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Probing Phenomenological Experiences Through Electroencephalography Brainwave Signals In Neuroarchitecture Study

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ABSTRACT

Experiences are a part of our daily lives through our interactions with the environment around us. We live life through the realm of experiences, be it playing or working. As we encounter phenomena frequently, it is deduced that most of it comes from within the built environment, considering how most of our time is spent indoors. Hence, it is imperative that we understand the impact of the built environment on human physiology especially within the context of religious spaces which is largely attributed to phenomenological experiences. Despite the importance of understanding the impact of the built environment on human physiology, phenomenological studies that addresses this relationship are still lacking. This presents a gap which necessitates evidence to be provided in the form of phenomenological studies. Hence, this study attempts to address the gap by utilising evidential data with the utilisation of the portable electroencephalography (EEG) device. In doing so, the brainwave readings from four participants at the Tuanku Mizan Zainal Abidin Mosque were observed. Data from the EEG device in the form of brainwave signals was analysed through the performance metrics detection suite which focused on the possibility of analysing brainwave data through three phases of habitation. The findings detected relaxation performance metrics from the participants whilst being within the mosque prayer area, whereas the phases prior to entering and after leaving the mosque appears to have detected higher excitement and engagement levels. Thus, it could be deduced that the interior prayer area of the mosque appears to have had a positive influence on the participant's physiology. This study could contribute to the novel field of neuroarchitecture in Malaysia, an area of study at the threshold of neuroscience and architecture that could be significant in understanding the relationship between the built environment and human physiology.

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1. Introduction

Experiences are a part of our daily lives. We live life through the realm of experiences, be it eating, speaking, playing or working. According to Edmund Husserl, a German philosopher who founded the philosophy of phenomenology; 'to live is to experience' (Bailey, 2013). Experience forms the basis of our conscious understanding of the world through sensory interactions. As stated by Pallasmaa (2009), human beings are connected to the world through their sensory stimuli which are not merely passive receptors but rather conscious modes of storing and structuring knowledge. Through direct interaction with the world, human beings were able to learn from their environment and study their experiences as a part of the formation of their knowledge. This is further elucidated by Pallasmaa (2014):

"The new sciences of bio-psychology and ecological psychology actually study such evolutionary causalities in human instinctual behaviour and cognition. It is evident that we are genetically and culturally conditioned to seek or avoid certain types of situations or atmospheres. Our shared pleasure in being in the shadow of large trees looking onto a sun-lit open field, for instance, is explained on the basis of such evolutionary programming – this specific type of setting demonstrates the polar notions of 'refuge' and 'prospect', which have been applied to explain the pleasurable pre-reflective feel of Frank Lloyd Wright's houses, for instance" (Juhani Pallasmaa, 2014).

This method of studying experiences is called phenomenology. According to Bailey (2013), phenomenology is understood "as the careful description of experiences in the manner in which they are experienced by the subject, proposes to study, in Husserl' s words, the whole of our 'life of consciousness'. In the Stanford Encyclopedia of Philosophy, phenomenology is defined as the "study of structures of consciousness as experienced from the first-person point of view"(Smith, 2013). As we encounter phenomena frequently, it is deduced that a majority of it comes from our interactions within the built environment, considering how most of our time are spent indoors. According to Seamon (2017) "on average in the Western world, people spend nine-tenths of their lives inside buildings; about two-thirds of that indoor time is spent at home". Bearing in mind the amount of time we spend indoors, it is imperative that we think about the impact that architecture has on our physical health as well as psyche; and the possibilities that could emerge from understanding our patterns of behaviour and the reasoning behind it.

In Holl's (1996) Intertwining book, he states that "architecture can shape a lived and sensed intertwining of space and time; it can change the way we live. Phenomenology concerns the study of essences; architecture has the potential to put essences back into existence. By weaving form, space and light, architecture can elevate the experience of daily life through the various phenomena that emerge from specific sites, programs, and architectures." By inducing various phenomena into architecture, an architect could improve the occupants wellbeing or elevate their sensory perception. Tadao Ando discussed his experience of sound phenomena within architecture, stating that architectural space becomes a phenomenon that we not only take in visually but through our senses and whole bodies as well. Ando discusses his experience in the interior of the Pantheon where a procession came in and sang a hymn. Ando remarked that it was the sound of space that affected him strongly (Shirazi, 2012).

