Architecture and Neuroscience; what can the EEG recording of brain activity reveal about a walk through everyday spaces?

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Abstract

New digital media and quantitative data have been increasingly used in an attempt to map, understand and analyse spaces. Each different medium with which we analyse and map spaces offers a different insight, and can potentially increase our tools and methods for mapping spaces and understanding human experience. The emergence of such technologies has the potential to influence the way in which we map, analyse and perceive spaces. Given this context, the project presented in this paper examines how neurophysiological data, recorded with the use of portable electroencephalography (EEG) devices, can help us understand how the brain responds to physical environments in different individuals. In this study we look into how a number of participants navigate in an urban environment; between specific identified buildings in the city. The brain activity of the participants is recorded with a portable EEG device whilst simultaneously video recording the route. Through this experiment we aim to observe and analyse the relationship between the physical environment and the participant's type of brain activity. We attempt to correlate how key moments of their journey, such as moments of decision making, relate to recordings of specific brain waves. We map and analyse certain common patterns observed. We look into how the variation of the physical attributes of the built environment around them is related to the fluctuation of specific brain waves. This paper presents a specific project of an ongoing cross-disciplinary study between architecture and neuroscience, and the key findings of a specific experiment in an urban environment.

1.0 Introduction

The notion of the experience of everyday spaces and environments has been addressed in a number of different ways by theorists, architects, urban planners, designers and artists. The effect of tangible elements of space (solid boundaries, volumes, forms) as well as the effect of less tangible elements (sounds, smells, memories) has been addressed by architects and has been examined through observation, video recording, interviews, questionnaires and other inventive and revealing representational methods. The Situationists, for example, proposed a new – at the time - approach to mapping the experience of the city through the visual representation of different ambiences. Psychogeographers attempted to correlate the 'solid' elements of a geographical map with other fluid, less tangible, temporal, elements of space. With the evolution of technologies and media, the above enquires evolve further. What the Psychogeographers called 'ambience' could be possibly re-interpreted and re-mapped with the use of contemporary methods and digital tools. Could ambience be re-interpreted, if, for example, one recorded the brain activity of people walking in the city, and identified different types of mood, or different levels of stress/ calmness/ engagement in different areas? Would this type of mapping open-up a new field for discourse about the human experience in everyday spaces?

In this paper the above questions are addressed through the engagement with a specific experiment, which draws from methods used in two different disciplines; architecture and neuroscience. The use of portable EEG technology (Emotiv Systems EPOC) to record the neural responses from the brain is examined as an additional method for mapping the human experience in everyday spaces. We draw links between what is happening in one's brain and what is happening in the space around them with the intention to: (a) engage with a methodology drawn from two different threads of though – a phenomenological and a positivist, (b) visualise the type of understanding or information recorded, and

(c) gain a better understanding of the human experience and behaviour in different everyday urban environments. In this specific stage of our study, we analyse the brain activity of ten participants along four walking journeys in an urban environment. We particularly focus on key moments where they make way-finding decisions. We analyse the EEG recordings in terms of frequency, amplitude and distribution in parallel to the participants' responses to a short interview, and to our live and video recorded observations. Through the correlation of these data we observe where the participants are most concentrated/ making a spontaneous decision as to where to go/ feel relaxed and calm, and we associate those with external parameters of their environment. The findings are analysed through the collaboration of an architect and a neuroscientist, and will lead to further experiments with a broader interdisciplinary network of specialists, in order for further solid conclusions and applications to be established. Through this paper we also reflect upon the inherent contradiction of the approach and methods used in the two disciplines; architecture and neuroscience.

2.0 Context

> 'If you enter the Cathedral in Amiens at twilight while an organ is playing and find that your "heart skips a beat," it's because your brain—not your heart—has filled you with awe. Cells in your brain are gorging themselves with a sudden flush of blood, raising your temperature, quickening your pulse, and flooding you with memories. Light flooding through stained glass windows is stimulating the V4 area of your visual cortex. Bach's music is vibrating within the cochlea of your inner ear and sending signals to the auditory cortex. The musty smells of centuries past register unconsciously on the olfactory neurons at the bridge of your nose. You are experiencing architecture.'[1]
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> *John P. Eberhard, 2006, AIA Journal*

John P. Eberhard, the founding director of ANFA (Academy of Neuroscience for Architecture), and his collaborators, were the first to explicitly propose the development of a new cross-disciplinary research network on architecture and neuroscience. Eberhard introduced the question of how the collaboration between architecture and neuroscience could lead to a better understanding of human nature, and to a better understanding of how people perceive their environment. He pointed out that this cross-disciplinary area would potentially offer a new and exciting understanding of human nature.[2]

