



Single-case Experimental Research: Designing emotions by designing spaces - A pilot study

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Abstract

The belief that the environment shapes human emotions followed by behaviour is not new, as acknowledged by many researchers. Recent studies show that the most significant illness by 2030 is depression, as most of our time spent inside the buildings. Hence, the importance of "re-connecting architecture with emotions" is an essential solution to improve the quality of life. A single-case experimental design (SCED) aimed to investigate the relationship between neural underpinnings of the brain, for a single participant and various environments. Data collected was based on the Electroencephalography tests. Findings showed a significant contrast between different water elements and environmental settings, each with its unique effect on participant emotions as well as the electrical activity of the brain.

Keywords: Depression; Neural underpinnings; Water-bodies environment; Quality of Life.

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1.0 Introduction

With modern science gaining momentum, people began to believe less about the human spiritual dimension. It influenced many engineers, architects, and developers to adopt a new paradigm in the way they view life and most importantly, designing buildings. The aesthetic awareness culture began to lose its value, oppositely, believing in, tangibles and materialism increased. Engineers always argue architects saying "there is no scientific evidence for the need of having a big window". It became all about money (Bica, 2016).

With the evolution of science, scientists and researchers started to understand the effect of design on human wellbeing, depression, and spiritual dimension. Recent studies by the World Federation for Mental Health (2016) reveals the most significant illness in 2030 is going to be the mental disorder of "depression" according to statistics, most of our time spent inside buildings and Architects design buildings. Hence, the importance of "re-connecting architecture with emotions and brain" is an essential solution to improve the quality of life for future generations; However, contemporary architecture has started to receive more accusations of emotional coldness, restrictive aesthetics, distanced from human and life (Pallasmaa, 2015). "Architecting" human's emotions of positivity mean designing environments of happiness, excitement, creativity, empathy, and performance-boosting, to improve human's ultimate performance and behaviour for a better quality of life. The fight is never about grapes or lettuce. It is always about people (Chavez, 1990, p.17).

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How much is a good building design worth? (Day, 2015) suggests that it increases the value of the land by 15%, but monetary cost and soul benefits are incomparable. When staff moved to NMB Bank headquarters designed by Albert and Max Van Huut, absenteeism declined and increasing of productivity around 15% (Day, 2015). Another study on patients found that improved environments of hospitals have reduced treatments by 21% and reduced the uses of Anglistics by 59%, (Ulrich, 1984) did a study to correlate this on the impact of view on patients and recovery time. However, patients spent shorter stays after surgeries, had a smoother recovery according to nurses, lower use of painkillers and slightly lower frequency of minor post-surgical complications. According to (Day, 2015) children behaved differently in a different environment, even mature adults think, feel and act differently as the environment changes.

The **objectives** of the study were first, to identify the variations of environments upon human's emotions. And secondly to determine the extent of effectiveness of the environmental and design elements upon human subjectivity and feelings.

2.0 Literature Review

2.1 Types of emotions

Psychologists have long explored and studied emotions, there are some different interpretations of the theory, but principally, they all categorise emotions, either positive emotions or negative emotions. One of the most cited and well-known psychologist Dr.Plutchik designed the famous Plutchik's model of emotions consisting of eight primary emotions, anger, fear, joy, trust, anticipation, surprise, sadness and disgust. Refer to Figure 1

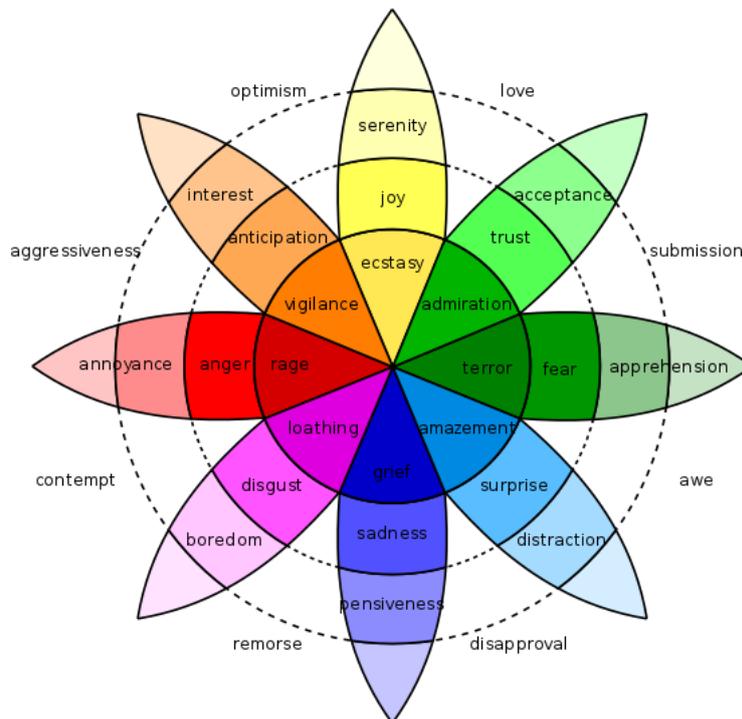


Figure 1 Plutchik's model of emotions consists of eight primary emotions
(Source: <https://www.6seconds.org/>)

2.2 How emotions are made?

Emotions have many definitions; if we look at the Oxford dictionary definition(2019), it is a feeling in which results from one's mood, circumstances. If we make it a step further and look at emotions from a medical point of view, according to (Friedman, 2010), it is a complex state of feelings results in a physiological change, which influences thoughts and behaviour. Another more recent definition by (Davidoff, 2018) defines emotion as a state of feeling which is expressed through physiological functions such as, facial expressions, quicker heartbeat, and behaviours such as aggression, crying, or covering the face with hands. By studying all the definitions, they all agree that emotions influence human behaviour, and it is an intricate and complex. The reason for this complexity influenced by many factors such as environment, genetics. Which makes it challenging for science to explain precisely the formation of emotions. (Davidoff, 2018).

