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Perception and Emotional Response to Architecture: Exploring the human reaction to spaces with different geometry

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Partner Institutions
Ciaud

Expected Future Partner Institutions
Academy of Neuroscience for Architecture (ANFA)

ABSTRACT + IMAGES

Geometry as the matrix of architectural space, in itself, generates different emotional reactions, present both in the visible limits that shape the space, and in the invisible and intangible limits that direct the user's look and perception. These emotional reactions condition people's well-being and, consequently, the way they choose spaces to inhabit.

In response to these concerns, in 2003 a new area of knowledge called neuroarchitecture emerged, after the creation of the Academy of Neuroscience for Architecture (ANFA) in San Diego, California. Since then, authors such as John Eberhard. Juhani Pallasmaa, Michael A. Arbib, Sara Robinson and many others have carried out various studies in this area.

Based on other studies (Balakrishnan et al., 2006; Shemesh et al., 2016; Banaei et al., 2017; Vartanian et al., 2019), we know that curved shapes can cause relaxation and that rectilinear shapes can cause user activation. However, there are sub-variables of geometry that have not yet been studied and that act together in the perception of shape and space, such as concavity (concave, convex) and regularity (regular, irregular). This project seeks to understand how the change in the concavity and geometric regularity of different spaces influences the perception and specifically the emotional reactions of users. For this, focus group meetings are held, with elements of the project team, namely architects, psychologists and invited designers, which will allow generating ideas for modeling spaces for a place of passage and waiting (i.e. railway station, airport). The selected spaces will be modeled in Rhino and exported to UNITY3D, where they will be prepared for a virtual reality experience (placement of textures, lighting, sounds and integration of a participant's avatar).

In this sense, a narrative will be created to give the same context to all participants and give them a goal to explore the space. In this experiment, the measurement of the participants' emotional reactions will be carried out using the proposed methods already validated by several neuro-architecture studies: subjective and objective methods. Subjective Methods, obtained from the participants' perception after interacting with the proposed spaces. These methods use scales and graphical representations, such as the Manikin Self-assessment, which measures levels of activation, pleasure and mastery. These methods are subject to several problems, related to the user's memory and inventive spirit, social influences, which can lead to less accurate answers. Objective Methods, using biosensors, which measure physiological reactions (ECG, EDA and Respiratory rate) and brain activity (EEG) in real time. These reactions are under the control of the autonomic nervous system and are less subject to the problems mentioned above.

With this project, it is expected to identify the relationship between the type of perceptions, including emotional reactions, regarding the concavity and regularity of shape and space, as well as to understand whether or not there is an interdependence of these two properties in the geometry and the experience of architecture.

The project presented is the result of the union of a plural team, where it is proposed that the base theme and respective process be carried out transdisciplinary, with researchers from various areas, including architecture, psychology, design and human factors.

The team of this project already has experience in using the methods proposed by neuroarchitecture, including publications in this area (Formiga et al., 2021).

The methodology we propose was tested in studies prior to this project, where we evaluated two virtual architectural experiences with curved and rectilinear shapes, resulting from the exploration of various design hypotheses for two apartments. In this study, a context narrative was elaborated, illustrated in a sequence of images and the participants had the possibility to roam the virtual space freely, something that was not verified in other studies of the bibliography.

The project will be developed at the ErgoUX Lab, at the Faculty of Architecture of the University of Lisbon, which has the necessary equipment for the development of this study (biosensors - EDA ECG, EEG, RESP, Helmet RV, Workstation RV).

