Laboratory Perceptual Computing Section Technical Report No. 321, 1995, p.14: *People's emotional patterns depend on the context in which they are elicited and so far, these have been limited to lab settings. Problems with studies of emotion in a lab setting (especially with interference from cognitive social rules) are well documented. The ideal study to aid the development of the theory of emotions would be real life observation, recently believed to be impossible [17].*

about[79]. The room is intended to be cosy and private to let people feel comfortable telling their stories. For this part of the interaction, I relied on introspection and on the capacity to self-report the emotion that the subject is communicating. They are asked to openly tell which one of the three emotions they are referring to.

- input –> trigger

The microphone detects participant's voice and sends it to the computer where the Max/MSP patch is running and analysing the audio signal for real time emotion recognition.

- effect – > output -> reaction

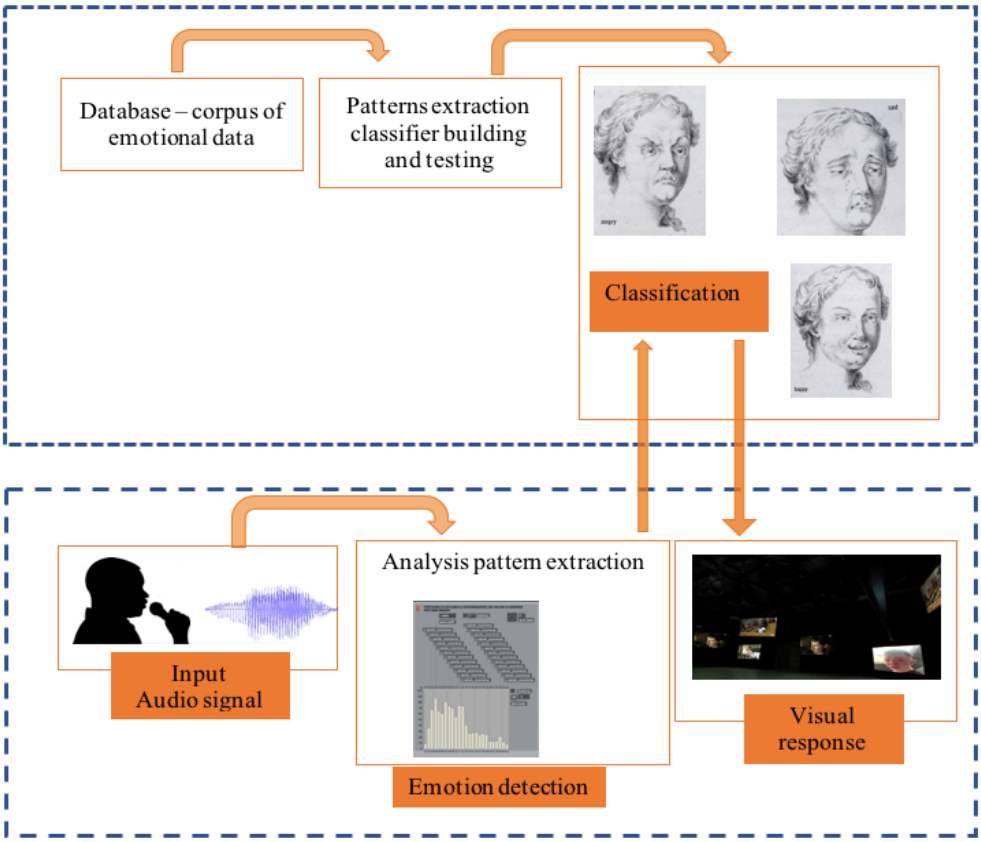


Fig.2 scheme of the process before and during the installation

[79] In order for emotion to influence the voice of the speaker, the participant needs to identify himself/herself with the experience even if it is not his/her own.

Once the program identifies patterns in the energy distribution and links them to an emotional state it starts a video related to the emotion that emerged from the analysis. I collected videos from the web with which I created 3 audio-visual works (one for each emotion: sadness, happiness, anger) that represent the computer's response to the detected emotion.

Input

The participant's voice is captured by a microphone in the room and the signal is sent to a computer where the Max/MSP patch "energy band analyser" is running. The patch's function is to detect changes in the overall energy distribution in the audio signal coming from the microphone in the installation (regardless of the content that the person is expressing in that moment as the software does not rely on content for the analysis and recognition). While the person is speaking the patch accumulates the energy of the incoming sound and the bars representing the 25 filters rise. The patch stops the analysis once one of the three possible patterns has been found (fig. 3, fig.4 and fig. 5)[80].

Process of analysis – Emotion detection

For a sound of any kind, the energy distribution within the acoustic spectrum constitutes its identity and its personality, making the acoustic event similar to a fingerprint: it represents a unique expression of that sound. The patch " energy bands analyser " configured with the software Max/MSP, is responsible for

[80]For more details go to chapter 5.1 p.95

analysing this distribution of energy by dividing the spectrum of the audio coming from the microphone in 25 critical bands which is incidentally also how the basilar membrane works[81]. When working on pattern recognition, choosing the appropriate features is fundamental in creating an efficient analysing system. As stated before the usual spectrum analysers would provide a flow of instantaneous data and the signals would be usually characterized by time and frequency which are similar to how the human auditory system recognizes sounds but are mostly mathematical calculations and do not work properly with the presence of noise or with smooth sounds[82]. The algorithm that I designed starts with a time and frequency values but instead of just analysing the sample instant by instant, it makes an average of these values and then integrates (or accumulates)[83] these values so that it is possible to study and compare them looking at the overall duration of the audio sample.

[81] Membrane located in the cochlea, the main body of our ear responsible for transduction of the acoustic energy into electrical impulses that from the cochlea start their journey through the acoustic nerve to our brains and our psyche and became a sound sensation.

[82] Chu S., Narayanan S., Kuo J., *Environmental Sound Recognition with Time–Frequency Audio Features,* Transactions on Audio, Speech, and Language Processing, Vol. 17, No. 6, August 2009: Audio signals have been traditionally characterized by Mel-frequency cepstral coefficients (MFCCs) or some other time–frequency representations such as the short-time Fourier transform, and the wavelet transform. The filter banks used for MFCC computation approximates some important properties of the human auditory system. MFCCs have been shown to work well for structured sounds such as speech and music, but their performance degrades in the presence of noise. MFCCs are also not effective in analyzing noise-like signals that have a flat spectrum. Environmental audio contains a large and diverse variety of sounds, including those with strong temporal domain signatures, such as chirpings of insects and sounds of rain that are typically noise-like with a broad flat spectrum that may not be effectively modeled by MFCCs.

[83] In this thesis when I talk about integration, I mean the accumulation or sum of the energy analysed from each filter during analysis. It is an operation that I do in the patch that is similar to what occurs in the organ of Corti. Accumulation or integration are used as synonyms.
http://www.sapere.it/enciclopedia/integrazi%C3%B3ne+%28lessico%29.html, accessed 20 July 2018: In acoustics, spatial integration, the auditory phenomenon that occurs in the organ of Corti: the basic membrane carries out an analysis of the sound signal, such that the individual components are distributed along it; the spatial integration consists in the fact that, to the effects of the sensation, all the components that are in certain frequency bands (critical bands), corresponding to certain portions of basic membrane length, are added together.

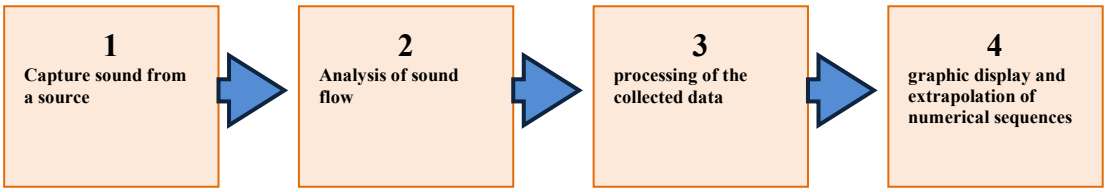


Fig.3 General diagram of the structure and functions of the patch

The patch is structured to carry out the following research and experimentation:

- **Capture sounds from a source:**
  - through a sound card for recording / analysing sources in real-time
  - reading a pre-recorded audio file
- **Analysis of the flow of the audio sample:**
  - the acoustic signal passes through a bank of 25 band pass filters with central frequency set according to each critical band
  - the flow is decomposed into a continuous stream of 25 values that represent the distribution of the acoustic energy of the sound event in time and frequency.
- **Processes during analysis:**
  - calculating the average energy per critical band
  - integration/accumulation of the energy acquired for each critical band
  - evaluation in terms of percentage of energy acquired until the time t_x for each band in relation to the total energy output of the sound until the time t_x
- **Display of graphics:**
  - data streams obtained are presented graphically through a system of bars with sliders positioned in relation to the values that are expressed. The values go from zero to one hundred (which in decibels correspond to a range from -76 dB to +18 dB)

Analysis, accumulation pattern and visual response

Computers are not able to experience emotions, so they cannot recognize them by comparing people's emotions with their own as we humans do through empathic processes[84]; but they have the capacity to make observations regarding emotional state. In fact, the patch detects the emotions by analysing the distribution of energy in sound with the help of a database that I created which includes a series of numbers corresponding to certain emotions that the computer reads. The computer does not have any previous experiences of any feelings to compare with the one being expressed by the participant in the installation that otherwise could eventually trigger its empathy. Consequently, I gave the computer a database to refer to. What the computer actually does is to read numbers from the analysis

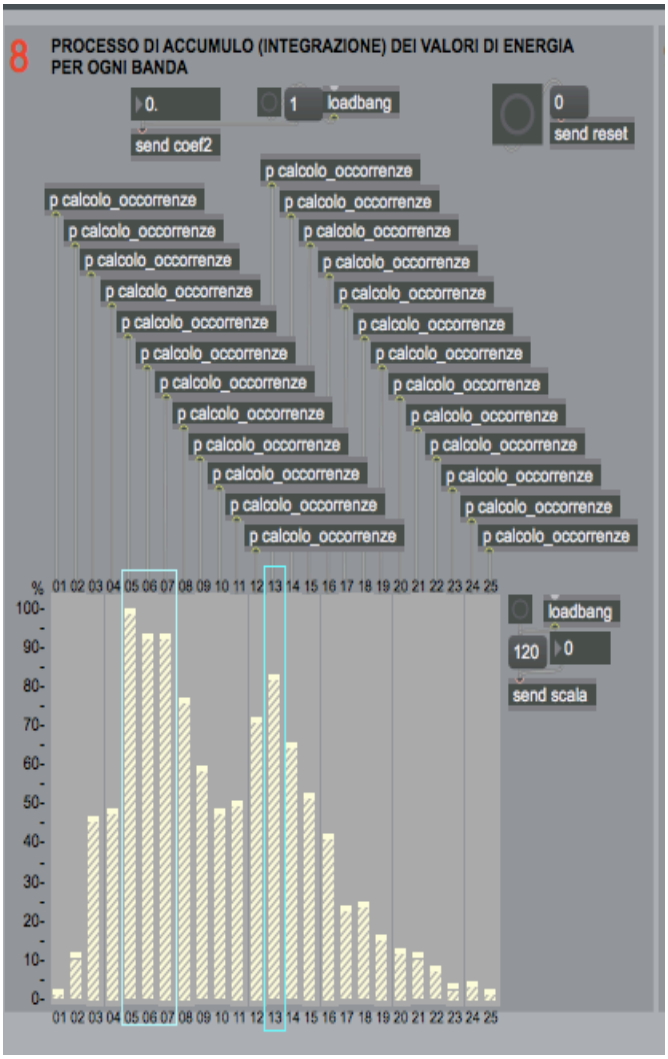


Fig.4 bands 5,6,13 raise more for happiness

[84] https://dictionary.cambridge.org/it/dizionario/inglese/empathy, accessed 22-May 2018*: Empathy, that is the ability to share someone else's feelings or experiences by imagining what it would be like to be in that person's situation, is based on a person memory of similar experiences and situations in which that feeling was involved. Not having these kinds of memories, the computer isn't actually able to prove empathy as much as it does not have emotional experiences at all (at least not yet*

and match those numbers with other numbers that point to a catalogue of videos. During the work in my studio, I outlined some specific patterns in the change of energy distribution that are linked to certain emotional states. While the signal is processed during the installation, in the energy band analyser specific parameters (patterns) raise depending on the emotion expressed.

During the analysis each of the 25 filters accumulates the energy of that part of sound and in a separate widow there is a graphic representation of this process. In this window each band's accumulation is represented by a bar that rises in real time, depending on the amount of energy present that it represents[85]. When one of the patterns related to an emotion is detected by the computer, a visual response is triggered on the screen. In this affective interface, each energy pattern is related to a different visual content, which means that when the patch (affective interface) detects happiness in sound energy (fig.4 – in this case bands 5,6,13[86] rise more than the others), it reacts with a sort of empathic response, projecting the audio-visual work that I created from images of people talking and expressing happiness. The same happens with the other emotions (anger and sadness): for example, if bands[87] 10 and 11 rise (fig.5) then the computer will interpret that the voice is expressing anger, and this will trigger a video with angry contents; if the patch detects that there is more energy on bands 5,6,12,13 and 14[88] (fig.6) it will interpret this data as sadness and show a video representing sad people. Therefore, there is a different audio-video reaction from the computer

[85] For more details see chapter 5.1 p.95
[86] And its relative bars
[87] idem
[88] idem

for each of the tree emotions taken into consideration. This is an attempt of the computer not only to recognize what emotion the person is expressing but as a response to it (and manifestation of its recognition) show a video that is also a way for the computer to put the participant in contact with other people feeling the same emotion.

Output - Content of the visual response

In this installation I propose an environment for combining participant's emotion input with affective interaction and with a sound analysis which controls the video-art response.

In order to give an affective answer, I decided that the computer should show a

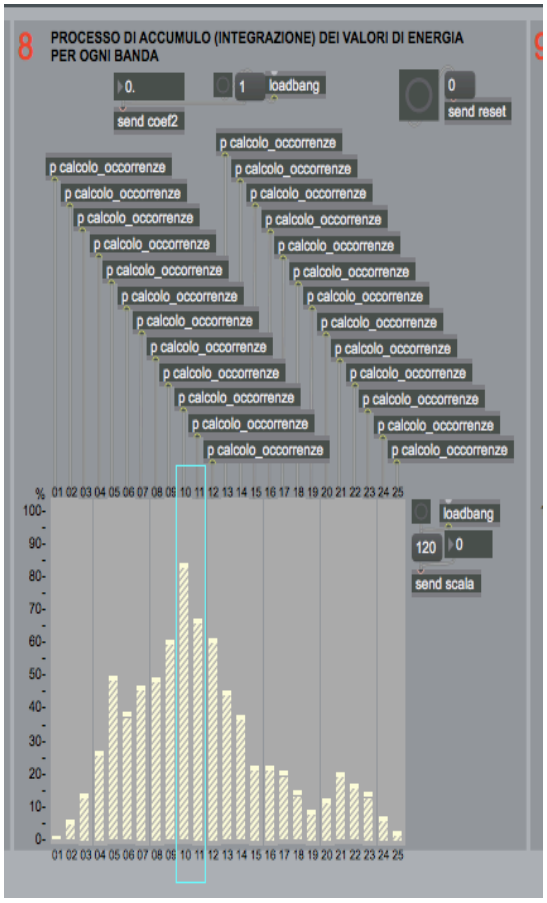


Fig.5 - bands 10 and11 are higher in the presence of anger

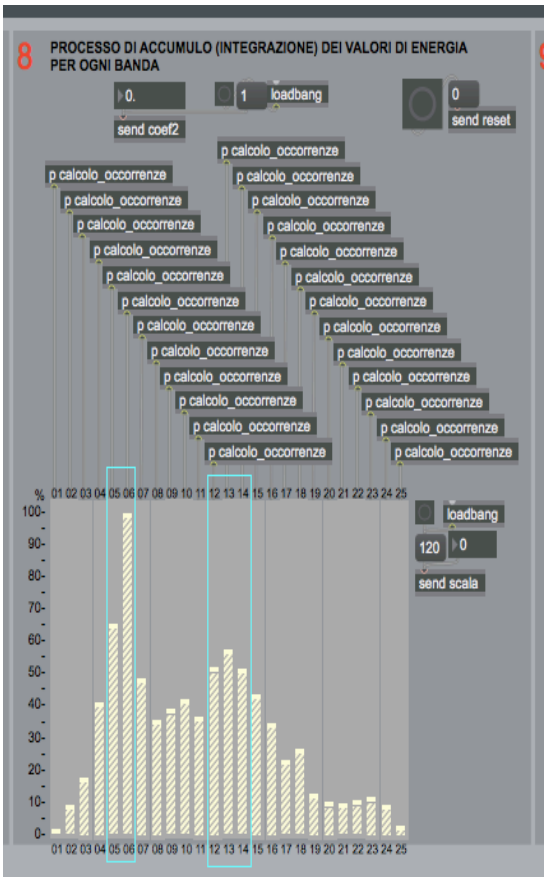


Fig.6 - bands 5,6,12,13,14 are higher with sadness

video as a response to the emotions of the person in the installation and that those videos are about individuals experiencing the same emotions.

The audio is a montage of voices that narrate these emotions and overlap in a crescendo. The videos representing the three emotions are made from the same video material from which I extracted the audio sample for testing and training the analysis of patterns through the patch. In fact, the computer's ability to recognize emotions from voices is built upon voices extracted from these web videos. The audio of these videos constitutes the "corpus of emotional data". The audio-visual part is important as it provides a sense of interaction and responsiveness as well as the aesthetic of art.

In Affective computing usually four applications are developed: a) Emotion expression, b) Emotion recognition, c) Emotion manipulation, d) Emotion synthesis[89].

I have focused on computers that recognize and portray affect, so I created a system that uses both emotion recognition and emotion expression.

I could have chosen pre-established phrases, colours or signs as affective responses from the computer. For example, the computer could have projected a happy emoticon when detecting happiness from the analysis of speech or a bright colour or any other symbol. As prof. Monovich states, computers allow us to easily map any data set into another set and even the very best art works which use data suffer from the fundamental problem of the arbitrary choices in mapping.

[89] a) Emotional expression: that consists in the realization of interface agents able to reproduce emotional expressions, mainly, the representation of digital faces that imitate the salient characters of human emotional expression; b) Emotional recognition: the purpose is to recognize the emotional state of the user to eventually adapt to it optimizing the performance of tasks; c) Emotional manipulation: this line of research is aimed at studying the ways in which it is possible to influence the emotional state of the user in the interaction with the machine (Affect interaction); d) Emotional synthesis: This is the most complex dimension of affective computing. The focus is to provide a computer of emotional intelligence thus making it able to "feel" emotions.

In his article “visualization data” he explains how the artist can potentially construct infinite number of different interfaces to a media object, to follow infinite trajectories through the object, and so on, and how computer media simultaneously makes all these choices appear arbitrary – unless the artist uses special strategies to motivate her or his choices[90].

In my case I thought that the computer should have to show more than just the fact that it understood what emotion was involved in a certain moment of the installation. I believed that was important to show other intentions, such as the fact that technology connects people to each other and give the opportunity to know how and what other people feel. So, the three videos I created (which constitute the database from where the patch draws the affective response), is a way for the computer to not only make clear that it can recognize emotions and is able to respond, but also make the participants reflect on the fact that other people on the net and around the world are feeling the same. Besides, by using the faces of the people whose voices were employed in the design development, the computer indirectly shows the process by which its ability was created. This kind of answer gives the participant the sense that the computer understands her/him and is also a reflection on the fact that its ability to understand the participant’s emotions relies on a training based on other people’s emotional experience.

I wanted to convey through art the message of the multiplicity of purpose that everything possesses, even an algorithm, and to propose my interpretation of the

[90] Monovich L., Visualization data from Software Takes Command, http://lab.softwarestudies.com/2008/11/softbook.html, accessed 20 Nov. 2019

Janus-face of technology. As Picard states, computers can or cannot induce people's emotion and they influence our emotions, so the question we should ask ourselves is not if they do it, but for which purpose we should use this influence[91]. Data on how we feel and what we are doing is currently being used in a controversial way; big companies use algorithms for emotion and mood detection, they analyse what people like or dislike in order to play into their desires or by better knowing the tastes and feelings of people, companies are able to push them to have certain desires. In my installation, on the contrary, I wanted to use an emotion recognition process not to sell something or manipulate people but to put them in contact with their emotions by mirroring those of others and connecting them to a network of other individuals who feel the same way. As a side effect, the visual response eventually makes them reflect on the positive applications of systems in affective computing.

Quantitative approach

Everything a computer can understand is numbers. In order to make the human-machine interaction possible within the installation, I had to find a way to translate an inner state into numbers, because this is the only way in which a computer works. Contrary to the message that many tech companies are trying to convey, it is not possible to literally transform the self into numbers, as much as is not possible to quantify or measure anything not measurable like happiness[92]. What

[91] Picard R. W., *Affective Computing*, M.I.T Media Laboratory Perceptual Computing Section Technical Report No. 321, 1995, p.9: Computer can/can't induce the user's emotions" as it is clear that computers (and all media) already influence our emotions, the open questions are how deliberately, directly, and for what purpose?

[92] Magister, C. *How Cyborgs Replace "Stories" With "Code," And What Happens Next*, Burning man journal, March 19, 2018-accessed 14th may 2018t: it is literally the transformation of self into numbers. If machines can understand us at all, it is this way. We are looking at ourselves as AI would look at us. To the extent that the cyborgs among us are merging with machines, they are becoming more quantitative, proposing that what's really important about us are not the stories we tell — that in fact those stories are not to be trusted — but that who

I did in my project is to detect the physical changes that are indications or symptoms as the psychologist George Mandler states[93] , of a change in emotional states and I converted them into numbers. Simplification comes from the fact that in order to use technological methods and tools, numbers are needed[94] but this does not mean that emotions are reduced to just data. The quantitative approach is related to the fact that machines obviously cannot understand the complex mechanisms that happen to us in the moment we understand or express an emotional content with voice. This approach is not reductionist per se, but the investigation including the computing, needs the dynamics of emotions to be reduced in some way and what we mainly take into consideration are their physical features and numerical representations. What I have done is to take into consideration the measurable part of the emotional process, the part that involves matter and modification of the environment. Analysing physical data in the voice is not better than understanding the contents that the voice is conveying; it is a different way of seeing and studying the issue. In a technological environment, analysing a physical parameter is faster and allows a faster connection with similar events. As in any scientific approach as with art that uses technology, the processes tend to be simplified in order to make them understandable to technical devices that have to read them. The

we really are is reflected in the data. This implies a very different vision of how life works and what the rational approach to a good life is. And the drive to become cyborgs, to say that our "selves" now include our internet devices, is at the vanguard of the world of metrics. Not just measuring what is easily measurable but turning those things that aren't (like happiness) into easily measurable approximations of themselves (your serotonin levels, or your answers to an hourly mood quiz, or the number of selfies you post in which you're smiling).

[93] Picard R. W., *Affective Computing*, M.I. T Media Laboratory Perceptual Computing Section Technical Report No. 321, 1995, p.4: The experience arises out of a Gestalt-like concatenation of two major components: visceral arousal and cognitive evaluation…. What we observe are symptoms of that inferred emotional state symptoms that range from language to action, from visceral symptoms to facial ones, from tender words to violent actions. From these symptoms, together with an understanding of the prior state of the world and the individual's cognitions, we infer a private emotional state. George Mandler [19]

[94] Magister, C. *How Cyborgs Replace "Stories" With "Code," And What Happens Next*, Burning man journal, March 19, 2018-accessed 14th May 2018

expectation of this type of process is paradoxically that we can apply limitations to broaden our understanding of the emotional processes and of ourselves.

Decontextualization

Associating some parameters with videos of people expressing the same emotion detected from the participants' voice is a way for the computer to remind the person experiencing the installation that, when we are experiencing an emotion, or a feeling arises, other people far away from us are feeling the same. The people next to us do not always experience our emotions, they don't necessarily notice and/or pay attention to how we feel. Then, using a physical parameter to recognize what we feel and make a trigger that connects us with other people who feel like we are doing can surprisingly be a way to make us feel less isolated. In fact, most of the use of internet and social media is based on crossing the boundaries of the physical environment, in order to find someone who could share our opinions, comprehend us and become "friend".

The affection of that moment in relation to the real context, expressed by the participant in the installation, may not be grasped by everyone, people close by may not understand how the person in the installation is feeling or what s/he wants to express. On the contrary, it may also happen that the participant does not feel comfortable expressing her/himself with people physically present (around her/him in that moment) but may be willing to share with the system in the installation (this it is what happened when some participants asked to be alone in the room during their experience in the installation). People presented in the videos are decontextualized and are not close to the speaker, they do not know her/him, and they do not share anything except the sentiment expressed in

that moment. The capability and function of the computer in the context of the installation is to make links that were not possible otherwise.

To do so, the computer doesn't need to get a holistic look at the participant's life to understand how s/he feels, nor does it need to know what happened to her/him during or before s/he entered the installation's room. It just checks the numbers on the other end of the microphone looking for data. In fact, two different happy stories from different speakers will cause the same parameters to rise, because for the computer the context and narrative are not important[95].

This means that in this case the computer is programmed to use a different approach from our own; in order to have a faster understanding of the emotion it relies only on the quantity of data. Obviously using this approach, we lose something, and the installation creates a decontextualized view of the self. As everything depends on the values we provide it, I chose to give more importance to a quick and automatic understanding of emotions over a holistic comprehension of the person and her/his story[96]. The idea was to decontextualize the self in order to underline the power of sharing just the pure emotion over the power of content and narrative.

Florence experience – Exhibition 20th-23rd June 2018, Le murate, "Il corpo la luce il suono" festival

[95] Magister, C. *How Cyborgs Replace "Stories" With "Code," And What Happens Next*, Burning man journal, March 19, 2018-accessed 14th may 2018: metrics, however, tend to treat information as decontextualized. The point is precisely that you don't have to read a book or an article to find the relevant fact, you just search for it, grab it out of its context, and apply it where it's needed. You don't need to get a holistic look at a person's life to try and make them happier, you can just check their key indices and fix whatever's broken. You don't need to have a sense of a student's interests or history or projects to know how intellectually apt they are — you have a test score for that, and the exact same number can measure two entirely different students just as accurately. that a quantitative approach to data can process more of it faster, to tremendously useful effect But the bigger the data gets, the more decontextualized it has to be, and something important gets lost[….] Which is "better," which is "smarter," depends entirely on what you are looking for and what you value — but it seems clear that the movement towards becoming trans human cyborgs, beginning with our phones and our wearables and our social media, creates momentum towards the decontextualized view of knowledge and the self.