2.3 The bio-psycho-social model of emotional construction.

The biopsychosocial model is one of the most recognised ways of understanding overall human wellness including emotions and behaviour; the model is an interdisciplinary model that looks at the interconnection between biology, psychology, and socio-environmental impacts of one's wellness. The model examines explicitly how these aspects play a role in topics ranging from health and disease models to human development. (George L.1977) developed this model and is the first of its kind to employ this type of multifaceted way of thinking. The Biopsychosocial Model (Refer to Figure 2) has received criticism about its limitations but continues to carry influence in the fields of psychology, health, and human development.

Overall human spiritual wellness is a combination of a complex process of these interconnected factors to shape one's welfare. As shown in the model (Refer to Figure 2), 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 our biological and social being. The environment shapes human behaviour and vice versa.

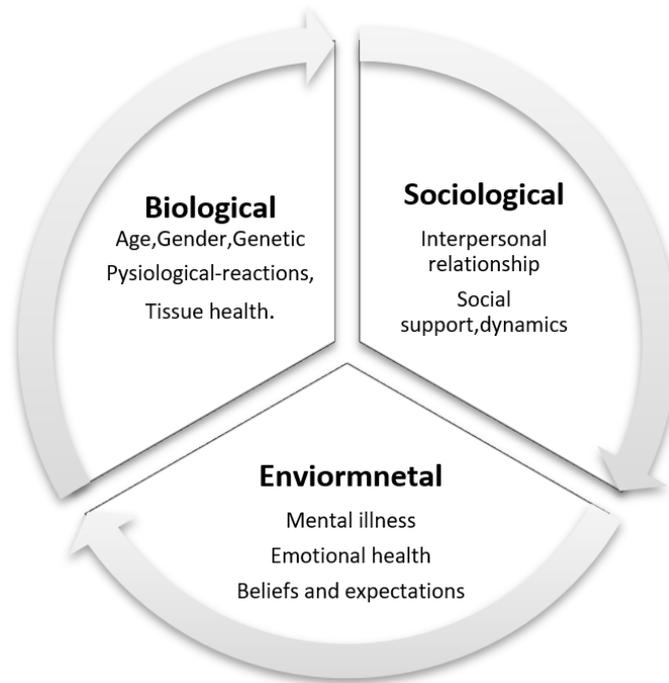


Figure 2 Bio-psycho-social model, by George L. Engel in 1977
(Source: <https://www.ncbi.nlm.nih.gov>)

2.4 Human between good design and money.

A survey was conducted by (World Business Council for Sustainable Development, 2018) found that most of the respondents on average believed that green features added 17% to the overall cost of a building. In contrast, a study has been done of 146 green buildings show a result of an actual marginal cost of less than 2%. Studies have shown that certified green buildings command significantly higher rents. A University of California–Berkeley study analysed 694 certified green buildings and compared them with 7,489 other office buildings, each located within a quarter-mile of a green building in the sample. The researchers found that, on average, certified green office buildings rented for 2% more than comparable nearby buildings after adjusting for occupancy level.

2.5 Savanna principle as an answer to the argument of "beauty and good are subjective".

A test was described as, Savanna Principle, it is supporting "Evolutionary behavioural Sciences", was carried with the help of that principle answering people who argue saying, beauty is subjective, it has become possible, and there is no one particular good thing for all, but the result of savanna principle test tells us a different story, the experiment was carried by (Kanazawa, 2019) where they brought kids from all around the world, and showed them pictures of various landscapes. The kids were asked to pick the view which they like, 80% of the kids chose the scene of savannah landscape. The Savanna principle concludes that, no matter how subjective beauty is, there are always good things for all human (Behling, 2016)

2.6 Emotional experience from theory to science.

The study of emotions has always been theoretical; By means, there is no scientific test that is measurable. However, recently when neuroscience has developed a device called Electroencephalography (EEG) device and 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. And emotions are no longer a theoretical science.

2.7 Designing spaces to provoke emotions of positivity.

The diagram below is a collected study of psychological, neuroscientific and medical backgrounds, which explain the main principles of designing spaces that evokes positive emotions. The positive environment we live in can be understood by understanding these nature and design elements, form and geometry and its integration with the natural environments are the primary keys to understand a positive emotional design.



Figure 2 A collected study of psychological, neuroscientific and medical backgrounds, which explain the main principles of designing spaces to evoke positive emotions
(Source: author)

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.

It is essential first to understand the emotions of one's self. First, emotions are feelings affected by complex development of biology, environment, and sociology (Engel, 1977),. According to (Plutchik, 2001) it is categorised as two, either positive or negative emotions. According to many doctors, the environment we inhabit, it influences our feelings, and in return, our feelings change our behaviour. Thus, it is critical to consider the environment we stay in as behaviour influencer.

Design matters, It affects our emotions because the design allows natural lighting or prevent it, Building design can provide natural air, green view, and many other elements. Studies indicate that aesthetic qualities of architecture have an impact on our mood, cognitive functioning, behaviour, and even mental health (Adams, 2014; Cooper, Burton, & Cooper, 2014; Hartig, 2008; Joye, 2007). Design can cause the development of anxiety, Insomnia, depression, weakened the immune system, muscle pain, heart diseases, and high blood pressure.