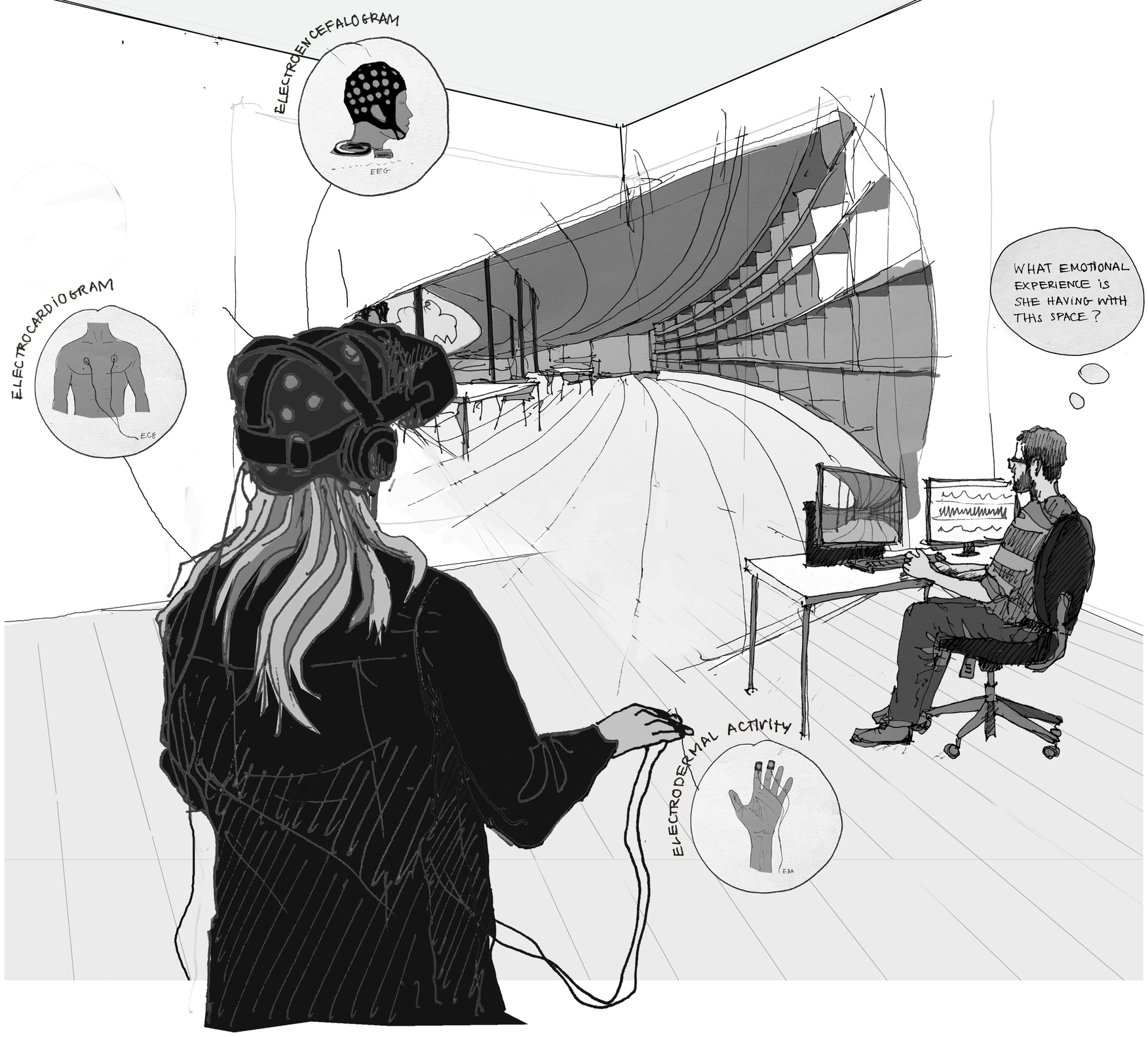
Within the scope of this project, two research grants will be provided and the participation of a PhD student who is integrated as a researcher and who develops studies in the area of neuroarchitecture.

At the end, we propose to organize an event (workshop) where the results will be disseminated and discussed with architects and architecture students, in order to obtain a new look at the geometry of architectural space and its influence on people's perception and emotional reaction.

We consider the present research proposal important for architecture, since For architects, the way in which space influences users' perception is a subjective matter that depends on each one's sensitivity. Understanding these affective relationships can open new fields for the way we imagine, create or design architectural space.