[96] This choice does not imply any judgment of greater or lesser quality of this approach compared to others.

From the 20th till 23rd of June 2018 I presented *Sounding Out* and *Seams* to the public. During that period the installations were open in the evening for a total of about 10 hours and people entering the installation were recorded for the scope of this research and for compiling a documentation of the outcomes.

- The audience

The characteristics of the audience were:

- Language: Apart from one person who was speaking in Farsi, all other people were Italian native speakers.
- Age: the average age of the public was 40 years.
- Modality of participation, group or solitary: the opportunity to enter alone or with other people was offered to each participant. Approximately half of the participants entered with a friend. The other half preferred to enter alone for a more private experience. In both cases the door was closed behind them so to not interrupt the process. People entering with a friend took turns speaking. There were no mixed group as no one entered the room with someone s/he did not know previously.

- Design of the room and equipment: use, location and meanings

The room was arranged with five monitors of different sizes (between twenty and forty inches) showing the same video. The video was a collection of images showing happy, sad or angry persons (the same videos that were used to extract the audio for the training of the computer)[97]. The video was the same for each

[97] For the detailed description of extraction of audio, analysis and training of the computer for emotion recognition see "Creation of a database 'corpus of emotional data'", in chapter 4.1 p.60.

monitor but the reproduction on each one was not synchronized, so that the same video was reproduced at a different time on each monitor.

In the middle, above those screens, a big projection of a luminous landscape was displayed on the white wall. A chair was in the middle of the room facing the screens and the projection. In addition to the video projection on the five monitors, the technical workstation, where I was sitting and from which I controlled the system to analyse and respond to the emotions, was behind the chair of the participant, in the right corner of the room. I chose this location in order to be enough close to the person so to be able to talk to them and give them the microphone, but not disturb their interaction with the computer and not interfere with the projection. The microphone was on the workstation and each participant held it in her/his hand during the time of the speech. There was no microphone stand in order not to interfere with the projection and to make people more comfortable in choosing their position (standing, sitting and turning around).

The audio equipment consisted of a microphone, one sound card and two speakers. Two computers were used to run the installations. One computer was employed to receive the audio from the microphone through and external sound card, to run the patch for the analysis and to send the video response to the main projector, showing the video on the wall. Another computer was employed to send the signal to the above-mentioned monitors with asynchronous reproduction. Two out of the five monitors were old ones so two DVD player were reproducing the video behind the Tv monitors. The choice of mixing different type and size of monitors was aesthetic but at the same time was a way to create a contrast in the repetitiveness of the video (showing always the same persons and

same situations) and the difference in quality and format of the reproduction (LCD or CRT tv) [98]. The mixture of old and new technology was also an implicit message about how human afflictions or joys are a constant in life, regardless of the era in which it is lived.

As openly explained to the people, the monitors at the bottom presented the material from which the computer deduced its capacity of understanding emotions. I described people how the computer needed a database to refer to in order to detect their emotions and the analysis process during their speech was based on a comparison between the energy in their voices with the voices of people reproduced on the monitors.

The choice to leave the room silently and to have only faces projected was made to help people concentrate on their speech and for a clean detection of the signal from the microphone (even if the analysis system is not much affected by noise), but was mostly used to underline that the analysis of audio samples happened in a prior moment and that these audio samples were not part of the actual installation anymore.

- Analysis and outcomes

Participation: expectations, confirmations and new discoveries during the process

The installation was designed for people to enter one at a time as I expected that people would have been timid and preferring to enter alone. But as stated before, half of the participants wanted to enter with their friends. I later realized that this

[98] Liquid-crystal-display or cathode ray tube television.

was a way for them to trigger memories and start the conversation. In fact, another discovery I made, during the days of the exhibition, was that the participants, both solitary or accompanied, had the need to have feedback and human stimuli so that they often turned to someone (or to me) while talking into the microphone, instead of just facing the screen from where they knew the response from the computer would appear.

I thought that my presence (or another people's presence) would have been a deterrent for the participants to openly express themselves. I needed to be in the room in order to control the system, but I would have automatized the process of turning on and off the system if I would have had more time. I saw my presence as a handicap, but I found out that it was a richness instead.

In fact, people were turning to me (or to their friends alternatively if there were any) to tell their story. After I noticed this behaviour being repeated (the necessity to talk to someone and the need for feedback), I decided to move my workstation and sit as close as possible to them so that they can face me more comfortably and still see the screens. (While when I was sitting behind them, they had to take on an awkward posture to talk to me).

I also expected the person to be embarrassed and for that reason I thought the process would have been much shorter than it was and that only one emotion would have been expressed. I planned the video response to be about one minute per each emotion, but I had to reduce it to 15 seconds as every participant wanted to go to the next emotion as soon as possible. They were impatient for the video response to end so that they could start to tell another story and experience another emotion with its related video response. Given the delicacy

of the subject I did not expect people to be so open and so willing to express their feelings, so that the passage between one video and another should have been quicker.

I also needed to adjust the duration and speed. Surprisingly, people's stories were very different in duration (while I thought they would cut their stories short because of their embarrassment) in the sense that they were mostly very long. A continuous adjustment of the coefficient of energy accumulation (i.e. the speed with which the energy was accumulated and the rate with which the bars, defining the patterns, were rising) was necessary. Generally, people talked for more than five minutes, compared to the two or three minutes that I had calculated. In fact, from a previous training in the studio I outlined that the coefficient of three hundred would have made the bars rise (therefore trigger the affective response) in about two minutes. But I had to increase or decrease the threshold many times, even during the performance of the same participant, as s/he was making pauses or talking more or less continuously or lengthy, depending on the type of memory and the type of emotion.

A big concern about the performance of the system was what would have happened if the emotion response was wrong. The corpus of emotion data was of about 20 samples at the time. All of them were in English. My concern was based on the difference of the language and on the fact that 20 samples would have not been enough material to train the computer and the system of analysis adequately.

Beside the fact that eighty percent of the answers were right and therefore the training was demonstrated to be enough (at least for the success of this

exhibition), another positive discovery was made. I was afraid that a wrong answer from the system would have influenced the overall experience of the participant in a negative way or that they would have not understood that the installation was an ongoing project whose improvement they were contributing to. Contrariwise, the few people receiving the wrong affective response (in the sense that they were openly declaring that the story was a happy one and the computer detected sadness instead) were not disappointed at all. This experience revealed to me that people were not focusing on the mistake but rather finding an explanation for it. They all started speculating on the fact that probably the content of the story also had other nuances and that the computer should have detected those hidden contents. I could not say what this reaction was due to, certainly my concerns about the failure of the installation were unfounded (at least with this audience).

- Conclusions and stimuli from the experience in Florence

The experience in Florence was enlightening and enriching in many ways. I made many adjustments during the process and will do some others for the continuation of the project. I hopefully will find a way to automatize changing the accumulation coefficient. I also would like to try the installation with no human feedback at all, in the sense that I would like to test what happens if everything is automatized and the participant is alone with the machine. For this purpose, I should find the right interface to show during their speech and the process of analysis, what should be on the main wall before the affective response is triggered. In the Florence experience a neutral background (a blurry landscape) was projected on

the wall, but considering people's need for feedback and human contact in future exhibitions I will probably have to change the starting projection and use an image that gives people a sense of connection and interaction from the beginning of the art experience.

Many novelties and curiosities arose, for example the fact that, based on the low rate of system mistakes, I can deduce that language has not a huge influence on the overall functioning of the analysis. At the moment, I can say that the training of the computer, done with English samples, was working also for detecting emotions in Italian. I would like to deepen this investigation analysing the Italian samples in the studio and experimenting with placing the installation in other countries and using other languages.

After a few more experiences in different languages I might be able to express with more certainty if the language is or is not a variable that influences the analysis of emotions in speech.

Another important issue to be tested during the installation was the difference between provoking and experiencing an emotion or instead recalling it. Recalling an emotion could have been a cognitive way of expressing and experiencing it without any physiological change. But I noticed that, as expected based on Picard's studies, when a person is told to explicitly express an emotion the autonomic responses are enhanced, and it is easier to underline the emotion under consideration[99].

[99] Picard R. W., *Affective Computing*, M.I. T Media Laboratory Perceptual Computing Section Technical Report No. 321, 1995, pp. 4 e 5: This expression through the motor system, or "sentic modulation" helps others guess your emotional state. When subjects are told to experience a particular emotional state, or when such a state is encouraged or induced (perhaps by listening to a story or watching a film), then they may or may not express their emotional state. If asked explicitly to express it, then autonomic responses are usually enhanced. Deliberate expression makes it easier to infer the underlying emotional state.

- Upcoming possibilities for collecting data - Creation of a website and application

During the exhibitions there was not enough time for people to fully express themselves due to the time frame of the installation itself. In fact, although everybody was free to stay as long as they wished, the fact that other people were waiting outside automatically caused people to hurry. But one thing I have noticed is that they were wishing to try to express all of the three emotions. I have observed that after a first moment of embarrassment or uncertainty on what content they should express, more and more ideas and memories were stimulated by the computer's reaction and unfortunately not all of them could be expressed due to the cue of people waiting for their turn. That is why I asked people to send vocal messages to my address and phone number, whenever some emotional moments or memories came into their mind in order to enlarge the "corpus of emotional data". Although sending a vocal message is really different from experiencing an installation, I thought that at least it was a way for them to recall the artistic experience and to be part of the project during their everyday life. It could be seen as a way for art to resonate in people's life once the exhibition is over. With this idea in mind I took into consideration, to create, in the future, a website and an application for the mobile phone with which people can automatically register their voice and send it in an easier and direct way, bypassing the need to register my number or having to fill out an email.

4.2. ***Seams***

Seams is an immersive audio-video representation of the processes of analysis and detection of emotions used in *Sounding Out* and in the research carried out in my studio using the "energy band analyser".

The title

Seams, as is the case with *Sounding Out,* has several meanings. One is *"the line along which two pieces are sewn together"* and this sense refers to the fact that the two installations have the emotions detection and analysis process in common. The meaning of *Seams* as *"underground layer"* instead refers to the fact that the 360° videos and their soundtracks represent the inner patterns of energy behind emotional expression.

Description – contents and meanings

The participants are asked to enter the installation space one at a time. The area is empty and almost dark. There is only a tiny light to make the space visible to the person so that s/he can find the sit and wear head mounted display (HMD[100]). Once s/he puts the HMD on, the video starts. It is possible for more than one person to see the video at the same time[101]. The video starts showing almost the same dark setting of the real space s/he is sitting in; after few seconds, s/he hears a sound coming from far away, getting closer and closer so that after few minutes the person can hear it in its complexity and fullness. At the beginning participants

[100] From now on the term "head mounted display" and "HMD" are used interchangeably
[101] For the technical description of virtual reality and mechanisms of display see p.92-93.

hear voices of people expressing different emotions. In the video they see faces of people talking with sad, happy or angry expressions and tone of voice. Then the voices slowly fade into a melody. This effect is obtained slowly increasing the volume in the speakers. This shift is used in order not to aggressively impact the participant and to gradually fall into the sonic environment. It is also a way to present to the participants the different emotions expressed by the voices that are in the soundtracks and also the timbres of the instruments used for the composition. The soundscape is divided into three different areas in the sonic space. In front of them they see happy faces and voices expressing the related emotion. At the left the participants see and hear sad people and on the right s/he can see people manifesting anger. These three audio and visual scenes slowly change after a few minutes. I decided to allow the audio to go on for a couple of minutes. The audio is made up of just voices so that the participant can understand that when s/he turns the head not only the faces change but the audio changes accordingly. In fact, using a max/MSp patch I was able to change the soundtrack following the participant head's movement. After this audio made up of voices the video and audio change with a fade. The faces in the video slowly crumble to leave place to a moving image of a landscape. Accordingly, the audio fades from just voices to a melody. As the beginning, the soundtrack is different for each side of the acoustic space. The participant hears a different melody in front of her/him, and on the left and the right another one. Again, this is possible thanks to the tracking system used by the patch. The three different melodies have common characteristics (they share some melodic patterns) but they slightly change in order to describe the different energy patterns of each emotion. The

audio part of the installation is in fact the sonification of the results of analysis of the emotion expressed in the audio samples in the corpus of emotional data.

While *Sounding Out* is a first-person experience in which the participant is actually trying to experience or express an emotion, *Seams* is designed to recall a specific condition that occurs in social circumstances, namely when a person is trying to empathize with another person and understand their emotions. To do so, s/he rely upon her/his own experiences, either directly or indirectly, but they are not experiencing the emotional state themselves. This way of behaving differs from a first-person perspective because it is not one's own experience that one tries to comprehend. On the contrary, in this part I want the participant to try to understand somebody else's experiences, their viewpoints, emotions, and needs, relying on empathy to be able to accomplish this[102]. Besides, more significantly, the installation with its symbolic representation provides an understanding of how energy distribution and modification is the canvas on which emotional images are formed.

Soundtrack – sonification

Each composition (one for each emotion) was edited in a project with audio tracks and each track contains a sound played with an instrument. The melody is played with a different instrument (acoustic or digital) and therefore a different timber. The timber and volume of the overall melody (i.e. the bounce of all tracks, namely

[102] Pauen M., February 2012, The Second-Person Perspective, Inquiry, p.15.: […] *specific epistemic situations (They) occur in social contexts, when epistemic subjects use their own mental experiences, either explicitly or implicitly, in order to understand other subjects and their mental experiences. These epistemic acts differ from first person perspective taking because it is not one's own mental experience that one tries to understand. Rather, it's somebody else's mental experiences, their beliefs, emotions, and desires, that are subject to second person perspective taking. But second person perspective taking differs from third person perspective taking also, because it's neither theories nor empirical evidence that these epistemic acts are based upon. Rather, it's one's own experience that is used to understand other persons' beliefs, desires, and emotions.*

the composition/sonification) is decided using the percentage of the energy detected in each bar of the patch. A filter of 25 bands is applied to the composition. This filter is mirroring the function of the filter that detects energy in the voice of participants. So, for example, if the parameters for anger shows that bars from 1 to 3 and from 14 to 25 are low then in the filter applied to that composition/sonification the same parameters (filters) are changed accordingly. Equally, since with anger bands 10 and 11 are higher, as the composition develops the filter applied to the composition will be set so that the bands 10 and 11 in the filter will dominate over the others. Consequently, the amount of filtering applied to each composition reflects the quantity of energy expressed in the relative bands. Once the composition is processed trough the filter I then exported three different versions of the same composition, representing the three different states of overall energy influenced by the relative emotions. The procedure I used of matching data sound parameters is called sonification, which is an auditory representation of the available data. The three compositions are then located one in front of the participant, one on the left and one on the right. The patch receives the data of the position of the participant's head (relying on the gyroscope) and switches between the three composition correspondingly. When the video starts changing towards the end of the experience the three other compositions (front, left and right) mix to symbolically represent (as in the video) that energy is what is behind all processes and that every modification of our selves starts and ends from it. In fact, in the meantime as the compositions merge also the video chenges and what has been shown until a certain point merge into

one single image. This is to express that all the emotions change the overall energy in voice and that behind all the process energy is the common element.

VR - 360°videos contents and description

The video shows many faces expressing the three emotions and after few minutes the images fade into a single one like for example a sky or a landscape flowing away, which covers the full field of view and that symbolically represent the energy pattern underling the emotion expressed in faces and voices displayed until that moment. The 360° video has a similar progression as the sound part of the installation, but the fade between the two-different visual environments does not follow the same rules. The change is arbitrary, the quantity of fade from one visual situations to the other does not reflect the quantity of energy expressed in sound analysis therefore has not direct connection with the data. But as for sonification also for the video part the use of mimesis in *Seams* is employed as a process opposed to telling. The use of immersive visual stimuli is used for its immediacy to transport the person into the core of the topic, into a quick intuitive understanding of it, without describing or showing long lists of data. As McRoberts quotes ‘‘a picture transports the spectator almost instantly into a landscape’, whereas ‘language can only describe it detail by detail, bringing it slowly into the reader’s mind’ (Ryan:2015)”[103].

- Narrative approach – Virtual reality and the mimesis experience

[103] McRoberts J., Are we there yet? Media content and sense of presence in non-fiction virtual reality, p.7: Spatial immersion can be achieved more instantaneously through mimesis – a process of showing as opposed to telling. Immersion triggered by visual stimuli is considered to require less interpretation than written description as ‘a picture transports the spectator almost instantly into a landscape’, whereas ‘language can only describe it detail by detail, bringing it slowly into the reader’s mind’

In *Seams* the narrative is not physically but emotionally interactive, the virtual space and the empathic process are used as a technique to link participants' feelings with the ones expressed in the images, to link the evocative power of the symbolic images and the emotions of the person who is seeing them. Unlike the latest developments in virtual reality, diving here is used abstractly in the sense that it abstracts the person from his physical interactions, (not allowing the typical possibilities of VR to change the virtual space) to rather give more space to the trigger of mental interactions. The immersive effect makes people abandon the concrete reality to move on to an immaterial narrative made of memories, intuitions and emotions. It is a sort of non-linear narrative, mysterious as the mechanisms that hide the origin of the emotions, not giving them the answer or explanation but, as Davey, Kennedy and Gaudenzi state, offer a tool to learn about life in first person and hopefully give power to audiences' empathic responses[104].

Preview of Seams in Cesena

The exhibition in the conservatory of Cesena was a preview in an academic environment. The event called "Graffiti di luce e suono" was part of a greater festival called "7 noches". I was invited to present my work and I decided to show the preliminary results and the first draft of the virtual installation.

[104] McRoberts J., Are we there yet? Media content and sense of presence in non-fiction virtual reality, p.5: The aim is not necessarily to bring an audience 'closer to the truth' (Willis 2003, 23) but to offer them different, immersive and altered ways of looking at aspects of the world and perhaps also to induce more empathic perspectives on issues outside their everyday experience. that the opportunity to be immersed, through such forms as VR, is viewed as 'a tool to learn about life through first person experience, rather than to acquire knowledge through someone else's explanation of it' (44). Such opportunities, it is argued, help generate meaning through a unique perspective that inherently contrasts more traditional forms of audiovisual storytelling (Dovey and Kennedy 2006; Gaudenzi 2013) and raise hopes that such forms of presence may reinstitute audiences' empathic responses to such nonfiction narratives (De la Peña et al. 2010) through widening their circle of compassion.

- Design of the room and equipment

The room was the conservatory's library, an informal environment not dedicate to art exhibitions. The room was darkened to create an intimate atmosphere and to lessen the strong characterization of the place. At that time, I was calling the installation a diptych with just the title *Sounding Out*; it included both *Sounding Out* and *Seams*. Lately, also thanks to the feedback of this preview, I decided to separate the installations and to give each its own identity and title (even if they still maintain a relation as described before in this dissertation). The equipment was the HMD with the mobile phone for the 360° video installation (now called *Seams*) and a microphone with projection and a speaker, for the recording analysing part (that now is called *Sounding Out*).

- The audience

The characteristics of the audience were:

- Language: Italian
- Age: being in a university environment and due to the educational characteristic of the event the average age of the public was 25 years (students).
- Modality of participation, group or solitary: the installation was designed to be experienced one at a time. This decision was also due to the fact that the music was coming from the speakers and not from headphones so in order not to spoil the experience other participants had to wait outside for their turn.
- Number of participants: As the design of the experience was still in process and it was at a preliminary stage, I decided to present the experience to a small group (approximately 10 participants).

- Participant's performance and reactions: expectations, confirmations and new discoveries during the process

As stated before, at that time the installation on sound analysis (*Sounding Out*) and the VR experience (*Seams*) were mixed in one (under the name *Sounding Out*). In the preview in Cesena I realized the impossibility of combining the two experiences together. There were several problems in presenting these experiences in one room and at the same time. First of all, the time frame. Asking people to first speak at the microphone and tell a story and after this to try the VR experience was time consuming and the experience would have lasted more than 20 minutes for each participant. Another reason was the setting. Apart from the fact that this experience was experimental, so the space (library) was left basically in its original form (just being darkened), I learned that the two experiences needed a different setting. For the analysis and interactive installation, a chair with one screen was too poor a setting and most of the meaning and history of the designing process and connotation of the work were lost in that simplified environment. At the same time the VR experience (*Seams*) also needed a specific scenery that was much cleaner and more basic. Besides that, the most important reason was that having the two possibilities combined together, people were keener to choose the VR experience instead of trying to tell a story. I think that this was due to the embarrassment of expressing their emotions. I am not sure if this was the only reason or if the young age of the participants (from 16 to 35) influenced their choice, or if it was just the newness and strangeness of the VR technology which overshadowed the experience of the sound installation (*Sounding Out*). The conclusion was that the 10

participants only tried the VR part of the installation. The response was really positive, 9 out of the 10 participants reported a sense of wonder and magic, the sensations of being transported into a magic world (even if actually in the video there were faces and landscapes). Based on comments, the participant seemed to have understood the symbolic message that the video was delivering, i.e. that all our emotions share the fact that they effect sound energy distribution.

5. Research Methods

As stated in the premises, my installations (*Sounding Out and Seams*) are a tool, a goal and part of the methodology of the research itself. In the following paragraphs I describe some tools that are parts of the setting for producing and representing the data but also the instruments for proving and analysing the results of my investigation.

5.1. Sounding Out

- Presentation of the patch “energy band analyser” used in *Sounding Out*

The patch for MAX / MSP “energy band analyser” has been designed in collaboration with prof. Belfiore of the Conservatory of Florence after the experience of the sound installation Quanta of sound. This patch has in fact its origin in the one used in Quanta of sound. For this work with the intent to treat sound events from an acoustic source in real-time or from a pre-recorded audio file. The patch is made of a bank of 25 band pass filters that analyses the sound stream running through it. Alike an optical prism, capable of revealing the spectrum of a light ray passing through it, separating its constituent colours, the

Number of bands (bark)	Centre of the band (in Hz)	Extremes of the band (in Hz)	range of the band (in Hz)
1	50	to 100	~80
2	150	100-200	100
3	250	200-300	100
4	350	300-400	100
5	450	400-510	110
6	570	510-630	120
7	700	630-770	140
8	840	770-920	150
9	1000	920-1080	160
10	1170	1080-1270	190
11	1370	1270-1480	210
12	1600	1480-1720	240
13	1850	1720-2000	280
14	2150	2000-2320	320
15	2500	2320-2700	380
16	2900	2700-3150	450
17	3400	3150-3700	550
18	4000	3700-4400	700
19	4800	4400-5300	900
20	5800	5300-6400	1100
21	7000	6400-7700	1300
22	8500	7700-9500	1800
23	10500	9500-12000	2500
24	13500	12000-15500	3500
25	18775	15500-22050	6550

Table 2 critical bands organized according to the model of Eberhard Zwicker

patch detects the distribution of acoustic energy along the spectrum unpackaging the signal in 25 "zones". These 25 packages of energy relate to the critical bands organized according to the model of Eberhard Zwicker shaping the ear with 24 critical bands for frequencies below 15 kHz while a twenty-fifth band collects the range of kHz between 15 - 20. Physiologically each critical band has a length of 1.3 mm in the cochlea (basilar membrane / organ of Corti) corresponding to about 1300 hair cells. The filter bank analyses not the overall acoustic energy together,

but it separates the total energy in 25 fragments so to detect how much energy there is in each part of the acoustic spectrum. In this way it is possible to know how much energy there is present in each frequency band (and in theory how much energy is pushing against one of the 25 zones of the basilar membrane). The patch performs several functions described below. The main screen contains the specific items of MAX / MSP whose main functions are to dialogue with the operator. Here you can make some major decisions, provide some necessary input to processing algorithms present in the sub-patches and observe in real time the different information, based on processing, through a numerical and graphical display. To facilitate a visual orientation the various commands and objects of MAX / MSP were ordered in nine areas, graphically highlighted by rectangles with a dark gray background marked by a number between 1 and 9.

Fig. 7 Screenshot of the main panel of the patch " energy band analyser " working

Area 1

In this area are the main options for determining the type of source that will provide the input sound to the patch:

- Source: Sound files (allows you to use a previously recorded audio file as the source of the flow of sound, useful for testing or for use in a permanent installation)
- Source: Oscillator (useful for calibrating the system)
- Source: ADC (input for the acoustic signal coming from a microphone or from an audio system, useful for a live performance)
- Source: Noise (useful for calibrating the system)

At its launch the patch assumes some default values, here we see the value assigned to 0.01 sensitivity threshold. This is an adjustable parameter depending on the necessity, with the aim to provide each resonator of the patch the exact threshold of intensity of energy detected beyond which the resonator will have to activate a special circuit. This device is intended for a future development of the patch .The other parameter assignable, here set to 100 by default, is the quality factor Q (resonance). The merit factor, quality factor or simply Q factor, is a dimensionless parameter that compares the time constant of the decreasing phase of the amplitude of a physical system oscillating, with its oscillating period. In an equivalent manner it compares the frequency at which a

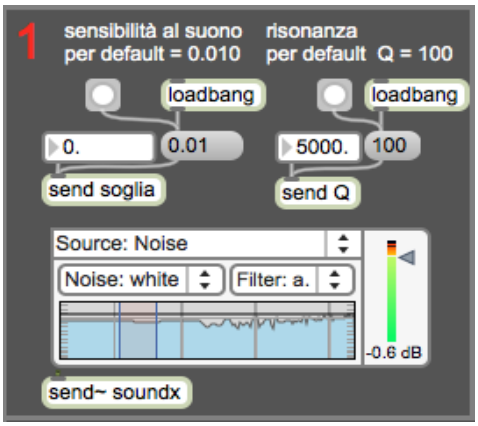


fig.8 Area 1, particular of the general panel

system oscillates with the rate of energy dissipation. A higher Q indicates a lower rate of energy dissipation relative to the oscillation frequency, so the oscillations will soften more slowly. For example, a pendulum of high quality, suspended in the air, would have a high Q, while a pendulum immersed in oil would have a low one. Resonators with high quality factor driven sinusoidally respond with large amplitudes (at their resonant frequency) but their band is narrow. Therefore, a tuning circuit with high Q in a radio receiver would be more difficult to adjust, but it would be more selective andwould do a better job in filtering signals from other nearby stations in the frequency spectrum. The concept of Q factor arises in electronic engineering, as a measure of the "quality" desired in a tuned circuit or another type of resonator. Generally Q is defined as:

Q = 2π · Energy stored / energy dissipated per cycle

or, in an equivalent manner:

Q = ω · Energy stored / Power Dissipation

*W*here with ω indicates the angular speed (or pulse) system, and stored energy, dissipation and power dissipation are properties of the system under analysis. Another interpretation of the figure of merit, is given by: $Q = f_0 / \Delta f$

Where f_0 is the peak frequency and Δf is the bandwidth.