In 2003 the ANFA was founded, and in 2012 the first conference on architecture and neuroscience was held at the Salk Institute, in San Diego. As Eberhard claims, the discussion of how architectural settings affect the human brain were prompted by Jonas Salk.[3] Dr Jonas Salk, in the 1950s, while trying to find a cure for polio needed a break and went on a sabbatical journey to Italy; to the Abbey at Assisi. As Eberhard presents, 'the setting of that abbey was so stimulating to his imagination that he created the concept for what became the Salk vaccine as well as how to produce it'.[4] Dr Salk was the first to open up the discussion on how neuroscience and architecture could together help us understand the effect of built environment on the human brain, and hence understand better how people experience spaces. Salk proposed to the AAF (American Architectural Foundation) – affiliated with AIA (American Institute of Architects) – to explore this research area further. His observations and proposals were followed up in the 1990s with the initiative of the AAF and the Salk Institute to found the ANFA.[5] As it appears through the book 'Brain Landscape'[6], Eberhard would expect that such a collaboration would have been sought after earlier. He also points out, though, that it is the recent evolution of relevant technologies that allowed this cross-disciplinary area to develop now as opposed to twenty or more years ago.

The first few research projects on neuroarchitecture, and the research supported by the ANFA, includes questions such as how classrooms and school environments facilitate the development of the cognitive functions of students, how the architecture of spaces can make people work more effectively, how architecture can help people with certain diseases such as Parkinson or Alzheimer to move in space, etc. As Jessica Pykett presents, by bringing closer architecture and neuroscience, the 'inaccuracy' of certain architectural research methods would be addressed, and one could 'understand the "true" impact of the environment on our brains and behaviour'.[7] Neuroarchitecture has been seen as a 'solution' for the scepticists of the architects' often intuitive and qualitative methods. As Pykett presents, 'the project of neuroarchitecture sets out to address perceived deficiencies in the evidence offered by architects, who are sometimes said to be too reliant on intuitive conjectures about how buildings affect occupants'.[8] In these terms, neuroarchitecture, is associated with a purely positivist approach, and is addressing architecture using a language of 'efficiency', 'productivity', enhanced cognitive function, assuming that these are generally desirable drives for the design of space.

The criticism and scepticism of this type of neuroarchitecture, which is based on a purely positivist approach and is using a language of 'efficiency', has been vocalised by several theorists and architects. As Lukas Ebensperger et al claim:

> 'Neuroarchitecture, especially in John P. Eberhard's vision, embraces a very specific idea of man, which derives from a pop-neuroscientific perspective; as well as an overly optimistic appraisal of future neuroscientific insights. Neuroarchitecture thereby adopts a simplistic representational theory of mind, together with an uncritical definition of humans as path seekers and problem solvers. The danger then is precisely that, by putting into place neuroscientifically informed architectures, the "architecture" of a neuroscientific outlook on personhood and selfhood (that is brainhood), is instantiated and reflexively institutionalised.'[9]

Jessica Pykett presents different aspects of the criticisms of the neuroarchitecture, amongst which the view that 'we risk portraying a deterministic account of human action and medicalising social phenomena'.[10] She points out the fact that neuroarchitecture often does not consider the broader social, cultural, political, historical context of the question at hand. It also 'promises to fulfil the quest for explanation' for observations that were based solely on the architects' 'intuition', and hence legitimise them through some kind of scientific proof. [11]

Concerns and debates such as the above are inevitable in a field developed across disciplines which emerge from a different context; a different philosophical and methodological standpoint.

3.0 Methods of cross-disciplinary research; paradoxes and contradictions

> *'Not all those who wander are lost'*[12]
>
> *J.R.R. Tolkien*
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> *'The phenomenologist is a perpetual beginner, continuously questioning the enigma that is the world by not simply acknowledging the nature of what is encountered but also by periodically questioning what is means to know something.'*[13]
>
> *Michael Jenson*

Several architects and neuroscientists have argued for the value of a cross-disciplinary approach to the experience of space involving architecture and neuroscience. Often, though, one of the main challenges is not opened up through the relevant practical applications and case studies: The inherent contradiction, or paradox, of the methods used in these two disciplines.

In architecture – or at least in certain areas of architecture relevant to the questions presented above – research is driven by open ended questions and by an open – often phenomenological – engagement with processes, which reveal a new approach and a new understanding of how people experience places. In contrast, in the area of neuroscience the methods follow a positivist approach, which emerges from a Cartesian analytic way of seeing the world. There is often a very specific and clear hypothesis which the experiments prove right or wrong.

Architects, designers, urbanists, social geographers, often follow methods emerging from a phenomenological approach; they attempt to gain a better understanding of a place by exposing themselves to it, by observing it, by mapping various aspects of it, by performing different tasks within it, and hence encountering it in a number of different ways. In this context, the immersion that such processes allow is what leads to the understanding, knowledge, and experience sought after. In a phenomenological perspective, the understanding (of a place/ an issue/etc.) occurs through immersing within a situation; through exposing one's self to it.[14] For Husserl, understanding occurs through exposure to a situation.[15] As Dermot Moran claims, 'Husserl wants to explore experience in a pure manner, unsullied by assumption. Thus when Husserl proclaims himself, in the manner of William James, to be a *radical empiricist*, that is to count only what is given in experience and all of what is given in experience, it is because Husserl claims to have identified far richer resources for evident cognition in experiences than any philosopher hitherto fore'.[16] This type of experience is devoid of solid pre-assumptions.

