

Architectural Space Alters the Expression of Gene that Regulate Physical and Emotional Stress

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Abstract

Newberg & Waldmans (2010) concluded their well-known scientific experiment, “*A single word has the power to influence the expression of genes that regulate physical and emotional stress*”. However, could architectural space also speaks? Or alter the expression of genes? This study aimed to investigate the relationship between architecture, brain and genes. The objectives were to test the influence of architecture over brain’s electrical-activity, and subsequently develop, a theory of space and genes. The research methodology involved three phases. Firstly, an integrated approach for literature review. Secondly, an experimental approach. Finally, an integrative analysis. Findings showed a significant change of brain-electricity by change of environments. Thus, alteration in the expression of genes.

Keywords: Architecture; Emotions; Behaviour; Genes.

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1.0 Introduction

As modern science emerged, human started to believe less in the spiritual dimension of life. It impacted many people, including architects and engineers to implement a new pattern of thinking in the way they live their lives and most importantly, In designing buildings, they started to believe less in aesthetics, but more about, function, tangibles and materialism. It has become all about money (Bica, 2016). With the evolution of science also, scientists and researchers started to understand the effect of design on human wellbeing, depression, and spiritual dimension. Neuroscience started to offer us a new perspective in the way we view reality as found in recent studies by the World Federation for Mental Health (2016). By 2030, it is anticipated that the most significant illness would be the mental disorder of “depression”. Furthermore, contemporary architecture has started to receive more accusations with emotional coldness, restrictive aesthetics, distanced from human and life (Pallasmaa, 2015).

Newberg & Waldman’s (2010) well-known scientific experiment concluded that words have the power to change the brain in profound ways. By altering the neural resonance, would eventually results in enhanced cognitive health. Their research suggested that long-term compassionate communication and contemplative practices reinforce a specific neurological circuit which generated peacefulness and solitude, followed by positive wellbeing. Furthermore, Sharon Begley (2007) believes that the human brain can remake itself and be changed through positivity. Neuroplasticity is the mechanism that allows these changes to occur in the brain (scientifically). Compassionate experience is cognitively structured, where thoughts-beliefs play a central role. This is because when we believe in a specific thing, we are informing our brain, talking to our self, and silently saying words to our brain. Neuroscience research suggests that compassionate experiences are associated with patterns of brain activity. However, no specific brain area mediates those experience (Jeeves & Brown, 2009; McNamara, 2014; Newberg & Waldman, 2010). Just looking at negative words for a few moments will increase your worry and depression. The more you ruminate, the more you damage key structures that regulate your memory, feelings, and emotions. You willlll disrupt your sleep, your appetite, and your ability to experience long-term happiness and satisfaction.

Architecture speaks

Newberg and Waldman’s (2010) concluded their research on how powerful speaking a single word can be. It alters emotions, followed by behaviour and the expression of gene. Long-term influence of words scientifically proven for its ability to restructure the biological system of one’s body and gens. Either positively or negatively. Everyone agrees with this conclusion. However, do architecture also speaks? What is the definition of a “word”? According to the Oxford dictionary (2020), a “word” is a single distinct meaningful element. Used to form a sentence to create communication. This research hypothesises the definition of “space” which is, “space” is a single meaningful element, built to form a structure to communicate with human existence, emotionally, physiologically and finally genetically. However, if the communication was uncompassionate it will influence humans, through three stages, emotionally, behaviorally, and ultimately altering the expression of genes. Therefore, any form

of turmoil, emotional experience, or rumination, for instance, worrying about your economic future, health, or achieving specific thing, will stimulate the release of destructive neurochemicals. The more negative thoughts/feelings they have, the more likely to experience emotional turmoil. But if you redesign things to be turned positively, you can turn your life around. Not philosophically speaking, but, scientifically (Newberg, 2010).

A positive experience can fight your genes back—if someone was born with genes tells that he is a depressed person, those genes create a neural pathway of depression in the brain. However, the positive experience, positive thoughts, or positive emotions recreate parallel neural pathway to the existing depressed ones. Those new neural pathways are created to tell a different story—a story which is designed by your beliefs and the environment around you (Newberg, 2010).

The objectives of the study were, to identify the variations of environments upon human's emotions and brain, and subsequently to develop a theory of spaces influence genes.