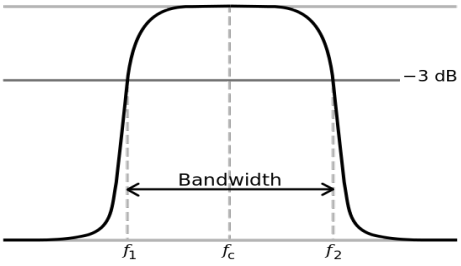


fig.9 frequency peak (fc in the image) and bandwidth (Δf = f2 - f1)

To get a better idea of the phenomenon we can observe in the same patch (area 3) the different behaviours of the resonators to the passage of the same signal produced by generator Noise with Q places respectively at 100 and 9000.

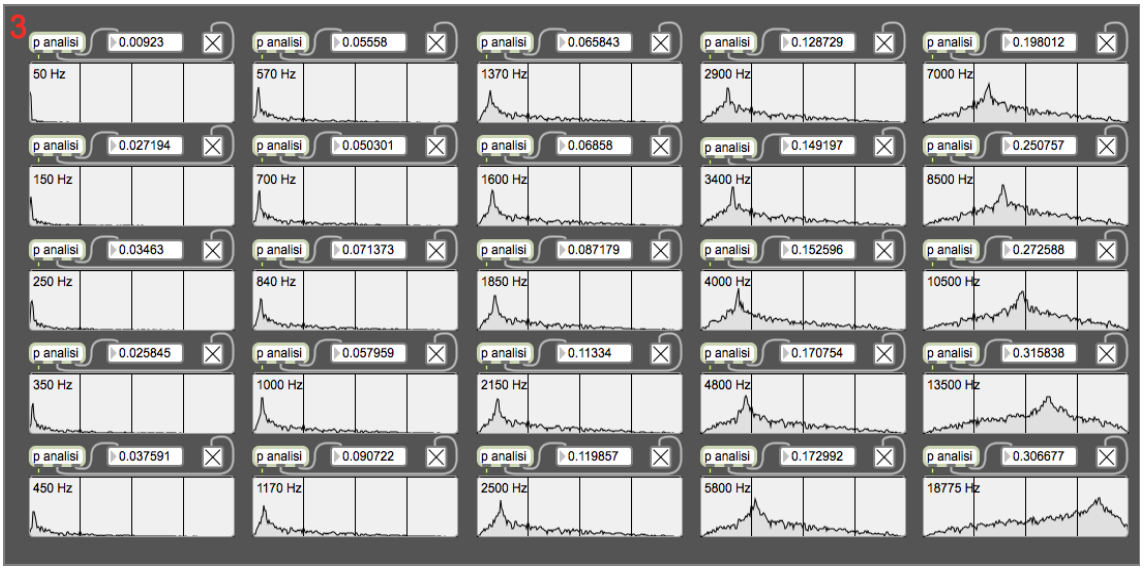


fig.10 signal input Noise, quality factor Q = 100

fig.11 signal input Noise, quality factor Q = 9000

Other elements present in Area 1 are the object "send~ SOUNDX" which has the task of sending the flow of sound to the objects of area 6, where it is possible to

activate the audio function for acoustic monitoring, and all objects of the patch organized for their preparation and for the sub-patch "p QUADRANTI_ANALISI" which has the task to activate the process of analysis and trace the flow of the values obtained by creating graphical representations and sequences code.

Area 2

In this area we have a traditional spectrum analyser that shows on its display the flow of the audio signal supplied to the system.

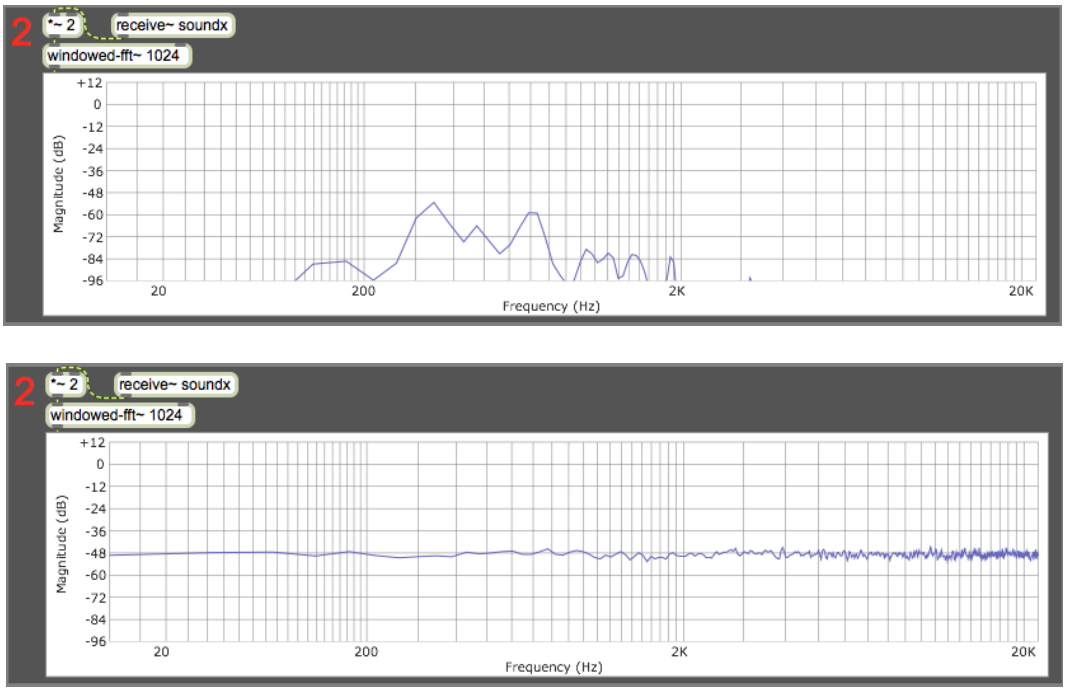


fig.12 Area 2, spectrograms of the signals provided at the entrance: top spectrogram of an audio signal taken from a pre-recorded audio files, down the spectrogram a signal provided by the white noise generator inside

Area 3

In this area, arranged in a matrix of 5x5, we find the modules relative to the 25 resonators, that is a bank of 25 bandpass filters capable of measuring the amount of energy passing through each of the bands on which every filter works.

Fig. 13 Area 4, screen 25 resonators with their display, set each on the centre frequency of the critical band corresponding second Eberhard Zwicker mode

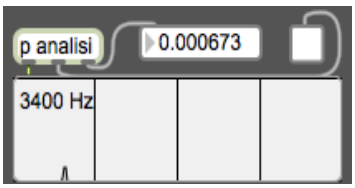


fig.14 Area 4, detail of critical band resonator centred on 3400 Hz

Each module is organized in the same way and has the sub-patch "p analysis" that conducts the calculation for the detection of energy in the corresponding critical band, in the case in fig.12b is the critical band centered on the frequency 3400 Hz, the display shows the presence of a peak energy in that band and the non-activation in the upper right toggle declares that the energy threshold set in area 1 was not been exceeded (this is an element prepared for future developments of the patch). The digital display in the center, at the top, shows the amount of energy found in that moment in this band.

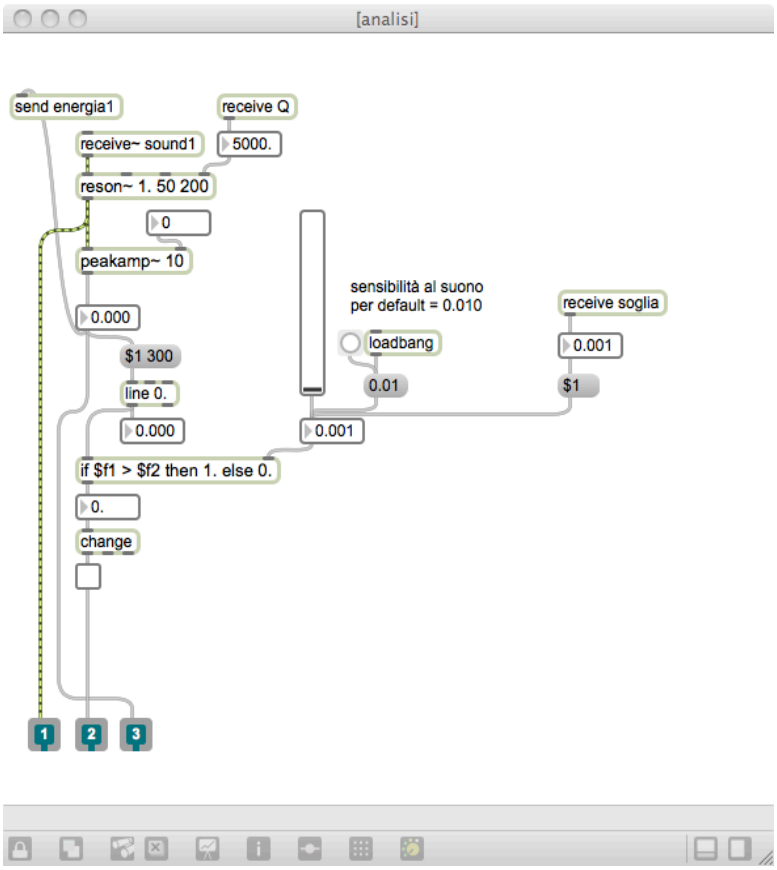


fig.15 sub-patch "p analysis" contained in each resonator

The sub-patch "p analysis", contained in each resonator, with relative settings, is the tool for the detection of the value of energy transiting for the particular band indicated, to a particular instant of time. Here is analyzed the flow of the acoustic signal received (sound1) that is treated with the resonance filter (band-pass) "reson~" and compared with the threshold value set energy in area 1. Each value detected for that particular band updates the energy variable (n), where *n* is from 1 to 25, relatively to the critical band treated. The value contained in the variable energy (*n*) is made available to all objects of the patch that will use it and send energy through the function (*n*) (visible in the upper left corner in the sub-patch).

Area 4

fig.16 sub-patch "p QUADRANTI_ANALISI"

In this area there is the sub-patch p QUADRANTI_ANALISI. This sub-patch has the function of reading the data processed by the bank of filters of resonance, data continuously provided for each band through the energy variables (*n*). In this sub-patch there are 3 areas that collect the tools for analysis and graphical representation according to the different strategies adopted to conduct this research.

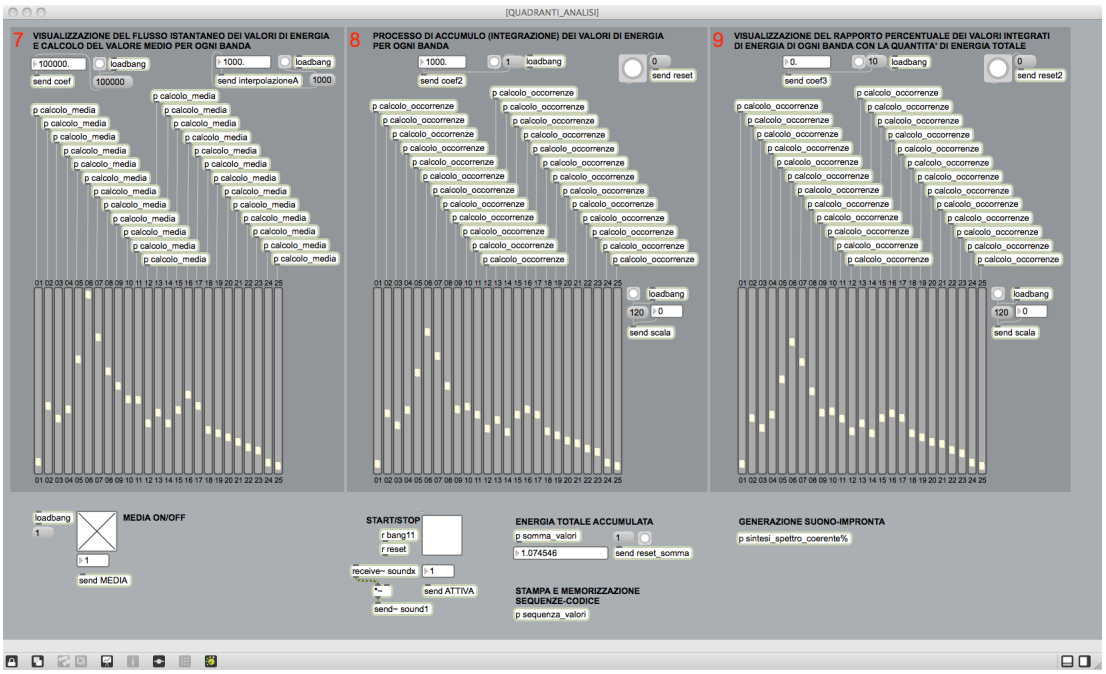


fig.17 sub-patch "p QUADRANTI_ANALISI" open, following an analysis, They are visible for the 3 areas for the different types of analysis-data representation and any other programs available

Area 5

fig.18 sub-patch "p audiorec" box number

The sub-patch "p Audiorec" allows you to make a recording of the audio signal supplied from the sound card in the case of a sound detection in real-time or just to make later analysis of the same sound event with various modes and strategies comparing the obtained results.

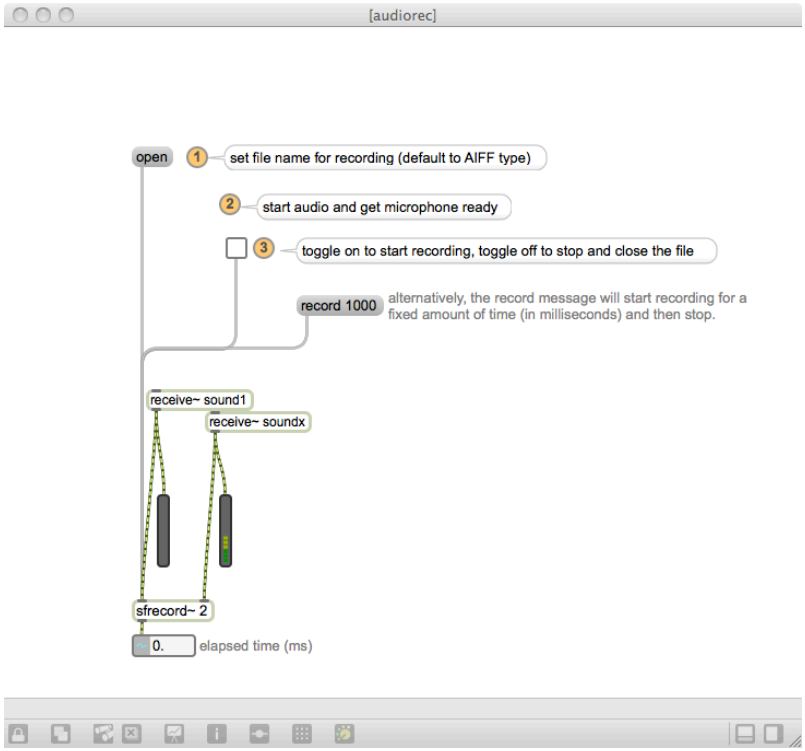


Fig.19 sub-patch "p Audiorc" open

By clicking on Open you can assign a name and a location on the disk to the audio file that will be registered; the registration will be activated by clicking the toggle (on-off) mentioned in point 3 of the figure and in the same way you can stop.

Area 6

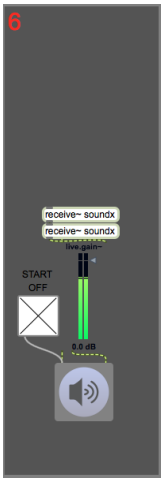


fig.20 area 6, contains objects MAX / MSP for activating audio

The area 6 contains the objects MAX / MSP for activating the audio, the volume control for the monitoring of the sound and a display for displaying the signal.

Area 7

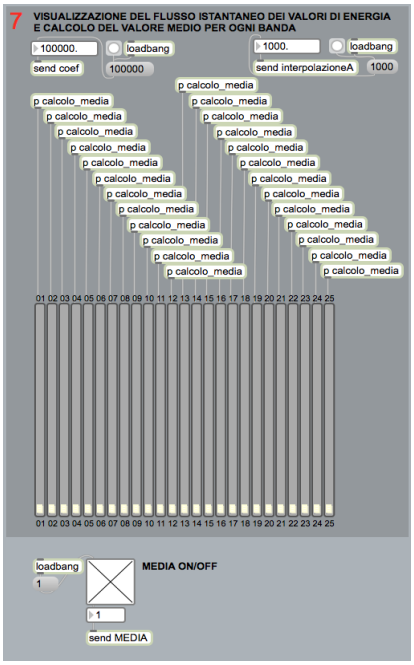


fig.21 area 7, display of the instantaneous flow of energy values and calculate the average value for each band

The area 7, within the sub-patch "p QUADRANTI_ANALISI", can show alternately

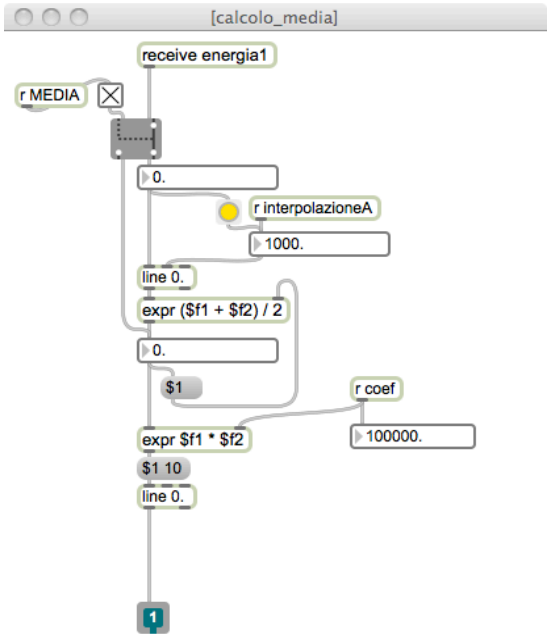


Fig. 22 content of the sub-patch "p calcolo_media"

(the choice you can click on the toggle MEDIA ON / OFF bottom which by default is set to ON):

a. the flow of the values supplied by the energy variable (n), instant by instant, for each of the 25 bands (OFF)

b. the mean between the last calculated value and the new value of energy (n)

At the top left you can set a coefficient (*coef*) to optimize the graphics in the display, the default value is set to 100.000. At the top right you can set a value in milliseconds (the default place to 1000) to perform a linear interpolation between the middling values of energy (*n*); this procedure makes it easier to read the static and soft flow of the values in the chart with respect to the display instant by instant, (condition a.). Without media and without interpolation, in fact, the analysis is more specific but so rapid in updates that is not easily readable. The main purpose of the instruments of this area is to provide elements of comparison with the results obtained with the other instruments of calculation, to best assess the strategies of investigation of the acoustic spectrum.

Area 8

Area 8, within the sub-patch "p QUADRANTI_ANALISI", shows the accumulation of energy for each band. It is a real integration process, in a certain window of time, of the values of the acoustic energy flow for each band. At the top left you can set a coefficient (coef2) to optimize the graphics in display, the default value is set to 1. By placing coef2 to 1000, values will grow faster saturating in a much shorter time bars in the graphic display. The absolute value of the collected amplitude for each band obviously tends to grow over time. It is useful to establish analysis timing and appropriate coefficients of graphic representation according to the nature of the sound event. At the top right, you can reset the values by resetting all the sums made at that time. Clicking on this button will reset at the same time the values of the tools in box 9.

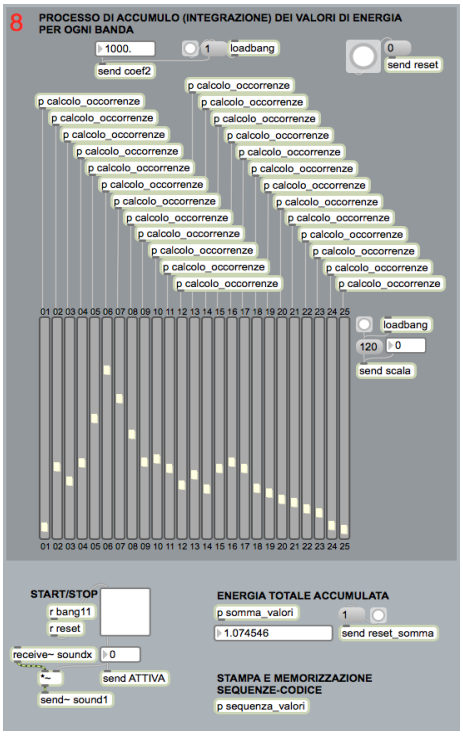


fig. 23a area 8, the process of accumulation (integration) of the energy values for each band

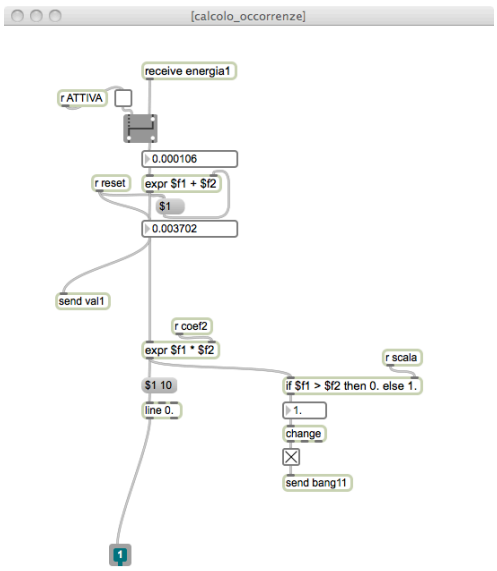


fig. 24 content of the sub-patch "p calculates_occuraces"

The system of 25 sub-patch "p calculate_occurrances", allows the treatment of the values supplied by the energy variable (*n*), for each band; the data are added together, instant by instant, during an appropriate interval of time, in which the analysed sound event is divided. The variable *val* (*n*) is constantly updated by integrating its value with the last energy value given (*n*). In the lower right corner of the sub-patch, it is compared to the last value obtained after being multiplied by the coefficient coef2 with variable scale (set by default to 120). If the value is greater it will block the process of analysis. This allows you to graphically not exceed the limits of the graphic representation provided in the displays. The threshold of 120 in this phase was preferred (although not strictly necessary) for the ability to relate it more easily (if needed) to the range of audible dynamics, 120 db. The display for the graphic representation of the values have been set at the time of a staircase of 158 steps but the value can be changed depending on the results of the experiments carried out. At the bottom left, activating the toggle START / STOP, you start the process of analysis and representation of values. At the bottom right under ENERGY ACCUMULATED TOTAL is the sub.patch "p somma_valori"

The sub.patch "p somma_valori" provides to the sum instant by instant, for each band, of each value provided by the variables val (*n*) also calculating the total sum of all values received by updating this value with the variable *val_g-lobale*, value that will be used in the next area to calculate the percentage of amplitude

values for each energy band. You can reset the variable to 0 val_globale clicking outside the sub-patch: *reset_somma*. Further down on the right we have: PRINTING AND STORING SEQUENCES-CODE and the sub-patch "p sequenza_valori"

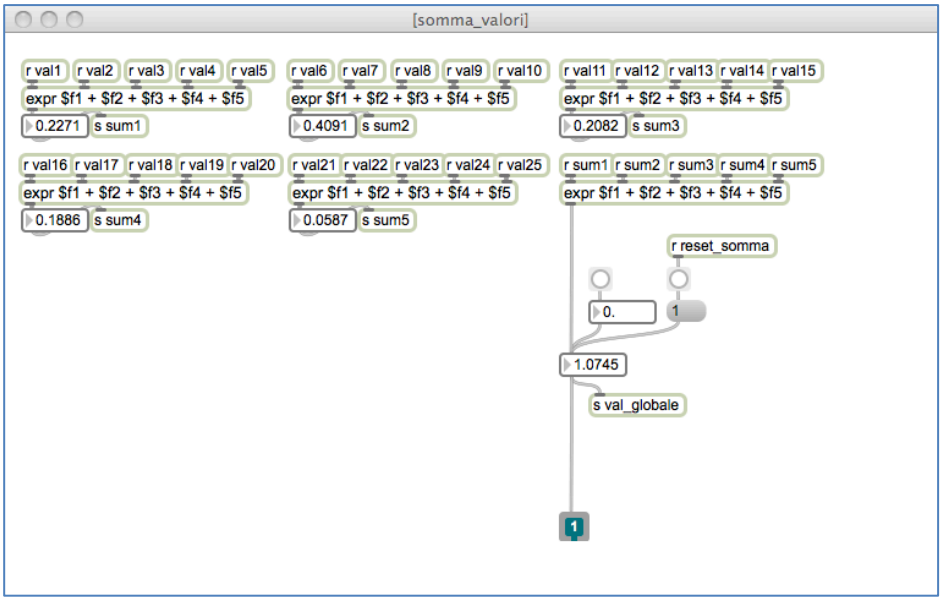


fig. 25a content of sub-patch "p somma_valori"

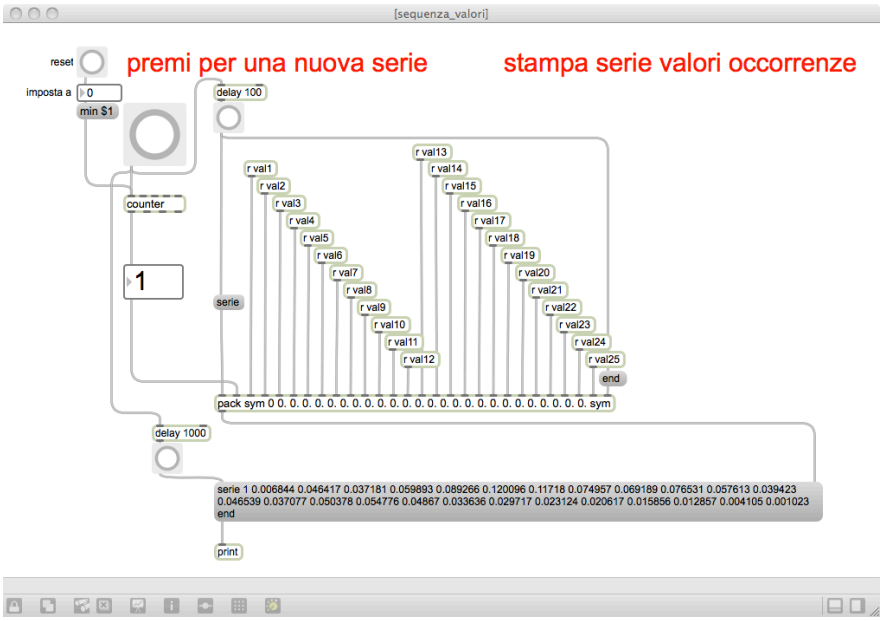


fig. 25b content if the sub-patch "p sequenza_valori"