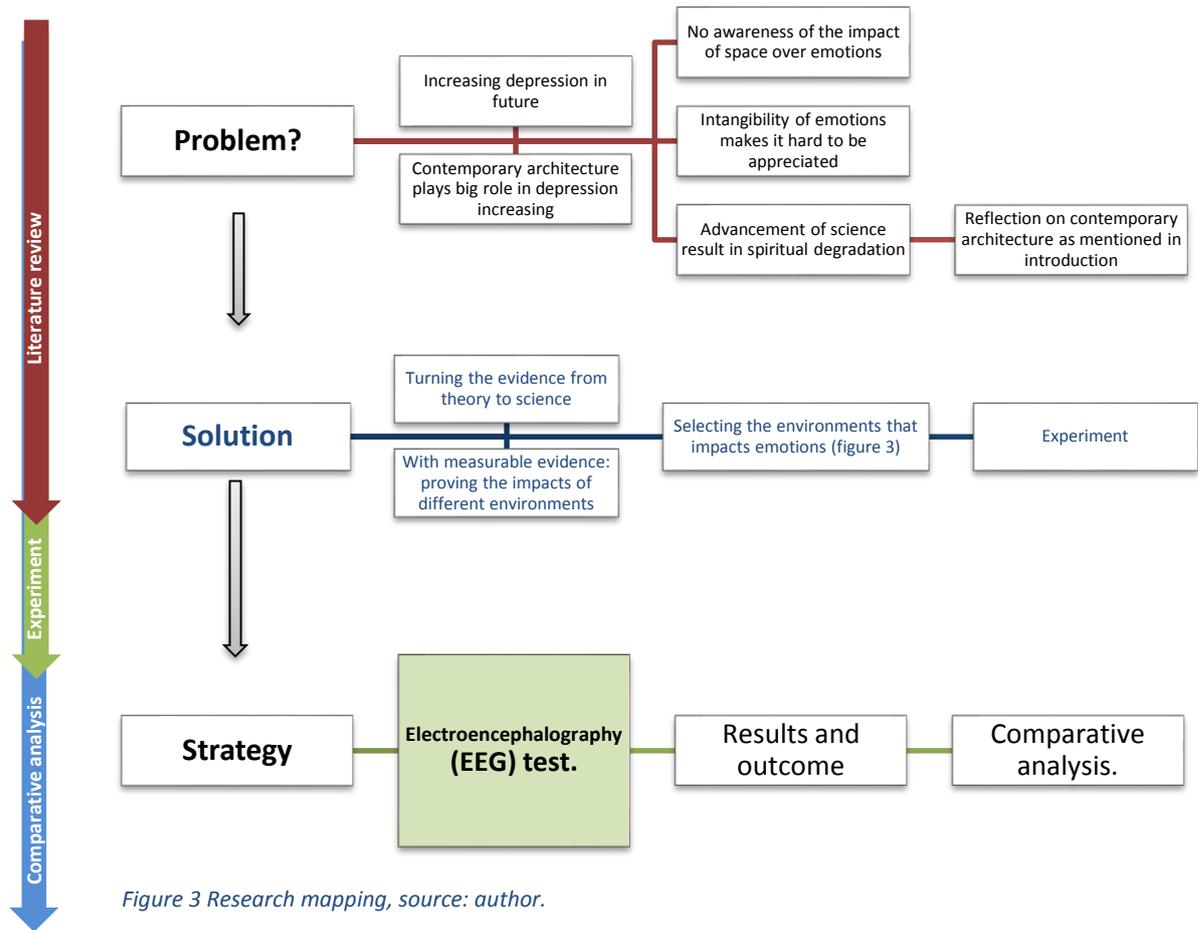


Figure 3 Research mapping, source: author.

3.0 Methodology

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

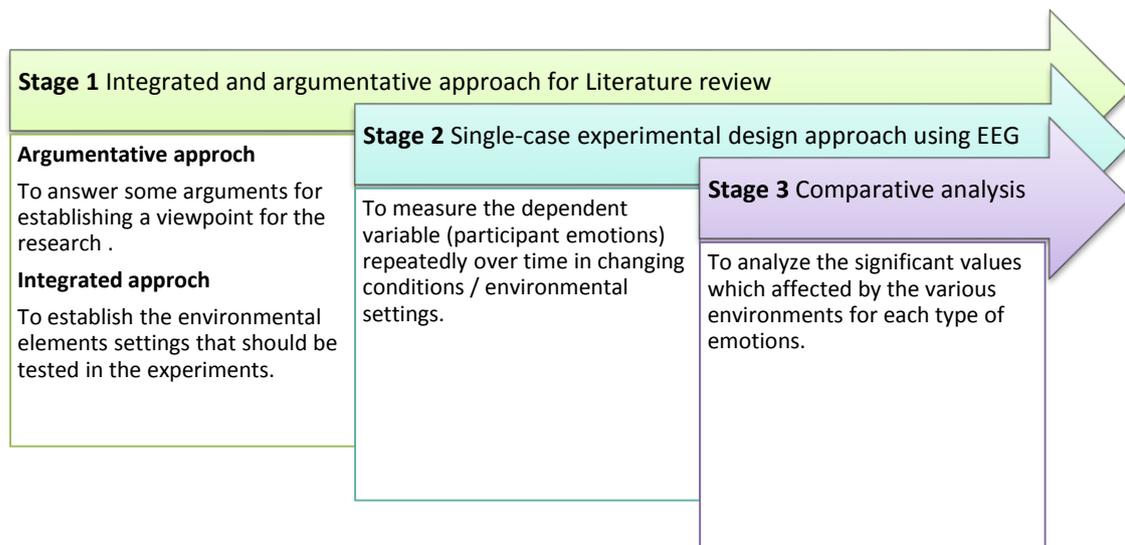


Figure 4 Research direction (Source: author)

3.1 Stage1: Integrated and argumentative approach for Literature review.

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

- What are emotions?
- How are emotions constructed?
- 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?

