

Mechanisms of Listening and Spatial Mental Imagery

Luca Forcucci

Switzerland
forcucci@gmail.com

Abstract

Listening requires attention, engagement toward an environment, and relies on subjectivity and (self) consciousness. The paper explores mechanisms of listening in the sonic arts through an ongoing research based on art process informed by cognitive science. The project focuses in particular on the American composer Pauline Oliveros' concept of *deep listening* (Oliveros 2005). She proposes an expansion to all what is humanly possible to listen to. It leads to the phenomenal world that lies inside the auditory cortex about one's personal space perception. To engage toward an environment as a sonic architecture and as a perceived atmosphere, necessarily involves the body. Sound and space are linked to vibration, and resonating energy within the body may result in mental imagery of space. The vibrational aspect of sound through experience provides new ways for spatial perception, as well as new paths in novel philosophy of sound and auditory perception. That is, the paper investigates fields of possibility of sonic meaning and experience in mind in relation to the world. Collaboration with cognitive science includes the investigation of body perception in relation to a spatial ecology.

Keywords

Listening, Perception, Space, Sound, Art, Science, Mental Imagery.

Introduction

Another dream: in the inside which is the outside, a window and myself. Through this window I want to pass to the outside which is the inside for me. When I wake up, the window of my room is the one from my dream; the inside I was looking for is the space outside. – Lygia Clark

The mechanisms & neurophysiology of *hearing* are well defined (Bregman 1990). However, the subjectivity of *listening* is less understood. Hearing is a physiological phenomenon, whereas listening is a psychological act according to Barthes (Barthes 1985: 245-260). The aim of the research presented in this paper is to better understand and possibly shade light on the subjectivity of listening.

First, space is defined in relation to (perceived) atmosphere and body. Then the paper moves toward *heightened* modes of listening. The following section proposes the idea of touch, as sonic vibration, as an important component for the perception of sound and space toward the body. The approaches are then introduced in the next section as a combination of practice-led and phenomenological investigation. The paper continues then with the results from a study conducted by the author and named Intention/Perception (In/Pe): Five electroacoustic pieces were presented to an audience for a dedicated listening, and with the idea to stimulate the experience of a spatial representations in mental imagery. Then, as an outcome of the research, the piece *Bodyscape* is introduced. The last section resumes the process of development lying between artistic process, (cognitive) science research, and possible directions in art and science collaboration in electroacoustic contexts.

Space, (Perceived) Atmosphere and Body

The term *space* derives from the French *espace* and Latin *spatium*. The later, from the point of view of this project, refers to the Greek *chôra* as being the *distance* between objects, sites, places and, as proposed by Casey:

‘*Chôra*’ is ‘room’ that is filled, not vacant space (*kenon*)(Casey 1998: 353)

Moreover the idea of *chôra* as a receptacle, not a void, in mental imagery, is viewed by Rickert as ‘a locatory matrix *for* things [...] *Chôra* includes emotions, sensations, and other marks and traces of psychical and material experience’ (Rickert 2007: 259, 260, 261). *Chôra* in the current paper relates to the idea of space filled with sound and how it leads to a) a definition of space by (moving) sound and b) a merger defined by the relation of sound and space. Therefore, the space is not a vacant space, but it exists because sound defines the space and *vice versa*. Moreover, the project investigates

the space occupied by sound and the kind of imprint that is left in the mind of the listener, as the merger of the sound and space relationship.

Extensive philosophical questions defining the space and how it is perceived are proposed in *The Poetics Of Space* by Gaston Bachelard (Bachelard 1992). The development of Bachelard is based on the poetic representation of space as internally produced by the imagination. Bachelard interprets metaphorically intimate spaces by proposing the house as a symbolic view of the body. Therefore, the study of space within the humanistic perspective is the study of ideas and spatial feelings linked to sensation, perception and conception (Sanguin 1981: 568).

The sum of the relationships of sound and space is *felt* and *is* actually the atmosphere that consequently *affects* and leads to perception *within* the body of the auditor. Böhme proposes that ‘the primary “object” of perception is atmospheres’ (Böhme 1993: 125). Therefore, in the context of atmospheric architectures it is the *felt* architecture that *affect* the body of the viewer/auditor. As claimed by Massumi, it relies ‘on the irreducibly bodily and autonomic nature of affect’ (Massumi 2002: 28). In the current research, *affect* includes the body as mental image.