However, despite all the potential of positives that could emerge from the application of phenomenology into architecture, it is still not a strongly observed, analysed or theorized method in the context of architecture (Juhani Pallasmaa, 2014). There is a difficulty in situating phenomenology amongst other schools of thought in architecture, mostly owing to its unique position of subjectivity. Many scholars on the other hand, from both architecture and other disciplines, believes that phenomenology is intersubjective . They believe that the aspect of shared understanding is possible and not wholly subjective as claimed by some theorists (Wang, 2013). Hence, it can be concurred that more architects may consider using phenomenological methods if its results can be substantiated.

This raises the possibility of using cross-disciplinary tools to measure phenomenology as an outcome. There is current research done in architecture in relation to clinical tools such as brainwave (EEG), heart rate (HR) and blood pressure (BP) equipments. The ongoing cross research between medicine, neuroscience and architecture is promising and holds opportunities for architecture as a discipline. As Pallasmaa; et al. (2013) states, "I believe that neuroscience can give support to the mental objectives of design and arts, which are in danger of being disregarded because of their "uselessness" and apparent subjectivity."

Thus, what if the interchange between neuroscience and architecture could help us document and interpret the brain activity of people within a specific location? Would this type of mapping and recording open up the possibilities of documenting and analysing architecture from the perspective of human experience? Within the context of Malaysia, there is a collation of opportunities for the study of phenomena in Malaysian architecture.

In Malaysia, the majority of the population are Malay Muslims and the established religion of the state is Islam (Embong, 2002). In accordance to the religious beliefs of a Muslim and their day to day lives, the mosque plays a central part of a Muslim's life. A mosque is seen not only as a place to pray but also to conduct multipurpose activities for the community of Muslims (Baharudin & Ismail, 2014). With so many possibilities of a mosque's function, there has been numerous reports and suggestions that mosques positively impact the feelings and behaviour of its occupants. According to Ardhiati (2013), "when a person enters a mosque he or she would have left the hustle and bustle of the material world and retreated into a calm shelter or sanctuary." The mosque is therefore also seen as an experiential phenomena of calmness wherein the stresses of the world are left behind and one enters a calmer state of mind.

Therefore, this study investigates the possibilities of clinical analysis in relation to phenomenological experiences in Malaysian mosques with the intention of substantiating evidence of phenomenological experiences.

Does an occupant's state of mind truly change when they enter a mosque? How does one know this? Are the experiences positive or negative? Which mosques contributes to a positive experience, and which ones less so? How does one prove this? The focus of the study is divided into two parts. The first delves into the attributes of phenomenology, its meaning, relationship to architecture, its relationship to human wellbeing. The second looks into the correlation between architectural phenomenology and human physiological, physical and mental responses in the context of the mosques which forms an integral part of the life of a Muslim. Within 1 pre-selected mosque, all EEG recordings are recorded inside the environment in real-time using the participants brain electrical activity readings through a EMOTIV brainwave equipment, as well as qualitative processes within a limited time frame. The relationship between brain activity in relation to the interior of a mosque is analysed and mapped to gain a better understanding of the experiences one encounters within it. Four (4) participants brain activity are analysed. Through a mapping of the data, we will seek to uncover the relationship between interior parameters of a mosque and its connection to their brain activity. The cross intersection between the disciplines of neuroscience and architecture is also reflected upon.

2. Context

"While the brain controls our behaviour and genes control the blueprint for the design and structure of the brain, the environment can modulate the function of genes and, ultimately, the structure of our brain, and therefore they change our behaviour. In planning the environments in which we live, architectural design changes our brain and behaviour". – Fred Gage, Adler Professor in the Laboratory of Genetics at Salk Institute (Pallasmaa; et al., 2013)

As one can summate from the paragraph above, architectural design has the capacity to change one's behaviour thereby modulating our brain reactions. According to Juhani Pallasmaa (2005) "architecture initiates, directs and organises behaviour and movement". Pallasmaa also goes on to state that architecture enforces the existential experience, one's experience of being in the world through not only vision but all the five (5) classical senses. These five (5) senses involve several layers of sensory experience which cohesively comes together and interacts to form a multisensory experience. Though the vision may be seen as the dominant sensory stimuli in our experiences, it is in actual reality a cohesive unit of sensorial experience. However, does architecture really have the ability to influence a person's feelings or behaviour?