3.2 Stage2: Single-case experimental design approach using Electroencephalography (EEG).

"Single-subject research (also known as single case experiments) is popular in the fields of behavioural science and counselling. This research design is useful when the researcher is attempting to test the behaviour of an individual repeatedly over changing conditions; in this case, the changing conditions are nine different environmental settings. However, refer to figure 6 for experiment design.

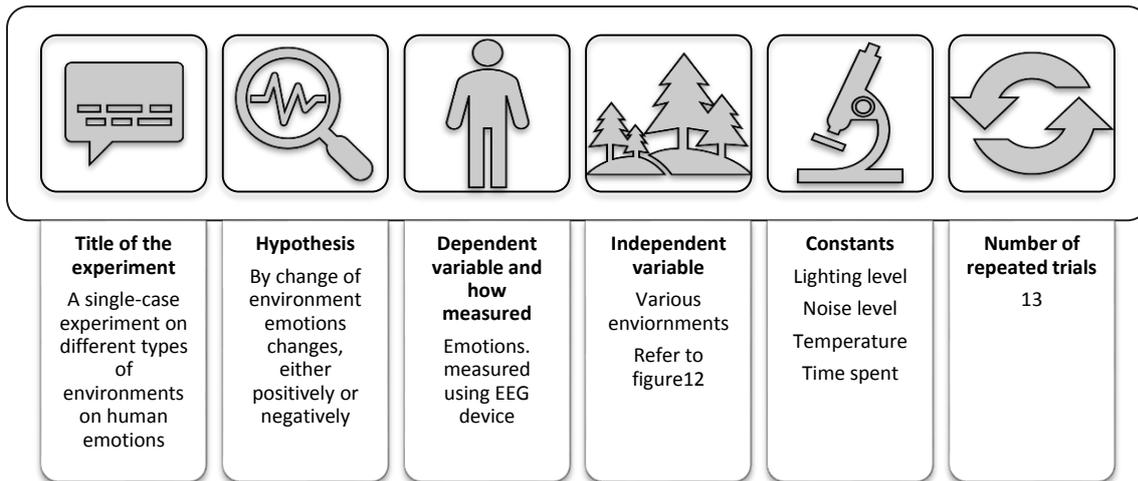


Figure 5 Experiment design

3.2.1 Electroencephalography (EEG) test.

The Electroencephalography (EEG) test evaluates the electrical activity of the brain. EEG scans are performed by placing EEG sensors small metal discs also called EEG electrodes – on your scalp. These electrodes pick up and 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. Refer to Figure 7 and Figure 8.

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, vice versa. Refer to Figure 7 and Figure 8 it demonstrates each colour's meaning and what does it render.

Types of waves;

- Delta wave – (1 – 3 Hz).
- Theta wave – (4 – 7 Hz).
- Alpha wave – (7 – 15 Hz).
- Beta wave – (15 – 30 Hz)
- Gamma wave – (>30 Hz)

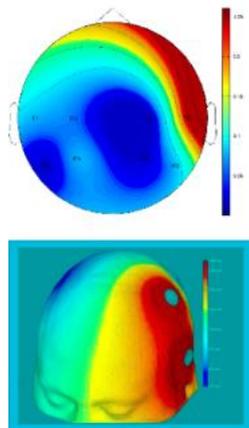


Figure 7 Sample of brain scan, (Source: author)

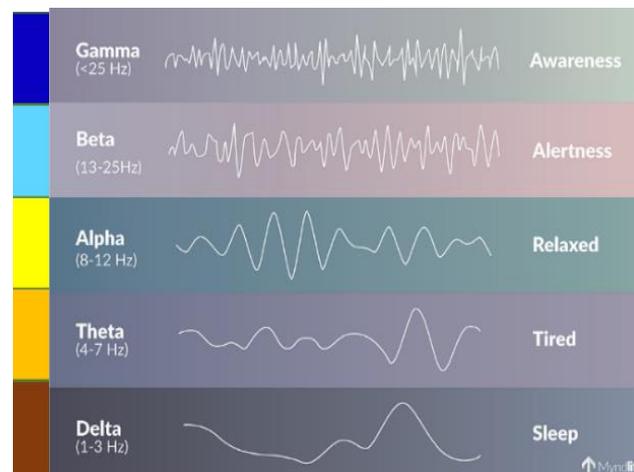


Figure 6 Brainwaves and colour meaning (Source: www.quantumleapmindtraining.com.)



Figure 8 Photo during experiments taken by:
(Source: Author, 2019).