The phenomenological approaches, as expressed by Husserl, Heidegger, Merleau-Ponty – amongst others – have influenced significantly the architectural thinking and practices. According to Jenson, 'Phenomenology, the unprejudiced investigation by the consciousness of encounters within the world so that things just emerge, is seen by many as an open, varied, and flexible alternative to the exclusionary naturalistic accounts of many positivistic philosophies.'[17] As Jenson claims, drawing from Husserl's writings, phenomenology is more interested in seeing than analysing, and is associated to an open reading and describing of the world.[18]

Threads of contemporary thought, such as the discourse of mapping, are influenced by the above phenomenological context.[19] James Corner, in his broadly published and very influential 'Agency of Mapping', argues for a kind of mapping that is generative; a kind of mapping that reveals – through the processes it undertakes – what was previously unknown. He interprets and describes mapping as an open-ended process; as a process which allows for the unexpected to be revealed. That type of mapping does not necessarily start with a clear question; it is more of an involvement with a place. As he claims, the mapping's 'agency lies in neither reproduction nor imposition but rather in uncovering realities previously unseen or unimagined, even across seemingly exhausted grounds'.[20] He draws from Gilles Deleuze and Felix Guattari's thinking[21] and quotes:

> 'What distinguishes the map from the tracing is that it is entirely oriented toward an experimentation in contact with the real. The map does not reproduce an unconscious closed in upon itself; it constructs the unconscious. It fosters connections between fields, the removal of blockages on bodies without organs, the maximum opening of bodies without organs onto a plane of consistency [...] The map has to do with ***performance***, whereas the tracing always involves an alleged competence.'[22]

In this context, a map may not (or should not) necessarily be based on what we already know or a clear hypothesis. A map often is an open-ended process of questioning, mark-making, revealing, re-addressing and re-adjusting the questions, and an engagement, an involvement in an exploratory journey.

The ideas of open-ended processes have been taken even further through the discourse of the Psychogeographers and Situationists. The mapping of the ambiences of different parts of the city were not based on the representation of buildings and streets; it attempted to map other, less tangible aspects of human experience in a systematic manner. It was based on experience, immersion, observation, and representational processes which also involved intuitive abstractions and assemblages. Kevin Lynch produced a provocative map of Boston, a type of mind-map, based on descriptions and narratives of inhabitants of the city that he interviewed.[23] Guy Debord, followed the method of dérive, which he introduced as 'a mode of experimental behaviour linked to the condition of urban society: a technique of transient passage through varied ambiances'.[24] Through this method he attempted to map 'the sudden change of ambiance in a street within the space of a few meters; the evident division of a city into zones of distinct psychic atmospheres; the path of least resistance which is automatically followed in aimless strolls (and which has no relation to the physical contour of the ground); the appealing or repelling character of certain places'[25], all that, as he claims 'seems to be neglected.'[26] As Denis Wood points out, the two types of Psychogeography – the one introduced by Guy Debord in Paris and the one introduced by Kevin Lynch in Boston – are quite different.[27] Both though, attempt to introduce a systematic way for mapping things that were previously ignored. Both types of mapping attempt to facilitate a discussion on issues previously ignored and provoke – or inform – policy making.

Considering the above context, new methods and technologies enable us to revisit relevant questions anew. What creates a certain ambience in a part of the city? What are the attributes that constitute or lead to the creation of the atmosphere of a certain area, street, public space, at a given moment in time? How one could map and represent those ambiences? How one could map the temporary 'mood' of a place? In what ways could such a mapping enhance our experience and understanding of a place? How could one examine these issues and take them into consideration when designing spaces?

These 'psychogeographic' questions can be also, in parallel, interpreted as the first stage of a scientific process; as the testing of a hypothesis. The close observation and mapping of the brain activity of people as they walk through the city may reveal, for example, patterns as to where they appear to be more concentrated, stressed or calm. The findings may potentially lead to observations which will inform the design of space.

As contemporary flâneurs[28], we immerse in an exploratory process; and this process draws from contradictory threads of thought. Our research is underpinned by the hypothesis that a new type of mapping and representation may reveal an interesting insight and may inform design practices. In parallel, we constantly remain critical of the absolute positivist approaches; we remain open to unpredicted ruptures, and questions that the process will itself bring forth.

4.0 The experiment

For the purposes of the specific experiment, ten participants were invited and were asked to navigate between different buildings in the city, through a route of their choice. Hence each participant walked along four distinct routes in Portsmouth city centre. All participants were familiar with the area to a smaller or larger extent. All participants agreed that they would be able to find their way between the buildings without a map or a GPS.

Each participant was equipped with a portable EEG device, the 14-channel Emotiv Epoc+. Each participant was also video recorded along their walk. The video recording was used for synchronising the EEG recording with the participant's movement in space. It was also valuable for revealing further information as to what was happening around the participant in each moment of the journey. Each participant was briefly interviewed after the experiment.