In a study done by Shariff and Najafi (2011), five (5) state mosques were chosen as a part of a study looking into factors influencing public attachment to mosques in Malaysia. These five (5) mosques were the National Mosque, Negeri Sembilan Mosque, The Federal Territory Mosque, Putra Mosque as well as the Al-Azim Mosque. In all selected mosques, participants "experienced feelings of peacefulness, safety, refreshing, relaxation, spiritual, tranquillity, comfort, calmness, presence of God, and worship." As such, it can be seen that architecture does have an influence on human behaviour and feelings, with the participants reporting feelings of calmness and tranquillity for all five (5) mosques.

However, as gathered from the mentioned study, a gap of existing literature exists wherein no substantiated evidence was offered. A participant may express their feelings but there is no process in which a validation of qualitative comments could occur. This is seen in most research approaches in relation to phenomenology as elements of biasedness may occur in regards to a participant's feedback. Most research approaches towards the study of phenomena in general employs the qualitative approach such as surveys, interviews, questionnaire which is deemed to be subjective in nature and lacks a definitive evidence to substantiate the claims of its participants.

Furthermore, there still remains criticism against the methodologies of the architects, in part owing to its apparent subjectivity. Without evidence, there is no proof to back up an architect's claims. However, an emerging field of cross disciplinary research between neuroscience and architecture offers hope that criticisms against a lack of evidence could finally be subjugated. At the helm of this cross disciplinary research is ANFA which stands for Academy of Neuroscience for Architecture. In 2003, ANFA was formed by John P. Eberhard, who is the founding president of the Academy of Neuroscience for Architecture and the fellow of the American Institute of Architects and his collaborators to address this growing body of research in relation to human responses within the built environment. ANFA's purpose was anchored to a frustration with a lack of evidence based design (Taylor-Hochberg, 2016).

It was found that many researchers rely on social sciences and economic research that are too subjective in nature, whereas neuroscience was found to offer solid evidence in comparison. Jessica Pykett, a researcher at the University of Birmingham in the School of Geography, Earth and Environmental Sciences, cited in Karandinou and Turner (2017); adds on that neuroarchitecture (fusion of the word neuroscience and architecture) can be seen as a resolution for sceptics who sees flaws in an architect's qualitative as well as intuitive methodologies. Thus, what is neuroscience?

Edelstein and Macagno (2012) explains that "neuroscience encompasses a range of disciplines that study the multiple functions of our brains, and how these functions change from birth to death and are affected by disease. Our brains survey our environments through multiple sensory organs, and generate appropriate behaviors, conscious and unconscious. Neuroscientific research reveals how dynamic and plastic our brains are, and informs us about how different our capacities to respond to our environments are as children and as adults, and how exposure to environmental conditions influence such capacities." Here it is important to emphasize that the brain scans the environment through our senses and generates behaviours accordingly in response to the environmental stimuli. The most appropriate method for examining behaviour would be to understand the neural mechanisms that selectively filters external information, generates and produces behavioural tendencies (Taylor-Hochberg, 2016). Studies has been conducted in this cross disciplinary research field to investigate such possibilities.

In 2017, a study was done by Banaei et al. (2017) through VR simulated interior rooms to understand the impact of interior forms on the human brain. On the overall, it was found that the participants recorded a strong impact on their brain dynamics when they were exposed to rooms with more curvature geometries. Hence it can be deduced that neuroscience has the potential to uncover the relationship between the built environment and our brain's neural responses.

Thus, the relationship between neuroscience and architecture is a highly promising fusion, as it enables an evidence-based approach towards the design of the built environment. Though the exact features that would be necessary to design a building in relation to neuroscience has not been spelt out, architects can certainly design buildings with features that promotes wellbeing through neuroscience data (Dance, 2017).

Nonetheless there are criticisms of the integration between neuroscience and architecture. Dan Montello, a geographer and environmental psychologist at the University of California, cited in Taylor-Hochberg (2016) claims that his concern is with the overestimation of the benefits of neuroscience which will instead be used to channel the designer's attention from an empathy based process to a quantitative based process instead. It has also been pointed out that neuroscience could be used for the betterment or quite the opposite in relation to the built environment. Rather than the promotion of wellbeing, it could end up merely being used as an excitement ploy by artists (Mehaffy & Salingaros, 2018).

Despite the reservations, as an emerging cross disciplinary field, it is expected that there will be hesitations as to the appropriateness of the medium in relation to the discipline. With more extensive research being done in this area, perhaps more architects will open up to the possibilities that neuroarchitecture offers.