By clicking on the button at any time you can get the code sequence relative to that moment. Each series is characterized by an initial number automatically updated by a counter (*n* series), 25 amplitude values obtained from the analysis according to the criteria adopted, then with the word "*end*" closes the series. The sequence code with the print command is published in Max Window and is available for any possible future use:

print: 1 0.006844 0.046417 0.037181 0.059893 series 0.089266 0.120096 0.11718 0.074957 0.069189 0.076531 0.057613 0.039423 0.046539 0.037077 0.050378 0.054776 0.04867 0.033636 0.029717 0.023124 0.020617 0.015856 0.012857 0.004105 0.001023 end

Table 3 printing of a sequence-code

Video sub-patch

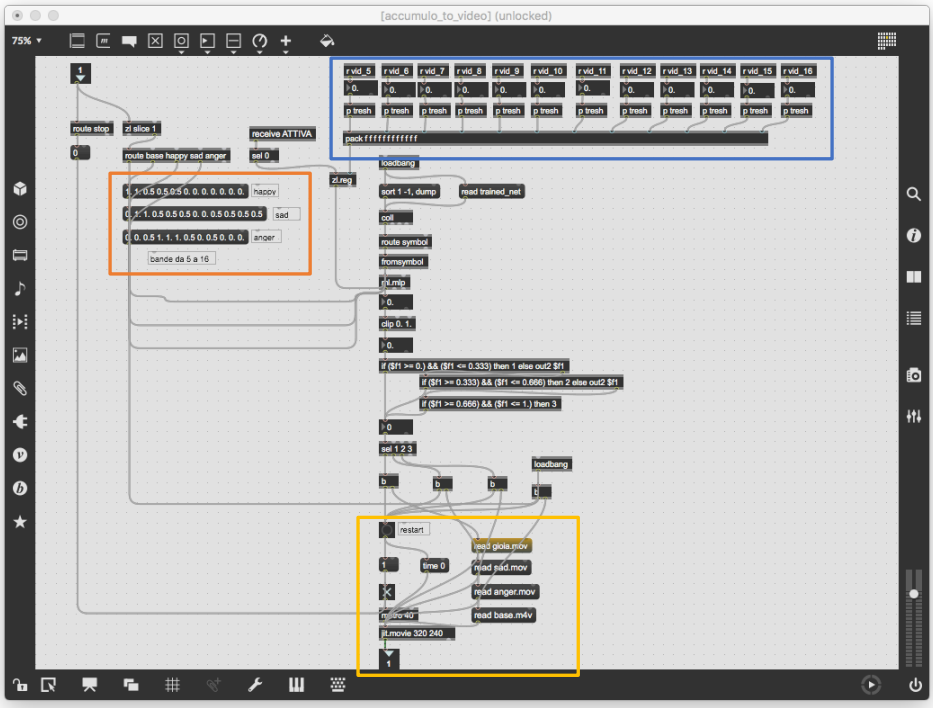


Fig.26 video sub-patch

The video sub-patch was created in a second moment of the installation design process. After using the patch for sound analysis, the data demonstrated that the most relevant bands expressing energy patterns are from 5 to 16. That is why this sub-patch takes into consideration only the energy accumulation on those bands (which is outlined by a blue frame in fig. 27). Receiving signal from 12 bands the patch unpacks it and sends the 12 elements to the zl object. *Zl* performs several kinds of list processing functions, setting the function with a keyword argument that in this case is reg. In this mode, the *zl* object functions as a register that holds a list. The object will accept a list as an argument to set the initial stored content of the object. The information in zl goes to the object ml-mlp that is a Multi-Layer Perceptron Neural Network. This object learns associations between given inputs and paired outputs. I used zl as a classifier for providing a numerical output for each category of given inputs. In general, the patch is designed so that there are three different settings inside the messages boxes. In these message boxes I described a pattern for each emotion.

During the accumulation the sub-patch continuously receives data and until it reaches one of the three settings defined in one of the message boxes on the left (which is outlined by an orange frame in fig. 27), it shows a neutral video. When one of the combination of values is detected then it triggers a new video. The video window jit.movie is connected to a read message box containing the argument that links to one video for each emotion (which is outlined by an yellow frame in fig. 26).

- Description of equipment *Sounding Out*

Two mac book pro computers

1 projector

2 speakers

5 tv monitors

2 cd players

1 dynamic microphone

1 external sound card

- How to use the Patch

a. Go to https://cycling74.com/downloads and download the version of the software Max/Msp run time that is most suitable with you operating system.
b. Open the folder chose the file “analizzatore bande di energia 2+scala percentuale copy”, right click on the file and select open with Max/Msp run time
c. If the software tell you that a third party library is missing from the software (ML.star) click on the yellow cube (package manager window) on the left of the main window and open it

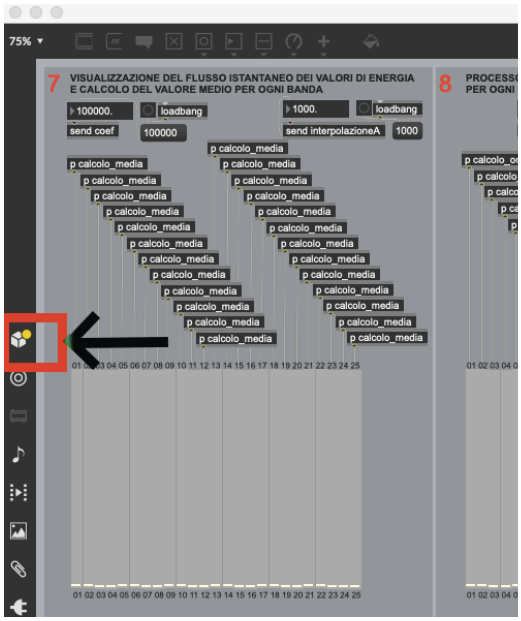


Fig. 27 package manager window

d. Once you are in this menu (available update write ml.star in the search bar and download and install in order to add to it the library)

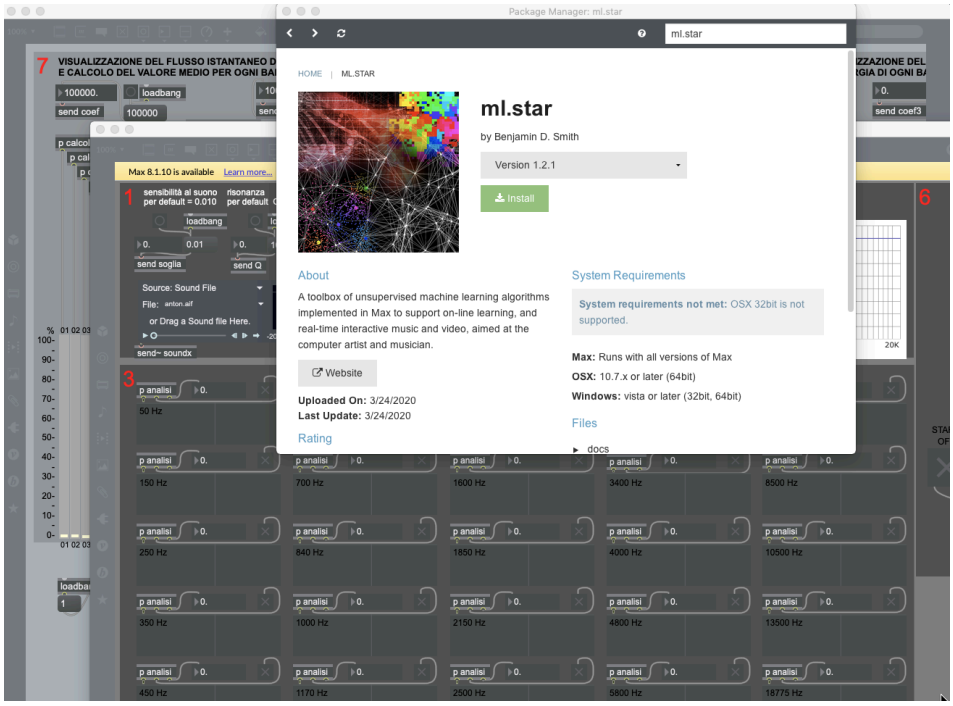


Fig. 28 package manager window

e. Once the patch is open you will see two windows divided into numbered panels
f. Press the start box in panel 6 and turn the audio on

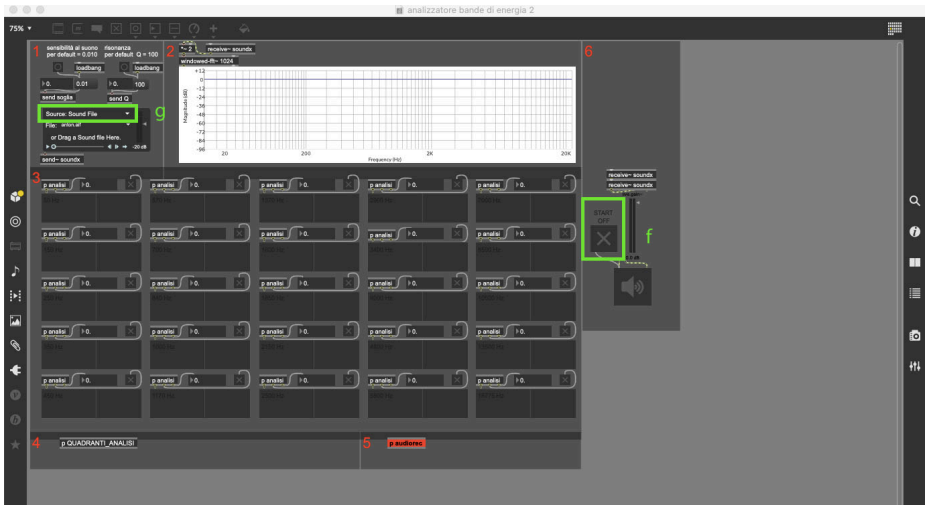


Fig. 29a analyser's main window

g. From panel 1 select source. Chose ADC input in order to listen from the microphone
h. Check the audio status in the options drop-down menu.

i. In case is not turned on click and turn on audio
j. In the audio status box select your input and output device
k. In the second window click on the x in panel 8 to start the analysis

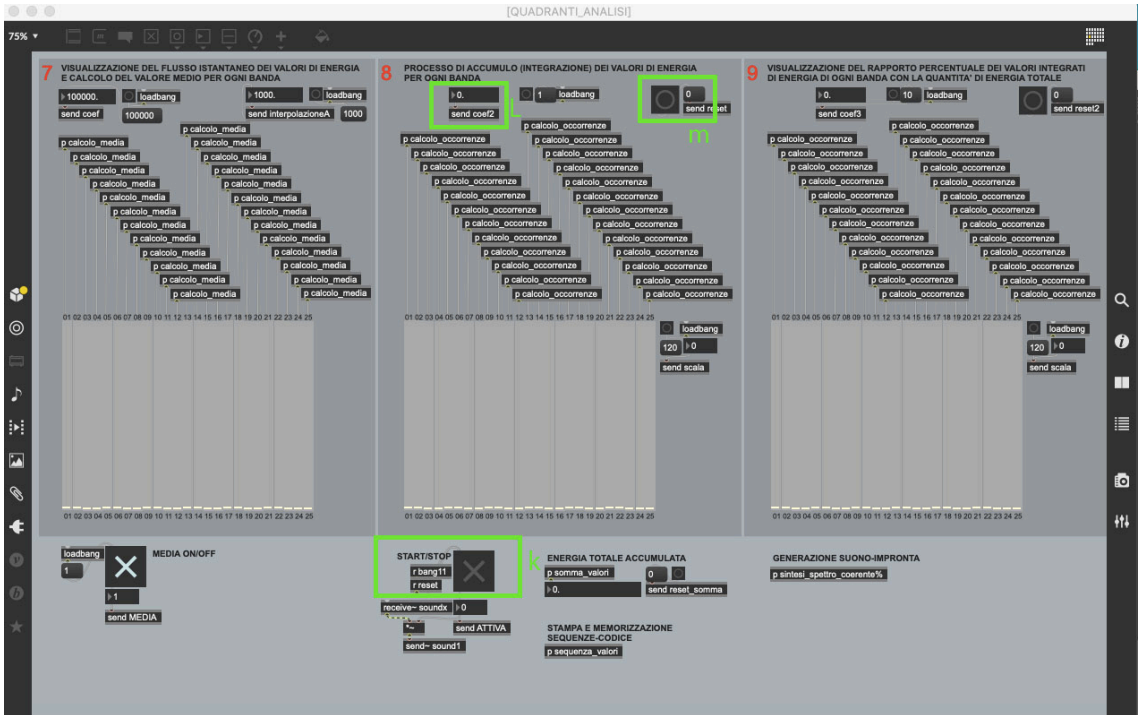


Fig. 29b analyser's secondary window

l. In panel 8 select a number in the number box in the up-left corner in order to decide the analysis time rate (a lower number is related to a low speed in the analysis process)
m. In case you want to start the analysis again you can click the bang box on the up-right corner

5.2. ***Seams***

- Sonification

Sonification as an auditory display is a way to facilitate the interpretation of data. The definition by Oxford Dictionaries is "the use of non-speech sound to convey quantifiable information or represent data, typically as the output from an electronic device; the conversion of data into sound for this purpose"[105]. Sonification can be considered a practice of representing features of the data to generate sound signals. This technique should meet certain conditions: reproducibility (it should be possible for others to convert it in the same ways and produce the same outcomes) and intelligibility (the 'objective' features of the original data need to be methodically reflected in the resultant sound (Hermann, "for a taxonomy of sonification"). There are different methods to exemplify data by using sound such as:

[105] https://programminghistorian.org/lessons/sonification - PUBLISHED 2016-06-07 - MODIFIED - 2018-05-13 - accessed 14 May 2018: Sonification is the practice of mapping aspects of the data to produce sound signals. In general, a technique can be called 'sonification' if it meets certain conditions. These include reproducibility (the same data can be transformed the same ways by other researchers and produce the same results) and what might be called intelligibility - that the 'objective' elements of the original data are reflected systematically in the resulting sound (see Hermann 2008 for a taxonomy of sonification). Last and Usyskin (2015) designed a series of experiments to determine what kinds of data-analytic tasks could be performed when the data were sonified. Their experimental results (Last and Usyskin 2015) have shown that even untrained listeners (listeners with no formal training in music) can make useful distinctions in the data. They found listeners could discriminate in the sonified data common data exploration tasks such as classification and clustering. (Their sonified outputs mapped the underlying data to the Western musical scale.) Last and Usyskin focused on time-series data. They argue that time-series data are particularly well suited to sonification because there are natural parallels with musical sound. Music is sequential, it has duration, and it evolves over time; so too with time-series data (Last and Usyskin 2015: 424). It becomes a problem of matching the data to the appropriate sonic outputs. In many applications of sonification, a technique called 'parameter mapping' is used to marry aspects of the data along various auditory dimensions such as pitch, variation, brilliance, and onset. The problem with this approach is that where there is no temporal relationship (or rather, no non-linear relationship) between the original data points, the resulting sound can be 'confusing' (2015: 422). However, the introduction of Model-Based Sonification (MBS) [3, 4] demonstrates methods to explore data by using sound in a way that is very different from a mapping: in Parameter-Mapping Sonification, data values are mapped to acoustic attributes of a sound (in other words: the data 'play' an instrument), whereas in MBS sonification models create and configure dynamic processes that do not make sound at all without external interactions (in other words: the data is used to build an instrument or sound-capable object, while the playing is left to the user). The user ex- cites the sonification model and receives acoustic responses that are determined by the temporal evolution of the model. By doing this, structural information is holistically encoded into the sound signal, and is no longer a mere mapping of data to sound. One can perhaps state that data are mapped to the configurations of sound-capable objects, but not that they are mapped to sound.

- Parameter-Mapping Sonification method, in which data features are plotted to acoustic attributes of a sound (in other words: the data 'plays' and is reproduced in sounds that reflect its features)
- MBS sonification models, that configure procedures that do not create sound. The data is used to make an instrument, while the playing is left to the user. The user excites the sonification model and receives acoustic responses and by doing this we do not have a mapping of data to sound, but instead data is mapped to the configurations of the instrument (Hermann: 2008)[106].

The results of the "energy band analyser" were used to design the different audio pieces to be used in the installation's room (in a certain way they can be understood as soundtracks of the 360°videos), each related to one emotion. The composition is an *auditory display*[107] of what happens during the process of analysis and detection of emotion in speech samples and to do so I used the results of the analysis as parameters of my sound design strategy. My emphasis is on the interaction between musical and non-musical domains. Inspired by Alfred Gell's suggestions and his book "Art and Agency", the main idea behind

[106] Herman T., *taxonomy and definitions for sonification and auditory display,* Proceedings of the 14th International Conference on Auditory Display, Paris, France June 24 - 27, 2008, p.1: *The shortest accepted definition for sonification is from Barrass and Kramer et al. [2]: "Sonification is the use of non-speech audio to convey information". This definition excludes speech as this was the primary association in the auditory display of information at that time. [..] As a more specific definition, the definition in [2] continues: "Sonification is the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation."*

[107] *Ibidem: Often, the word 'mapping' has been used interchangeably with 'transformation' in the above definition. This, however, suggests a severe limitation of sonification towards just mappings between data and sound – which was perfectly fine at the time of the definition where such a 'Parameter-Mapping Sonification' was the dominating paradigm. However, the introduction of Model-Based Sonification (MBS) [3, 4] demonstrates methods to explore data by using sound in a way that is very different from a mapping: in Parameter-Mapping Sonification, data values are mapped to acoustic attributes of a sound (in other words: the data 'play' an instrument), whereas in MBS sonification models create and configure dynamic processes that do not make sound at all without external interactions (in other words: the data is used to build an instrument or sound-capable object, while the playing is left to the user). The user excites the sonification model and receives acoustic responses that are determined by the temporal evolution of the model. By doing this, structural information is holistically encoded into the sound signal, and is no longer a mere mapping of data to sound. One can perhaps state that data are mapped to the configurations of sound-capable objects, but not that they are mapped to sound.*

the compositional part of this installation is that the things that result from a creative act summarize and symbolize real life relations (in my case the relation between emotions and energy distribution in sound). Borrowing Gell's words, through the art object, data relations are distributed and dispersed both temporally and spatially[108].

Brief introduction to the history of sonification: music research and psychoacoustic

The interest and connection between perception, acoustic and psychoacoustic phenomenon with music and composition is not recent or new. The generation of musicians and researchers working at IRCAM[109] in 1980s was studying psychoacoustics in order to understand the perceptually and musically meaningful characteristic of sound, for improving both analysis and synthesis of music (in the attempt to make synthetic sound more pleasant and plausible). But the studies on perception also need to be contextualised with regard to the period's criticisms of serialism[110]. In fact, these composers started to research

[108] Born G., *Music research and psychoacoustic*, **the sound studies reader**, ed. by Sterne J., Routledge, London-New York, 2012, p.420: Yet the anthropological scope that Gell adopts nonetheless yields tremendous insights. His theory of agency in art centers on the idea that the objects that result from creative agency condense or embody social relations, and that they do so by spinning forms of connectedness across time and space. Through the art object, these social relations are distributed and dispersed both temporally and spatially. But in the process the social relations are also relayed and transformed, as are the objects themselves. The art object has a kind of career; it changes not only via its changing interpretation in performance and reception, but it can change even in its very physical form.

[109] IRCAM, https://www.**ircam**.fr, the Institute for Research and Coordination in Acoustics/Music, is one of the world's largest public research centres dedicated to musical creation and scientific research. A unique venue where artistic vision converges with scientific and technological innovation, the institute directed by Frank Madlener brings together over 160 collaborators. IRCAM hosts the UMR9912 STMS Ircam - CNRS - Sorbonne University science and technologies research lab.

[110] http://www.oxfordmusiconline.com/grovemusic/view/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000025459: a method of composition in which a fixed permutation, or series, of elements is referential (i.e. the handling of those elements in the composition is governed, to some extent and in some manner, by the series). Most commonly the elements arranged in the series are the 12 notes of the equal-tempered scale. This was so in the technique introduced by Schoenberg in the early 1920s and employed by him in most of his subsequent compositions. Serialism was quickly taken up by his pupils, including Berg and Webern, and then by their pupils, but not at first by many outside this circle, the most important exceptions being Dalla Piccola and Krenek. The method spread more widely and rapidly in the decade after World War II, when Babbitt, Boulez, Nono and Stockhausen produced their first acknowledged works. These composers and their colleagues sometimes extended serialism to elements other than pitch, notably duration, dynamics and timbre.

psychoacoustics and acoustics to develop a scientific foundation from which to criticize the serialism. They were interested in perception to validate the fact that serial music was incomprehensible because it violates the perceptual limit of the listener[111].

These studies on how we perceive and appreciate or understand music and how to reproduce these natural mechanisms, led to a development. As in applied cognitive modelling, where the computer analyses a phenomenon and simulates it, also in music researchers started using computers to not only analyse the deep structures of music but to develop the computer's knowledge of music and provide it with rules so that it could compose its own music.

However interesting and important the legacy between perception, cognition and music still is, the computer was never able to produce new schemes of music or a compositional thought based on cognitive analytical work, or, as the main IRCAM psychoacoustician Stephen McAdams says, if they did the results were really disappointing[112]. I think that in my compositions there are traces of this experimental music or at least of their intentions. This vanguard music, informed by psychoacoustic, was inspiring although it was a failure. From this investigation at IRCAM I took the will to inform my art with psychoacoustic, cognitive studies on perception and emotions. But I learnt from their mistakes that my studies and findings on perception and emotions can only inform my compositional structure and never lead me to a computer-generated composition. I did not want to create music based on data analysis, sonification instead seamed a good way to convey

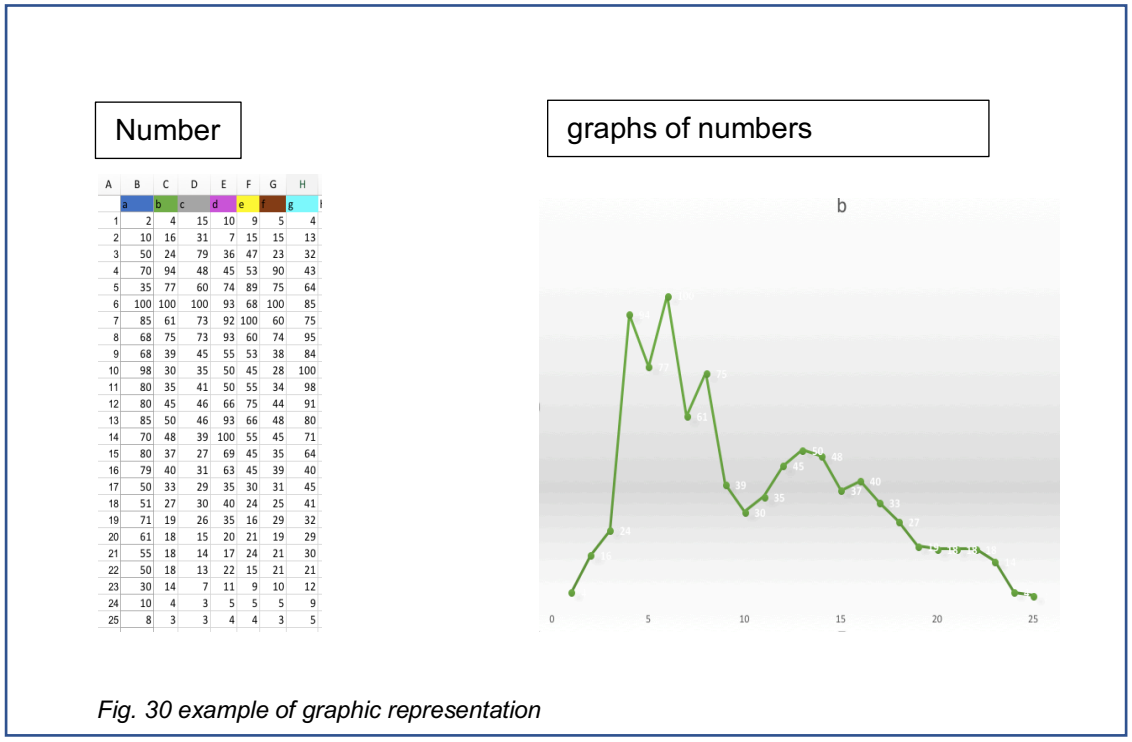
[111] Born G., *Music research and psychoacoustic*, the sound studies reader, ed. by Sterne J., Routledge, London-New York, 2012, p. 420
[112] Born G., op.cit., p.422-425

the data identified by the energy band analyser, maintaining a margin of arbitrariness and a way to keep my own aesthetic. This arbitrariness is nothing more than the artistic dimension, the poetic gesture. The freedom in choosing which music structure will be combined with the data and using the data only to modify the volume and character of each track (therefore the dominance and compositional relation of each piece in the work) prevented me from an aesthetic failure. In fact, the vanguard attempts were looking at just the scientific and acoustic level, disregarding the cultural and aesthetic perspective. Not aiming at a generative process, I created a sonification with ready-made structures that have musical sense and coherence, intelligibility as well as pleasantness.