The relationships between sound, space, body, perception, and issues about interiority and exteriority are of particular interest and refer to the *Glass House* of the architect Mies van der Rohe, with the idea of interpenetration of external and internal space as the work implies a connection among sound, space and architecture as a metaphor of internal vs. outer spaces of the body. Mies van der Rohe’s *Glass House* includes Duchamp’s ideas found in *The Large Glass*, as proposed by Lebel:

The design of the *Glass* thus can never be seen *by itself*, apart from its surroundings, but it is inscribed, as it were, like the other image of a double exposure, ceaselessly transformed by a background of reflections in which that of the spectator himself is included. (Lebel 1959: 68)

The ideas of silence, and the interpenetration of the interior, exterior, and the reflections of the surroundings metaphorically refers to the spatial mental imagery perceived by the listener.

Deep and Heightened Listening

The sound object is linked to *reduced listening* as a sound removed from its original context through recording

practice. Pierre Schaeffer first coined the term with the information theorist Abraham Moles between 1948 and 1952 (Schaeffer 1952) while conducting research into *musique concrète*. It was further elaborated in his book *Traité des Objets Musicaux* (Schaeffer 1966). It implies an abstraction of the context of origin and a focus on the sound object, which becomes a self-referential entity. The opposite of *reduced listening* is *heightened listening*, and a major influence in the current study refers to larger sections of sound as soundscapes, which include the context. The composer Barry Truax mentions that ‘perhaps the biggest obstacle that environmental sound erects to its musical usage is the fact that its meaning is inescapably contextual’ (Truax 1996: 52). However, the focus here is on the late American composer Pauline Oliveros and her concept of *deep listening* (Oliveros 2005). Thus, *reduced listening* removes the context of the recording and focuses on the *sound object*, whereas *heightened listening* observes each detail of the sound, as proposed by Oliveros:

With heightened listening ability one can detect the slightest differences in sounds. This enables acute voice recognition, echo detection, spatial location, etc. Such heightened listening substitutes auralization for visualization (or seeing) by creating sonic pictures (Oliveros 2010: 79).

She developed ‘a practice that is intended to *heighten* and expand consciousness of sound in as many dimensions of awareness and attentional dynamics as humanly possible’ (Oliveros 2005: xxiii). Oliveros specifically proposed sound imagining in her sonic meditations (Oliveros 1974). Such ideas (sonic pictures and sound imagining) contribute towards the development of a new dimension in listening, composing, and perceiving sound. The heightened and deep listening modes are paramount in the exploration of the relation of sound and space, and for the study of the visual imagery induced by sound, it may relate to architectural and environmental space visualisation where the body of the observer/listener is certainly present. If the listener experiences the space and environment in his mental imagery while listening, then I expect that he shall perceive as well his body as part of the environment that can be acted upon (sense of agency). By claiming that the first person experience is an environment, it necessarily involves the observer/listener, and as such it might appear in the mental image.

Sonic Vibration and Proprioception

Sound is a vibration that may be touched, and the idea opens new opportunities for the perception of the dynamic relations of sound and space as multimodal perceptions. Primarily, the experience *is* the artwork. Movement generates proprioception for the measurement of the geometry of the external space. When sound is included in this equation, it triggers visual mental imagery within the listening experiences. Considering proprioception opens fields of possibilities for the composition of works in electroacoustic contexts. The audience is sensually involved by sound, as the vibrational wave of sound touches the whole body, and generates an internalised experience. The body thus becomes the theatre where the piece appears. The geometry of the external space is measured by a sonic proprioception, allowing new insights for psychoacoustic and (deeper) listening experiences. More fully explored in dance, proprioception is a sense that could enhance perception of sonic arts beyond spatialisation and may even have the potential to redefine spatialisation. The term proprioception suggests a perception of the world through our 'secret sixth sense' as proposed by Metacek and Mechsner, which define the term as follow:

In 1906 Charles Sherrington coined the term proprioception (perception of one owns) for the sensory modality based on these receptors and called it our 'secret sixth sense' [...] Proprioceptors precisely measure physical properties, such as muscle length, tendon tension, joint angle or deep pressure. Signals from this sensory orchestra are sent by afferent nerves through the spinal cord to the somatosensory, motor and parietal cortices of the brain, where they continuously feed and update dynamic sensory-motor maps of the body [...] So proprioception provides information on the physics of the body, the momentary distribution and dynamics of masses, forces acting on the limbs and their highly nonlinear interactions. The maps derived from these complex calculations not only guide body movement, they also (together with touch) sense the size and shape of objects and measure the geometry of external space. (Smetacek and Mechsner 2004: 21)