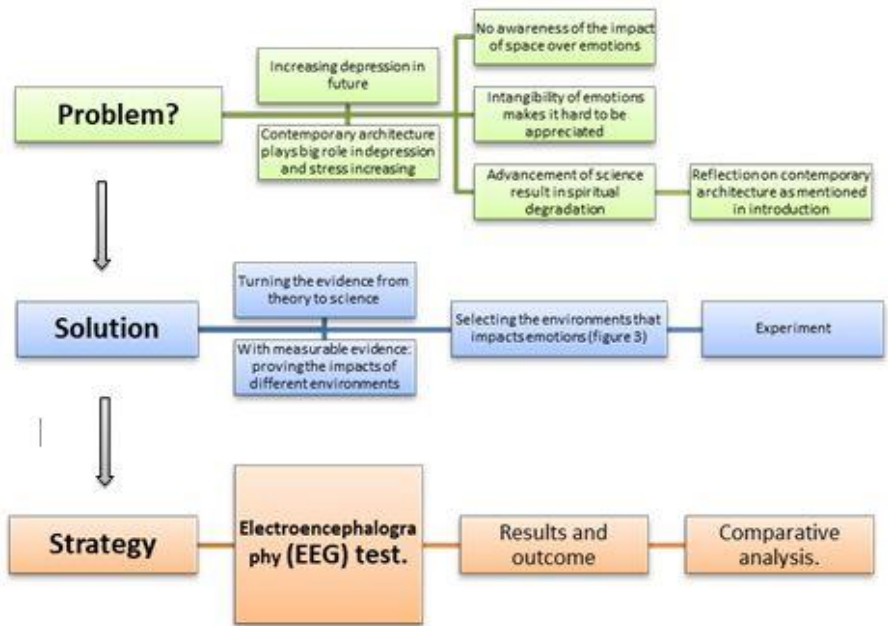


Figure 1: Research justification. (Source: author).

2.0 Literature

The problem begins with the awareness of emotional architecture. Engineers and architects do not believe in the emotional aspect of space. Artificial environments are turning the world outside in, and that is not the way to save the planet (Simon Marvin, 2017). Contemporary

architecture has started to receive more accusations of emotional coldness, restrictive aesthetics, distanced from human and life (Pallasmaa, 2015). Recent studies by the World Federation for Mental Health (2016) revealed that the most significant illness in 2030 could be the mental disorder of “depression”. According to statistics, 80-90% of our time are spent inside buildings.

Architectural spaces designs affect how we feel. Feelings influence behaviour. Behaviour influences genes. But the problem is people do not believe very strongly in the things they cannot see, although many researchers are aware of emotional architecture. Still, not many are taking it as a severe problem because emotion is something that cannot be touched or seen.

Newberg & Waldman’s scientific experiment (2010)

Newberg & Waldman (2010) conducted a scientific experiment of uncompassionate communication, as shown in Figure 2.

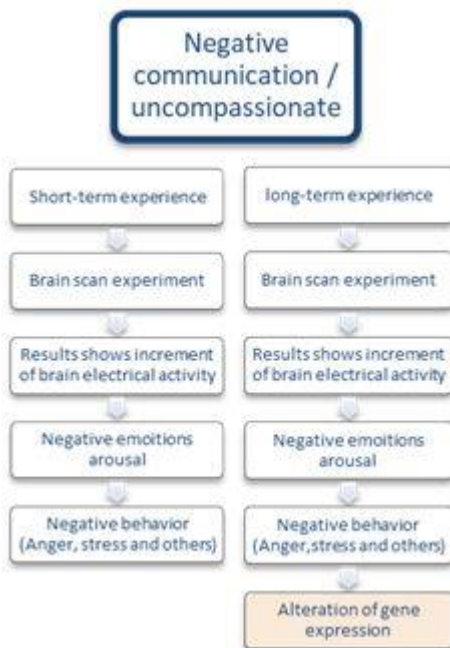


Figure 2: Summary of the experiment by Newberg, A., & Waldman, M.R. (2010).

(Source: author)

They tested the influences of negative words upon emotions, and tested different brain experiencing negative words. They found that by just listening to negative words for a few

moments will increase worry and depression. The more you ruminate, the more you damage key structures that regulate your memory, feelings, and emotions. You will disrupt your sleep, your appetite, and your ability to experience long-term happiness and satisfaction. However, the experiment, as shown in Figure 2 concluded that if you hear, experience, look and feel negativity, it will change your thinking, subsequently will influence the expression of your genes.

2.1 Emotions

2.1.1 Definition of Emotion

Emotion has many definitions. Oxford Dictionary (2019) defined emotion as a feeling which resulted from one's mood or circumstances. Taking a step further and looking at emotion from the medical point of view, Friedman (2010) stated that it is a complex state of feeling that resulted in a physiological change which influenced thoughts and behaviour. A more recent definition by Davidoff in 2018 described emotion as a state of feeling which is expressed through the physiological functions such as facial expressions, quicker heartbeat, and behaviours such as aggression, or covering the face with hands. By studying all the definitions, they all agree that emotions influence human behaviour, and it is a complex feeling. It is complicated because it is influenced by many aspects such as environment and genetics that are hard to scientifically outline how exactly it gets formed (Davidoff, 2018).