3. Methodology of Neuro-Architecture Research

With the emerging possibilities of cross-disciplinary research, architects and neuroscientists alike has lent their voice to support the integration of these two (2) disciplines. The advocates for this integration claim that the fusion of these two (2) disciplines will help architecture and the field of neuroscience move forward. However, it is important to note that these two (2) bodies of disciplines are quite different from one another especially in the context of research methodology. In architectural research, the architect has relied more on observation and intuition whereas in neuroscience, the focus has been on experimentation and proof (Sternberg & Wilson, 2006). In studying a phenomena, an architect would usually observe the patterns of human behaviour, study physical settings and intuitively synthesize a solution, immersing themselves in a situation or experience to gain an insight into the encounters that the built environment delivers. As defined by the Stanford Encyclopedia of Philosophy, phenomenology is the "study of structures of consciousness as experienced from the first-person point of view" (Smith, 2013). This varies substantially from the methodology employed by neuroscientists which seeks an evidence-based approach.

A neuroscientist would follow a predetermined path of research, gathering quantitative data and then validating it, either proving or disapproving the experiment's hypothesis.

As such, the phenomenological (interpretive science) approach used by architects differs from the method used by neuroscientists due to different schools of scientific thought employed. Neuroscientists follow a logical positivism approach, in which data and facts takes precedence over intuition. According to Amaratunga et al. (2002) "logical positivism uses quantitative and experimental methods to test hypothetical-deductive generalisations". Positivism seeks fundamental laws and causal explanations, and reduces the whole to simplest elements in order to generate analysis. It is also based conceptually on social structure and social facts, with quantitative and hypothesis tests being used. On the other hand, the phenomenological approach uses naturalistic and qualitative approaches to comprehend human experience holistically. It is based on social construction and meaning, with qualitative and hypothesis generation being its cornerstone (Amaratunga et al., 2002).

According to Papale et al. (2016), both schools of scientific approaches are equally needed to validate one another. "Many socially relevant research questions could be explored by neuroscience and architecture in synergy. Whereas currently the outcomes of this dialogue and contamination between architecture and neuroscience are hardly predictable, we believe in the paramount importance of sharing knowledge among disciplines" (Papale et al., 2016). Hence, the triangulation methodology was employed for the purposes of this research. "Triangulation is the combination of methodologies in the study of the same phenomenon" (Amaratunga et al., 2002). The essence of triangulation lies in its effectiveness to counter-balance the weakness of each methodology and is seen as an effectual research approach which combines both qualitative and quantitative methodologies in approaching a phenomena. Thus, an interdisciplinary synergy was deemed most appropriate for this research with a combination of quantitative (neuroscience data) and qualitative (interview) methodology being used to gain further clarity into the phenomena.

As for the building typology, a space of worship was chosen. In a study conducted on places to pause and be introspective, participants identified places of worship (Shah, 2009). Therefore, in Malaysia, as Muslims make up the majority of the population and Islam being the established religion of the state (Embong, 2002), the mosque was chosen as the most appropriate typology of worship spaces. In relation to the historical nuances of Malaysia and feedback of visitors to mosques, the Iron Mosque of Putrajaya was seen as the most appropriate mosque for the experiment to be done as it has recorded numerous feedbacks online about the calmness it exudes to its visitors (Saya, 2018) (Noorashani, 2018).

For this study, only a single case study of the mosque was employed. This is because single case studies are proven to be better models to test new theories (Gaya, 2016). The study is also not comparing sets of mosques but rather looking into a single mosque to understand the specific physiological changes of the participants. This is also corroborated by Yin, cited in Gustafsson (2017) who states that if a researcher is only focused on a single group of people, then the single case study would be the best method as it is not a comparative study.

For this experiment, four (4) participants from the Built Environment discipline were chosen. The students from this discipline was chosen because it has been proven that education can affect the impact of a person's experience. In one fMRI (functional magnetic resonance imaging) study, Wiesmann and

Ishai, cited in Coburn et al. (2017) found that architecture students employed different cortical areas when viewing buildings as compared to students from different disciplines. Architects also seemingly employ activation of the hippocampus region and precuneus when viewing buildings as compared to faces, which demonstrates that their education memories had a contribution to their affective responses.

All chosen participants were Muslims as it was necessary to enter the prayer space to experience the interior context fully. On the duration, the rationale behind the fifteen (15) minutes was to record three (3) separate phases of five (5) minutes each. The three (3) separate phases of habitation were outside of the prayer space, in the prayer space and outside of the prayer space again. This was necessary in order to understand the reaction of the brainwaves before entering a mosque prayer area, whilst being in it, and after departing it.