Proprioception provides information to the body on the geometry of the external space and invigorates the idea of a possible novel form of listening inducing spatial visual imagery. In particular, it highlights the idea of

experience of the work of art as a physical perception, which triggers the phenomenal world of sensation. The French philosopher Jean-Luc Nancy underlines about listening, touch and sensation that:

To listen, as well as to look or to contemplate, is to touch the work in each part—or else to be touched by it, which comes to the same thing [...] An intimate and delicate marriage between sensation (or feeling, it's all the same) and the composition of the sensory. (Nancy 2007: 80)

The secret sense revealed by proprioception in the mechanisms of perception and the similarities between sound and touch in perceiving sonic vibrations open the door to the idea of art and electroacoustic music being an experience for dynamic perceptive behaviours. It includes as well the opportunity to augment listening toward dynamic multimodal experiences. In electroacoustic contexts it leads to spatial representations in visual mental imagery.

Approaches

The initial ideas of the current study emerged in 2009 during a residency with the Swiss Artists in Lab project at the Brain Mind Institute in Switzerland (Forcucci in Scott 2010: 150) and were further developed until today (Forcucci 2015; Forcucci 2016). The project relies on a combination of practice-led research, which blend with ideas inspired from cognitive science, physiological data acquisition and first person experience as an open process of investigation. The visual mental imagery is observed within the audiences' experience of sonic works, by linking the artist's intention and audiences' perceptions (Blanke, Forcucci and Dieguez 2009). That is, the analysis of the perception of an artwork should include in addition to the viewer and/or listener, the author perspective. For this reason, the combination of (cognitive) science and (sonic) art may bring new questions on both side, not by vulgarising one by the other, but by ways of unifying the development process and inspiring each other.

The creation of sonic environments as practice-led research, heightened and deep listening, structured interviews of audience to explore subjective issues through comparison of patterns, and physiological data acquisition (EEG, EMG, ECG) for artistic developments set the base for the research presented in this paper. Two ways collaboration with cognitive scientists is sought to validate precisely the embodiment of space through

the vestibular system and proprioception. Accordingly, Benson proposes that:

The non-visual systems that contribute to the perception of orientation and movement of the body embrace the vestibular, somatosensory, proprioceptive and auditory systems. (Benson in Warren and Vertheim 2014: 145)

Varela claims that one of the objectives of experimental neurophenomenology is to bridge first-person experience and neurophysiological data (Varela in Bockelman et al. 2013aa) and thus extending Edmund Husserl's idea of 'naturalizing phenomenology'. The project proposed here aims at naturalizing phenomenology by focusing on 'an *explanatory gap* between the objectivity of cognitive sciences and the subjectivity of experience' (De Preester 2002: 641). Subjectivity *per se* is directly linked to listening and vice versa.

In/Pe Project

The Intention/Perception (In/Pe) project is the name of the research developed by the author, *via* an empirical survey informed by phenomenology. The result of a practice-led methodology leads to a portfolio and the audience perception of it. The analysis, through a questionnaire, informs the Intention/Perception link emerging from the *audience's empathy with space perception*. The idea is to explore whether and how the audience develops empathy toward the experience of the space explored by the composer. The qualitative phenomenological methodology relies on a questionnaire investigating the respective spatial visual mental imagery of the participants exposed to the portfolio. The link with the portfolio is paramount, since the inquiry relies on the process of the development of the artworks (however not presented here): the practice-led methodology is approached not as a sole project, but in relation to the audience perception – by including perception of oneself within the visual mental imagery. In other words, the intention is not to develop the artworks according to the answers given, but to observe whether common spatial patterns emerges from the perceptions of the audience.

A majority of the participants in the survey were chosen mainly among students in music, sound studies, media art, and art, as well as established artists, musicians, composers, and curators; only a small fraction were not professionally involved in the arts. The reason for choosing them lay in their inclination and their specific

training in spatial representation. These categories have better mental representation of space, because their practice requires constant and intense visualisation into mental imagery (e.g. imagining playing a particular section of a piece or imagining a person or an object to draw or sculpt). Thus, the choice relies primarily on their potential respective abilities 'as artists to represent objects in space, and for musicians, because they perform well in visuo-spatial tasks' (Brochard *et al.* 2004: 103, 104, 106, 107, 108). Moreover, as proposed by MacIntyre, Moran, Collet and Guillot 'a strength-based approach may be valuable in illuminating both fundamental and applied questions' (MacIntyre, Moran, Collet and Guillot 2013:1). However, the relation between their professional backgrounds as regards their perception is not analysed, yet it provides information about their familiarity with experimental forms of art, music and spatial perception.