With the above process we mapped a total of 40 routes in the 10 volunteers. The EEG recordings (using Emotiv system EPOC) were analysed through the use of the programs of the Emotiv Suite which allowed the EEG activities to be specifically analysed into frequency band widths Beta, Alpha, Theta, Delta. The EEG system uses a validated signal detection algorithms to detect the EEG signal.[29] Once analysed, the Emotiv 3D Brain application was used to represent and visualise the different brainwave frequencies; and spatial location of the activities in relation to the recording sensors on a real time basis during each following a calibration of the base point adequate for each participant in order to produce a dynamic neural map of each of the EEG figures as the participant moved through the journey (fig.1).

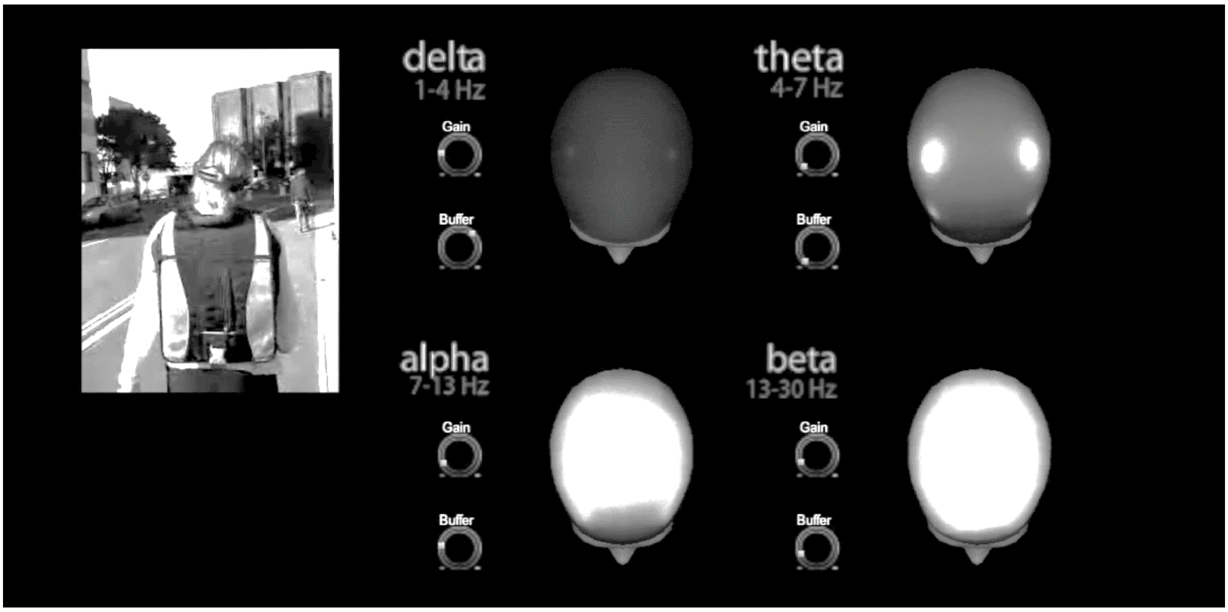

Figure 1: Video of the participant synchronised with the EEG recording.

The analysis of these recording was following two parallel threads of thought:

(a) Through the analysis of these recordings our aim was to observe common patterns. Is a way-finding decision-making 'visible' on this type of brain-activity recording? How is it manifested? Does it show in a similar manner across different participants, or it varies? Does the degree of familiarity of a place have a visible impact upon the brain activity of the participants? How does the brain of each participant respond to the crossing of a street? Or to the waiting at the stop lights of a pedestrian crossing? How does the brain respond to quiet parts of the journey and how to busier ones?
(b) The recordings and relevant observations can be represented visually in a number of different ways. How do we choose to represent the recorded information and what type of abstraction do we apply? The amount of data collected through this method is quite big, and for any visual representation a critical selection and editing needs to take place.

The limitations of this experiment need to be clarified. The number of participants is similar to other studies in architecture, urban, or anthropological studies, and adequate for making some observations and correlating the relevant literature to the recorded patterns. It is not, however, a number that can lead to statistically solid conclusions which could be generalised. Hence, the findings are approached critically, as indicators that support a hypothesis, and as a tool for testing further hypotheses which will be examined in later experiments.

Additionally, as mentioned earlier, the cross-over between methods of anthropological studies (such as the studies of psychogeographers, the situationists, and other studies of urbanists and architects) – and methods of sciences, is something that is currently being developed. Hence, the aim of laying out the methods and experiments conducted here is also to contribute to this developing conversation.