2.1.2 Design of space matter

While it is understood that the IEQ performance of space contains a significant effect on emotion (Kim, Chong, Chun, & Choi, 2017; Steinmetz & Posten, 2017), studies suggested that emotions can directly affect health. By influencing the immune systems, inflammatory response, as well as indirectly alter health-related behaviours. Consequently, further diminishing wellbeing. For example, negative emotional states affect disease aetiology and cascade to lessen social interaction, physical movement and compliance with healthcare recommendation as a secondary effect on overall wellbeing (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002). Design practitioners and researchers have long argued that the places we inhabit, whether urban landscapes or even buildings, directly affect our behaviour (Altman & Wohlwill, 1976),

To matter means to be of consequence, of importance (but not self-importance) significant, relevant, warrant note and significant value. After we discussed the importance of the space we live, the evidence above shows that the critical the link between design features and characteristics of the built environment, health and wellbeing of all humans alike.

2.1.3 The bio-psycho-social model of emotional construction

The bio-psycho-social model is one of the most recognised ways of understanding overall human wellness, including emotions and behaviour (Epstein et al., 2004). This interdisciplinary model associates the significance of three fundamental dimensions, (biology, psychology and socioenvironmental) which collectively, is responsible for the human

wellbeing. Furthermore, it provides an integrated framework and understanding health and wellness in various disciplines, ranging from social, emotional and behavioural difficulties (Cooper, 2014) to health and human development. The model was first introduced by George L. Engel in the 1970s, who argued the need for a new biomedical model (Engel, 1977). Since then, it has been critiqued for its limitations, but yet continues to guide interventionists, scientists and researchers in fields of psychology, health, and human development (Epstein et al., 2004).

Overall human spiritual wellness is a combination of a complex process of these interconnected factors to shape one's welfare. The factors that may affect the emotional state could be either genetic or sociological; simultaneously the environmental aspect plays a significant role in impacting human emotions and reflecting it on the biological and social being, as shown in the model in Figure 3. The environment shapes human behaviour and vice versa.

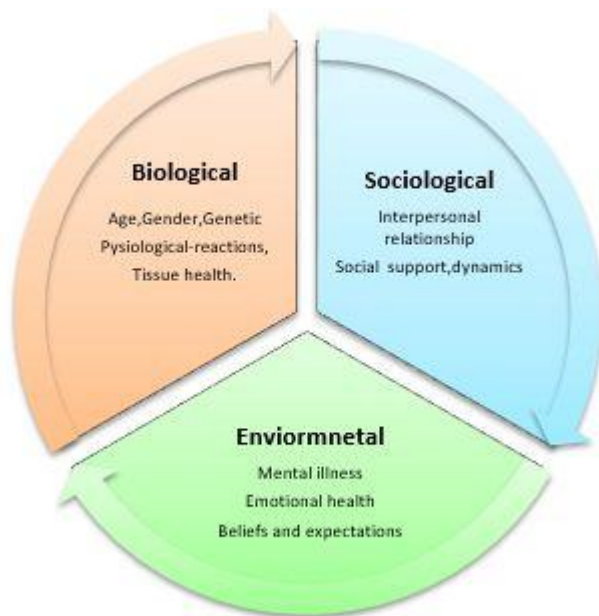


Figure 3: Bio-psycho-social model, by George L. Engel in 1977.
(Source: <https://www.ncbi.nlm.nih.gov>).

2.1.4 Beauty is in the eye of the beholder. Beauty is subjective

An experiment conducted, supported by the “Evolutionary behavioural sciences” answered the argument that beauty is subjective and there is no common good for all. The experimental work presented in the Savannah principle brought kids from all around the world and photos of different landscapes were showed to them. They were tasked to choose a view they liked

the most. 80% of them singled out the picture of the savannah landscape (Kanazawa, 2019) The result of this seminal experiment established that regardless of the subjectivity of beauty, there is a common good thing for all humans (Behling, 2016).

2.1.5 Human between good design and money

The World Business Council for Sustainable Development (2018) showed a surprisingly common belief among the participants that around 17% of the overall cost of a building is attributed to the green characteristics of that building. However, a study done on the green cost of 146 green buildings indicated an actual marginal cost of less than 2% and showed that green-certified buildings bring significantly higher rent than conventional buildings. A University of California–Berkeley study evaluated and compared 694 certified green buildings and 7,489 office buildings, each situated within a 400m radius of a green building. The results showed a remarkable outcome that on average green-certified buildings rented 2% higher than nearby conventional buildings after adjusting for occupancy level (Green Research Institute, 2011).