The use of sonification: strengths and weaknesses

As much as sonification may seem strictly related to specific experimental music environments, it can be used in many ways and fields. An example of sonification is the sound of cardiac monitors (the beep) that is a sonification of the rhythm of heart beat. Following this example of sonification it becomes immediately clear that sonification can also mean simplification. In fact, the beep is and immediate and simple way to detect and monitor the heart beat instead of reading a very long list of numbers or interpreting a graphical representation of the heartbeat's trend. To understand the trend of someone's heart rate from Vector graphics of the cardiogram you have to recognise and count peaks, measure the distance between one peak and another to know if the heartbeat was constant or if was accelerating or decelerating. A simple sound, such as a beep, immediately conveys all this information in real time. In any case, the visualization of such

graphs is a step forward compared to an endless list of numbers. So, both visualization and sonification are a way to quickly gain insight and recognise patterns at a glance.



	a	b	c	d	e	f	g
1	2	4	15	10	9	5	4
2	10	16	31	7	15	15	13
3	50	24	79	36	47	23	32
4	70	94	48	45	53	90	43
5	35	77	60	74	89	75	64
6	100	100	100	93	68	100	85
7	85	61	73	92	100	60	75
8	68	75	73	93	60	74	95
9	68	39	45	55	53	38	84
10	98	30	35	50	45	28	100
11	80	35	41	50	55	34	98
12	80	45	46	66	75	44	91
13	85	50	46	93	66	48	80
14	70	48	39	100	55	45	71
15	80	37	27	69	45	35	64
16	79	40	31	63	45	39	40
17	50	33	29	35	30	31	45
18	51	27	30	40	24	25	41
19	71	19	26	35	16	29	32
20	61	18	15	20	21	19	29
21	55	18	14	17	24	21	30
22	50	18	13	22	15	21	21
23	30	14	7	11	9	10	12
24	10	4	3	5	5	5	9
25	8	3	3	4	4	3	5

Fig. 30 example of graphic representation

There are studies that try to understand if one day we will rely much more on sound to understand things[113]. One of the most useful uses, apart from the example of medical devices, is accessibility for impaired people (another good example is the traffic light beep).

[113] Hermann T., Hunt A., Neuhoff J.G , The Sonification Handbook ed. By., Logos Publishing House, Berlin, Germany ISBN 978-3-8325-2819-5 - 2011, 586 pages.

It is an interesting way of representing data also because our ears detect much better patterns in noise than our eyes when there is a visual interference. Therefore, sonification might be more reliable for representing very complex data. But just as colours are randomly assigned to data parameters, also the correlations between sounds and data are arbitrary. Sometimes researcher create sonification of movement of planets, or sonification of firing neurons and the way this representation is proposed often leads people to fall into the error of believing that what they are hearing is how the universe sounds or how our brain sounds. Choosing which parameter of data to relate to a sound (Parameter-Mapping Sonification method) or part of the instrument that plays (MBS sonification models) is an arbitrary process that can lead to a misinterpretation of the information. It needs to be made clear that the composition just like the graph of data, is not how emotions looks like or how they sound. It is a way of reproducing the information on how energy distribution in speech is changed by our inner states. It is a way to understand this change using a direct channel such as listening rather than reading and trying to comprehend and compare long lists of data on a piece of paper. In the installation *Seams*, the composition that accompanies each 360° video is a symbolic sonic representation of how in emotions expressed in speech a modulation takes place of the overall energy of the audio itself. The composition related to the 360°video (and the emotion taken into consideration) is a way to represent how with my research process I revealed the hidden patterns that emotions impress on sound energy of voices. The musical structure emerges and manifests itself in its totality as well as, with the

analysis of the audio samples, we get to unveil the emotional patterns contained in the sound energy.

- Max/MSP patch for the distribution of soundtrack in space

For the distribution of the three composition in the acoustic space surrounding the participant I diffused the sound on different channels and therefore different speakers surrounding the person wearing the HMD. In order to make it more interactive I also projected another system in which a Max/MSP patch is involved. With this technique the cell phone inside the HMD is connected with the computer via internet connection. For this purpose, I use the data from the gyroscope of the cell phone and send them to the computer using an application that is called GyrOSC.

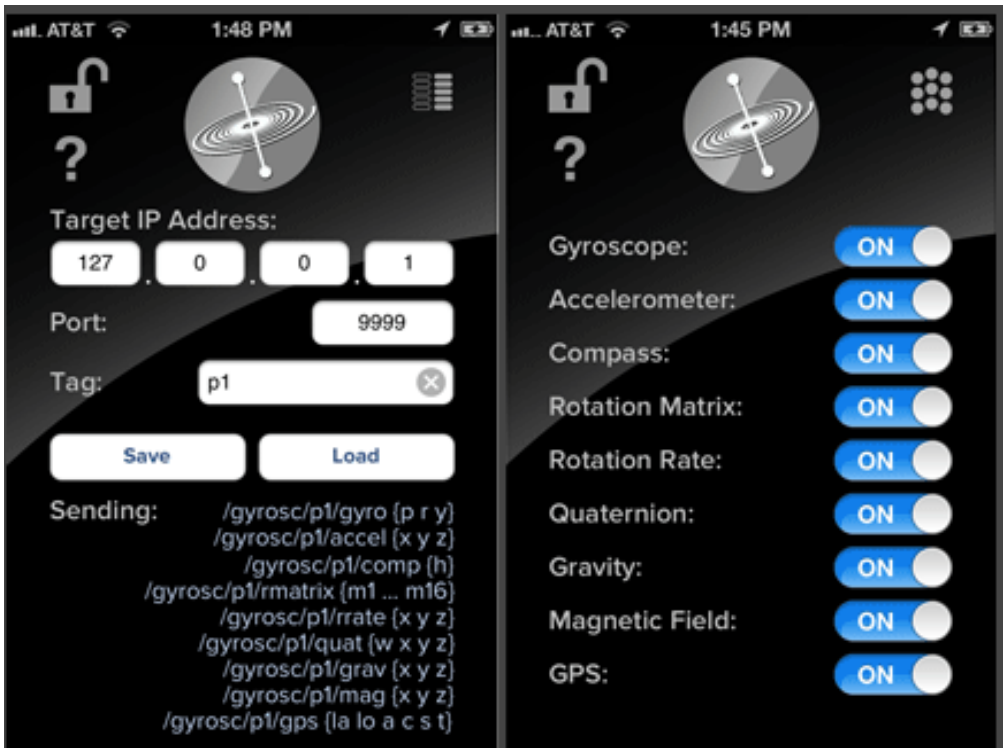


Fig.31 GyrOSC interface

GyrOSC is a lightweight utility that sends the iPhone motion sensors over the local wireless network to any OSC capable host application. This application allowed me to control the live audio with my device's built-in gyroscope. GyrOSC accesses the same raw data that iOS developers use for their applications. The sensor data is sent directly out from GyrOSC. The data rate is high in fact messages send sensor updates approximately 40 times per second for precise control.

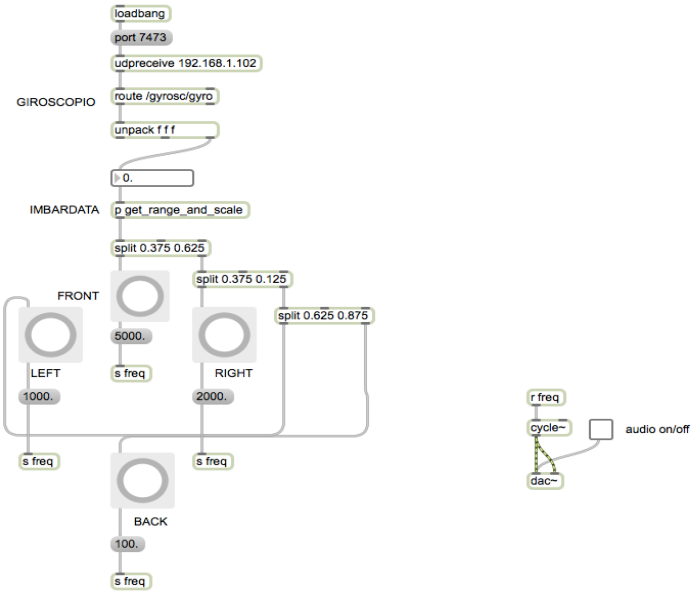


Fig.32 Max/MSP patch for distributing the soundtrack in the acoustic space around the participant

On the other side the computer is detecting the signal from the phone using the same port and IP number that I chose in the GyrOSC application. Once the signal is detected is unpacked so that the acoustic space is dived in four part: front right, left, back. The front, right and left are connected to three different composition that represent the three analysed emotion, the acoustic space in the back is

connected to a neutral composition. Both systems (or way of experiencing the sonification) create the same sense of being surrounded by sound. In both cases the soundscape changes depending towards which direction the person is turned, and the sonic space is divided in three different situations.

The use and meaning of 360°videos and VR

Following the dictionary's definition, *virtual* (in the technological domain) is something that can be done or seen using a computer and therefore without going anywhere or talking to anyone[114] and *virtual reality* is a set of images and sounds produced by a computer, which create a place or a situation that a person can take part in[115]. But more specifically the term VR is usually intended for those experiences where an artificial environment is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment[116]. According to the latter for VR we should only consider computer generated environments with digital nature (computer graphics products); the interaction and immersion in these environments should be total in the sense that the person not only can walk around but also the situation evolves in time and space depending on the user's choices.

My 360° videos instead share some features with the latter definition in the sense that people are totally immersed in the image but what they see is not explorable in the content or time domain. A person wearing goggles, watching a 360° video

[114] From https://dictionary.cambridge.org/dictionary/english/virtual,accessed 04th September 2018
[115] https://dictionary.cambridge.org/dictionary/english/virtual-realit, accessed 04th September 2018
[116] https://www.merriam-webster.com/dictionary/virtual%20reality accessed 04th September 2018

are immersed in it but cannot move or change what they see or the duration of the experience with the exception of their point of view (they can turn their head in any direction) or just taking off the equipment even if the video is not finished (without waiting for the fixed end of the experience). In this thesis I have used the terms 360° video and VR interchangeably as I think that the first definition is the most suitable for my purposes and for describing what I did in my installation. I think that shooting in 360° and seeing this video material on an HMD with spatialised sound can be considered VR in its wide sense. The fact that watching a 360° video does not allow you to change the story does not mean that you are not immersed in it or you are not interacting with the story and its content. The difference is that your movements do not generate consequences on the timeline and storyboard. As much as I wanted the participant to be part of the video I also wanted the environment to be natural, therefore computer graphics, besides falling out of my expertise, was not my aesthetic choice. I wanted to include scenes with real faces and real environments nonetheless enhanced by the immersion and different perspective that only the empowering lenses of VR can give. I chose the VR not to be completely interactive as I did not want people to have to have expertise in using such technology, and to have to explain the use or the rules of the experience. I just wanted people to keep the mystery interacting with their emotions and body in the right percentage which would have enabled them to enjoy the experience without struggling with any technical ability. In this way the amazement of observation, the magic of perceiving would have been preserved and just closeness and change of perspective was added to the "recipe" (i.e. to my usual 2d audio-visual art practice). As the artist Char Davis

states, virtual space has paradoxically many different qualities such as immersion, presence, immateriality and interactivity at the same time. But while she uses those qualities for the admirable purpose of dismantle the boundary between outside and inside ("the western worldview")[117] I use them in the attempt to enchant people and offer new ways of seeing and perceiving. VR for me means surprise and the magic of closeness, abandonment of the real perspective for one that paradoxically should be "as real" but which actually amazes us more than ours just for being of someone else (the author's one). My intentions in using VR is to give a dreaming vision that like a child's lens takes us to a different way of feeling, where the wonder, the mystic and the disorientation boosters our excitement. As Davis says the interesting point of VR and its most important power is the potential for confusion, for the dissolution of habitually conceived categories and boundaries[118].

Watching a 360° video the person believes to be in the place in which is immersed and to see the faces that are in front of her/him. It does not matter if few minutes before, without HMD, the setting was totally different or if the images they are seeing in the video are running against them while they are still on a chair; the fact that they are visually and acoustically immersed in the scene, that they can turn around and change perspective, confuses them and make them interact with the environment which seems so real although its contradictions and

[117] Davies Char. Rethinking VR: Key Concepts and Concerns, 2003, p.7. http://www.immersence.com/publications/char/2003-CD-VSSM.html Accessed 01/10/2017, 1541: By employing the medium of immersive virtual space—through its paradoxical qualities of immersence, immateriality and interactivity—as a facilitating or enabling spatio-temporal context for perceptual experience of boundary dissolution, my ongoing artistic/philosophical project is nothing short of attempting to dismantle the western worldview by dehabituating and re-invigorating our perceptions of being in the world.

[118] Ibidem: The potential for such confusion, such dissolution of habitually conceived categories and boundaries, is the source of the medium's most singular power. It is this potential which most interests me.

strangeness. I chose to limit the possibilities of interaction constricting the person in a fixed storyboard, but I did that in order to give them the possibility to free their empathy and imagination. Again, I chose the oxymoron intrinsic in the use of technology which with reduction enlarges possibilities.

On the contrary, is my opinion that giving them sensors and joystick to control the story and the environment (therefore more interaction in terms of contents and time line of the art work) would have affected negatively their sense of immersion and abandonment. The use of tools (joystick and other connecting devices) brings the participants back to their real clumsy body, banned by goggles, slowing down their dip into the “other world”. It takes time to adjust the equipment and to learn what to do and how to use it (not many are familiar with VR and games tools). From my point of view, giving space to the interaction with the story would have caused the loss of magic, that raping moment at the beginning of an art experience where you don’t know what to expect but you are willing to deep dive in it.

Description of equipment Seams

1 HMD

1 Cell phone

1 Headphone

1 iPad

1 Mac book pro computer

3 Speakers

5.3. **Description and analysis of art projects and publications during the PhD process**

The installations I describe in the current thesis draw not only on my research into others' artistic practice, but also on my own previous practice-as-research, which has many similarities with the current investigation in terms of use of technology, the focus on people's behaviours, phenomenology of perception, and the use of sense stimulation as a pivot to start an investigation into insights. Critical examination of and reflection on my practice-as-research and projects carried out during the PhD period of study is therefore essential to identify successes which were replicated, and failures which were avoided in the PhD's final project. Below I outline four previous projects: *Endless Fire* (2014), *Pieces and parts* (2014/2015), *Noyss* (2016), *RDC2 project* (2017) in full details. I briefly summarise the scope and shape of each project and then analyse them in terms of the lessons learnt and how they were applied to my last artistic case study (*Sounding Out* and *Seams*). This dissertation investigates how and if it is possible that contemporary multimedia and multisensory art practices articulate and explore the relationship concerning an individual's perception, emotions (actual or memories), their awareness (within the domain of sound and music). I could not accept a passive role for people or avoid acknowledging the influence of their actions and presence on the artwork that I was conceiving and plan to create in the future. I felt that a total connection among elements and an operational approach in which people could consider themselves as immersed participants

in the installation and not merely as observers was necessary. Emotions, in relation to sound or not, involve everyone so a study on sound and emotion could not exclude people[119] from the process of investigation and discovery.

To be able to comprehend and to go beyond my conceptions of art and performing, I have gone through many stages of creation and taken an extensive experimental approach. This process demanded challenging study of the self, modes of perceiving and being perceived, relationships with the environment and the continuous flow of different levels of sensation and awareness. *Endless Fire, Pieces and parts, Noyss and the RDC2 project*, as examples of experiments I have carried out during the years of my research, represent keystones in my understanding of what was and really is important for my artistic research process and what instead was still lacking in these works. These projects have helped me shape a better vision of how to manifest levels of consciousness and awareness in relation to memory and sensations for participants. By re-examining them I was able to identify which elements required a different approach and those that I should implement in the ultimate project.

Lessons learned from previous art projects

From these experiences, I learnt that it is better if the installation space is a single room, and preferably if people are inside it one at a time. In *Endless Fire* project I realised that the impossibility for people to understand if what they were watching on the screen was about themselves or others could have been

[119] When I say people, I intend everyone with no limitation regarding age, sex, expertise or education on the contrary of the usual target of student or selected trained volunteers in other research studies on the field.

confusing. For my last projects (*Sounding Out* and *Seams*), I decided to restrict the area of interest to the relationship between one person and one environment. The relations between more than one person and the environment is something that might be investigated in another research project or further study after the PhD stage. From *Noyss and Pieces and parts* I learnt the important lesson of just how fundamental first-person investigation, self-observation and self-perception are. As much as historical happenings were engaging, is not so easy to emphasise with a crowd and also the lack of knowledge of that specific historic event leads to impoverishment of the artistic experience for some of the participants. Third-person observation was part of *Seams* and *Sounding Out* in the sense that the outcome and aims of my research on sound and emotion were explained and discussed before and after the art experience. In *Seams* the fact that people see, and experience other people's emotions can be seen as a third-person observation but by relying on empathic process (mirroring in a one to one relationship) and VR immersion the ultimate result of the experience is a first-person overview. From the RDC2 I understood how important immersive environment are. Although the project remained a prototype, my experience of it, the writing and literature review on the filed improved my understanding and expertise on virtual reality, both in the theoretical and practical application. After passing the RDC2 stage and after deepening the topic on memory and consciousness I concluded that those topics were too far from my main expertise and culture and I would not be able to be proficient on them by the end of the PhD. Although I was fascinated by them, I decided to combine the idea of immersion and my previous project on sound. From the RDC2 studies I kept the

concept of memory related to emotions and used it in *Sounding Out* as subject of analysis, mixing this idea with the precious analysis of crowd noise. I used a similar analysis tool and I changed perspective from presenting people the analysis of something happened in the past to other people, to asking people to tell their personal stories and get emotional themselves so that their personal emotion become the object of observation. From the VR project of the RDC2 I experienced the power of being immersed in a landscape, from where I took inspiration for the 360° video in *Seams,* in which the faces with the various expressions dissolve into a landscape. As stated in the RDC2, google street view was a poor although still impressive tool to navigate landscapes, so I decided not to employ it as I did not want to use an immersive environment just to replay reality, to just give people a virtual tour in a real place. I realized that my aim was far more than give people the possibility to see a place: my true intent was to give a new perspective on observing in general. In composing *Seams*, I decided to shoot landscapes by myself so that they were moving images (more involving than just stitched pictures as in google street view) and also much more personal as they were part of my personal experience, reflecting my point of view (not a collection of material from random people and made for casual purposes). I thought that choosing a personal point of view and a narrative behind the immersive environment (instead of a casual one), was a far more powerful way to push people towards a new way of seeing and being emotionally engaged with whatever they were immersed in.

6. General Conclusions

After a series of artistic case study and projects such as *Endless Fire*, *Quanta of sound*, *Pieces and Parts*, two final projects have been created in which the main aspect of emotion recognition and expression was taken into account: *Sounding Out* and *Seams*. My original contribution to knowledge lies, on the one hand, within the function that both *Sounding Out* and *Seams* have on a person's ability to gain a better understanding of how emotions reflects on sound energy and how sound energy analysis makes the computer able to recognise what we are feeling without understanding the contents we are expressing. On the other hand, this thesis forms a valuable tool of analysis, as well as the installations that I created: *Sounding Out* is an effective setting for the live detection of emotions, it allows the use of normal persons instead of trained ones, broadly enlarging the basin from which to draw volunteers for testing the system of emotion's recognition. Also, the testing of the system of analysis with online fonts, shows that it also works on recorded live events, in which case the number of sources is even greater and gives the possibility to carry out the research by drawing on the vast world of online users.

The innovative contribution to the research in the field is making the process of analysis faster and easier by taking into consideration the only overall energy of audio signals instead of the voice features used in other studies[120]. It is also the

[120] Some articles in which is described the use of this kind of setting and tools are: Petrushin V.A:, EMOTION RECOGNITION IN SPEECH SIGNAL: EXPERIMENTAL STUDY, DEVELOPMENT, AND APPLICATION (ICSLP 2000); EmoVoice - Real-time emotion recognition from

principal reason why the recognition of emotions in a real-life setting is possible. In my analysis (which is based on the accumulation of energy) I did not have to face the problems and critical points other researchers have had to deal with, which are: using specific equipment (the quality of microphone is not determinant in my analysis process), quality of the setting (there is no need to acoustically isolate the environment) and degree of clarity in the voice emission (people attending the exhibition do not have to pay attention to the pronunciation, speed or rate of words while they are speaking, hence they do not need to be trained). Beside wanting to frame the research on emotion in an art installation environment as an artist I also wanted to present my data and research process in an artistic form rather than using conventional charts. The installation *Seams* although using known techniques and tools (sonification and VR for immersive experience) is innovative in the way it is used to present academic research data. *Seams* is original in its intentions as it aims to make data more accessible and intuitive and particularly disseminate the study not only to researchers but to a broader audience. Unlike the purely scientific approach, my artistic approach in the representation of data gives great importance to the fact that people are involved not only in the study (*Sounding Out)* but also in the understanding of the research outcomes. This multimedia project aims to improve understanding of how matter changes according to emotional states and what is going during the process by translating the data into images. To describe the use of data in my work I want to quote Lev Manovich who states in his article on data visualization,

speech https://www.informatik.uni-augsburg.de/lehrstuehle/hcm/projects/tools/emovoice/ accessed 18/may/2018, Sezgin M.C., Gunsel B.* and Karabulut Kurt B., Perceptual audio features for emotion detection Article in EURASIP Journal on Audio Speech and Music Processing · December 2012;

the quantitative data “is reduced to its patterns and structures that are then exploited into many rich and concrete visual images” (Lev Manovich: 2002[121]).

[121] Manovic L., Data Visualization as New Abstraction and Anti-Sublime, *SMAC!,* 3 (2002). Print. <http://lab.softwarestudies.com/2008/09/cultural-analytics.html>.

7. Summary and conclusions from previous projects

Endless Fire (2014)

Cephalonia – aquaponics/moist media exhibition - April 2014

In my first project, “Endless Fire”, I designed an installation in which people were both the object and subject of the situation. The project foresaw that people emotions and their manifestation through moist parameters (body temperature) were translated into sounds and images. The moist parameters captured should have changed according to the audience's sensory and emotional responses, which could be accidental or might be caused by the surrounding environment, which was characterised by synthetic (sounds, cameras), material (smells, objects) and human (performers) elements.

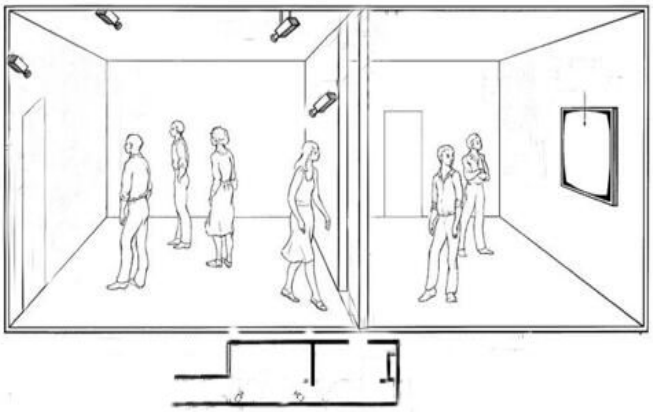


Fig. 33 Endless Fire sketch of the rooms

The project of this work was based on the assumption that emotions and perceptions change and influence the alteration of our biological parameters such as temperature. The other assumption was that what was supposed to happen in the first room emotionally would have changed people's state of mind and body and would have led to the emergence of a new layer of consciousness. The aim was to create an audio-visual work projected on a screen in the next room, that could show how the connections between perception, emotion and new states of

consciousness were visible and audible. The vision of the audio-visual work should have hypothetically affected people's consciousness and enabled them to find (see and hear) a new awareness of the trajectories of their innermost being. But then I realized that the screen would have been more a mirror than a physical pragmatic impact with the trajectories of their consciousness. First, consciousness trajectories would have emerged in the first room, so what actually could have happened in the second room was that people watched the effects of their different layers of consciousness rather than realising through their body and mind that new trajectories of their consciousness were emerging in the feedback and flow with the environment in an immersive real time experience.

Conclusion from Endless Fire

After a deep analysis of the project I decided not to go on with the realization of it although the study and the poster that came out of this research were really fruitful for my research process and future work. I think that the large theoretical research behind this paper influenced the technological choices of *Sounding Out* and *Seams* as well as the work Quanta of Sound. I realised that focusing on audio realm as well as the visual one was more effective. I also recognised that moist data collected from the body were more difficult to be collected in an art environment compared with the sonic one. In fact, the most difficult part for realising the installation was to find the right equipment and to calibrate it. The thermographic cameras besides being very expensive are also a tool that is in general used for many other purposes so I had no point of reference on matching and linking those parameters with audio and video objects that could represent

them. The processing and analysis moist of data from thermographic cameras was a complex process that was hard to do in real time and to be translated into sound and images live. Even if I would have decided to produce this work, I should have made a lot of choices to limit the parameter and amount of data coming from the cameras in order to sonify them quickly. In term of time and equipment, capturing and analysing just the sonic realm was both cheaper and easier to be taken into consideration.

Fig.34 thermography images

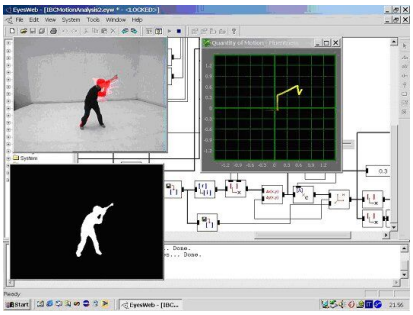


Fig.35 example of a software capturing and using images from

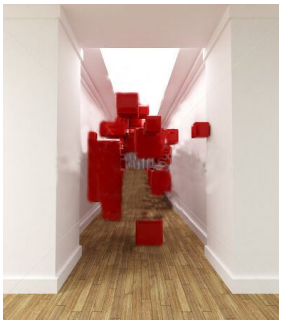


Fig.36 Endless Fire: sketch of entrance of the installation

Istanbul Pieces and Parts (2014)

Realised in Istanbul – Halka Project - November 2014

Presented at the PhD meeting in Johannesburg - South Africa and Fak'ugesi Conference - December 2014

This installation explores the relationship between the two components of memory, identity and self-consciousness. The elements of this project are: Pieces of puzzles, puzzle of myself, video of Istanbul, empty luggage, music, taste and smell. The main topic is memory. In the design process, I conducted a

literature review that led me to the statement that memory has always been associated with identity, which, as knowledge, is mostly derived from and strongly affected by the relationships we have with the environment and with people around us. The standpoint from which we come to understand ourselves and become self-conscious is mainly through our relationships with others and places, which led me to the idea that experience and memories of experience are what create us.