The investigation was conducted without a control group, because it was analysed through individual experiences with structured interviews. In addition, most of the interviews were made during fieldwork, where organising any contributory features of control groups is problematic. This is a pilot study, and control groups will be included in future research.

The above-mentioned proposals relate to the observation of the experience of the participants as the main scope, and as explored in the twentieth century by philosophers such as Husserl and Merleau-Ponty (Husserl 1931; Merleau-Ponty 1963). Hence, in Husserlian phenomenology it is claimed that:

Our experience is directed toward — represents or 'intends' — things only through particular concepts, thoughts, ideas, images, etc. These make up the meaning or content of a given experience, and are distinct from the things they present or mean. (Phenomenology 2013: 2)

In relation to the In/Pe project, the investigated experience of the audience relies on the 'ideas, images' (as perceptions) of architectural and environmental spaces, which make up the meaning, and it is thus distinct from the composition *per se* (things they present or mean). As proposed by Merleau-Ponty, who:

focused on the 'body image', our experience of our own body and its significance in our activities [...] In short, consciousness is embodied (in the world), and equally body is infused with consciousness (with cognition of the world). (*Ibid*: 11)

The current project aims to observe how the audience perceives their body in the architectural and environmental space through the listening experience. Husserl and Merleau-Ponty 'spoke of pure description of lived experience' (*Ibid*: 4), which relates here to the lived experience, through listening, of the spaces investigated by the research. Heidegger in Ratcliffe also 'stresses that the body, although neglected by his previous works, is important and needs to be discussed by the phenomenologist' (Ratcliffe in Gallagher and Schmicking 2010: 133). The body, in the present research, is included in the exploration and creation of space, by a) the movement of the composer while field recording and b) by the audience when listening and perceiving the architectural and environmental space within the visual mental imagery. Thus, the body is present in the mind of the audience by exploring what the composer has recorded and composed.

Thirty candidates were invited to listen in darkened spaces to each of the five pieces of the portfolio. They were recruited while in art residency in China and at universities in the UK, Germany, and Brazil. The participants were introduced to the aims of the research before the listening sessions. No information about the pieces was provided; this was omitted deliberately in order to avoid influencing their answers. All participants gave written consent for the study according to the protocols of the human research ethics policy of De Montfort University, Leicester, UK. These were approved by DMU's relevant committee. None of the participants was remunerated.

Data Synthesis

The synthesis of the data collected from the In/Pe project relies on a questionnaire, which focuses on the observation of common spatial patterns emerging from the listening process of the portfolio. The portfolio includes three fixed-medium pieces (*The Fall*, *De Rerum Natura*, *My Extra Personal Space*), one sound installation (*Kinetism*), and one performance (*Music for Brainwaves*). The questionnaire investigates visualisation of architectural spaces as well as natural environments in mental imagery by asking the following questions:

- a) Which architectural spaces or urban environments, moving vehicle or moving persons and natural elements were perceived through visualised mental images?
- b) In which locations, architectural spaces or natural

environments the participants envisioned themselves while listening?

c) Which types of sound made the participants think of a particular location, space or environment?

And if yes, which one?

Then the answers for each question are grouped inside clusters:

Question a)

- Architectural / Urban Environments;
- Moving Vehicles / Moving Persons;
- Natural Elements;
- Answers not retained.

Question b)

- Locations / Architectural Spaces;
- Natural Environments;
- Answers not retained.

Question c)

- Sounds;
- Related Locations / Spaces to the sounds;
- Answers not retained.