Figure 10 EEG Headset
(Source: www.emotive.com)



Figure 9 EEG with 12 sensors
(Source: www.emotive.com)

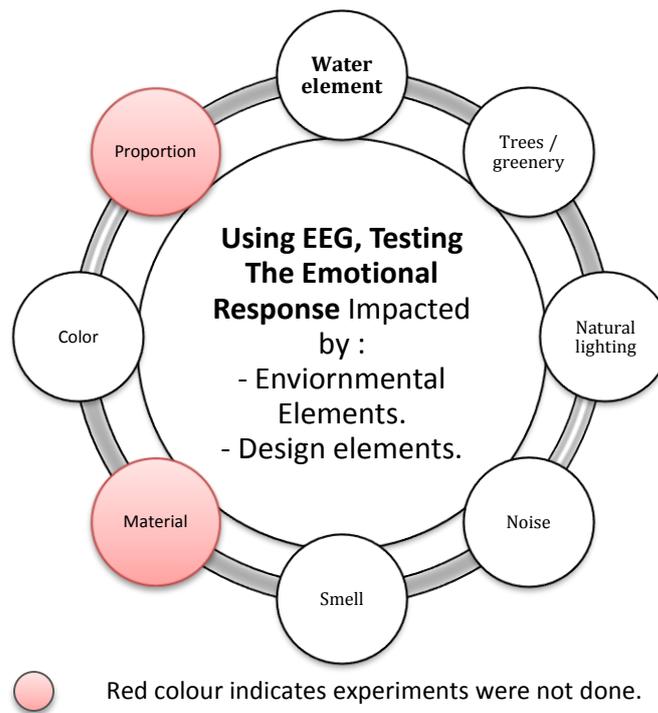


Figure 11 Summary of experiments done
(Source: Author)

3.2.3 Procedures for conducting experiments.

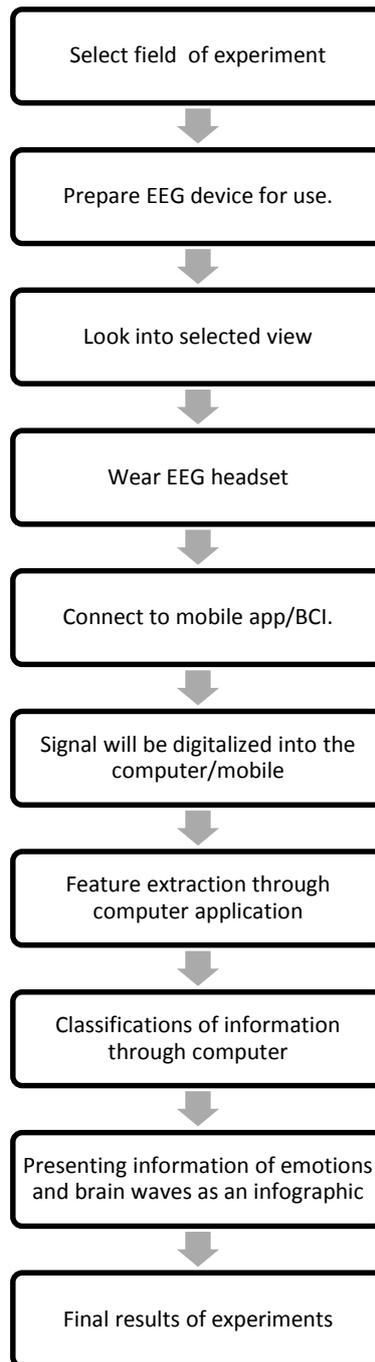


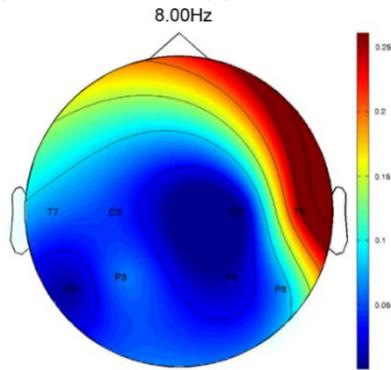
Figure 12 The strategy used
(Source: Author)

3.3 Stage3: Comparative analysis

After getting the results of experiments, it was compared in the form of a chart to evaluate the differences between each experiment for every single emotion in order to identify the significant values for each type of emotions such as relaxation.

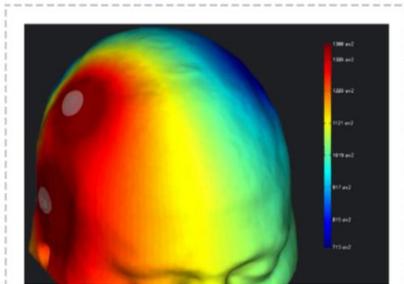
4.0 Findings

4.1 Experiment 1 – Water (open view – sea view)



Experiment Description

The experiment was carried with an open water view (the sea)
Refer to Figure 16, to understand the impact of open view water compared to the enclosed view of water such as lake on the brain and emotions. Refer to Figure 14 and Figure 15.



- 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: 10mins.

Figure 13 (BCI) looking into the view below
Source: (EEG) device

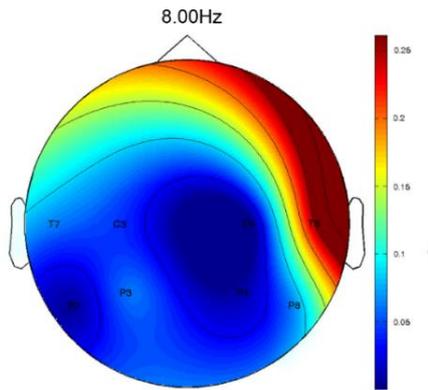


Figure 14 Results from (BCI) by (EEG) with a mobile app
Source: (EEG) device



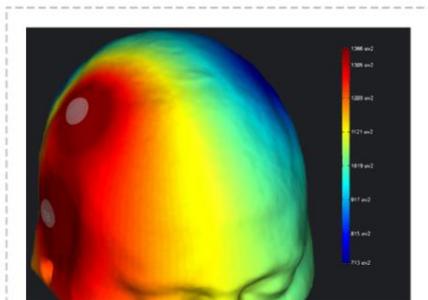
Figure 15 Pantai Remis, Selangor, Malaysia.
Source: Author

4.2 Experiment 2 – Water - (Non-open view – lake view)



Experiment Description

The experiment was carried with a non-open water view setting (lake). Refer to Figure 18. To understand the impact of the view compared to the open view of water on the brain and emotions, Refer to Figure 17 and Figure 19.