> *[…] Philosophers and psychologists have argued that having an understanding of who one is requires access to memories and, in particular, those relevant to our personal experiences […] Indeed, this interdependence between self and memory has been acknowledged for some time and the dynamics of this relationship are coherently summarized in the fact that 'self and memory organize, construct and give meaning to each other in a way so intimate that we can truly say that we are what we remember and that our memories are ourselves […]*[122].

Certainly, identity and knowledge of who we are and what the world is are not based entirely on our memories, and the complexity of the self cannot be reduced to just our capacity to remember. Nevertheless, memory indeed plays a very important role and every experience we collect in our brain will be a lifelong part of us. In this work, I chose puzzles as a symbol of the little pieces that are the basis of our identity; I left

Fig. 37 pieces and part puzzles of myself

[122] Haslam C., Jetten J., Haslam S. A., Pugliese C., Tonks J., *Memory and Identity*, British Journal of Psychology 2011, British Psychological Society, p. 3

puzzles incomplete because this reflected my belief that each experience is incorporated only in little separated pieces inside what I call my identity and self-consciousness. The puzzle of myself is the only one that is put together, so as to express that all our memories and experiences create the whole that we call identity. Memories themselves are randomly fragmented and kept in my personality, my background, and my culture; in a word my 'luggage'. Everything I have inside is like luggage that I bring with me; the empty luggage around the one suitcase full of puzzle pieces represents my future experiences, travels, the people I will meet and memories I will create. In my life, I have always tried to carry out empirical and spiritual research to find symbols to metaphorically express my findings or simply my experience of searching and living. The question of memory and how it is activated is certainly more complex than a collection of frozen pieces in our brains or even reducible to a simple synaptic neurotransmission. Our brain and memory system do not work in this way and memories are not fixed pieces in a static shape that, once recalled, will perfectly fit together.

> *[...] "Memories are system properties, dynamic, dependent, for each of us, on our own unique individual history. What they absolutely are not is "stored" in the brain in the way a computer stores a file. Biological memories are living meaning no dead information […] memory is an active not passive event, and draws on a variety of cognitive and affective processes"*[123]

[123] Shaughnessy N., Affective performance and cognitive science: body, brain and being, Bloomsbury Methuen Drama. Bloomsbury, London, p. 63

Fig. 38 pieces and part - puzzles - luggage

Fig. 39 pieces and part – puzzles – empty luggage - video

Hence, my choice to project pictures and videos of Istanbul. The moving images in the installation helped me represent how memory is a changing and flowing thing, just as our identity and consciousness are continuously changing and evolving. The elements of the installation - luggage, puzzles, moving images, sounds, odours - were an attempt to let people touch memories, immerse their hand in the luggage of puzzles as they could do in their past or in mine. Because this experience is only possible through metaphors and artistic representations. I wanted to recall my experience but also to appeal to the shared imaginary, cultural background and everyday life. I included the odour of coffee in the installation to stimulate and recall our sense of conviviality and hospitality, as in

almost all cultures around the world there is a tradition of offering coffee (or tea) as soon as guests come into the home. I knew that all the elements of the installation were only symbols, but what was important in this work was that all the stimuli were related to our shared background. This was a way to understand and get in contact with one concept: we all create our identity and self-consciousness in the same way we relate to self-awareness and to the world through knowledge, memories and body.

Conclusion from Pieces and Parts

The positive aspect of this project was the strong involvement of people watching the video of the city, which for part of the audience involved recollecting memories of places they had been to and for others represented new stimuli. The puzzle metaphor was successful in making people reflect on the mystery of identity and consciousness. Nevertheless, these considerations were only on an intellectual and aesthetic level, and, as much as I tried to use multisensoriality, the design of the work still lacked immersion and first-person involvement. From this experience as for the others I saved some information and elements and I excluded the others. For example, I decided to leave the multisensorial element excluding the smell and touch. I was always very interested in the multisensorial investigation but for the study of emotion and especially recognition from a mechanical and technological system simplification was an important part. I thought that any other action that could have distracted from storytelling and memory would have affected negatively my research (although being very enriching from another perspective). Instead I kept in consideration the

importance of memory, of digging inside our brain searching for our or others experience and how memories can be a strong trigger for emotion to erase. This experience thought me that people are as much touched from other people experiences as they are from their own. That is why in *Sounding Out* I decided to let people tell stories about themselves or about others (if other people stories moved them in a profound way so to be as their own). Another important element I brought into *Sounding Out* was the use of symbols. It has been hard to search for the right visual response to show to people after emotion recognition as well as which images to use in the 360° videos. From the experience in Istanbul (that was also replicated in Florence in the Multimedia festival "il corpo, la luce, il suono", Teatro dell'affratellamento, 2016) I realised that we have a very strong shared background and it does not matter if seeing a place or a face but the connection between what is shown and what we are or we remember is strong and immediate. I also decided to make a quote of the puzzle in this artwork using a puzzle video effect in the 360° to fade from the images of faces to the final landscape.

Quanta of sound (2015/2016)

Presented in Museum of modern art in Monsummano Terme February 2015 and Conservatory of Cesena April 2016 – Poster of the art project presented in ISEA Hong Kong May 2016

During my research career, I have explored a number of compositional techniques and communication strategies and in this this work I provide an overview of the multimedia installation that Prof. Alfonso Belfiore and I designed

for the Museum of contemporary art *“Mac,n”.*

Three main approaches characterize the realization of this installation:

- Reconsideration of acoustic spectrum
- Analysis and use of acoustic / electromagnetic wave phenomena
- Use of new media

There are great similarities between the behavior of electromagnetic wave phenomena and phenomena in the acoustic domain, and those correspondences inspired the work "Q" (Quanta of Sounds). The interactive installation takes as its point of origin the electricity distributed in the spectrum of audible sounds generated by the instrument (in this case the voice of audience captured by microphones), treating it and returning it with profound deviations in time and space. The energy distribution in the spectrum of the acoustic sound is its own identity, its character, a pattern that makes the event unique and unrepeatable. The patch configured with the software MAX / MSP is responsible for analysing the energy distribution (energy of sound) by dividing the spectrum in typical critical bands that are also the one with which works the basilar membrane, located in the cochlea. The energy (of the original sound) captured in the 25 critical bands is analysed and then returned in time in small packets (quanta) no longer in a synchronized manner but with appropriate time intervals that make more distinct and perceptible their presence, opening like a ray of light refracted by a prism.

Similarly, the original sound source (where the microphones/people’s voice are located) will no longer be the location (not the only one) of the "quanta of energy"

which will instead be projected in the surrounding acoustic space in every direction. Thanks to this irradiation in time and space, the energy (of the original captured sound) contained in the acoustic spectrum will be perceivable in a direct way in its essential components.

As anticipated, the energy distribution in the spectrum of the acoustic sound is its identity while the quantization process and irradiation of the acoustic energy in different time and directions provide an opportunity for exploration of the sound generated by people's voices and this process will highlighting new variations of that identity of the sound, normally trapped in the structure of the sound itself. The release of the energy within the sound and its expression through this alchemical process put in place by the new dimensions of space and time, define a new identity or better yet a different way of reading what is happening.

During the design process we considered two elements that we wanted to emerge:

- Profound involvement of the audience in an experience that was both active and passive (people should have been performers and receivers at the same time)

Accordingly, our efforts will be mainly directed to:

- Stimulate interaction through an immersive and multimedia environment

Structure and description of the installation

This installation is a project that translates data from the acoustic domain

analysing the sound energy distribution in 25 critical bands and return that energy with different locations, strength, and different time. I this installation the translation of the original sound energy is also used for matter manipulation. These data are captured from people's voices through microphones. The sound energy captured is analysed from the Max Msp Patch and the parameters of the sound are returned accordingly to the 25 critical bands filter. The interactive installation involves two different settings in the same room:

- A: The microphones in the metallic sculpture, that are used to capture the original sound energy from the audience
- B: a tank of water in which people can see matter manipulation.

The main features of A setting are:

- Input element
- Possibility for audience to choose to become the performer/trigger of the installation

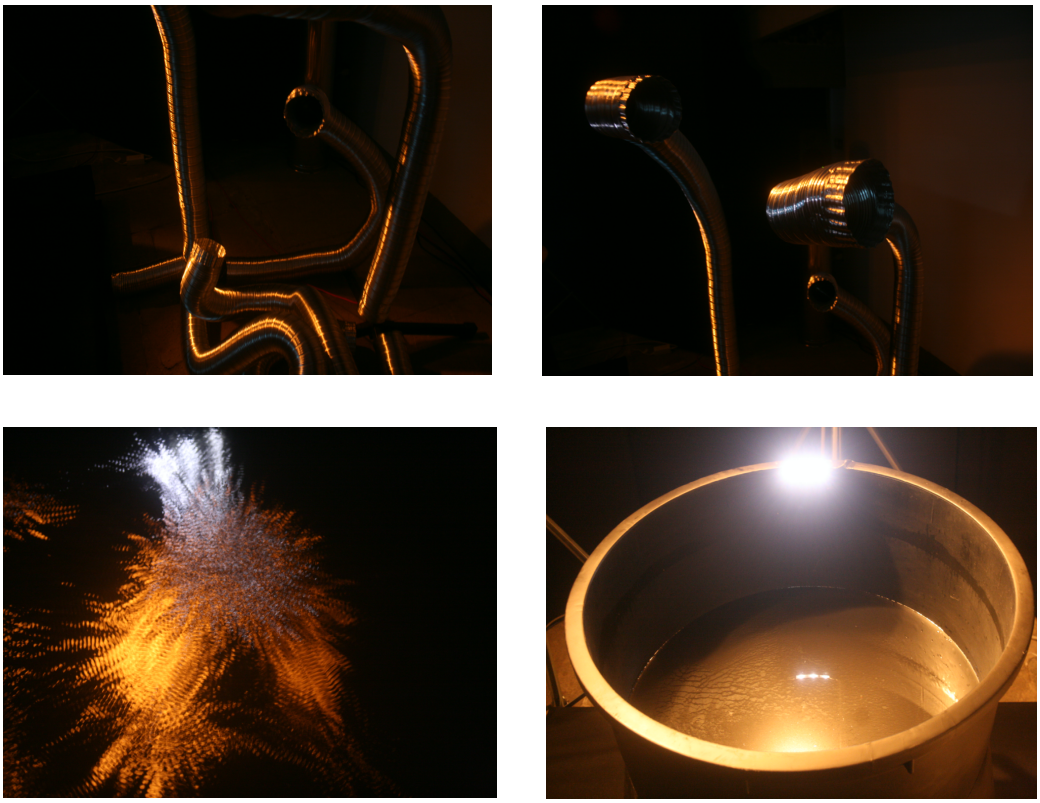


Fig. 40 – Quanta of Sound: metallic sculpture with microphone inside

- Tactile element, it is possible to alter and manipulate the shape of the sculpture in order to drive people to a more complete and corporeal involvement with the installation. The manipulation of the sculpture also produces sounds and triggers the installation so to help to skip a possible embarrassment of using the voice for some people of using.

The main features of B setting are:

- Output element
- Letting people see how the translation and delivery of quanta from the original sound energy will affect matter (water and its stationary waves).

The tactile elements are included in the installation in order to help people enter in the action. As said before people's voice or noises trigger the installation so the possibility to touch is another way of interaction in the installation, rather than just using voice. Farther more the water in the tank makes possible to visualise the control and expansion in time of sound, manipulated by the algorithm running in max msp. People can move in the space and listen to the manipulation having their voices back in the room with different timing, energy and location, but they can also see these changes on the surface of water, they can see how the manipulated sound sent to a speaker underwater will create visual effect on the surface of the water.

Technical description "risonatore6-bis"(Max Msp patch)

The patch for MAX / MSP, "risonatore6-bis" has been designed specifically for this work with the intent to develop sound events from an acoustic source, in this case the audience's voice, returning in real time the product of the processed performance (while also recording the audio samples on separate tracks and synchronizing all the sound material generated by acoustic source for any subsequent use). The patch works similarly to an optical prism, capable of separating into its constituent colours a ray of light that passes through it, revealing the spectrum. It analyses the sound stream that passes through it and detects the distribution of acoustic energy along its spectrum, packaging this energy in 25 "zones". Those zones evoke the critical bands that according to the model of Eberhard Zwicker (who structures the ear with 24 critical bands for frequencies below 15 kHz while a twenty-fifth band collects interval 15 – 20 kHz).

Physiologically each critical band has a length of 1.3 mm in the cochlea (basilar membrane / organ of Corti) corresponding to about 1300 hair cells. The process of developing acoustic energy thus takes place in the patch mainly through two processes:

a) The granulation that is a fragmentation of acoustic energy (grains) developed in the time domain (vertical strip).

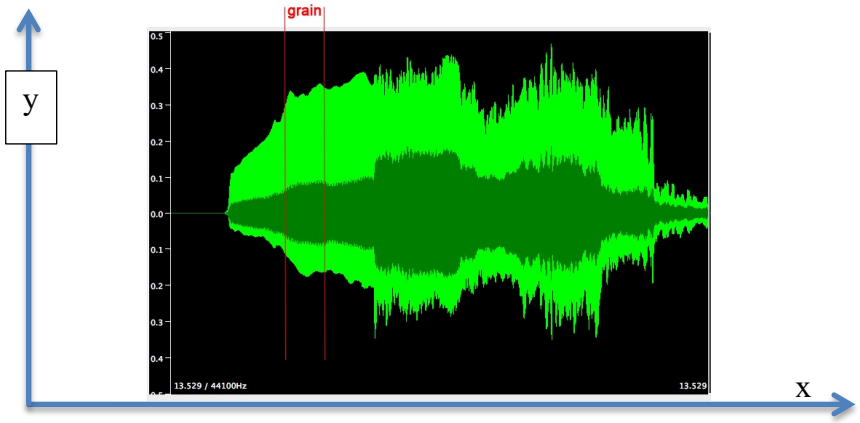


Fig.41a – Quanta of Sound: In the granulation process the grain of energy is extracted in the domain of time (Y-axis shows the amplitude of the energy while the x-axis is expressed time)

b) The analysis of the energy distribution in the spectrum marking acoustic energy found in each frequency band and producing a fragmentation of acoustic energy (quanta) in the frequency domain (horizontal band). The patch has different functions described below, the various commands and objects MAX / MSP were ordered into 8 areas, graphically highlighted by rectangles with pink background marked by a number between 1 and 8.

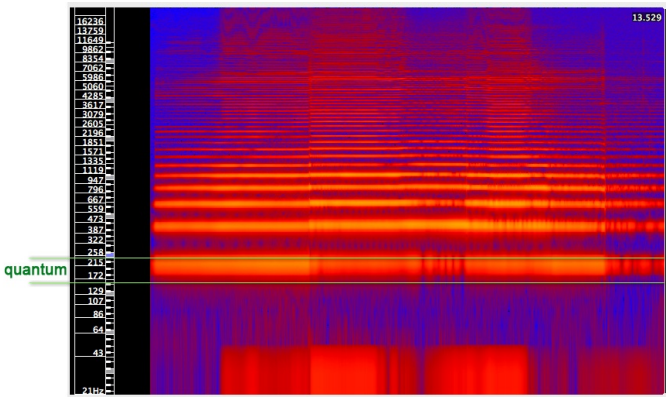


Fig. 41b – Quanta of Sound: In the quantum process the quantity of energy is extracted from the sound flow in the domain of frequencies. (Y-axis shows the frequency in Hz, the colour in the interval blue/red-orange expresses the amplitude of the energy -blue pianissimo and red-orange forte- while the x-axis expresses time).

Area1

In this area are the main options for determining the type of source that will provide the input to the patch:

1) Source: Sound files (you can use a previously recorded audio file as the source

Fig.42 General scheme of the patch

of the sound flow, useful for testing or for use in a non-participative installation)

or

• Source: Oscillator (useful for calibrating the system)

• Source: ADC (input) (input for the acoustic signal from a microphone or from an audio system, useful for a live performance)

• Source: Noise (useful for calibrating the system)

2) the object send~ sound1: has the task of sending the sound flow to all objects of the patch arranged for its processing

3) the sub-patch "p pansound": has the task of dealing spatially flow signal by creating a 'virtual image of the oscillating position of the source at the centre of the stereo using a random engine for the calculation of the factor of spatial extension.

The location of the acoustic source will appear as a continuously oscillating movement controlled in speed and in amplitude of oscillation.

Area 2

In this area there are three screens showing the flow of the audio signal at various stages of its progress within the system. The first display on the left shows the spectrum of the acoustic signal at its input (the original signal), the central display shows the spectrum of the energy extracted from the acoustic signal by the resonator, the display on the right shows the global emission of the analysed energy and delivered with a phase shifts (delays) introduced by an algorithm that takes its range of values from the input in Area 3 of the patch. For each representation of the signal also undergoes an appropriate amplification in order to highlight the acquired differences.

Area 3

In this area you can specify the factor "time stretching" by selecting the range of delays in the energy detected by each resonator that will be returned.

Area 4

In this area organized in a matrix of 5x5 are the modules of the 25 resonators.

Area 5

The area 5 of the general panel of the patch collects the objects of MAX / MSP for the creation of an AUDIO MIXER to which converge the various audio signals processed by the patch.

Area 6

The area 6 contains three sub-patches specialized in the functions of granulation of the sound flow and in pre-fader and post-fader multi-track recording of all the material prepared by the patch including the original sound.

Area 7

The area 7 contains a useful structure for storing settings panel General of the patch. The settings are so stored and recalled simply by clicking on the numbered circle in which it was previously stored.

Area 8

The area 8 of the patch contains a sequence of "LED" for each of the 25 resonators; the lightening occurs when the threshold exceeds.

Conclusion from Quanta of sound

This installation was a milestone for the realization of *Sounding Out*, together with the project Noyss. The most important elements that I conveyed in the last installation of my PhD research are:

- Include people in the process of the production of sound samples
- Analysis of sound samples in an artistic though natural and spontaneous environment
- Use of sound analysis to trigger a response from the system
- Use of sound energy as a good parameter to analyse for the understanding of sound nature
- Produce a physical and visual output so that the process of analysis could be visualised and understood from participants (i.e. translating the patch process and data collected in another medium)

Starting from these points I then investigated more on the fact that people vocal expressions changed the patterns in sound energy, but I realized that in order to underline this process I should have set a specific topic to explore. I realized that random speech was not the direction I should have followed if I wanted to work. So, I decided for the future works I decided to use audio samples whose content were not neutral but about emotions. As I stated many times I was always interested in emotions and in their connection with sound which has been the most important element of my artistic expression throughout my creative career. Moreover, I learned, from several reading about automatic recognition, that restricting the field of action, (i.e. the contents to be expressed) would have been helpful in the analysis by a computerised system. The samples in Quanta of

sound were too wide-ranging and it was not possible to create a coherent database. Similarly, the outcome, the artistic product, reflected the lack of coherence in the vocal expression. While, on the one hand I moved away from this project restricting the field of action of people as well as of the system, on the other I kept the idea that what happens in the installation and all data collected can be translated in another form so to show in an artform the outcome of the research project and of what was happening in the physical realm as a reflection of our inner state.

Noyss (2015/2016)

Plymouth presented during the PhD meeting and at "The undivided mind" conference - July 2015

In a subsequent effort searching for manifestations of emotions I thought that confronting people with a very moving situation which was collectively shared and known would create a stronger and more direct opportunity for people to grasp and understand new layers of consciousness and different ways and channel that we use to process and manifest emotions emerging at those moments. In this project I analysed the recordings of important historical events such as the fall of the Berlin Wall, funerals of important people or significant speeches like that of Martin Luther King. Contemporary science says everything is energy, so layers and trajectories of emotions should also be trackable in the changes of energy. Using the algorithm designed for *Quanta of sound* through which I could decode

the 'tremble' of the moment from the noise of the crowd, and by which I could extract from the audio track of these great events for which emotion had revealed a different level of emotions according to the course of time. In this specific case, I wanted to transcribe a type of trajectory of the collective emotion of the crowd. This project seemed much more engaging because certain events, though they have not been lived by us personally, affect us considerably; I thought that the traces that changes of emotional states would leave on sound energy would be very significant when transcribed in audible form. The algorithm in fact worked so as to make integration of the energy of the audio signal and returned a precise drawing of the event after analysis. The next step was to translate data into the sonic domain, by applying the data to white noise filtered following the parameters of the behaviour of energy. In this way the outcome was a sonification of the manifestation of emotions and collective emotion of events. Each event produced a different coloured noise. However, even this step was not very effective.

Conclusion from Noyss project

As charming and engaging the idea of describing the emotions of people at a very exciting event in world history was, it still did not involve the first person. Besides, talking about aesthetic the automatic production of noise filtered following the percentage extracted from the noise analysis was not a beautiful outcome. As much as the sonification could have been considered valid in the sense that was reflecting the data and translating it in a different media, it did not express my aesthetic or any aesthetic at all. Being researcher in the art field,

beauty (even if is always subjective) could not be left aside or ignored.

Regarding the first-person experience of the installation with this project I stumbled back onto the problem of observing the movements of emotions and the fact if I would have realised this installation, the need for people to experience them in their own skin was still not fulfilled. In this case also, the emotions that were placed at the centre of the project were not those of the participants, but of people who were not present at the installation. Therefore, compared to E*ndless Fire* I had moved slightly further away from people, because the feelings under analysis were not those of the people participating. On the other hand, by analysing important historical events I had the correct intuition and was able to successfully approach the concept of changes in energy levels during emotional states. Through studying energy at very emotionally engaging events, I was able to understand how important this element was. Consequently, for the final installation, to strongly disclose the movements of emotions and their recognition, what I needed was precisely magnification and involvement bringing participants to try to experience emotions and perception. In the exceptionality of the event the modification and new trajectories of emotions and the consequent modification of energy are also expanded.

This second project on the emotions in crowd noise made me realise how important spectacularising was for my future work. Another important lesson was that equipment, recording quality and sources do not alter the process of analysis of the patch. Taking into account energy was a good intuition and the fact that this parameter was not influenced by noise or other elements, led me to the use of online sources as starting point of *Sounding Out* project. Searching for the

recording of important historical moments I also came across to a lot of people telling their story online that is how I started collecting them and creating the base of what in the future project would have become the “corpus of emotional data”.

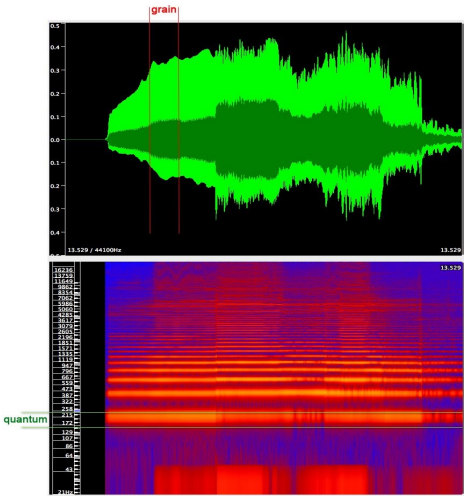


Fig.43 – Quanta of Sound: Analysis of sound

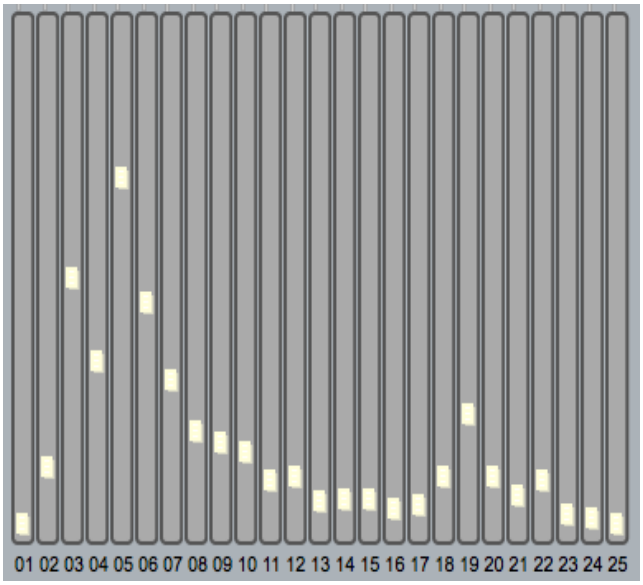


Fig.44 – Quanta of Sound: analysis of energy in a voice reading a text

RDC2 Project (2016/2017)

Starting from Edelman's model in this project (just theoretical, a prototype presented for my RDC2) I wanted to investigate the effects of perception, emotions and memory on behaviour and aspects of consciousness states and self-consciousness. One of the components of the investigation was HMD (head mounted display), which immerses people in an audio-visual environment with which they will interact. The project of the installation aimed to provide participants an immersion in a specific place (a square, a street, a landscape seen through goggles) and the same place should have been experienced by people that have been to the place previously and by people who have not.

Aims of the Installation

By giving people the possibility to be immersed in places using virtual reality I planned to investigate how moving in such spaces could change if this experience is accompanied by memories. My point was to understand if awareness of places and the level of consciousness in a given situation (i.e. being in a square or in a street in a specific city) was influenced by our memories of past experiences in the same place. The question on which the prototype was designed to pivot were:

- Do memories and emotions associated with those memories influence self- consciousness and perception of the environment?
- Do immersive sound and images enhance this process of investigation?

The installation project was designed as a room in which people could have moved freely. Each person enters the room alone and wears HMD, on which a

location is screened. At that moment, I planned to use Google street view, which gives viewers the possibility to see places all over the world and to move around their chosen place.

fig.45 Google street view from cardboard
(https://www.flickr.com/photos/chijs/24967114271-

For the audio part of the work, in different corners of the room there should have been speakers to create different audio environments so as to create a mixed reality (virtual and real). The goal was to record people's movements, which afterwards would have been analysed in relation to what they were seeing and to the different audio areas. People's movements (recorded on video or through pressure measurement systems for foot mapping), together with interviews, would have helped me understand if and how audio landscapes and immersive imaging influenced people and if their self-consciousness and awareness were altered and/or enhanced by the interactive situation. In addition to the immersive stimulation, I wanted to detect the importance of remembrance in the process.

To do so, I would have examined the influence of memories during the experience of people who have already been to the places screened on the HMD, in contrast

with the control group (people that have never been there). The installation was a prototype, but I have conducted experiments on a sample of people (including myself), without making recordings or official interviews. In the project, I planned to shoot my own video of the places that I wanted people to experience. This was because street-view is designed only for static images (pictures in a seamless panorama form) while I wanted to create a more involving situation by providing people with a cinematic VR situation, i.e. to immerse them in a video rather than a picture. After recording and collecting data from people participating in the installation, the intention was to look for indirect evidence of relations between elements in the installation, by analysing the interviews but also recordings of movements, timings, and similarities in the behaviour of people exploring the installation.