The questions are linked, meaning that patterns of perception of architectural spaces, locations, and environments may be observed through the three questions and thus verified through repetitions of patterns inside the clusters. The participants were requested to explore the spaces they perceived during the listening experience. The participants' answers are analysed in order to find common patterns of space. The answers are then grouped by patterns of analogue answers. *Table 1* provides a synthesis of the answers. The same participant may answer with more than one pattern to the same question. Poor data / Answers not retained are considered as those not answering the question or being incoherent (e.g. 'There was no reference for me to begin', 'lots', 'many', 'random thoughts', 'Not too far, but far away enough to not be touched by the noise'); for Question c), giving information about the sound although not the related locations/spaces or *vice versa*, such data are not retained. The analysis of the data provided a positive answer to the question of the research, which asked whether participants have a common perception of architectural spaces as visual mental imagery while listening to the portfolio of electroacoustic works. The spaces appeared as follows:

Name of the piece	Visualised Architectural Spaces
<i>The Fall</i>	Large spaces: Hall, warehouse, industrial building; Small spaces: Cave, tunnel, pipe.
<i>De Rerum Natura</i>	A black, confined space (such as a cave, and underground).
<i>My Extra Personal Space</i>	An internal space (building, atelier, beach house or shelter); An industrial space (a factory, harbour, industrial plant or port city);A church or cathedral.
<i>Kinetism</i>	An enclosed space (inside human body, box or room).
<i>Music for brain waves</i>	A room (apartment, closed room).

TABLE 1

The questionnaire submitted to the participants initially included questions on the quality of the pieces (relaxing /stressful, pleasant/unpleasant, happy/sad, musical/not musical). The participants were asked to answer by value on a *Visual Analogue Scale* (VAS) going from -3 to +3, and then to describe the reason. However, the results were not convincing in terms of homogeneity. That is, they were spread along the visual scale from one extreme to the other with no significant patterns. The questionnaire also included questions which asked a) if the participants had the impression of being in contact with their bodies; b) if they saw any part of their bodies moving; c) if they were in a static or moving position in their mental imageries; d) from where they did imagine themselves looking towards the perceived images; e) if they saw many locations, spaces or environments, and if so, whether they perceived them simultaneously or sequentially. Instead I decided to concentrate the analysis on the research question of the current study, concerning the quality and typology of the perceived architectural and environmental space.

Discussion

When cross-analysing the answers of the participants among the different pieces, the common pattern of architectural space appears as a small confined dark space such as a cave or an underground space. The interpretation of such a pattern is the possibility that visualising any space compares it to the internal space of the body. Such affirmation is for now, only a hypothesis and shall be further investigated. The questionnaire and the In/Pe project in general were effective because they

observed architectural mental imagery as spatial visual mental imagery. Firstly, because studies into mental imagery triggered by sound tend to relate to auditory mental imagery – even in the absence of sound, as claimed by Zatorre and Halpem:

[...] neural activity in auditory cortex can occur in the absence of sound and that this activity likely mediates the phenomenological experience of imagining music (Zatorre and Halpem 2005: 9).

In contrast, in the present study, the focus lay on the spatial mental imagery triggered by sound works. Sound and space are in this circumstance therefore closely related, since such spatial mental imagery might not occur withoutthe sound.

The originality of the In/Pe project focuses on mental imagery induced by sound, combined with a methodology that is based on qualitative and phenomenological concerns in the representation of architectural and spatial visual perceptions. In other words, the approach of cognitive aspects and neural mechanisms of visual mental imagery must be approached by the experts and tools of neuroscience. However, the quality of the phenomena and possibly their interpretation could be emphasised by the current methodology, which investigates the typology of the perceived spaces.

The In/Pe project shed light on such issues according to the discoveries provided by the results as a map of space perception (*Table 1*). Similarly, Damasio proposes the idea of mapping as the main methodology of our minds to inform the brain, in order to develop and manipulate mental imagery:

The distinctive feature of brains such as the one we own is their uncanny ability to create maps [...] When the brain makes a map, it *informs* itself [...] When brains make maps, they are also creating images, the main currency of our minds. Ultimately, consciousness allows us to experience maps as images, to manipulate those images, and to apply reasoning to them. (Damasio 2010: 63)

Secondly, the findings proposed by the In/Pe project include the perception of the body of the auditor in the spaces and inside the mental imagery, especially in Question b) of the questionnaire (e.g. *In which locations, spaces or environments did you see yourself while listening?*) or through the sound of the body (breathing and heartbeat) in *Kinetism*, according to the patterns of the answers. The portfolio provides contexts where the bodily sounds includes motions (e.g. sounds of

footsteps in *My Extra Personal Space*, or a stroll in the sound installation in *Kinetism*), and thus it may provide room for self identification within mental imagery. Again, cognitive science has important tools in this area towards understanding motor imagery, according to Zatorre and Helpem:

Motor imagery is the imagination of the kinesthetics involved in actual movement and has been examined for both simple tapping and complex musical routines [...] In many musical situations, sound is associated with movement [...] Given the behavioural and neural evidence for people being able to imagine musical movements, is there evidence that auditory and motor imagery may be integrated in the brain? (Zatorre and Helpem 2005: 10)

However, the In/Pe project investigates spatial perception and the movement of the body into architectural spaces within mental imagery. This happens in electroacoustic contexts with loudspeakers, not as movement related to a musical instrument. Thirdly, in asking the participants to listen to the pieces and to visualise architectural mental imagery, it promoted a deeper listening, a way to focus on the composition, to analyse it, and to concentrate on their own (live) *experiences* during the listening process. Thus, it possibly creates a link between the composer (intention) and audience (perception), not only through a matter of sound, but by pushing it further as an experience, as proposed by Prinz:

Conscious experience is not restricted to what is in my head but includes the environment around me, then the richness of experience is not an illusion [...] The idea that the world is literally a component of conscious experience may sound bizarre, but it has been proposed as a serious possibility. (Prinz in Robbins and Aydede 2009: 423)

The environments in which the sounds were collected were explored while deep listening, allowing a deeper *experience* of the locations through sound. Later, the audience was invited to deep listen to the works, and to visualise in their own mental imagery the architectural spaces, allowing an even deeper experience of the works. The intention of the composer and the perception of the audience are thus linked through deep listening.

Bodyscape

The transdisciplinary collaboration presented in the previous sections has been developed through long term

exchange with cognitive science. Moreover, the piece *Bodyscape* (Figures 1, 2, 3, 4) integrates conceptually political and social situations.

As a performance, the project is a site-specific electroacoustic composition with live electronics and sensors. The performance space and its architectural resonating and spatial characteristics are included. The main idea focuses on the body of a dancer as the main sonic source. Two performances were presented a) at the Lab in San Francisco, USA in August 2015 and b) at Centre Friedrich Dürrenmatt in Neuchâtel, Switzerland in January 2016. *Bodyscape* includes as well fifteen days field recordings at the border of Botswana, Limpopo Region, South Africa with the biologist and composer Francisco Lopez in November 2015. Then, the research was conducted further in other regions of South Africa and on the base of a text from the Swiss writer Friedrich Dürrenmatt (*L'épidémie virale en Afrique du sud*) from December 2015 to January 2016. The novel was published originally in the column of a Swiss newspaper and describes a virus transforming the body of white persons into black ones. A text about privileges and how those are kept in a specific context. I explored the country with the text in mind and observed the social division within the population a decade after the end of the Apartheid.

The live performance in Switzerland includes layers of cut-up text, pictures, video and sound composed into an electroacoustic piece, like a road movie. The fixed media composition includes the live recordings of San Francisco (involving the instruments built by Cheryl Leonard, which are made of sand, wood, bones, stones, and the sound of the dancing body of Crystal Sepúlveda) and Neuchâtel (with the sound of the dancing body of Crystal Sepúlveda and the cellist Ulrike Brand). The recordings were then *composed* at NOTAM in Oslo Norway in April 2016, by layering and reworking them. These manipulations lead to a piece intended to be played in the dark and thus by possibly generating visual mental imagery to the audience, and in relation to the intention of the composer as proposed by the study contextualised in the In/Pe project. The composition invokes embodiment of another person. First, by recording the movements and sound of the body of a dancer in two different architectural spaces (The Lab Gallery San Francisco, and the Friedrich Dürrenmatt museum in Neuchâtel). Second, my exploration of the South African territory with Friedrich Dürrenmatt's novel,

which is an embodiment and appropriation of his text.

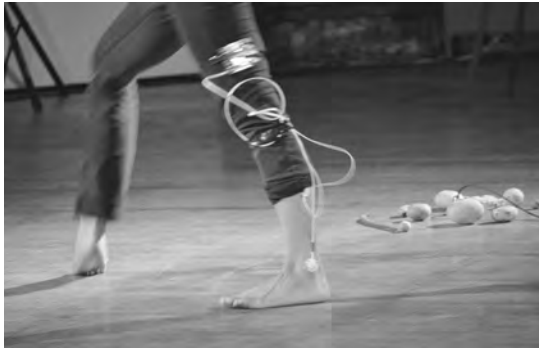


Figure 1. Luca Forcucci, Bodyscape at The Lab, San Francisco (with Crystal Sepúlveda and Cheryl Leonard 2015) ©Luca Forcucci. Photo: Swissnex SF