- 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. Participator: 1 male.
- i. Time spent: 15mins.

Figure 16 (BCI) looking into the view below,
(Source: (EEG) device)



Figure 17 Results from (BCI) by (EEG) with a mobile app
(Source: Author)

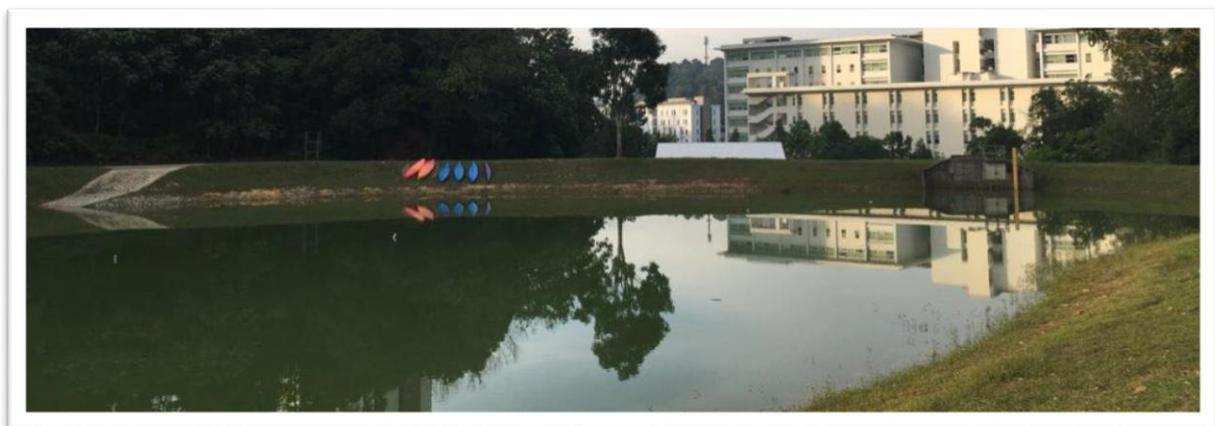


Figure 18 UiTM Puncak Alam, Selangor.
(Source: Author)

5.0 Discussion

5.1 Why water element with an "enclosed view" had the highest record of evoking relaxation?

It is very uncertain to answer that results due to the many aspects that play a role in impacting emotions. Still, perhaps there is a possibility of speculating what these reasons may be.

- a) The potent healing effect and energy of water element compare to other elements.
- b) It also had a higher record compared to water element with an open view and a possible answer for that is, the scale and proportion of space, the enclosed view had a smaller, and more intimacy compared to big ample space that is out of human scale. According to (Vartanian et al., 2015), Height and enclosure play an essential role in human emotional response.

5.2 Why "water element" with an enclosed view had the highest record of evoking focus?

It is very uncertain to answer that results due to the many aspects that play a role in impacting emotions, but perhaps there is a possibility of guessing the reason.

- a) The potent healing effect and energy of water element compare to other elements.

5.3 Why "water element" with an open view had the highest record of evoking interests?

According to (Vartanian et al., 2015) enclosure plays a vital role in human emotional response therefore the big scale of the sea might bring a sense of awe and wonder as and that might result in evoking a higher interest in responding to this wonder.

6.0 Conclusion & Recommendations

The research paper concludes two points:

6.1 The ability to measure emotions impacted by architectural spaces.

Emotional architecture has always been a theoretical discussion, by means, no measurable shreds of evidence. However, the experiments provide **scientific** evidence of the ability to **measure** emotions impacted by different spaces or environments as it shows, how a change of environment changed the participate emotions.

6.2 Top vital elements in designing spaces that arouse positive emotions.

The papers conclude a study that shows the elements which evoke positive emotion in space. However, the impact of those tested elements is compared to find out which element had the highest level in evoking positive emotions of:

- a) **Relaxation and tranquillity:** In evoking emotions of relaxation, it was a water view with a limited/enclosed view, which feel cosier and more intimate.
- b) **Focus and attention:** Based on the research paper, the element that evoked the highest state of focus was water view with a limited enclosed view.
- c) **Excitement:** In evoking emotions of excitement, it was natural lighting with a 450lux level.
- d) **Engagement:** "water element" with an open view had the highest record of evoking engagement.
- e) **Interest:** "water element" with a free view had the highest record of evoking the emotion of interest.
- f) **Stress:** "natural lighting" with a 450lux had the most top record of evoking stress.

6.3 Recommendation & implications

6.3.1 Usage of better (EEG) equipment.

This research tested using a Low-cost EMOTIV Insight, 5 Channel Mobile EEG, which is less accurate than EMOTIV EPOC+ 14 Channel Mobile EEG device. However, if someone seeks more accurate results, he shall use EMOTIVE EPOC+, which is slightly more expensive.

6.3.2 The number of participators for an experiment.

According to many sources, single-case experimental researches are accepted to be done on one. However, it is best to conduct it on more participates, but due to the short time It was done only on one participate.

6.3.3 Comparing with people from different cultures and regions.

According to the Bio-psycho-social model, by George L. Engel in 1977, human emotions are formed based on environment, genetics and old experience. Therefore, it would be much more accurate to compare people with different experience and regions, that would permit us to extract results, which than can be generalised on all human being.