Through phenomenological literature contexts, the act of sitting has appeared in various phenomenological discussions. According to a study conducted by Shah (2009), "sitting is the activity which most of the participants have described while narrating their contemplative experiences – whether this be sitting on a bench in a park, or church, sitting on the floor while praying, or sitting in a tree for fun. It appears that the activity of sitting provides a ground or basis for moving to another dimension of experiencing." In another two (2) studies, it was found that the assessment of phenomenological experience could be reliably tested through sitting quietly and keeping the eyes open or closed (Pekala et al., 1986). For Elbow (1989), the act of sitting on the floor achieved an altered feeling of phenomena. As Elbow described, "I remember sometimes sitting on the floor-I'm not sure why, but probably as a kind of bodily acting out of my sense of desperation. I could type fast and I learned that I could just let myself flow into words with a kind of intensity." It can be surmised that the act of sitting quietly with the eyes open or closed could bring about a contemplative experience for a person, which in turn leads to experiential phenomenology.

The participants were advised to avoid sudden movements and to abstain from the act of prayer as movements could affect the accuracy of data readings. This is because any activity of any kind would result in biased consciousness which would display inaccurate readings (L Singer et al., 1981). The EEG readings were measured during non-prayer times as it was imperative to avoid any sensory interferences which could result in biased readings as the focus of this study is to understand the relationship between the mosque's-built environment and the participants physiological responses. All participants have not experienced this mosque before and are visiting for the first time.

In deciding the appropriate amount of time for a baseline EEG reading to be stabilized, though the current range to achieve baseline conditioning varies, a figure of four (4) minutes was deduced. According to L Singer et al. (1981), a time period of four (4) minutes is enough for any stable and intransient properties of consciousness to be assessed without disrupting one's stream of consciousness and remembering the experience would not be difficult. In another study, a psygram depicted the pattern of the act of sitting quietly with eyes closed for fifteen (15) minutes (Rock & Kambouropoulos, 2007). However, since this experiment is related to the context of the built environment, a visual stimulus of the built environment is needed to correspond to the brain signals therefore the act of sitting quietly for fifteen (15) minutes in total with the eyes open was deemed the most suitable position as shown in Figure 1.

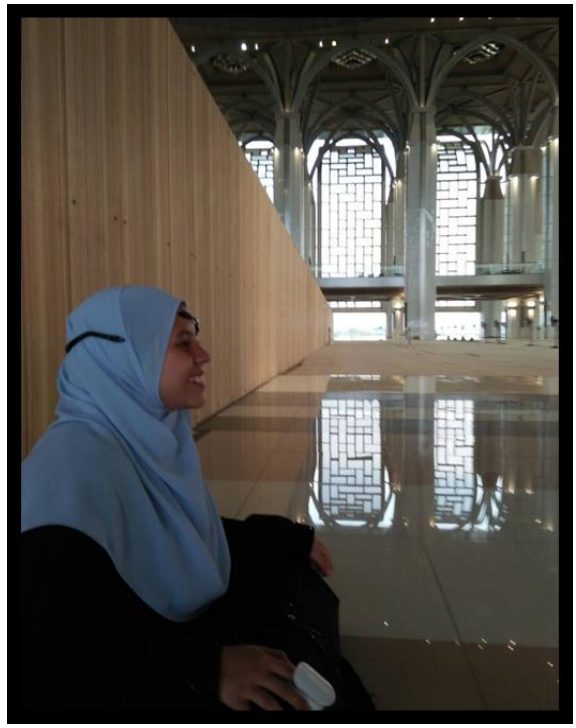

Figure 1 Participant's Sitting Position

The device used to measure the brainwave signals is an Emotiv Insight 5 Channel Mobile EEG Device, as shown in Figure 2. The device has a high accuracy range with an over 85% accuracy range for Excitement and over 70% for Interest. However it must be noted that the accuracy of emotions varies across individuals as not every individual has the same limits for certain emotions, therefore EMOTIV calculates the dominant performance metric of the motion out of a 0-100% range which is divided into excitement, engagement, relaxation, interest, stress and focus on the MyEmotiv application (Emotiv, 2019). Engagement is a mixture of attention and concentration, focus is the measurement of one's fixed attention on a task, interest is the degree of attraction or aversion, relaxation is the ability to rest and recover or 'switch off', excitement is the level of mental arousal, whereas stress is the measurement of the level of comfort one has with a particular task (Emotiv, 2012). This device would enable the justification of the objective of study which is to study physiological differences of a person's brainwave signals in response to the built environment, which in this study is the Iron Mosque in Putrajaya.