2.1.6 Emotional experience from Theory to science

Traditionally, the study of emotions has always been theoretical, depending on interviews, self-reports etc. Meaning, there is no scientific test that is measurable. However, when neuroscience developed a device called Electroencephalography (EEG), measuring emotions has become a scientific process. The possibility of studying the impact of a big window on human emotions and behaviour has become scientifically measurable. Emotions are no longer a theoretical science.

2.1.7 Designing Spaces of positive emotional experiences

Figure 4 is a collection of several studies from psychological, neuroscientific and medical backgrounds; It explains the central values of creating spaces that evoke positive emotional experiences. Positive environment designs can be understood by understanding those nature and design elements, form and geometry. The integration with the natural environments are the primary keys to build a positive emotional design

The essential elements in designing spaces to evoke positive emotions:

(1) Integration of water element. Presence of sound, colour and the touch of water, all those elements are healers to human emotions. **(2) Visual force of building form;** curvy, rigid, squarish or linear, every form brings a different experience on human's emotions. **(3) Materiality:** natural, e.g. wood and stone. **(4) Quality of natural lighting:** providing an optimised lux level or figuring out the perfect level, for the targeted space. That brings a significant difference in the emotion of space. **(5) Psychology of colours:** every colour evokes different emotions, **(6) Noise level:** it has a significant impact on the user's emotional comfort. **(7) Green element;** one of the essential aspects to be considered to create a space of positive emotions. **(8) Creating alive spaces:** the overall integration of birds singing, natural lighting, buffering of trees, all the natural features that make a space comes alive without the need for other things to bring the space alive like, televisions, music or people.



Figure 4: Collection of several studies from psychological, neuroscientific and medical backgrounds; It explains the central values of creating spaces that evoke positive emotional experiences.

(Source: author).

2.2 Behaviour

While fear causes fleeing, and courage causes confronting, motivation helps to pursue dreams. Behaviour is the key function of emotion. Emotion is the feedback system that influences behaviour (Roy, 2007). Perhaps the idea of human behaviour shaped by environments is not an argument anymore. What is missing is a deep understanding of the neural underpinnings that drive human behaviour impacted by the environment. Thus, this study, with the help of neuroscience explored the answer of the question - can space, shape our action and behaviour followed by alteration of genes?

2.3 Genes

Human is a genetic creature. Genes express itself by giving commands to the brain. On the long-term process, those genetic expressions influence the pattern of our thinking; it outlines behaviour, emotions and thinking paradigms. However, genes develop neural pathways in the brain. The neural pathways may carry a specific behaviour (or feature). It resists any attempt to change. Nevertheless, it is not impossible to change it. According to many neuroscientists such as Andrew Newberg (2010), we can change by creating new neural pathways through starting new living experiences, positive emotional experiences, or change the stories that we tell our self. This fact is called Neuroplasticity – the brain's ability to restructure itself by forming new neural connections/pathways throughout life. It allows the neurons (nerve cells) in the brain to alter their behaviour in response to new situations or changes. It also may compensate for injury, disease.

3.0 Methodology

The research was conducted in three phases, firstly is the literature review, specifically on the nine principles as highlighted in Figure 3. Secondly, is the scientific experiments that tested those elements, using Electroencephalography (EEG) device. Finally, comparing the results from the experiments with each other to identify which element resulted in the highest positive impact on emotions and brain.

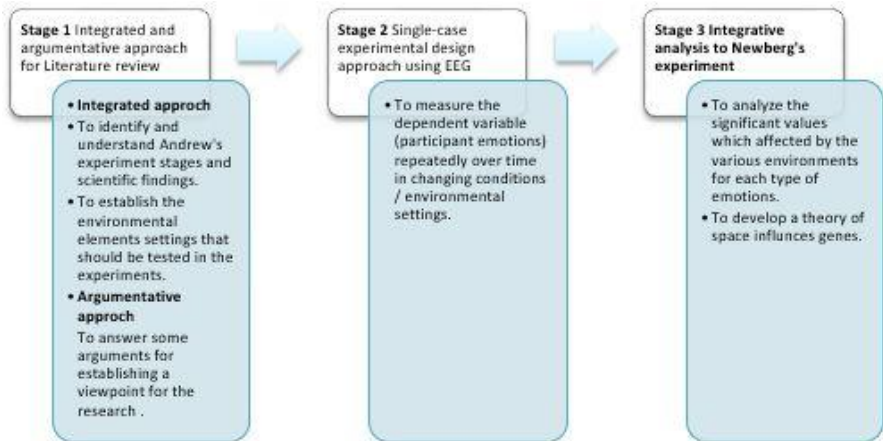


Figure 5: Methodology stages justification.
(Source: author).