7.0 Documentation

The following charts and data Figure21-figure26 are the pilot data collected from all experiment for each type of emotions in comparison to each other.

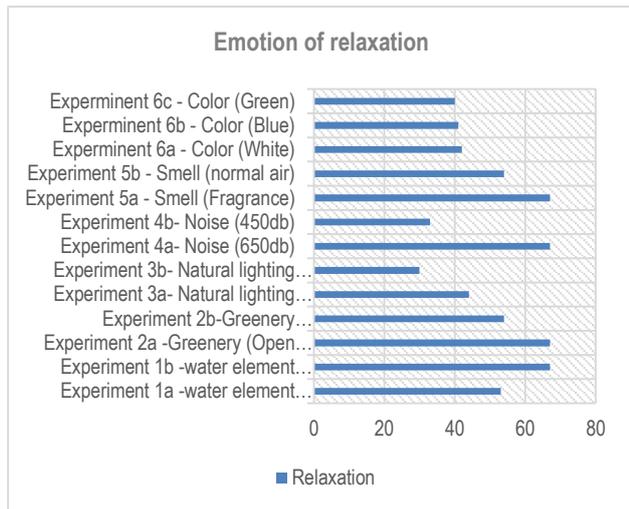


Figure 251. Emotion of relaxation
(Source: Author)

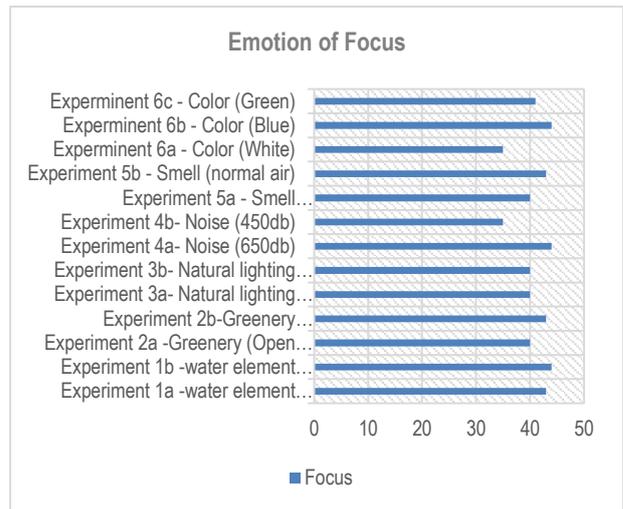


Figure 24 Emotion of focus
(Source: Author)

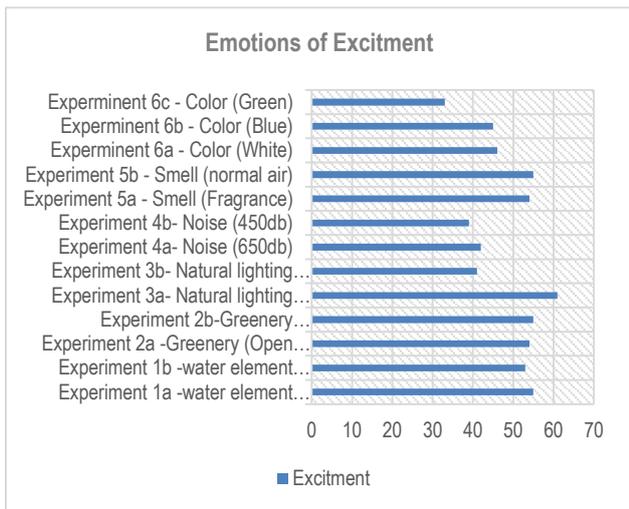


Figure 233 Emotion of excitement
(Source: Author)

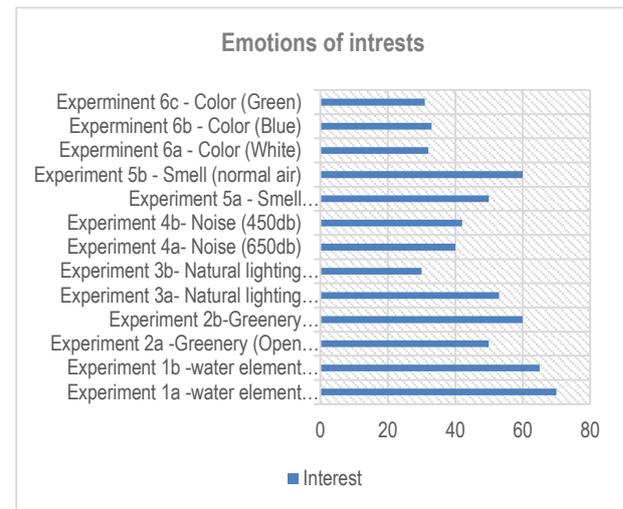


Figure 224 Emotion of interests
(Source: Athor)

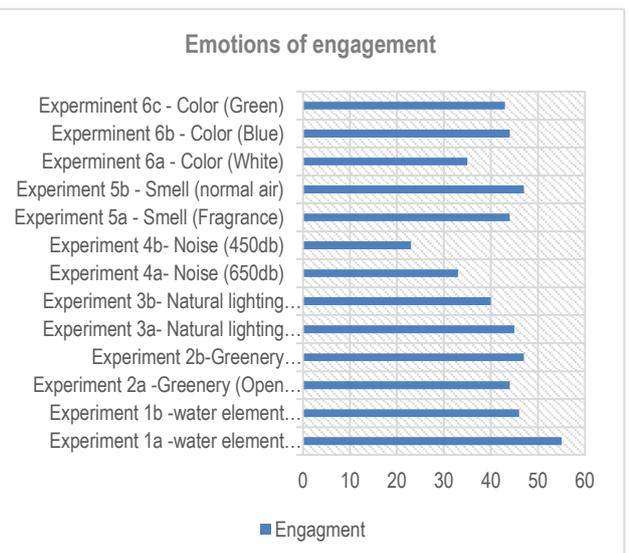


Figure 205 Emotion of engagement
(Source; Author)