OBJECTIVES

The objectives of this project take into account previous investigations, in which the geometric shape of space was explored. However, these antecedents essentially served as a pilot study to validate the methodology, rather than to explore the geometry property. In this sense, this project intends to deepen the knowledge of the affective relationship with the geometry of space, that is, to understand how the geometry of architectural spaces influences people's emotional reactions. In the bibliography presented, there are investigations that explored this component, but none of them deepened the study in order to try to understand that other sub-variables or properties of geometry may be influencing emotional reactions, such as concavity and regularity. This study specifically intends to explore the influence of these geometric sub-variables and identify the relationship between the type of emotional reactions with the concavity and regularity of spaces.



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SCIENTIFIC RELEVANCE FOR THE DISCIPLINE

The way the brain reacts to the environment has been the subject of a great deal of study in the field of neuroscience, presenting concepts and a set of techniques that best translate the sensory, cognitive and behavioral stimuli of the human being in relation to a given environment. As stated by António Damásio, “if the body and the brain interact intensely with each other, the organism they form interacts no less intensely with the environment that surrounds it”, that is, the values of form, scale, light , are environmental stimuli that interact intimately with the subject, changing their way of living and interacting, since most people spend about 80% of their lives inside buildings. For architects, the existing knowledge on this subject has always been considered subjective and its application often depends on the sensitivity of the architect who designs the space. However, for architecture it is essential to know how users will be influenced by a certain space, with certain characteristics. Faced with this reality, architecture together with neuroscience, have an important role to play, understanding how architectural properties influence people's emotional reactions, so that architects can design according to this knowledge.

EXPECTED ECONOMIC AND SOCIAL IMPACT

- Training and integration of students in research in the field of neuro-architecture
- Cross-disciplinary teamwork
- Expansion and dissemination of knowledge through publications, seminars and workshops
- Research that aims to reveal how geometry, shape and space influence people's perception and emotional reactions, with the aim of proposing architectural solutions that meet the success of companies and institutions, making them more appropriate to the objectives and to the target audience.

RESEARCH PLAN AND TASKS

Investigation plan

The research plan stems from the proposed specific objectives:

- Develop models of spaces where the sub-variables concavity and regularity will be explored and their adaptation to virtual reality, including a narrative. This study will begin with several meetings with specialists to discuss how the three-dimensional spaces will be created and designed, which will be developed and adapted for virtual reality. Subsequently, these will be the spaces experienced virtually by the participants involved. This discussion also involves the creation of a contextual narrative, to give a goal to the participant during the interaction with the virtual environment.
- Study how the sub valuables of the shape: concavity and regularity influence emotional reactions. This study will be developed using biosensors to collect objective information (EDA, ECG, RESP, EEG) and a questionnaire with scales (SAM) for subjective information.- Identify the relationship between the type of emotional reactions with the concavity and regularity of spaces. This identification will be developed from the crossing of subjective and objective information of the participants, synchronized with the images collected during the experience.
- Provide the training of architecture students in the field of neuro-architecture and virtual reality. Two architecture students will be included in this project, to whom we will award two research initiation grants, for specific training in this area of neuro-architecture.
- Disseminate the knowledge achieved to the scientific and academic community. In this project we propose the organization and realization of a final event (seminar, workshop), where professionals in this area and the academic community will be involved.

Tasks

Task 1 – Exploration of different spatial forms

- Goals: This task consists of selecting the architectural solutions with greater differentiation between them, in order to cover a greater diversity of results in the face of emotional reactions. The selection criteria for design hypotheses/solutions for a railway station or an airport (e.g.), take into account the geometric diversity/variability of these hypotheses, in terms of shape (curved, rectilinear), concavity (concave, convex) and regularity (regular, irregular).
- Methods: Continuation of the literature review to systematize the existing information in these areas of knowledge. Meetings with specialists (architecture, design, human factors and psychology) to establish ideas about the shapes to be modelled. Development of the project hypotheses will be carried out in sketches by hand in an exploratory phase, and later only the chosen solutions will be designed by computer, for the creation of virtual environments.
- Tools: Sketches and computer design programs
- Scheduling:1 month