Figure 2 EMOTIV Insight 5 Channel Device

Using the MyEmotiv application, the participants will have their device calibrated between 1-2 minutes however this time period will differ according to each participant's sensor contact with the scalp (Emotiv, 2018). After the calibration period, the participants physiological responses will be recorded through screenshots taken at three (3) intervals using the MyEmotiv application which detects their Mental Performance Metrics.

It is postulated that in this study, participants may display higher relaxation metrics whilst being in the mosque prayer area, whereas prior to and after leaving the mosque, it is expected that the participants will record higher engagement or excitement metrics.

The participants were briefly interviewed the day after to garner their qualitative feedback. This was important as the what the participants felt could be cross validated to the data. Through an analysis of the brainwave signals performance metrics, are there any patterns that can be deduced from it? Is there a correlation between the brainwave signals and the participants qualitative feedback? These questions can be seen as stages of a scientific process; as the testing of a new theoretical methodology in relation to neuroarchitecture. The observation and recording of the participants' brain activity may reveal patterns as to their brain wave performance metrics, such as engagement, excitement, stress, focus or relaxation. The findings may potentially lead to observations which will inform the impact of the space on the participants physiology. This study has a limited number of participants but is acceptable in relation to other studies done in the field of neuroscience and architecture. This experiment is exploring the possibility of theoretical cross fertilization between neuroscience and architecture and therefore should not be used as a generalized statistical outcome. It is an exploratory study and it is the aim of this study to test the possibilities of neuroscience within architecture.

4. Principal Experiment Observations

Before delving into the experiment observations, the participants were given an alphabetical and numerical combination label in order to identify each participant. Since there are two (2) males and two (2) females, the males are labelled M1 & M2 and the females F1 & F2. All participants were given an informed consent form and hence agreed to the publishing of specific details such as gender. The following are the key findings observed throughout the experiment for each participant for the EEG performance metrics as well as the brief focus group feedback:

1st Interval

After the participants had achieved a stabilized EEG calibration, the performance metrics were then captured. In the first interval, based on the performance metrics dominant range, participants exhibited either excitement or engagement dominant frequencies as shown in Table 1. M1 recorded 74% on excitement, M2 had 82% on engagement, F1 displayed 92% on engagement and F2 recorded 73% on excitement. As previously mentioned, engagement is a mixture of conscious concentration and attention whereas excitement is the level of mental arousal. It could be deduced that all participants exhibited a conscious level of thinking and engagement with their new surroundings, and this is consequently reflected in their performance metrics. According to Patel (2015), arousal happens when the body issues chemicals into the brain that stimulates emotions and creates physical agitation in readiness for action. The dominant frequencies of the participants appear to support the premise that all participants seem to be either engaged or excited within the context of the compound of the mosque.

2nd Interval

During the second interval, another reading was taken after a stabilization of the EEG calibration on the device. It was found that all participants recorded a dominant relaxation frequency, with participant M1 recording 73%, M2 with 82% as shown in Figure 3, F1 with 83% and F2 with 80%. This appears to support the early mentioned postulation that participants may record relaxation frequencies whilst being within the prayer area of the mosque. It could be surmised that participants were feeling relaxed within the prayer area of the mosque and demonstrated physiological changes that were specific to the area of the mosque.

3rd Interval

Upon exiting the prayer area of the mosque and being seated once again at the compound of the mosque, a final reading was taken after the calibration of the device. It was found that participants returned to exhibiting either excitement or engagement frequencies. Participant M1 recorded 72% on excitement, M2 with 78% on engagement, F1 with 82% on engagement and F2 with 69% on excitement. The dominant metric points to the possibility that participants were actively engaged with their thinking processes and the environment around them thereby demonstrating these specific metrics. It appears that participants display a sense of animation upon leaving the vicinity of the mosque prayer area. It must be noted however that the frequency of engagement and excitement is lower than at the first interval, and this could be possibly attributed to the sense of relaxation experienced at the second interval and the gradual engagement with the outside world upon leaving the prayer area.