Figure 2: The routes of different participants between given points in the city. Journey A (participants 1513, 1514, 1515, 1516, 1519) and Journey B (participants 1515, 1516, 1517, 1518, 1519)

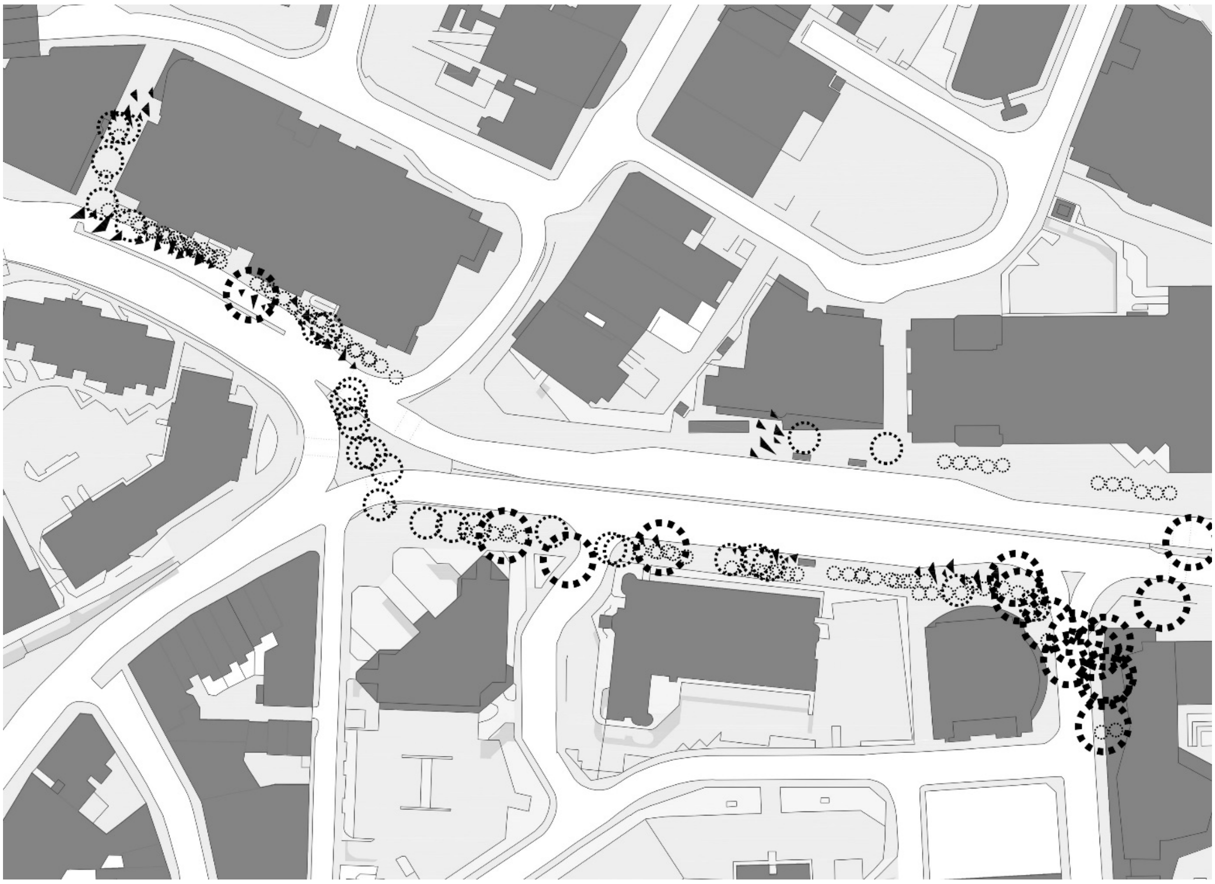

Figure 3: The maps of journey 1 combined

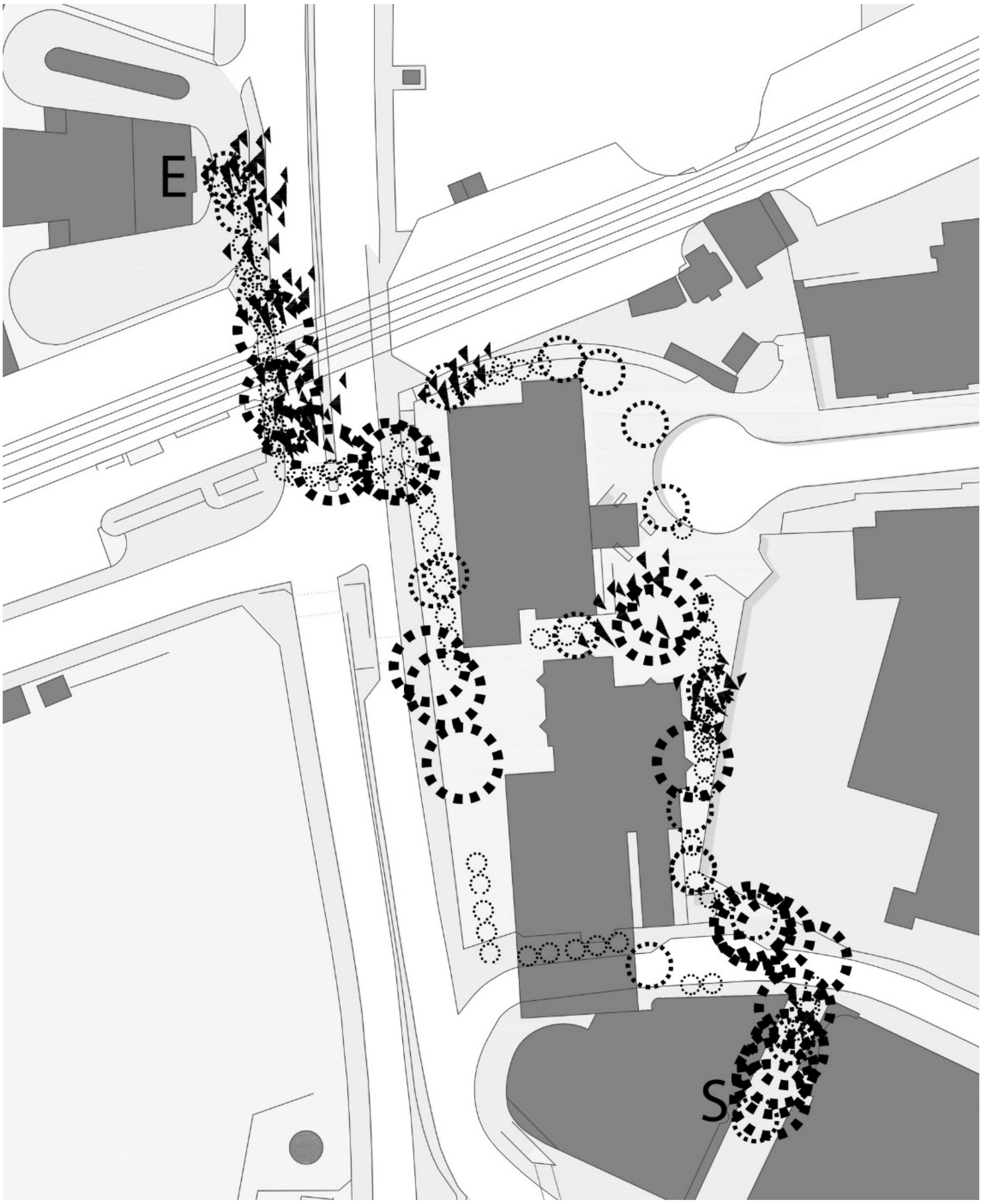

Figure 4: The maps of journey 2 combined

5.0 Main observations

- Beta-peaks and decision making: We observed that all the key-moments that the participants identified as moments where they made a critical way-finding decision (a decision as to which direction or route to follow) show a short and intense peak of the Beta frequency. There is little understanding as to the individual origin of EEG brain activities, most literature suggests that the EEG is the sum of all combined neural processes of the brain. However, limited literature has suggested that alpha activity is related to processes involving attentive processing whilst beta activities reflect activities involving cognitive processing of the brain.[30] The observation of beta activities during critical points requiring way-finding decision observed in our study provides the first observation in real time real life activity to support what the relevant literature shows and supports literature that suggests that Beta brain wave frequency is associated with active decision making or with other intense cognitive function.[31]

Additionally, the participants appear to have been making other less significant or memorable way-finding decisions, which one can notice from observing the video recording. Those show as brief peak of Beta of varying intensity. However, those moments that the participants themselves verbally identified appear as the most intense peaks of Beta.

The peak of Beta frequency is short and intense when associated with a way-finding decision making. The Beta frequency may appear increased for other reasons too; however, in those instances its form is often different: The peak is of longer duration and less intense. Figure 2 shows a visual representation of the brain activity of five different participants along journey 1 and journey 2. The short and intense peaks of Beta are shown as big circles. Beta peaks of medium intensity are shown with smaller circles. The smallest circles show a minor fluctuation of the Beta frequency. The triangular marks represent moments where the participant came across other groups of people.