Task 2 - Modeling solutions for VR and rendering

- Objectives: this task consists of designing selected design solutions in 3D modeling and rendering programs, in order to create digital models that enable experiences in Virtual Reality. Several pilot studies will also be carried out to assess the quality of the experiences created.
- Tools: 3D modeling and rendering program, Unity3D and VR glasses, VR
- Workstation Scheduling: Five months

Task 3 - Data collection and assessment of emotional reactions to the modeled solutions

- Objectives: this task aims to collect data and assess the participants' emotional reactions to the selected architectural spaces.
- Methods: The evaluation consists of the application of a protocol for the placement of biosensors, namely the EDA (electrodermal activity), which will measure the variation of the skin's electrical impulses, the ECG (electrocardiogram), which will measure the variation of the heartbeat and the EEG (electroencephalogram), which will measure the variation of electrical impulses in the brain, transmitted by brain waves. These analytical instruments will provide participants' physiological data on the unconscious state of the autonomic nervous system, which acts during virtual experiences of different architectural spaces.
- Protocol: 1. The participant is informed about the objectives of the study and that the information collected was completely confidential; 2. The participant signs the document in which he/she agrees to participate in the study; 3. It is explained how to place the EDA, ECG, RESP, EEG biosensors; 4. The participant places the biosensors on himself, and the EDA is placed in the left hand if the person is right-handed and in the right hand if the person is left-handed; 5. The participant is placed in the area destined to the Virtual Reality experience, it is explained and indicated which buttons of the command he will have to handle during the experience; 6. The participant undergoes a three-minute relaxation period to obtain the baseline of rest, while listening to relaxing music. 7. The participant watches a two-minute film that shows the contextual narrative of the experience. 8. The participant enters the virtual experiences in a randomly assigned sequence among participants 9. After the end of the experiences, the SAM questionnaire is carried out regarding each space they visited and the participant responds taking into account their valence level (displeasure/pleasure) and arousal (calm/excited).10. At the end, an open interview is carried out, where considerations of the participant's perception of their preference were obtained.

Instruments/software: The electroencephalogram (EEG) is a neuroimaging test which can detect and record minute changes in electrical activity within the brain. This is recorded using macro-electrodes (large, flat electrodes stuck to the skin or scalp). It produces a chart (an encephalogram) which shows how ‘brain waves’ vary by frequency (number of waves per second) and amplitude (height) of electrical output from the brain changes over time.

- An Electrocardiogram (ECG) records the electrical signals in the heart. It's a common and painless test used to quickly detect heart problems and monitor the heart's health. Electrodes (small, plastic patches that stick to the skin) are placed at certain spots on the chest, arms, and legs. The electrodes are connected to an ECG machine by lead wires.
- Electrodermal activity (EDA; sometimes known as galvanic skin response, or GSR) refers to the variation of the electrical conductance of the skin in response to sweat secretion (often in minute amounts).Scheduling:5 months, one of which overlapping with the previous task.

Task 4 - Results and Discussion

- Objectives: the objective of this task will be to observe the results obtained through the questionnaires and the biosensors and relate them to the properties of the geometry that were being experienced by the participants at the same time. In this way, it is intended to find an affective relationship between the different geometries/shapes of space and the perceptive-emotional reactions of the participants.
- Methods: Analysis and discussion of results in working meetings with the team
- Scheduling:1 month
- Task 5 – Disclosure
- Objectives: the objective of this task will be to disseminate the results obtained, publishing in journals with an impact factor, as well as organizing a seminar/workshop on the topic, aimed at students, researchers and architects, with the invitation of other specialists.

EXPECTED SCIENTIFIC RESULTS

- Identify the relationship between perception and the type of emotional reactions in the virtual architectural experience provided, in relation to the geometric properties of concavity (concave, convex) and regularity (regular, irregular) of spaces.

BUDGET: € 7.000,00

- 2 research initiation grants: €485 x 9 months = €4365
- Data visualization
- Heart Rate Variability (HRV) - €485.85
- Electrodermal Activity (EDA) €485.85
- Video Synchronization - €485.85
- Total software: (HRV+EDA+Video Syncronization) €485.85 each = €1457.55
- Payment of services to participants involved in virtual experiences/tests: €577,45
- Workshop: €600
- Total Financing: €7000