3.1 Stage 1: Integrated and argumentative approach for Literature review

The literature review was established based on research questions which are:

- Why is there not enough awareness of emotional design?
- What is the experiment done by Andrew Newberg?
- What are emotions?
- Can space affect emotions and cause depression?
- Is beauty subjective by all means?
- Is there a good design for all?
- Can we measure emotions?
- How to design a space to evoke positive emotions?
- How behaviour affected by negative experience?
- How are genes affected by negative behaviour and negative experience?

3.2 Stage 2: Single-case experimental design approach using Electroencephalography (EEG).

“Single-subject research (also known as single case experiments) is well-known in the fields of behavioural science and counselling. This study design is useful when the researcher is attempting to examine the behaviour of a person repeatedly over changing conditions. However, in this case, the changing conditions are nine different environmental settings

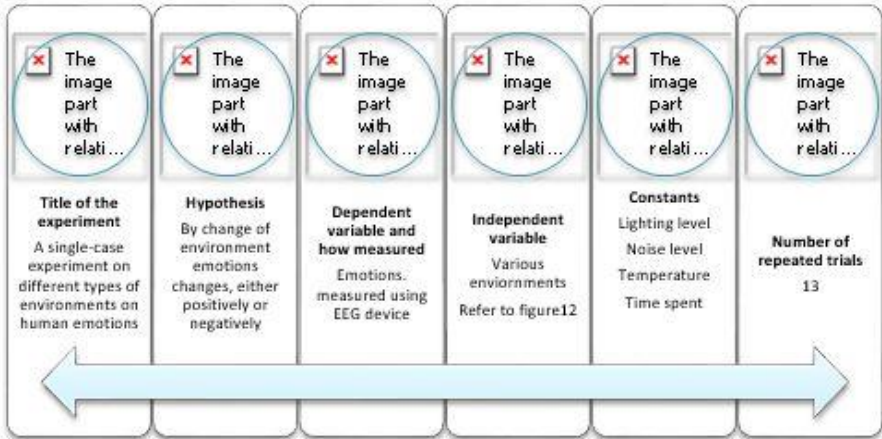


Figure 6: Design of experiments.
(Source: author).

3.2.1 Electroencephalography (EEG) test

The Electroencephalography (EEG) test assesses the electrical activity of the brain. EEG scans are achieved by placing EEG sensors small metal discs called EEG electrodes on your scalp. Those electrodes record the electrical activity in your brain. The collected EEG signals are amplified, digitised, and then sent to a computer or mobile device for storage and data processing, as shown in Figure 7 and Figure 8.

3.2.2 The (EEG) device can detect six emotions

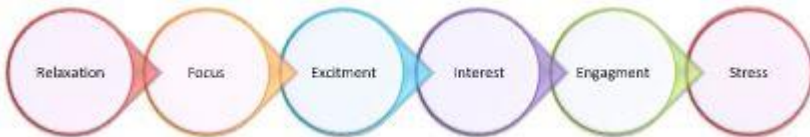


Figure 7: Emotions measured using EEG.
(Source: author).

3.2.3 The meaning of each colour

The different colours represent the behaviour of the different waves; each wave represents a feeling. The lower the wavenumber, the higher the feeling of relaxation and positivism, and vice versa. Figure 7 and Figure 8 demonstrates each colour's meaning and what it renders.

Types of waves;

- i) Delta wave – (1 – 3 Hz).
- ii) Theta wave – (4 – 7 Hz).
- iii) Alpha wave – (7 – 15 Hz).
- iv) Beta wave – (15 – 30 Hz)
- v) Gamma wave – (>30 Hz)

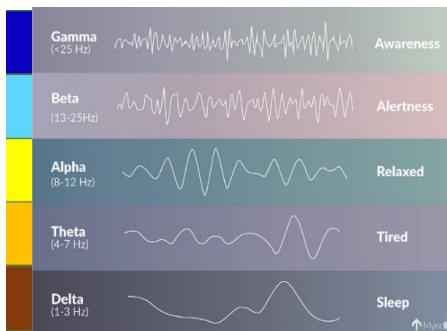


Figure 8: Types of frequencies
(Source: www.quantumleapmindtraining.com).

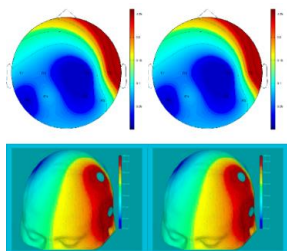
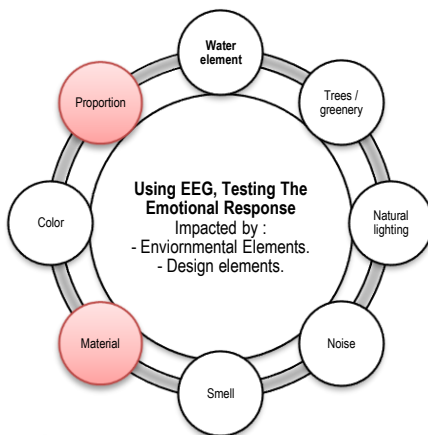


Figure 9: Samples of brain scan.
(Source: Emotiv Insight).