- Common patterns: We observed that there were a few moments – for most participants – in the beginning of their journey – and in some instances in a few other key-moments of their journey, where they thought and decided about a major part of their route. They reflected on which route they should take. Those moments are shown in our mapping as some of the most intense brief peaks of Beta activities coinciding with decision making during the journey. The more intense beta activities that we observed are those in the beginning of the journey or of a key part of the journey where the decision is not a small decision only about the next step, but also about a major part of the route that will follow. At those moments the participants pause for a second and look around to identify and decide their route; hence what they verbally identified at the short interview is also shown through the video recording.

- Encountering people: When a participant comes across other people, this shows on the brain mapping as an intense cognitive function. The Beta is increased, and in most cases this is associated with a transient increase of the theta/alpha range activities. Such Increases in theta/alpha range activities have been reported to be associated with cognitive and memory performance.[32] From our recordings, we observed that in all instances where a participant encounters other people, a clear increase in Beta occurs. The closer the encounter with passers-by, the more intense the impact. We need to acknowledge that the fact that the participants wear the EEG device, which is visible to others, may have an additional impact on that; participants may feel self-conscious at those moments. Still, though, the participants themselves argued that the equipment was very light and they almost forgot they were wearing it. They claim that they believe that wearing it did not make them feel self-conscious when walking amongst other people, with one exception. If, as the literature suggests, the transient theta/alpha activities observed in our study do represent some aspect of the workings of memory cognition, an alternative suggestion might be that the participant was looking at the approaching individual 'sub-consciously scanning' the individual for face recognition or for signs of unusual eye contact/ behaviour / or potential for adaptation to the pre-calculated way finding map constructed in the brain of the participant. The EEG changes observed in this study would lend support to the hypothesis that the transient appearance of the theta/alpha activities moments before the beta activity peak may be a reflection of specific memory cognition processes, as presented by Klimesch.[33]