Conclusion from RDC2 project

From this research project, although only theoretical I have gained many insights. The main poit I decided to include in the next project were:

- The VR technology (visual immersion)
- Immersive soundscape
- Recording of data from the participants in order to analyse and compare the results

Although the experiment carried out during the design process of the RDC2 project were informal I realized through this practical experience that 360° video

is a valid tool for understanding and processing information in a very direct and deep way. I then decided to use the VR as a representation of results rather than as part of the process of triggering emotions and memories. But apart from the change of usage the VR remained a big part of my PhD research. I kept the idea of making my own video as in fact static images are less involving that moving video and audio landscape. Another element that was important is the fact the use of memories as booster for emotion externalization. Instead of showing people places that were connected to their memories in *Sounding Out* I asked people to express memories (stories) about their emotions. As in Endless Fire also in this installation the parameter tracked are different. As stated before after studying the possibilities to use body parameters such as temperature (Endless Fire) and foot pressure (RDC2 project) I then decided that voice was the most direct and easy way to have live data from the participants, both in terms of equipment used and of time.

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APPENDICES: PREVIOUS RESEARCH IN DETAILS AND PUBLICATIONS

Pieces and parts – installation

Exhibited in Istanbul October 2014 and Florence 15th -20th March/ 2016 Il corpo la luce il suono festival

PIECES AND PARTS, multimedia installation by Paola Lopreiato

We see only in parts / the flash of a tail, the beating heart / in Pieces and Parts / And there may be a few things you can't recall at all / And you're in pieces and part / Pieces and parts. *(Revised text from the song "Pieces and Parts" by Laurie Anderson)*

The present installation explores the relationship between the two components of memory and identity. Memory has always been associated with identity that, as knowledge, is mostly derived and strongly affected from the relationships we have with the environment and with people around us. The standpoint that we come to understand ourselves mainly through our relationships with others and with places brought me to the idea that experience and memories of experience is what create ourselves as a whole.

[…] Philosophers and psychologists have argued that having an understanding of who one is requires access to memories and, in particular, those relevant to our personal experiences […] Indeed, this interdependence between self and memory has been acknowledged for some time and the dynamics of this relationship are coherently summarized in the fact that 'self and memory organize, construct and give meaning to each other in a way so intimate that we can truly say that we are what we remember and that our memories are ourselves

[…][124].

Certainly, identity and knowledge of who we are and of what is the world is not based entirely on our memory and the complexity of self cannot be reduced to just capacity of remember, but nevertheless, memory has indeed a very important role and every experience we collect in our brain will be part of us for our lifelong. I chose puzzles as a symbol of the little pieces that are at the base of our identity. In puzzles, as we all might know, the whole picture is fragmented in little pieces that are meant to be putted together in order to create over the original photograph. In my installation I am not putting together the pieces; I leave puzzles undone because this reflects my belief that each experience is incorporated only in little separated piece inside what I call myself. For instance, when I visit a new place, as my experience in Istanbul, I make a memory of the city but it does not means that I have stored a complete picture of the place itself. Inside myself the memory of the city is made of little pieces not even in the original order but randomly kept in my brain and composed by little fragments like a smell, a sound, a colour, a shape or a glimpse of landscape. On the other hand, these little pieces are making a picture, but is the image of myself. The puzzle of myself is the only one that is putted together to express that all our memories and experiences create a whole that is what we call identity. Memories themselves are randomly fragmented and kept in what is my personality, my background, and my culture, in one word my luggage. Everything I have inside is like a luggage that I bring with me; the empty luggages around the one full of puzzle's pieces represent my

[124] Haslam C., Jetten J., Haslam S. A., Pugliese C., Tonks J., *Memory and Identity*, British Journal of Psychology 2011, British Psychological Society, p. 3

future experiences, travels, people I will meet and memories I will create. In my life I always try to carry out an empirical and spiritual research and try to find symbols to metaphorically express my findings or just my experience of searching and living. The question of memory and how it is activated is certainly more complex than being a collection of frozen pieces in our brains or even reducible to a simple synaptic neurotransmission. Using pieces of puzzle as symbol of our memory has advantages and limitation in the attempt to help understating memory and identity in a metaphorically way. Actually, our brain and memorizing system does not work like that and memories are not fixed pieces in a static shape that, once that are recalled, will perfectly fit together.

[..]"Memories are system properties, dynamic, dependent, for each of us, on our own unique individual history. What they absolutely are not is "stored" in the brain in the way a computer stores a file. Biological memories are living meaning no dead information […] memory is an active not passive event, and draws on a variety of cognitive and affective processes"[125]

Hence comes my choice of projecting pictures and videos of Istanbul. The moving images in the installation helps me represent how memory is a changing and flowing thing as much as our identity is continuously changing and evolving. The elements of the installation, luggage, puzzles, moving images, sounds, odours are an attempt to let people touch memories, immerse their hand in the luggage of puzzles as they could do in their past or in mine. Because this experience is

[125] Shaughnessy N., Affective performance and cognitive science: body, brain and being, Bloomsbury Methuen Drama. Bloomsbury, London, p 63

only possible in metaphors and in artistic representations, I set a place and time in which people can come in and try what is not possible in real live: try to access through their senses what is inside them and inside me. I wanted to recall my experience but also to appeal to the shared imaginary, cultural background and everyday life. I included coffee's odour in the installation to stimulate and recall our sense of conviviality and hospitality; in almost all cultures around the world there is a tradition of offering coffee (or tea) as soon as guests comes into the house. It doesn't matter if is Turkish or Italian coffee, it doesn't matter if is only metaphoric and I am not able to really touch my history and memory, but what is important is that all this stimuli are in relation with our shared background, are a way to understand and get in contact with one concept: we all create our identity in the same way and that we relate to identity and to the world through knowledge and memories from our mind and body.

Fig. 46 Brochure of Pieces and Parts exhibition

RDC2– essay, installation's project

Approved January 2017 (examiner: John Matthias**)**

My research practice intends to introduce new data so as to inform and hopefully clarify how memory and phenomenological perceptions influence consciousness. Since it is currently impossible to solve and explain why consciousness accompanies human beings' every experience and action, I think it is important to engage people in this research and observations. Being conscious a problem that should include first-person observation, it is important to me that everyone participating is aware of the research and progresses in the field of consciousness. Including people and using art as an investigative tool can provide a new impulse and perspective to the research. The fact that awareness, memories and perception, as well as feeling and emotion, accompany experience and emergence of different states of consciousness is useful to the survey on consciousness and its emergence. To date, there are no artworks that investigate the influence of memory on consciousness. There are, however, several artworks that can be included in the following categories (I will propose examples of artworks in these categories in future chapters and explore this topic in greater depth):

I) Art referencing science

These works are informed by research but have no aim to be scientific or use scientific methods in their design or fulfilment.

> The artworks do not need to be a kind of research themselves, nor do they have to adhere to certain scientific standards. The concept describes art with research - not in the sense of art understood as research, but rather by recourse to scientific research[126].

II) Art about research

This kind of artworks start from scientific research:

> It includes works that focus thematically on research and its genuine procedures and conclusions (…). Here, science is translated into art and artistic knowledge is generated about sciences — without admitted scientific methods being claimed for art, to the extent that scientific claims to truth and objectivity are qualified by artistic reflection[127].

At the moment, in the field of memory related to consciousness, there are not works that fall into the category of art *as* research, although many practices based and practice informed PhD studies are focusing on consciousness from other perspectives. I consider my artistic practice to be of a "art that understands itself as research". In my case research is part of the artistic process and is new knowledge in itself. My installation is not just a matter of integrating scientific concepts, tools and discoveries in its constitution: I am creating new content and producing new knowledge about technologically mediated process of memory

[126] Bush K., ART&RESEARCH: A Journal of Ideas, Contexts and Methods. Volume 2. No. 2. http://www.artandresearch.org.uk/v2n2/busch.html, Spring 2009, accessed 15th February 2017, p.2

[127] ibidem: Research is considered a part of the artistic process and is carried out by the artist herself. In this case, art is in fact a form of knowledge. It becomes the site of knowledge production and does not restrict itself to integrating previously known concepts. This can be considered a radicalization of the first constellation of art and science mentioned above, whereby theory is now interpreted as a constitutive element of the artistic practice itself, and scientific methods of research and knowledge generation enter into the artistic process

and consciousness. Elements such as interviews, data collation and qualitative analysis are scientific methods that will become part of my investigation[128].

With this research, I am not able to explain consciousness, nor provide a tool with which to navigate the various levels of consciousness. Instead, as rituals and plant technologies navigate first-person experience and neuroscience investigates the physical correlates of consciousness, I shall add an artistic tool for investigating the same issues. The fact that is still not possible to explain consciousness in physical or psychological terms does not mean that studying issues related to consciousness is not a valid way to find out more about it, and possibly in the future to be able to have a theory to fully explain consciousness. The installation starts from a set of elements, but is designed to develop gradually, adding new parameters to the research. At the moment the elements being considered are:

- virtual reality (audio-visual)
- memory
- environment
- perception of environment linked to memories

With virtual reality, I intend to involve people and their first-person experience to say something about memory and perceptual processes correlated to conscious states. This topic should not only be studied with scientific tools such as MRI, since so far, the results have demonstrated that NCC are insufficient for a theory

on consciousness. Therefore, introducing virtual reality and its immersive nature, can provide new input to what we can discover, using quantitative analysis.

> Another known physiological theory of consciousness has been outlined by Gerald Edelman in the Remember Present (1989) and other books and articles. The central element of his theory involves re-entrant neural circuits by which person perceptual signals can conceptually categorised before they contribute to memory. *Perceptual information and internal state interact in a subtle way to give rise to primary consciousness* [emphasis added]. His model a "higher order consciousness" brings a new memory element through "semantic bootstrapping" which yields concepts of the self, past and, future. All this is linked to language production to Broca's and Wernicke's areas. Much of Edelman's work is devoted to the explanation of perception, memory, and language, rather than of consciousness. Insofar as it is devoted to consciousness, the discussion is often vague, but it seems that what ultimately might be explained by this sort of model is perceptual awareness – that is the effects of perceptual processing on later processes and on the control of behaviour - and aspects of self-consciousness, especially the origin of the concept of the self[129].

Although it may be true that Edelman's explanations of how consciousness emerges are vague, this does not mean that research in this direction is useless or incorrect. I believe that every researcher can construct, albeit in their elusiveness (as Chalmers states), new information and new ideas to address

[129] Chalmers, D.J., The Conscious Mind: In Search of a Fundamental Theory, 1996, Oxford University Press, New York p. 116

such a complex topic, because before understanding why consciousness emerges we must explore what it is linked to and to which psychological and phenomenological events it is related.

Besides the fact that I am an installation artist, the choice to produce an installation as an investigative tool was also determined by the nature of the research topic itself, which straddles the concrete and the ephemeral. As mentioned previously, the embodiment and the strict connection between body and mind is a key element in the arising of consciousness (Varela/Thomson 1991; Damasio 1999; Noë 2010). Expanding the awareness of changes in our conscious state through its relationship with behaviours, memory, immersive environment, perception, feelings and decision-making leads inherently to the need for a practice to support this intent, as these relationships all occur in a physical reality (including the brain as the body part in which mental processes take place). Not being a scientist or a psychologist, I will concentrate on the artistic practices, although I am nevertheless inspired by my reading on the practice implemented by Damasio in the field of emotions and decision-making, by Proust in the field of memory and remembrance and by Jung in the field of images and symbols (objects, mandalas or rituals) used to investigate interiority and to search for 'what is already in our consciousness and what still has to become[130]. In the field of psychology, I will also include the contribution and analysis of an expert in the field of virtual reality related to psychology.

[130] Jung C.G., L'UOMO E I SUOI SIMBOLI, Tascabili Editori Associati , Milano 1991., Titolo originale "Man and his Symbols". Copyright © 1967 by Aldus Books Limited, London., Traduzione di Roberto Tettucci, Edizione su licenza della Longanesi & CI: In these remarks, there are two equally important aspects of the symbolism of the mandala. The mandala artwork is to keep close - exactly in order to restore a previous order. But it also has the creative aim of giving expression and shape to something that to this day doesn't exist, something new and unique. The second aspect is even more important than the first, but does not contradict it. Because, in most cases, what is to restore the old order, involves simultaneously some new creative element.

I decided to leave the practice as one of the last tasks to complete because I believe that first obtaining a strong background in literature and in exploring and comparing my artistic practice with contemporary artists was important to better contextualise what I aim to do. Below, I will present my installation and detail the aims, methods and ideas which shaped it.

I first provide an "*Explication*", which is *what* I want to explain and investigate. In this section I will also describe the aims of my installation.

Subsequently I will give an "*Explanation*", which is *how* the research aims will be satisfied. In this section I detail the form of the installation, how I want to pursue my aims and goals, and describe the different stages of the creative process, data collection and methods of data analysis.

"**Explication**"

Starting from Edelman's model I investigate the effects of perception and memory on behaviour and aspects of consciousness states and self-consciousness. One of the components of the investigation is HMD (head mounted display), which immerses people in an audio-visual environment with which they interact. People are immersed in a specific place (a square, a street, a landscape seen through googles) and the same place will be experienced by people that have been to the place previously and by people who have not.

Aims of the Installation

By giving people the possibility to be immersed in places using virtual reality I will investigate how moving in such spaces changes if this experience is accompanied by memories. My point is to understand if awareness of places and the level of consciousness in a given situation (i.e. being in a square or in a street in a specific city) is influenced by our memories of past experiences in the same place.

- *First question:* Do memories and emotions associated with those memories influence self- consciousness and perception of the environment?
- *Second question:* Do immersive sound and images enhance this process of investigation?

The installation consists of a room in which people can move freely. Each person enters the room alone and wears HMD, on which a location will be screened. At the moment, I am using Google street view, which gives viewers the possibility to see places all over the world and to move around their chosen place.

Fig.47a google cardboard

Fig.47b Google cardboard viewer
https://commons.wikimedia.org/wiki/File:Google-Cardboard.jpg

For the audio part of the work, in different corners of the room there will be speakers that create different audio environments so as to create a mixed reality

(virtual and real). The goal is to record people's movements, which afterwards will be analysed in relation to what they were seeing and to the different audio areas. People's movements (recorded on video or through pressure measurement systems for foot mapping), together with interviews, will help me understand if and how audio landscapes and immersive imaging influenced people and if their self-consciousness and awareness were altered and/or enhanced by the interactive situation. In addition to the immersive stimulation, I want to detect the importance of remembrance in the process.

To do so, I will examine the influence of memories during the experience of people who have already been to the places screened on the HMD, in contrast with the control group (people that have never been there). The installation is currently a prototype, but I have conducted experiments on a sample of people (including myself), without making recordings or official interviews. This is because the system is not finished yet. The use of a cardboard viewer and street-view software is not the final setting of my installation. In the project, I will aim to shoot my own video of the places that I want people to experience. This is because street-view is designed only for static images (pictures in a seamless panorama form) while I want to create a more involving situation by providing people with a cinematic VR situation, i.e. to immerse them in a video rather than a picture.

This choice to shoot video was made first of all because there is currently no platform or any availability of moving images and videos of this kind. Google has designed a new tool for travelling around the world (Google earth vr) but it is

expensive (it is sold as a videogame) and although movement around the world is more fluid and similar to life (except for the flight mode) and the 3D feature is much more accurate, is still made from pictures and thus too aseptic and detached from reality for my scope[131].

On the other hand, shooting my own film will have a downside as well. There will be people and things that will not move or change their trajectories when the person testing the installation 'passes by', so there will be a sort of “ghost effect”, i.e. the action in the world around ignores you (Google earth and street view would have the same problem). Nevertheless, it is a live place with people moving and acting in day-to-day ways consequently is more involving than a world made from still images, which may be more synchronised but is less vibrant. Furthermore, film history teaches us that people have strong empathy mechanisms so the lack of certain relationships between their movements and the video they are watching will not be so detrimental as it may seem (I will explore this point more depth in future chapters). Another reason for making my own footage is that I want to show a specific location. My installation has, moreover, sociocultural purposes and even if there could be many uses of my

[131] Machkovech S., VR’s killer app has arrived, and it’s Google Earth: Squishy geometry aside, you won't find a cooler free VR app on any device. Sam - 11/17/2016: *Google Earth VR* (…) I launched the app while floating high above the planet Earth and was instructed to use the Vive wands to move around. One button zoomed me closer, while another let me "grab" the planet and reorient it. I used these motions to spin the globe towards North America, then the USA, then Washington, until I was close enough to trigger a perspective shift. Before, I was looking down from a bird's eye view; now, I was more level, like a guy in a jetpack flying over a city and checking it out. With a few more taps, I was no longer flying; I was on ground level at "average adult height." This is where *Google Earth VR* gets cool. (…) Some of *Google Earth VR*'s content looks really, really crappy, though. Squishy geometry and fuzzy textures will make some of your favourite real-life locations look like they've been ripped out of an N64 game. (…) (Be warned: this level of detail does not apply to much of the non-Western world within *Google Earth VR*. You'll have a lot better luck finding fully rendered geometry in American cities than in others.). (…) The worst aspect of *Google Earth VR* in its launch state is an inability to type in cities, landmarks, or other custom coordinates. If you want to go to, say, your childhood home in VR, you'll have to grab the planet yourself and pick through roads, landmarks, and terrain until you find the old homestead at 227 Charleston Avenue. In my case, I struggled to find my childhood home for a while (…) *Google Earth VR* displays city names and landmark names, but roads and smaller details go unlabeled. (…) That hindrance, and the fact that some content renders quite weirdly, are worth tempering expectations over. The Statue of Liberty and Fenway Park are not perfect replicas here. But even these feel cool to fly over and walk through, and you can warp between them and far more convincingly rendered outdoor scenes with just a few clicks

work, for now I am targeting the project at a specific group of people: expatriates. Topics such as memory and place and awareness of emotions and perception are closely related to the experience of emigration. I myself have experienced the emotions and feelings of living in a place that was not my hometown. My PhD has taken me and my artistic practice around the world. The history of my family is marked by departures and returns from distant lands, and the stories of relatives who have emigrated are very much a part of my history and who I am. For these reasons, I have decided to choose two specific groups for my research:

First group: emigrants which see in HMD places already known to them and which they had to leave

Control group: generations of children and grandchildren who have never been to those places

“Explanation”

After recording and collecting data from people participating in the installation, I will need to look for a connection between my statements and the practice: a proof of concepts. There is no direct evidence that memories and an immersive environment can alter or enhance our understanding of self-consciousness and how consciousness itself arises, due to the fact that it is an inner experience and thus difficult to share and observe. To address this problem, I have chosen to base my research on the principle that verbal reports are indicators of the actual experience, on the principle ‘that people's reports concerning their experiences by and large accurately reflect the contents of their experiences’ (Chalmer: 1996). Though I cannot prove that this is the case, in doing so, I am drawing on the fact

that most researchers base their studies on the plausibility of this principle. I will rely on reports of people's experiences, extract evidence of correlation between memories, perception, emotions and consciousness states from their descriptions. As Chalmer states, by following this principle we can obtain a significant amount of data and can use both first-person and third-person information:

> This is not a principle that we can prove to be true, but it is antecedently much more plausible than the alternative. This plausibility is based to some extent on an inference from our own case, but it also has the character of a methodological constraint in developing a theory of consciousness. If the principle turned out to be entirely false, all bets would be off: in that case, the world would simply be an unreasonable place, and a theory of consciousness would be beyond us. In developing any sort of theory, we assume that the world is a reasonable place, where planets do not suddenly pop into existence with fossil records fully formed, and where complex laws are not jury-rigged to reproduce the predictions of simpler ones. Otherwise, anything goes. With a plausibility assumption such as this one in hand, we have a very useful constraint on a theory of consciousness, and indeed a rich source of data even from the third-person case: to find out whether someone is consciously experiencing a stimulus, just ask them! This principle allows us to draw much stronger conclusions about the association between conscious experiences and their physical bases. Of course, the assumption is so plausible that researchers rely on it all the time, and few would think of

> questioning it. Furthermore, I can also rely on the correlation and coherence between the conscious and the cognitive. Usually when people have a sensation or a feeling, they are actually experiencing it. When I judge that I am having an auditory sensation, I am usually having an auditory sensation. When I think I have just experienced a pain, I have usually just experienced a pain. There is also a converse principle, which we might call the detectability principle[132].

I will similarly look for indirect evidence of relations between elements in the installation, by analysing the interviews but also recordings of movements, timings, and similarities in the behaviour of people exploring the installation.

Form of the installation

The starting point for my installation is the interaction between the environment and the people that enter the installation. To create and control this interaction there are various features I want to include in the installation and which I will need to modulate so as to obtain a work capable of realising my aims. These are: space (how to use it and its limits); emphasis; duration of the experience; number of participants; interaction with the environment; resonance (how the feedback between the user and the environment continues after the initial interaction); and finally, the 'new' contained in this feedback. I will outline below these key features of my installation.

i) Enclosed space

[132] Chalmers, D.J., The Conscious Mind: In Search of a Fundamental Theory, 1996, Oxford University Press, New York, p. 216

When I refer to the installation, I intentionally use the word "enter", because the space will be designed as a closed space in which people can temporarily be isolated from the reality around them. The need to enter a different space has the function of predisposing individuals towards a heightened perception and reflection. I have previously designed this type of space in my installation *Endless Fire* (see Appendix 1) and in making this choice I am also referencing a long tradition of interactive (and non-interactive) installations which use enclosed space as the site for the beginning and end of the artistic experience, in which the public has to come into and experience a given situation. I will address these types of work in more detail in the next phase of my research in the planned section on my research context.

ii) Emphasis through exceptional space

My research, as well as my previous artistic attempts (see Appendix 1 and 2), has shown me that emphasis is important to focus people on themselves, encourage greater participation and reinforce the link between participants and what is happening to them within the installation. To achieve this I will chose to show places with a strong emotional relation to the first group (expatriates) and to use VR linked with specific sonic landscapes.

iii) Duration

The work has not yet been realised and at this stage of planning the important question of duration has emerged. How much time is it necessary for people to spend in the installation to give them time to experiment and linger on the modifications to their consciousness? This will be determined in the next phase of my research.

iv) Number of participants

To avoid overlapping impressions and to make people concentrate on what they are experiencing and hopefully influence the emergence of their consciousness, I feel it appropriate that people enter one at a time. In the installation, the relationship between the participant and the environment (the room and the virtual environment) is extremely important. The presence of other people in the room and their behaviour or emotions could influence and distract, besides the fact that people wearing HMD are basically blind so they need a free space in which they can move freely and follow their emotions and sensations with no fear of bumping into other people or objects.

v) Resonance and newness

Some installations have the limitation that once that the participant understands the mechanism, the experience terminates, in the sense that the interaction between environment, motion and perception of the changing state of consciousness, ends. This is because the action-reaction relationship remains static, so the participant's surprise and state of awareness towards his/her own state of consciousness becomes weaker. On the other hand, the installation's physical and emotional impact may remain vivid due to the 'spectacular' situation and probably stands out from everything else. Therefore, I want to design soundscapes that change in different part of the room so that people move around the virtual and real space in relation to what they hear. I would also make changes to what they see in HMD and make the video change based on their movements. As much as this choice creates a loss in the truthfulness of action

(in fact, we do not disappear from one place and appear in another and the perspective of our vision follows a precise pattern and not the one decided by the author), this choice will give people a sense of surprise and stimulate new insights and connections (elements that are more important for the scope of my research than the likelihood factor)

Data Collection and Qualitative Analysis

Data from practice research will be collected using the following techniques:

Interviews

A systematic collection of verbal information, asking about users' judgments and feelings. The answers will be recorded and will take the form of structured interviews. This means that the subject of questions and their order will be predefined; in such a way, my data collection will be more systematic.

Observation

Observations of individual behaviour or interactions between events (what they see in HMD) and physical surroundings (in this first step, the soundscape in the room) within the site (my installation). I will need training in observation and the support of well-trained observers, besides following detailed guidelines about whom or what to observe, when and for how long. The primary advantage of observation is its validity and because it is a method that produces first-hand, impartial information from researchers (me and another trained observer). This technique is much more time consuming as it requires a long period for development of the observation tool, my training as observer and the data

collection itself. Example of data collected for observation could be movements in the room, how long a person lingers in a place, sureness and intentionality of movements (recorded by shooting video or through pressure measurement systems for foot mapping).

Software for Data Analysis

The management of so many qualitative and observational data will require the use of software applications that allow me to collate the audio, video, text material and perform various forms of analysis. Depending on costs and intuitiveness I will choose these from among some that I have already identified: NVIVO, Observer (by Noldus), HyperRESEARCH and INTERACT.

Short aside on the future development

As already mentioned in this document, my project is also based on the studies of diseases that deal with the theme of memory loss, related to the detachment from the self, self-consciousness and loss of sentience. In addition to running my research in the social field in relation to the "immigration-emigration", I'm also starting a collaboration with the University of Trento (department of psychology and cognitive science and department of neuroscience) for the use of virtual reality related to the use on Alzheimer's patients. The partnership is growing now, and since it will need a time for financing and for the consolidation of relations between universities and hospitals, I decided to postpone it as a post-doctoral study otherwise the timing for data collection would cross my period of doctoral studies.

Conclusions

My background as a sound artist means I am used to mediating my natural perception with that which is technologically facilitated. I work constantly with machines to create artworks, using mechanisms with which I can listen to what we do not usually hear, or which allow me to interact with sound by manipulating energy and operating an analogue-digital exchange. I started research in a recording studio, gaining experience in recording, filtering and analysing sound; as well as research into matter and numbers. This involved embracing the physical, psychological and physiological and engaging on a daily basis with these dynamics and studying vibrations and noise, which led me to deal with issues of emphasis, suppressing the qualities of matter, bringing out different types of energy, contextualising sound and proposing it in different contexts or transforming the original environment while maintaining some parameters. This background is built on years of working on the relationship between matter, the virtual, psychology, attention, consciousness and appearance, and truth and fantasy. I have also studied and taught acoustics and psychoacoustics, so I have carried out in-depth research and documentation in this field. I have previously investigated different points of view, explaining and demonstrating with examples and exercises how matter can be unattainable (like waves), or how to deal with something that you cannot touch or see (psychoacoustic phenomena) but which you can nevertheless perceive. Additionally, as an artist, I have also addressed these topics, creating performances in which I mediated these reflections through technology and my own body (using technology to perform actions on the stage).