Table 1 Performance Metrics Dominant Readings at Tuanku Mizan Zainal Abidin Mosque

Participant and Dominant Performance Metrics	Before Dominant Frequency (0-100% Range)	During Dominant Frequency (0-100% Range)	After Dominant Frequency (0-100% Range)
M1	74 (Excitement)	73 (Relaxation)	72 (Excitement)
M2	82 (Engagement)	82 (Relaxation)	78 (Engagement)
F1	92 (Engagement)	83 (Relaxation)	82 (Engagement)
F2	**73 (Excitement)**	**80 (Relaxation)**	**69 (Excitement)**

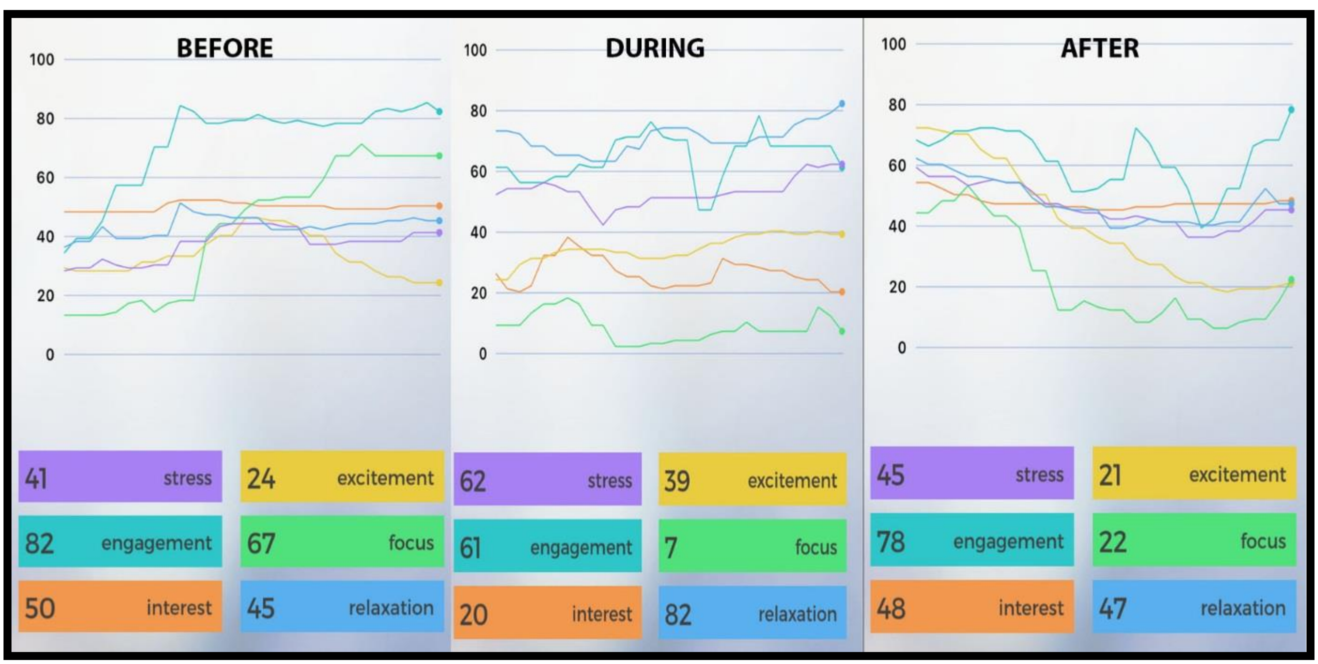

Figure 3 Participant M2's Brainwave Performance Metrics

Experiment Summary & Feedback

We observed some principally similar themes that emerged from this experiment.

Before entering the mosque prayer area and after leaving it, all participants recorded excitement or engagement performance metrics which is associated to active thinking processes and mental arousal. Whilst being in the mosque area, all participants recorded relaxation performance metrics which is related to aspects of rest and recovery. This is corroborated by Aoun (2016) in a study done using a portable EEG headset to measure the impact of architectural elements on emotions. It was found that architectural elements did trigger emotions and provoked feelings of engagement, emotion and relaxation amongst others. Thus, it can be determined that the participants were reacting in relation to the environment around them across all three intervals. It appears that the mosque prayer area was the context that impacted them most positively as it brought about a sense of relaxation.

Mosque Prayer Area (2nd Interval)

All participants expressed their affinity towards the design of the interior of the mosque. They identified words such as joy, serenity, surprise and amazement as the notable feelings they felt within the interior. All participants agreed that scale was an important factor in the feeling. They also observed that the aspect of nature was involved in the design of the mosque and that it had a positive reaction on them.