Figure 10: Photo of the EEG.
(Source: author).



Red colour indicates experiments were not carried out.
Figure 11: Experiments were carried out.
(Source: author).

3.2.3 Procedures for conducting experiments.

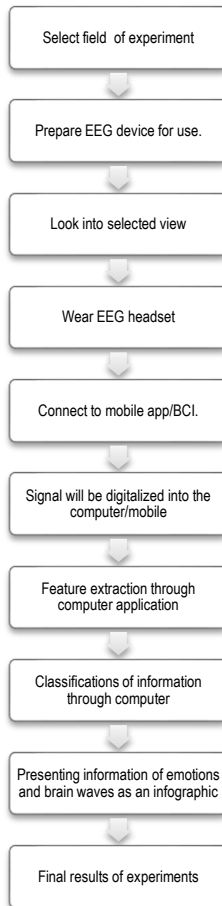


Figure 12: Procedures of conducting each experiment.
(Source: author).

3.3 Stage 3: Comparative analysis

After getting the results of experiments, it was compared to each other. Findings were integrated into an existing literature review to form a theory of space and genes.

4.0 Results

Thirteen experiments were carried, presenting two of them thoroughly and the rest only the data collected from the experiment.

Experiment 1: Description

The experiment was carried with an open water view (the sea) as shown in Figure 13, to understand the impact of open view water view compared to the enclosed view of water such as lake on the brain and emotions. The electrical activity of brain while experiencing the view is as shown in Figure 14, while the results as shown in Figure 15.



Figure 13: View - water (Open Sea).
(Source: author).

- a. Location: Pantai Remis, Selangor, Malaysia
- b. Type of view: Sea-open view.
- c. Methodology: EEG Device.
- d. Lighting level: 1000 lux.
- e. Noise level: 40db.
- f. Temperature: 30c.
- g. Time: 5:00pm
- h. Participant: 1 male.
- i. Time spent: 15mins.

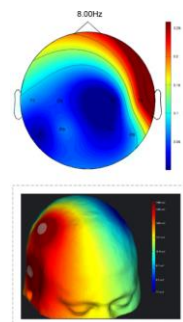


Figure 14: Electrical activity of brain while experiencing the view.
(Source: author).



Figure 15: Results from (BCI) by (EEG) with a mobile app.
(Source: author).

Experiment 2: Description

The experiment was carried with a non-open water view setting (lake). Refer to Figure 17. To understand the impact of the view compared to the open view of water on the brain and emotions, The electrical activity of brain while experiencing the view is as shown in Figure 18, while the results as shown in Figure 19.



Figure 16: View - water (Lake).
(Source:author).

- a. Location: UiTM Puncak Alam, Selangor.
- b. Type of view: Non-open view.
- c. Methodology: EEG Device.
- d. Lighting level: 800lux.
- e. Noise level: 50db.
- f. Temperature: 34c.
- g. Time: 5:00pm.
- h. Participant: 1 male.
- i. Time spent: 15mins.

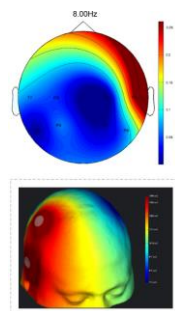


Figure 17: Electrical activity of brain while experiencing the view.
(Source: author).



Figure 18: Results from (BCI) by (EEG) with a mobile app.
(Source: Emotiv insights app).