- Crossing streets: When the participants stop at a red light at a pedestrian crossing, the Beta shows a decrease. Their state of alertness drops while they wait. The opposite happens when they pause at a busy crossing without a stop light; they become more attentive to decide when to cross. This does not come as a surprise, as it aligns with what one would expect. A busy street, although intense, does not have an impact on the Beta brain wave frequency of the participants, when those are just waiting for the stop light to become green. When the participant's brain recording shows an increase in Beta while they cross a busy street, we observe that this peak of Beta appears a little delayed. The video shows that they are alert and cautious to cross a street, they start carefully crossing, while they still look around. The peak in Beta appears just a couple of seconds later. This makes us notice that for many cognitive functions, the intensity in brain wave frequency appears with a small delay.

- Degree of familiarity: In the areas and part of the route that one is more familiar with, generally, the Beta is lower. Our sample was small, however, in the parts of the journey where the participant said s/he is very familiar with the place, the Beta was lower in comparison with parts of the journey where s/he said it is a part of a route that s/he has never or very rarely crossed.

- Curiosity: At some specific moments of the routes, a distant view of a different part of the city, or of a distant street or building is suddenly revealed. We noticed that these moments often show as a brief increase in cognitive function on the brain activity recordings. One example is participant 1514, in the recording of Journey 1 (Fig.2). The participant walks along the main street, and a brief intense peak of Beta appears as soon as s/he notices a hidden view between two big buildings. The video shows that s/he notices this gap between the buildings and looks towards there. Similarly, at key moments of Journey 2 (Fig.2) participants look towards views that are suddenly revealed and this shows as a brief increased cognitive function. One could argue that this observation is relevant to the previous one; the degree of familiarity. At parts of the route that the participants were less familiar with, they looked more around them and discovered new views of the city. Moreover, one can note that during journeys which are more complex and involve several turns (and possibly a bigger number of small decisions to be made), participants' cognitive functions are more intense throughout. Journey 2, for example, appears to be more 'intense' than journey 1.

- Technology glitches limitations: During the analysis of the recordings we observed that there were several artefacts, or 'noise'. One example was associated with the fact that the strong sunlight was blinding the participants at a specific part of a route. This became obvious through the video recordings and the equivalent EEG recordings. These parts of the recording were left out so as not to influence the conclusions of this study. Similarly, in instances when one or more sensors were detached, the relevant parts of the recordings were left out in our analysis. For the journeys selected to be visualised in the earlier described manner (Figures 2-4), there were glitches and no parts of the journeys were left out.

6.0 Conclusion

This study is meant to enhance the relevant discussion and open further paths for investigation of the human experience in everyday environments, and for representation of interesting relevant phenomena.

One of the main observation of our study is the following: The recording of beta activities during critical points requiring way-finding decision provides the first observation in real time, and real life activity, to support what the relevant literature shows. It also supports literature that suggests that Beta brain wave frequency is associated with active decision making or with other intense cognitive function;[34] in our case representing a quick and spontaneous way-finding decision.

A second observation of our study was the fact that the Beta is increased when encountering people, and in most cases this is associated with a transient increase of the Theta alpha range activities. Such Increases in theta/alpha range activities have been reported to be associated with cognitive and memory performance.[35] From our recordings, interestingly, the closer the people who are passing by the more intense the effect on the intensity of the beta peaks. Meaning of this is unknown without further study.

Finally, we observed that interesting points of the journey were identified by the beta activity peak and in most cases confirmed through the questionnaire. Curiosity was raised when discovering views revealed along the way - reflecting increasing in cognitive processing along the way finding journey.

Overall, we additionally observe that drawing conclusions and correlating the participants' brain activity with the environment around them is much more complex in outdoors urban spaces, in comparison with spaces within a building. The light, the sound, the complex change of scenery are parameters that make the analysis much more complex in outdoors environments.

The above observations are based on a fairly small sample; 10 participants conducting a total of 40 journeys. The sample is similar to other relevant studies. However, we need to clarify that in order to reach statistically significant solid outputs to interpret the human experience and behaviour, a much bigger sample is needed. This study, still, helps us discuss some hypotheses, and develop new ones to be tested further.

This experiment is part of an ongoing investigation of how architecture and neuroscience can collaboratively lead to the development of new methods for mapping and understanding human experience in the built environment. This investigation draws from the experimentations of the Situationsists and Psychogeographers and attempts to engage practitioners of different disciplines in an exploratory process. An understanding of space and human experience is gained through immersing in such processes. In parallel, this experiment is part of a study which aims to develop a method for gaining a better understanding of human experience - which will in turn inform design practices. In other words, we can discuss about the value of the development of such methodologies via a phenomenological perspective – where the value lies within the un-concealing of links, of relationships between spaces and intensities of brain activity – or via a positivist perspective, where the value is associated with potential practical applications, such as improving the design of spaces for people with disabilities of health issues, improving the design of public space, of exhibition spaces, and so on. With the development of cross-disciplinary projects, a new 'language' and set of methods will be gradually developed to address and include the above, and often contradictory, narratives.