M1 remarked that the high ceiling of the mosque gave him a feeling that he was small, and God was big. He also remarked that he felt calm. M1 also felt that the multiple smaller entrances which were small revealed a delightful surprise of the sudden disclosure of the heightened scale of the mosque. M2 verbally identified the views from the mosque looking outwards towards the water feature had a calming effect.

He also commented that the materials on the floor felt cool to the touch, and somehow felt a correlative effect on calming himself down. F1 had similar views on the water feature which felt like it had a calming effect on the body and mind however she felt interrupted by the sudden construction noise. F2 observed that the scale of the space was big, and made her feel like her problems were small and insignificant in comparison. She mentioned that 'there were greater things out there.' F2 also pointed out that the volume of the space made her feel 'overwhelmed.'

As such, it could potentially be surmised that the interior of the mosque left a considerable impression on the participants at the 2nd interval. Being within the mosque's prayer area seems to have brought a change to the participants' EEG performance metric readings and could possibly point to the positive effect it has on the wellbeing of a Muslim. There appears to be a relationship between the performance metrics data and the qualitative feedback. Both appear to support one another in relation to the qualitative feedback of calm and the performance metric of relaxation. The possibilities of portable EEG readings in analyzing how a person may feel or respond within the context of a mosque could determine the efficiency of the design of the mosque in relation to the wellbeing of Muslims who congregates there for prayers.

Technical / Equipment Constraints

Despite spending fifteen (15) minutes per participant for the recording, the actual time to adjust the sensors and calibrate the equipment for each participant and the three (3) intervals was much longer. An approximate additional half an hour was spent calibrating each participants' sensors to achieve polymer contact with the scalp. During the recording, there were moments in which the sensors were detached and this produced 'noise' glitches on the readings. The removed noise glitches were left out so as to not influence the bearing of this experiment.

It should also be noted research has demonstrated that though one brainwave state may dominate at a specific time depending on the individual's activity, the remaining brainwave states are present at all times. Thus if a person is exhibiting a dominant brainwave, it does not mean that all other brainwave patterns cease to exist; it would still be present at a trace level whilst demonstrating the dominant frequency (Herrmann, 2019). This must be kept in mind when viewing the performance metrics.

5. Conclusions

This experiment was initiated as a point to further instigate the possibilities of neuroarchitecture and to enhance the possibilities of studying the wellbeing of occupants within the framework of architecture and neuroscience. Throughout this study, several observations were found to be supported by existing literature. This is demonstrated by the recording of engagement and excitement metrics whilst the participants were actively thinking of their surroundings and involved in cognition processes. The other observation found in this experiment relates to the recording of relaxation metrics when the participants were within the prayer area of the mosque, which demonstrated a possible relaxation phase within the interior. The participants also verbally identified words such as joy, serenity, and amazement in relation to the interior of the mosque which correlates to the collated data. Two (2) participants felt that the scale of the mosque positively overwhelmed them into contemplation and reflection. It can be surmised that specific design factors of the mosque such as scale, tactile qualities and the element of water within the mosque seems to have made an impact on the participants' emotions. It was also found that setting up the equipment and calibrating it fit each participant took much longer than expected and was challenging as there were moments during the reading when the sensors would become detached.

On another note, it is important to elucidate that the principal observations are based on a small sampling size, four (4) participants in one (1) mosque, for the purposes of testing the cross disciplinary bridge between neuroscience and architecture. It is imperative to note that this experiment was done as a theoretical study, and must not be used as a generic tool to

reach conclusions on a much larger scale representative of any population. Having said that, this experiment develops new ideas in relation to proving architectural phenomena in mosques in Malaysia and seeks to enhance this discussion on a much larger network.
It seeks to be part of an ongoing discourse on the relevance of neuroscience within architecture and the various possibilities it could propose in the context of architectural phenomenology. As it stands, there has been further excavation of this cross-disciplinary research field with well-known architects involved and therein lies potential for this body of research to be investigated further. Architectural phenomenology, for all the years it has been discussed, lectured on and debated, has not been put through rigorous scientific tests hence this is an opportunity to prove the existence of specific phenomena within the context of architecture especially within Malaysia.

With such exciting collaborations between the field of neuroscience and architecture, architectural phenomenology may yet undergo a paradigm shift of sorts, examining the link between space and brain, logic and intuition, architectural design and human emotions. This is a narrative that will bring together an alchemy of ideas and disciplines, though it may be on opposite ends of the scale, to a new frontier of phenomenological neuroarchitecture.

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