Figure 2. Luca Forcucci, Bodyscape at The Lab, San Francisco (with Crystal Sepúlveda and Cheryl Leonard 2015) ©Luca Forcucci. Photo: Mystic Media



Figure 3. Luca Forcucci, Bodyscape at Centre Dürrenmatt Neuchâtel, Switzerland (with Crystal Sepúlveda and Ulrike Brand 2016) ©Luca Forcucci, photo: Olivier Chételat



Figure 4. Luca Forcucci, Bodyscape at Centre Dürrenmatt Neuchâtel, Switzerland (with Crystal Sepúlveda and Ulrike Brand 2016) © Luca Forcucci, photo: Olivier Chételat.

Third, within a multitrack DAW, I layered the recordings of the spaces and environments during the compositional process at NOTAM studio Oslo in Norway. The fixed media piece relates to the *intention* of the composer encapsulating a spatial sonic identity, and a resonance of the spaces. This hopefully lead to visual mental imagery perceived by the audience of the movements of the bodies insides those spaces. This may be the *experience* during the diffusion of the piece in the dark, when the instrument builder, the dancer and the cellist are not anymore present physically.

Summary and Future Research

The current questionnaire from the In/Pe project offers a solid base for the inquiry since the results provide

positive answers not only to the research question about architectural space perception in mental imagery, but also about body perception in relation to motions provided by the sounds. Bodily feelings have been explored through bodily sounds, and how they relate to the perception of the self in mental imagery. On that basis, future research will observe how a multimodal environment may trigger emotions and emotional feelings, and how those can be investigated.

In the future, the research will consider collaboration with cognitive neuroscience in order to investigate issues of body perception, how the body is perceived in mental imagery and if it includes a sense of agency as ‘the experience that I am the one who is causing or generating the action’ (Gallagher 2012:18). It might be useful to merge both disciplines because the breadth of area of the undertaking requires additional knowledge from specialists; it may shed light on listening mechanisms in relation to mental imagery of perceptions of body, out-of-body experience, and space in electroacoustic contexts.

Art and science collaboration will be pushed further for the development of the research, since the actual main limitation of the study has been further investigation of the perception of the auditors’ respective bodies in the perceived spaces and environments in order to validate more precisely the embodiment of space through the vestibular system and proprioception; this will in turn lead to opportunities for the development of perceptions of space through sound and multimodal environments, including dynamic movements and dynamic situations.

Acknowledgements

Pro Helvetia, Swissnex San Francisco, Djerassi Foundation and Leonardo ISAST (Scientific Delirium Madness), Foundation Nicati – De Luze, The Lab Gallery San Francisco, Canton de Neuchâtel, Ville de Neuchâtel, Centre Dürrenmatt Neuchâtel, De Montfort University GB.

References

- Bachelard, G. (1992). *The Poetics of Space*. Translated from French by M. Jolas. Boston, MA: Beacon Press.
- Barthes, R. (1985). ‘Listening’, in *The Responsibility of Forms*. Translated from French by R. Howard. New York, NY: Hill and Wang.
- Blanke, O., Forcucci, L. and Dieguez, S. (2009). Don’t Forget the Artists when Studying Perception of Art. *Nature*, 462: 984.
- Bockelman, P., Reinerman-Jones, L., Gallagher, S. (2013). Methodological lessons in neurophenomenology: Review of a baseline study and recommendations for research approaches. *Frontiers in Human Neuroscience*. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3794193/>
- Böhme, G. (1993). Atmosphere as the Fundamental Concept of a New Aesthetics. *Thesis Eleven*, 36: 113-126.
- Bregman, A.S. (1990). *Auditory Scene Analysis: The Perceptual Organization of Sound*. Cambridge, MA: The MIT Press.
- Brochard, R., Dufour and A., Després, O. (2004). Effect of Musical Expertise on Visuospatial Abilities: Evidence from Reaction Times and Mental Imagery. *Brain and Cognition*, 54: 103-109.
- Casey, E.S. (1998). *The Fate of Place: A Philosophical History*. Los Angeles, CA: University of California Press.
- Damasio, D. (2010). *Self Come to Mind, Constructing the Conscious Brain*. London: William Heinemann.
- De Preester, H. (2002). Naturalizing Husserlian Phenomenology: An Introduction. *Psychoanalytische Perspectieven*, 20(4): 633-647.
- Forcucci, L. (2016). Body(e)scape. *Leonardo Journal*, 49(3): 195.
- Forcucci, L. (2015). *Mapping Dynamic Relations in Sound and Space Perception*. PhD Thesis in Music, Technology and Innovation. De Montfort University, London: British Library.
- Gallagher, S. (2012). Multiple Aspects in the Sense of Agency. *New Ideas in Psychology*, 30: 15-31.
- Gallagher, S. and Schmicking, D. (2010). *Handbook of Phenomenology and Cognitive Science*. New York, NY: Springer Press.
- Husserl, E. (1931). *Ideas: General Introduction to Pure Phenomenology*. Translated from German by W.R. Boyce Gibson, London: George Allen & Unwin Ltd.
- Lebel, R. (1959). *Marcel Duchamp*. New York, NY: Grove.
- Massumi, B. (2002). *A Shock to Thought, Expression After Deleuze and Guattari*. London: Routledge.
- MacIntyre, T.E., Moran, A.P., Collet, C., Guillot, A., (2013, April). An Emerging Paradigm: A Strength-Based Approach to Exploring Mental Imagery. *Frontiers in Human Neuroscience*, 7(104): 1-12.