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[1] Eberhard, J. P. (2006). "You Need to Know What You Don't Know." AIA **1**.
http://info.aia.org/aiarchitect/thisweek06/0127/0127eberhard.htm

[2] Eberhard, J. P., Ed. (2009). Brain Landscape; The Coexistence of Neuroscience and Architecture. Oxford; New York, Oxford University Press.

[3] Ibid.
pp.21-23

[4] Ibid.
p.21

[5] Ibid.

[66] ibid.

[7] Pykett, J. (2015). Brain Culture: Shaping Policy Through Neuroscience. Bristol; Chicago, Policy Press.
p.72

[8] Ibid.

p.72

[9] Ebensperger, L., et al. (2010). Designing the Lifeworld: Selfhood and Architecture from a Critical Neuroscience Perspective. Cognitive Architecture: From Bio-politics to Noo-politics. D. Hauptmann and W. Neidich. Rotterdam, 010 Publishers.

pp.243-244

[10] Pykett, J. (2015). Brain Culture: Shaping Policy Through Neuroscience. Bristol; Chicago, Policy Press.

p.174

[11]Ibid.

p.73

[12] J.R.R. Tolkien (1965), The fellowship of the Ring.

[13] Jenson, M. (2014). Mapping the Global Architect of Alterity: Practice, Representation and Education. Oxon, New York, Routledge.

p.52

[14] Caputo, J. D. (1987). Radical Hermeneutics: Repetition, Deconstruction, and the Hermeneutic Project. Bloomington, Indiana University Press.

, Snodgrass, A. and R. Coyne (2006). Interpretation in Architecture: Design as Way of Thinking. London, Taylor & Francis, Routledge.

[15] Husserl, E. (1999). The Idea of Phenomenology, Kluwer Academic Publishers.

, Held, K. (2003). Husserl's Phenomenological Method. The new Husserl: a critical reader. D. Welton. Bloomington, IN, Indiana University Press.

[16] Moran, D. (2002). Introduction to Phenomenology. Oxon, New York, Routledge.

p.12

[17] Jenson, M. (2014). Mapping the Global Architect of Alterity: Practice, Representation and Education. Oxon, New York, Routledge.

p.52

[18] Ibid.

p.52-55

[19] Perkins, C. (2003). "Cartography: mapping theory." Progress in Human Geography **27**(3): 341-351.

[20] Corner, J. (2002). The agency of mapping. Mappings. D. Cosgrove. London, Reaktion**:** 213-252.

p.213

[21] Deleuze, G. and F. Guattari (1987). A Thousand Plateaus: Capitalism and Schizophrenia. London, Athlone Press.

[22] Corner, J. (2002). The agency of mapping. Mappings. D. Cosgrove. London, Reaktion**:** 213-252.

pp.213-14 Quoting: Deleuze, G. and F. Guattari (1987). A Thousand Plateaus: Capitalism and Schizophrenia. London, Athlone Press.

[23] Lynch, K. (1960). Image of the City. Cambridge, Mass., Cambridge Technology Press.

[24] Guy Debord, ''The´orie de la de´rive'' (1956), Les Le`vres Nues 9 (1958), reprint: Internationale Situationniste 2: 19–23. From Knabb's translation: ''Theory of the De´rive,'' in Situationist International Anthology, ed. Ken Knabb (Berkeley, CA: Bureau of Secrets, 1995): 50–54, 50. Quoted from: Wood, D. (2010). "Lynch Debord: About Two Psychogeographies." cartographica **45**(3): 185-200.

Debord, ''Introduction to a Critique of Urban Geography,'' trans. Knabb quoted from: ibid.

[25] Debord, ''Introduction to a Critique of Urban Geography,'' trans. Knabb quoted from: ibid.

[26] Debord, ''Introduction to a Critique of Urban Geography,'' trans. Knabb quoted from: ibid.

[27] Ibid.

[28] We will not expand here on the discussion of the differences between the flâneur and the dérive, and we use this term in its broader sense. The dérive, according to Debord, is a collective activity of groups of two or three so as to reach an objective conclusion about a place. In contrast the flâneur is often wanders in the city alone, either aimlessly, or observing and exploring the city life.

[29] Hairston, D. W., et al. (2014). "Usability of four commercially-oriented EEG systems." Journal of Neural Engineering **11**(4).

[30] Ray, W. and H. Cole (1985). "EEG alpha activity reflects emotional and cognitive processes " Science **228**(4700).

[31] Ibid

[32] Klimesch, W. (1999). "EEG alpha and theta oscillations reflect cognitive and memory performance: a review and analysis." Brain Research Reviews **29**(2-3): 169-195.

[33] Ibid.

[34] Ray, W. and H. Cole (1985). "EEG alpha activity reflects emotional and cognitive processes " Science **228**(4700).

[35] Ibid