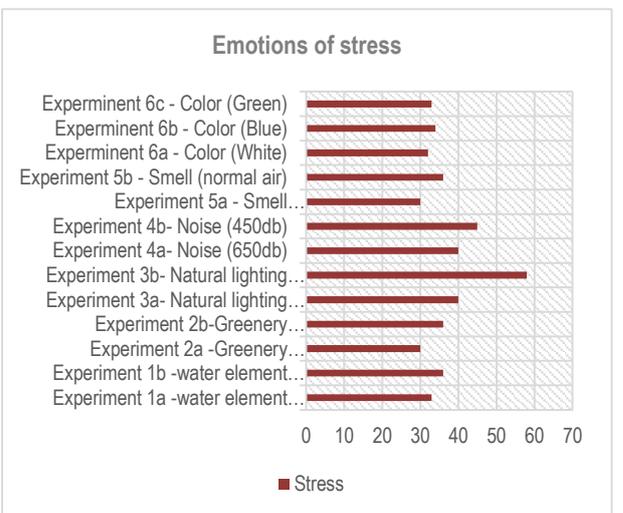


Figure 196 Emotion of stresst
(Source: Author)

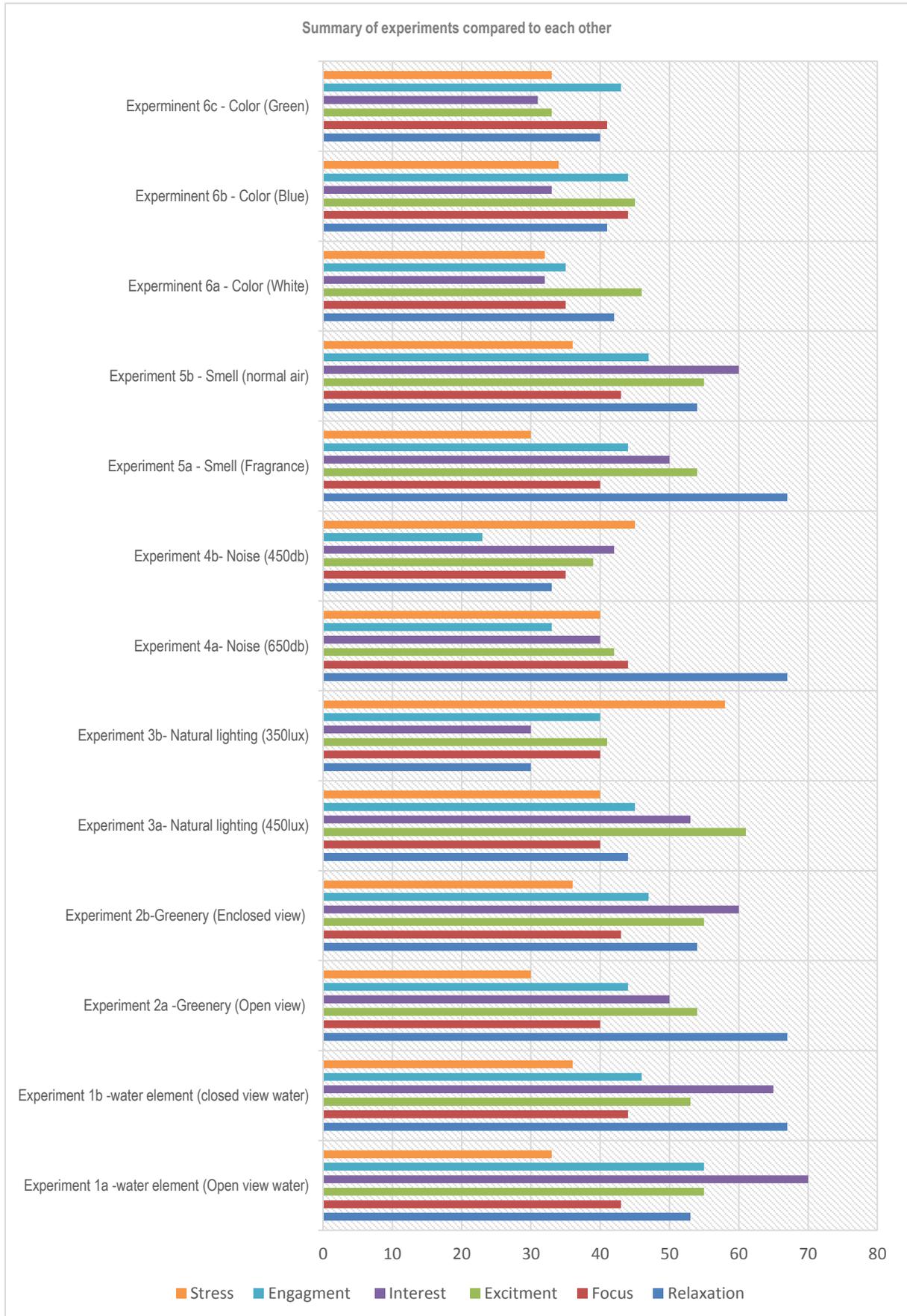


Figure 7: Pilot data collected from all experiment

Acknowledgement

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