I found different perspectives in my music and art but was always searching for new extended forms of composition and performance. My installations depart from energy and vibration that pass through the body and by which the body is changed, and then spread to all the other senses. The study of sound has made me reflect on how important it is to understand that reality is not something fixed, but rather as Pepperel says, everything is a different manifestation of energy (Pepperel 2000). Fundamental to my work is the notion that reality is based on illusion and preconceptions, the belief that we continuously transform the information we receive, and that there is instead a clear distinction between inside and outside. Psychoacoustic phenomena are the exemplification of how our psyche changes the subject, and how an event that seems concrete and physical in reality can seem completely different to us. My combined experience made me realise that the search for our interiority is not very different from the search for the material and factual, and that our physical apparatus responds to changing energy and therefore itself changes in turn. This change, in my opinion, is followed by a first-person method of observation from within us:

> *Everything is energy. It would be consistent with what is understood about reality at the sub-atomic level to say that the smallest 'particles' known are actually fields of energy rather than 'solid' material (Davies & Gribbin, 1991). Therefore, it is plausible to think of everything in the known Universe as energy in various states of manifestation and transformation. Again, such a view would be in harmony with the world-view of those Eastern traditions already mentioned as well as some early Greek thinkers such as Heraclitus and Thales. The appearance of solid matter around us is a consequence of the way our perceptual apparatus apprehends the forms that energy takes – rocks, plants, sea, stars, etc. The illusion of separation between things results from a combination of: the various manifestations and transformations of*

energy and the ways in which our sensory apparatus respond to the manifestations and transformations of energy[133].

If reality, as Pepperell argues, is composed of energy, and if energy is not just sound or noise, but is also warmth, image, flavour and pressure, and if energy is understood as a flow, as volatility and process, then to be able to follow who we are and the states that we cross in our own beings in the emergence of awareness of ourselves and experience, we must also use a changeable method. The focus of my research and my art practise will therefore be changeable and will fluctuate between the fictional and real, the ontological and aesthetic, both separated and part of the experience and people, using sound as a metaphor for being both inside and outside at the same time. This research is developed from a determination to explore the relationship between art media and technology interfacing with experience, mood, behaviour and perception towards a deep exploration of consciousness.

My findings to date consist more of a theoretical analysis/literature review of related fields of studies such as neuroscience, philosophy, literature and media art history (art criticism and reviews of contemporary practise in the field of interactive installations). Starting from these findings, for the theoretical side of the research I need to my broaden literature review with books and publications on digital media, human-computer interaction, affective computing, and also on physics and psychology, in order to contextualise the relevant characteristics of this research in a more reliable way. I will develop practise through realisations

[133] Pepperell R, The Posthuman Conception of Consciousness: A 10-point Guide, Art, Technology, Consciousness, mind@large, Edited by Roy Ascott, Intellect Books, 2000, Bristol UK

of an installation that I will take to several contexts, such as art-spaces and conferences. I will consider this practice to be research into aesthetics and originality, considering especially how and if there is a match between the practice and the theory and if the practice is actually the exemplification of the statements proposed in this thesis. Through this practise, I aim to pursue new knowledge, specifically knowledge of consciousness through real-time exploration in an immersive art environment.

APPENDICES: Photographs of installations

Cesena

fig. 48a exhibition in Cesena participant experimenting seams

fig. 48b exhibition in Cesena participant experimenting seams

fig. 49 exhibition in Cesena setting VR for a participant

fig. 50 exhibition in Cesena setting VR for a participant

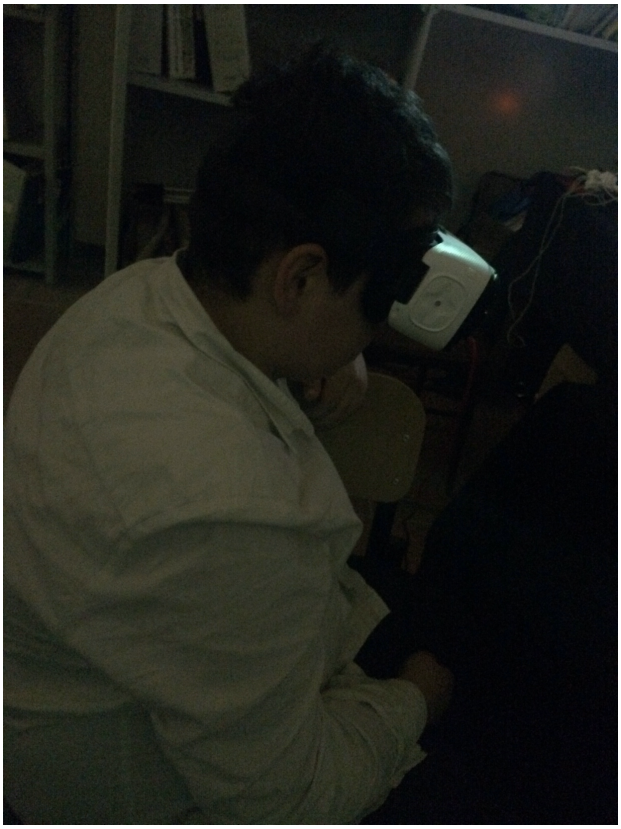

fig. 51 Exhibition in Cesena - participant experimenting seams

fig. 52 Exhibition in Cesena - participant experimenting seams

Florence

fig. 53 Exhibition in Florence - participant experimenting SoundingOut– explanation of the procedure

fig. 54 Exhibition in Florence - participant experimenting SoundingOut– ongoing analysis

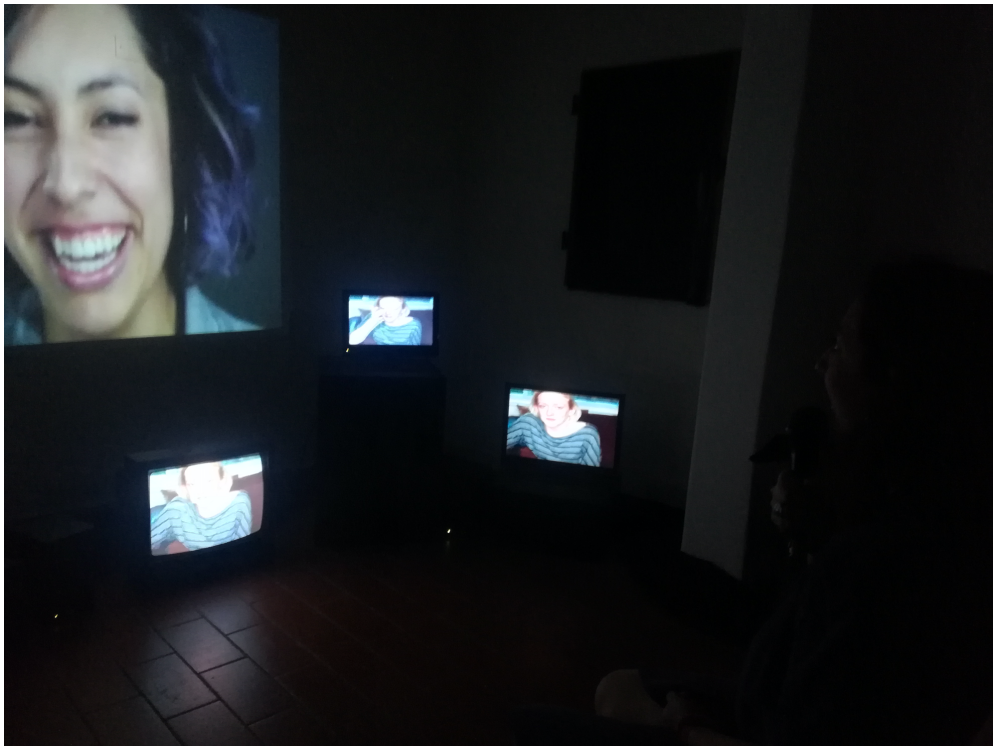

fig. 55 Exhibition in Florence - participant experimenting SoundingOutanswer from the system after analysis (detected happiness)

fig. 56 Exhibition in Florence - participant experimenting Soundingout- asking question on the process of analysis

fig. 57 Exhibition in Florence - participant experimenting SoundingOut– ongoing analysis process

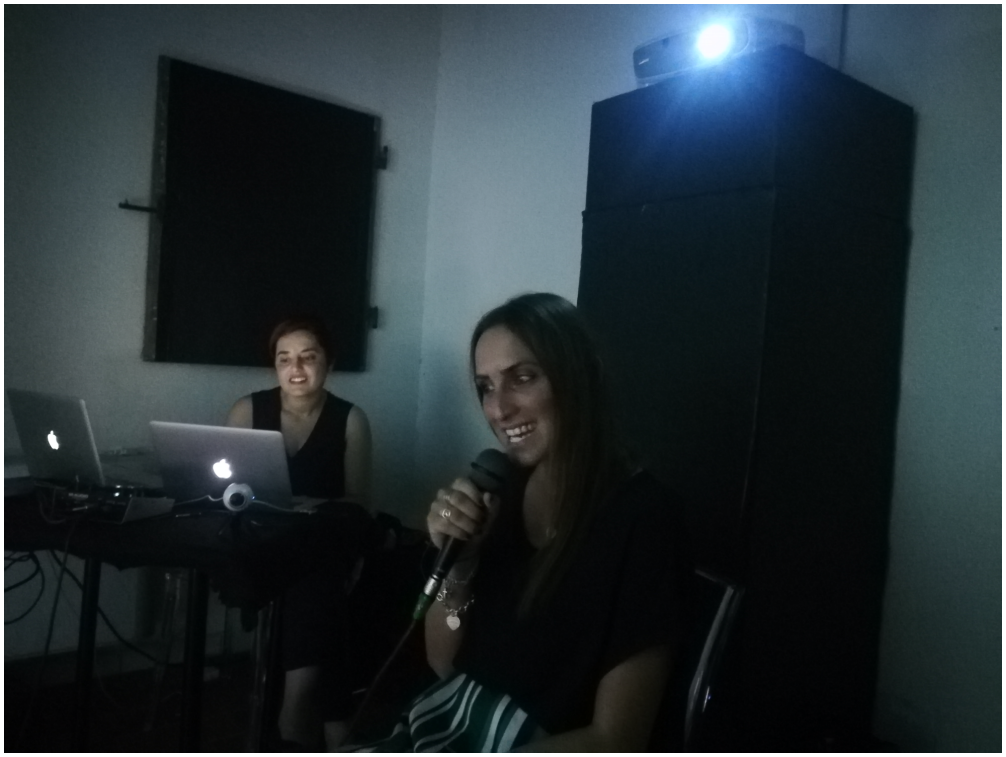

fig. 58 Exhibition in Florence - participant experimenting Sounding Out – ongoing analysis process

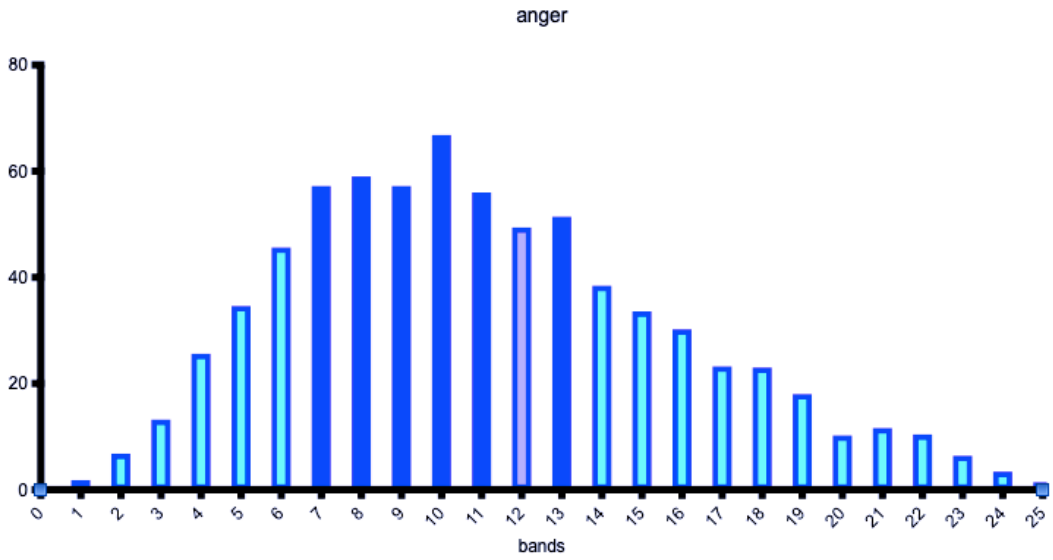

Table 4 anger data and graph –visualization of energy percentage per each band

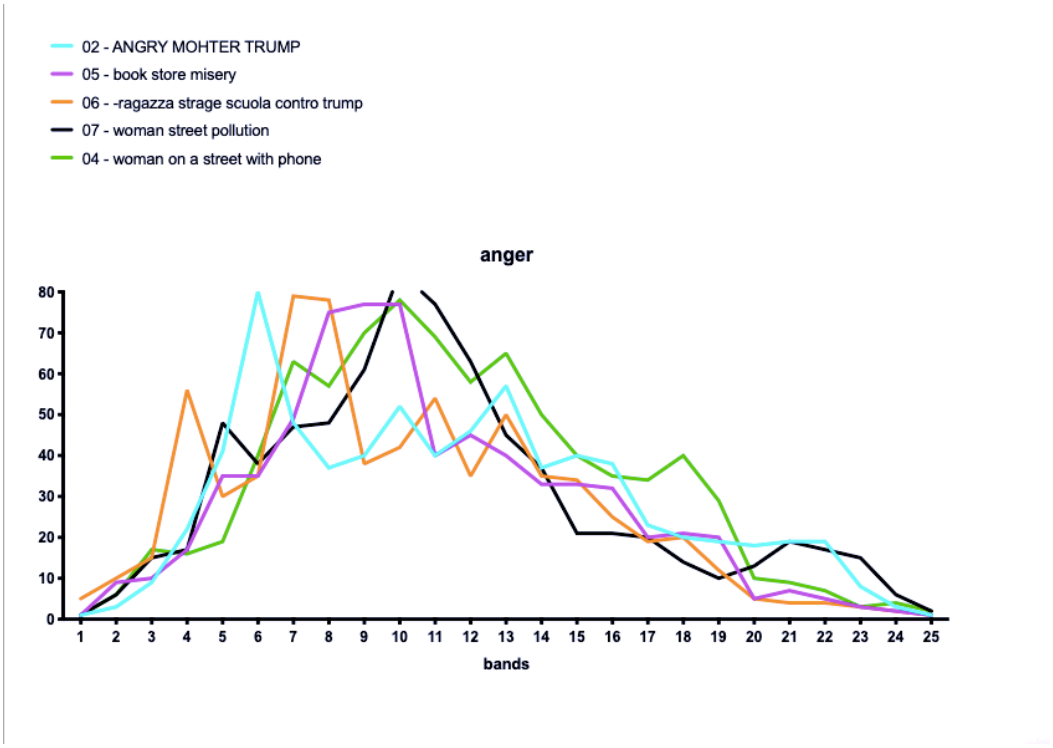

Table 5 anger data and graph – visualization of comparison between samples - energy percentage per each band

02 - ANGRY MOHTER TRUMP	04 - woman on a street with phone	05 - book store misery	06 - -ragazza strage scuola contro trump	07 - woman street pollution
Y	Y	Y	Y	Y
1	1	1	5	1
3	6	9	10	6
9	17	10	15	15
22	16	17	56	17
41	19	35	30	48
80	40	35	35	38
48	63	49	79	47
37	57	75	78	48
40	70	77	38	61
52	78	77	42	85
40	69	40	54	77
46	58	45	35	63
57	65	40	50	45
37	50	33	35	37
40	40	33	34	21
38	35	32	25	21
23	34	20	19	20
20	40	21	20	14
19	29	20	12	10
18	10	5	5	13
19	9	7	4	19
19	7	5	4	17
8	3	3	3	15
3	4	2	2	6
1	2	1	1	2

Table 6 anger data chart of energy percentage per each band - comparison between samples

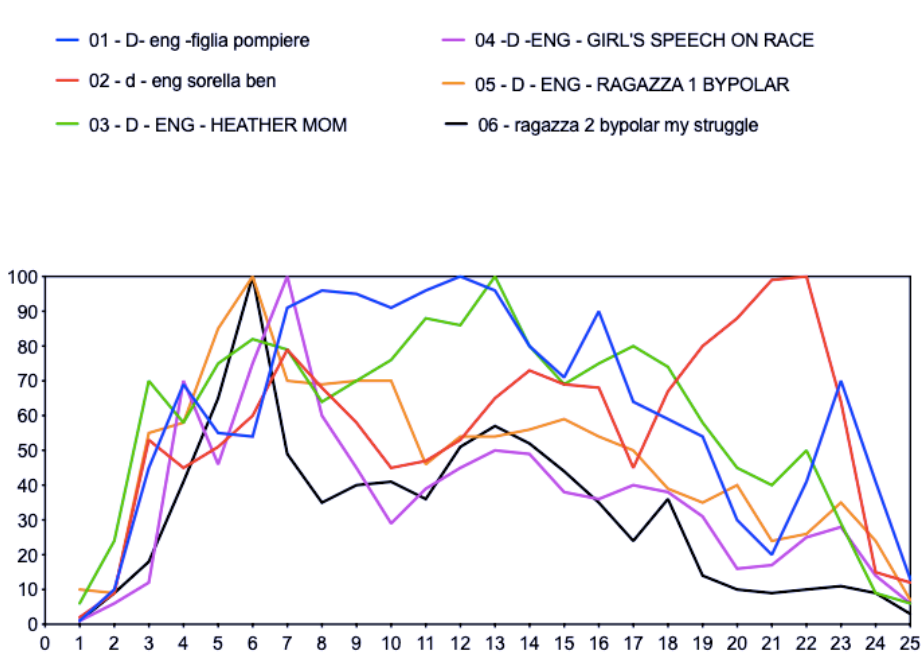

Table 7 sadness data and graph – visualization of comparison between samples - energy percentage per each band

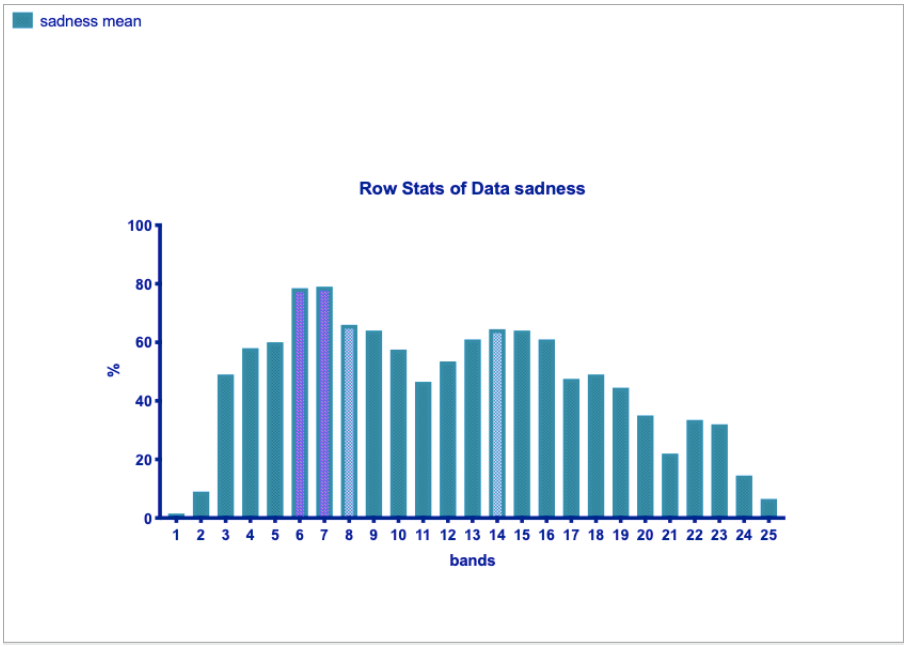

Table 8 sadness data and graph – visualization of energy percentage per each band

X Title	01 - D- eng -figlia pompiere	02 - d - eng sorella ben	03 - D - ENG - HEATHER MOM	04 -D -ENG - GIRL'S SPEECH ON RACE	05 - D - ENG - RAGAZZA 1 BYPOLAR	06 - ragazza 2 bypolar my struggle
X	Y	Y	Y	Y	Y	Y
1	1	2	6	1	10	1
2	10	9	24	6	9	9
3	45	53	70	12	55	18
4	69	45	58	70	58	41
5	55	51	75	46	85	65
6	54	60	82	75	100	100
7	91	79	79	100	70	49
8	96	68	64	60	69	35
9	95	58	70	45	70	40
10	91	45	76	29	70	41
11	96	47	88	39	46	36
12	100	53	86	45	54	51
13	96	65	100	50	54	57
14	80	73	80	49	56	52
15	71	69	69	38	59	44
16	90	68	75	36	54	35
17	64	45	80	40	50	24
18	59	67	74	38	39	36
19	54	80	58	31	35	14
20	30	88	45	16	40	10
21	20	99	40	17	24	9
22	41	100	50	25	26	10
23	70	64	29	28	35	11
24	41	15	9	14	24	9
25	13	12	6	6	7	3

Table 9 sadness data chart of energy percentage per each band - comparison between samples

Table 10 happiness data and graph – visualization of energy percentage per each band

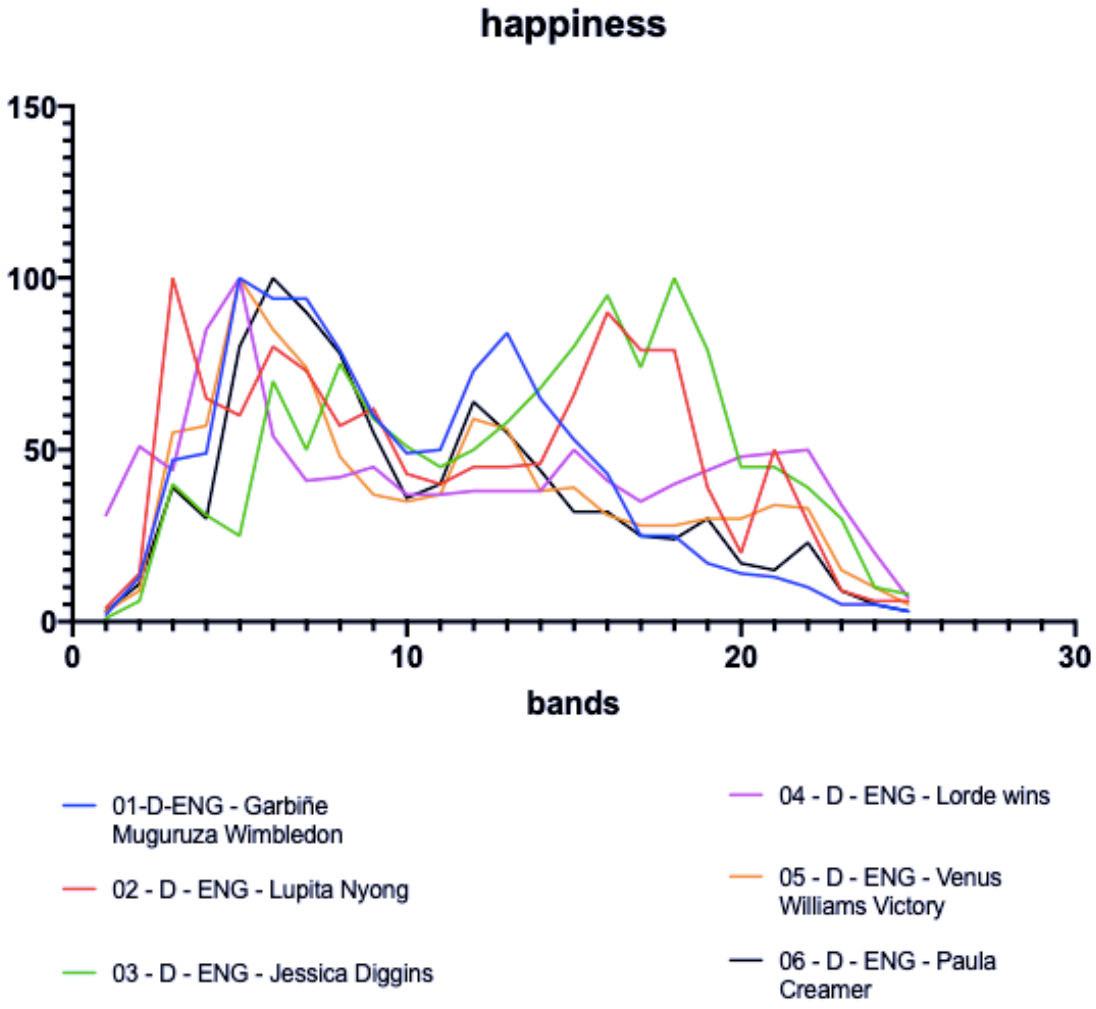

Table 11 happiness data and graph – visualization of comparison between samples - energy percentage per each band

01-D-ENG - Garbiñe Muguruza Wimbledon	02 - D - ENG - Lupita Nyong	03 - D - ENG - Jessica Diggins	04 - D - ENG - Lorde wins	05 - D - ENG - Venus Williams Victory	06 - D - ENG - Paula Creamer
Y	Y	Y	Y	Y	Y
2	4	1	31	3	3
13	14	6	51	9	11
47	100	40	44	55	39
49	65	31	85	57	30
100	60	25	100	100	80
94	80	70	54	85	100
94	73	50	41	74	90
79	57	75	42	48	78
60	62	59	45	37	55
49	43	51	37	35	36
50	40	45	37	37	40
73	45	50	38	59	64
84	45	58	38	56	55
65	46	68	38	38	44
53	66	80	50	39	32
43	90	95	41	31	32
25	79	74	35	28	25
25	79	100	40	28	24
17	39	79	44	30	30
14	20	45	48	30	17
13	50	45	49	34	15
10	29	39	50	33	23
5	9	30	34	15	9
5	6	10	20	10	5
3	6	8	7	5	3

Table 12 Happiness data chart –comparison between samples - energy percentage per each band