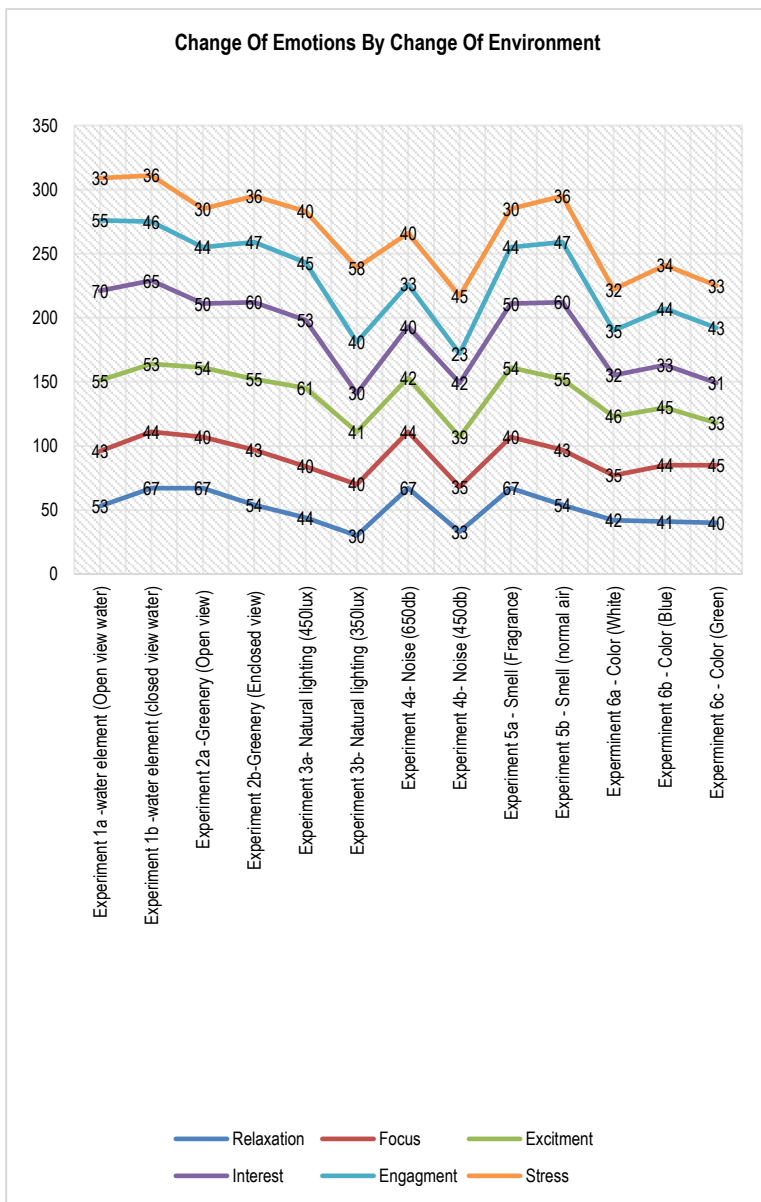


Figure 19: Data collected from experiments (emotions).
(Source: author).

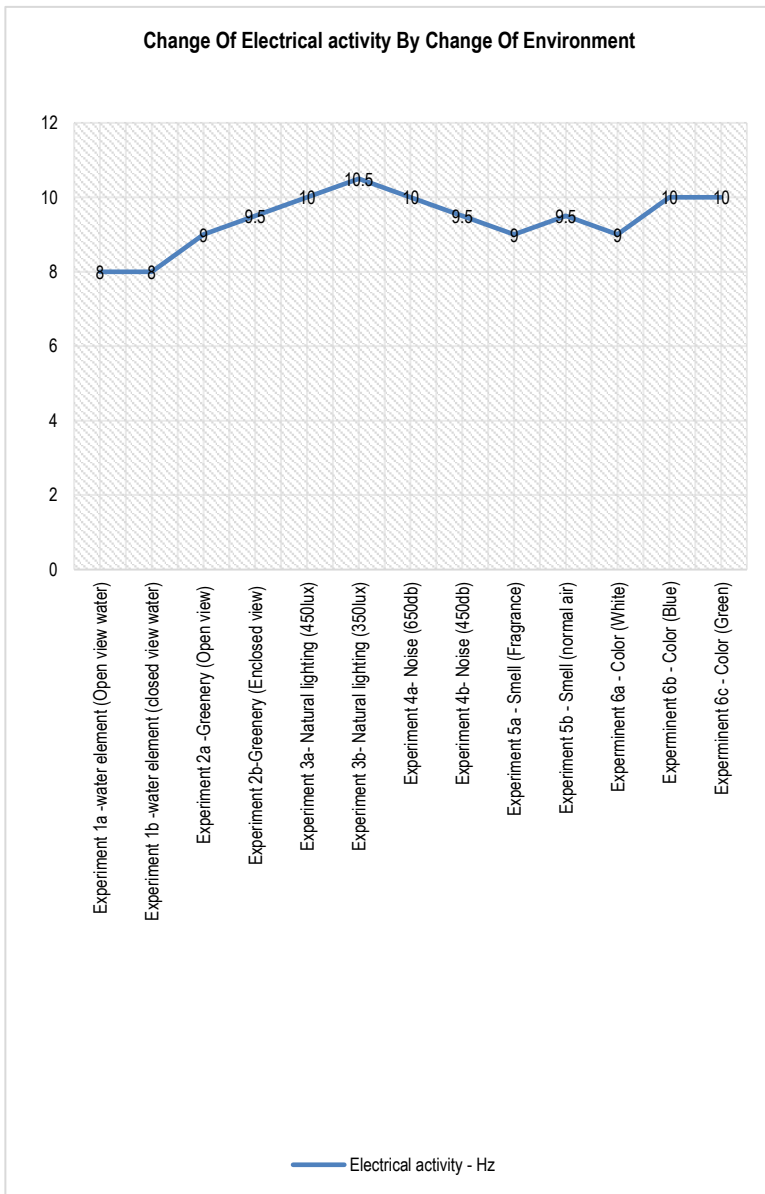


Figure 20: Data collected from experiments (Electrical activity).
(Source: author).