- Merleau-Ponty, M. (1963). *The Structure of Behavior*. Translated from French by A. Fisher. Boston, MA: Beacon Press.
- Oliveros, P. (2010). *Sounding the Margins: Collected Writings 1992-2009*. Kingston, NY: Deep Listening Publications.
- Oliveros, P. (2005). *Deep Listening: A Composer's Sound Practice*. Lincoln, NE: iUniverse.
- Oliveros, P., (1974). *Sonic Meditations*. Sharon, VT: Smith Publications.
- Nancy, J.L. (2007). *Listening*. Translated from French by Mandell, C. New York, NY: Fordham University Press.
- Phenomenology (2013). Retrieved from <http://plato.stanford.edu/entries/phenomenology/>
- Rickert, T. (2007). Toward the Chôra: Kristeva, Derrida, and Ulmer on Emplaced Invention. *Philosophy and Rhetoric*, 40 (3): 251-272.
- Robbins, P. and Aydede, M. (2009). *The Cambridge Handbook of Situated Cognition*. Cambridge, MA: Cambridge University Press.
- Sanguin, A.L. (1981). La Géographie Humaniste ou l'Approche Phénoménologique des Lieux, des Paysages et des Espaces, *Annales de Géographie*, 90(501): 560-587.
- Schaeffer, P. (1966). *Traité des Objets Musicaux*. Paris: Editions du Seuil.
- Schaeffer, P. (1952). *A la Recherche de la Musique Concrète*. Paris: Editions du Seuil.
- Scott, J. (2010). *Artists-in-Labs, Networking in the Margins*. Vienna/New York: Springer Press.
- Smetacek, V., Mechsner, F. (2004). "Making Sense", *Nature*, 432(21): 21.
- Truax, B. (1996). Soundscape, Acoustic Communication and Environmental Sound Composition. *Contemporary Music Review*, 15(1-2): 49-65.
- Warren, R. and Vertheim, A.H. (2014). *Perception and Control of Self-motion*. New York, NY: Psychology Press.
- Zatorre, R.J., Halpern, A.R. (2005). Mental Concerts: Musical Imagery and Auditory Cortex. *Neuron*, 47: 9-12.

Author Biography

Luca Forcucci's research observes the perceptive properties of sound, space and memory. The field of possibilities of the experience is explored as the artwork. In this context, he is interested in perception, subjectivity and consciousness. A great influence is the late

American avant-garde composer and musician Pauline Oliveros and her concept of deep listening expanded to all what is humanly possible to listen to. Luca achieved a PhD in Sonic Arts from De Montfort University and a MA in Sonic Arts from Queens University of Belfast. The research was further conducted at University of the Arts of Berlin, INA/GRM Paris (Institut National d'Audiovisuel/Groupe de Recherches Musicales) while investigating at Bibliothèque Nationale de France François Mitterrand, and at the Brain Mind Institute in Switzerland to explore cognitive neuroscience of out-of-body experiences. www.lucalyptus.com

fundación suiza para la cultura

prochelveticia

With support from The Swiss Arts Council Pro Helvetia