5.0 Discussion

The scientific-discovery found by Newberg & Waldman's (2010) proved the negative impact of words over the brain; therefore, genes. They explained about the effects of negative emotional experiences, such as, negative communications, or even looking at a list of negative (or positive) words. It stimulates neural pathways in the brain, which in turn, leaves a negative trace on our genetical system, In return, our genes rebuild another neural pathway which carries a negative feature, if that experiment was emphasising on negative emotional experience, which occurred by uncompassionate words, In contrast to that, architectural space also brings different feelings - some have the perfect amount of light, some space has a beautiful view, others are noisy. Architectural space has many elements that impact human emotional wellbeing—for instance, temperature level, the geometry of the form, materials used, and many other aspects. If space is not designed in a way that comforts human, such as not having enough lighting or probably excessive lighting, it will bring a negative experience Nevertheless, the argument is not about that different spaces have different feelings (many researchers know that), it is more into turning this philosophical thinking into scientific work. By analysing the issue (emotional coldness in contemporary architecture), it was found that people do not take negative emotional experiences very seriously, unlike physical experiences. If a kid was injured, the father would immediately take the kid to the doctor, as the hurt is physical and seen visually, hence, easy to believe it. Many researchers believed in this idea, but scientist proved it. According to Alan Fogel, a Professor of Psychology at the University of Utah in Salt Lake City, when people feel emotional pain, the same areas of the brain get activated as when people feel physical pain. Still, it is hard for people to equalise those two aspects. However, one of the critical approaches in creating awareness is to turn philosophical ideas into science work because of the possibility to measure it. After all, this research attempted to provide a piece of scientific evidence for the seriousness of a bad architectural space. During the experiment, the presence of water was very significant in lowering the electrical activity of the brain and improving emotions of participates. Still, that is not the central information needed. What is significant is the change of electrical activity that occurred by the change of space and environment, and the change of emotional experiences which was detected, by change of environment, as shown in Figure 19.

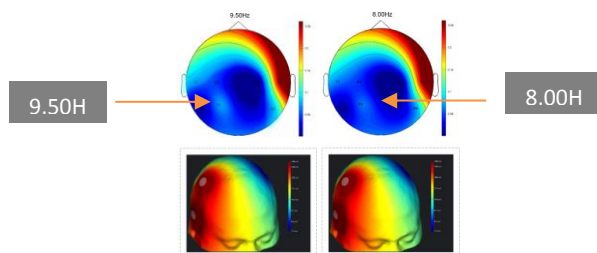


Figure 21: Compare between experiment 1 and 2 (Water and Greenery).
(Source: EEG).

Figure 21 is a comparison between two experiments only; the rest of the data is presented in Figure 20. The data collected from thirteen different experiments using (EEG) were based on a collection of study from diverse background about the principles that make a positive emotional experience in a space. The experiments tested those principles. The chart showed the change in the electrical activity of neural pathways as the condition of the environment changed. In contrast to Newberg & Waldman's (2010) experiment, he said in his book (*Words can change your brain*), a single word has the power to change your brain and influence the expression of genes that regulate physical and emotional stress. Correlating that, the change of brain he referred to, is a change in the electrical activity of natural pathways, that change has the power to alters the expression of a gene that regulate physical and emotional stress. Change of space has also changed the brain of the participant. It changed the electrical activity in the neural pathways. However, this alteration of the brain by the change of space will lead to the modification of genes. According to Newberg & Waldman's (2010) the change of brain will alter the expression of a gene that regulate physical and emotional stress.

6.0 Conclusion

The research attempted to increase awareness about the seriousness of bad architectural space design by turning philosophical and theoretical ideas, into work of science.

Scientific data was collected for a different aim. Surprisingly, it found the change of electrical activity of neural pathways of the brain by the change of environment, By studying Newberg & Waldman's (2010) experiment, and merging this data with their findings it was awakening to realise that architecture space does not just change our feelings and brain but, alters the expression of a gene which regulate physical and emotional stress.

This research concluded the establishment of this Theory which hypothesis that: architectural space alters the expression of gene that regulate physical and emotional stress.

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