

Review Paper

## A Review of Approaches and Methods for Assessing Sensory Factors in Architectural Environments (Spiritual Experiences in Religious Architecture) †

Ali Sadeghi Habibabad <sup>1\*</sup>, Pietro Matracchi <sup>2</sup>

<sup>1</sup> Department of Architecture (DIDA), University of Florence, Italy

<sup>2</sup> Department of Architecture (DIDA), University of Florence, Italy

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### Abstract

The design of religious spaces around the world is of particular importance. Spaces such as churches, synagogues, graveyards, cemeteries, and shrines are among religious buildings. Such spaces are specially designed for each religion and faith. All forms of architecture should be easily reflected in form and space, given the meaning of the word “religion” (faith, religion, method, tradition, sharia, method, and way [rule of life]) based on the more manifest concepts in religion. The purpose of this study is to investigate approaches and methods for measuring sensory factors in architectural environments, in the form of a review [article] and literature review, on how to measure sentiments in architectural space. Therefore, this study seeks to answer this question: What are the methods for measuring sensory factors in architectural environments? This study is desk research in nature, to define all the issues raised in the theoretical section using a descriptive-analytical method to analyze the content and logical reasoning and collect the required data on the concepts by doing a literature review. Findings indicate that the architecture in the past sought to take advantage of the formal dimensions of religious buildings, such as mosques and churches, as a medium for a spiritual leap into the world of truth and meaning. Religious (sacral or sacred) architecture can also be translated into organizing components to navigate the appearance of phenomena and remember their interior to enhance the spiritual spatial quality. One has to note that the effects of the architectural body and buildings built affect people's minds. Thus, if this issue is ignored, the created space will cause confusion and a negative effect on the minds of the users of the space for sure. In the field of sensory factors in architecture, architects and urban designers can answer most of the hypotheses by using cognitive sciences.

**Keywords:** Approaches and Methods, Religious architecture, Cognitive sciences, Environmental psychology, Measuring spiritual sense.

### 1. INTRODUCTION

“Whether religious or non-religious, many people experience spiritual moments in their lives and come to a broader sense of meaning, peace, and connection to the world around them. Scientists now claim to have

succeeded in discovering the place where these sublime moments are processed in the human brain. They have identified an area in the parietal cortex that is effective in gaining supranormal (or paranormal) human experiences” (Miller, 2019). Spiritual experiences are a series of acute states with potentially profound effects on human life. Understanding the neural foundations of spiritual experiences helps us better understand their calming (peacemaking) role and restoring mental health.

These states, meanings, and concepts in the architecture of religious places are understandable and tangible. Although they may not be seen, users of such spaces gain peace of mind and spiritual experiences. However, if architecture is designed with such a goal in mind, which is a controversial issue, thinkers will measure the components of architecture and examine and explain

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\* Corresponding author: A.sadeghi@sru.ac.ir

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their impact on the minds and psyches of users of these spaces. There has been a close connection between meaning and form throughout the history of art and architecture of religious places and Islamic architectural thought. The reason is that in the Islamic worldview, the productions of Islamic art are based on the idea of monotheism. In its most beautiful expression, this connection is undoubtedly manifested in the architecture of [Islamic] mosques and churches.

1.1. Research Method and Objectives

This study is desk research in nature, intending to define all the issues raised in the theoretical section using a descriptive-analytical methodology to analyze the content and logical reasoning and collect the required data on the concepts by doing a literature review. In this regard, books, dissertations, and articles are used as research tools, and the required data are collected in the form of literature

texts review and indexing. The collected data are analyzed in the form of sorting, selecting concepts, listing, and coding (Figure 1).

The main purpose of this study is to investigate approaches and methods for measuring sensory factors in the in architectural environments, in the form of a review [article] and literature review, on how to measure sentiments in architectural space. Therefore, this study seeks to answer this question: What are the methods for measuring sensory factors in architectural environments?

2. RESEARCH BACKGROUND

Table 1 examines research on function and meaning in architecture and religious sites (places of worship), as well as measuring sentiments in architecture. Here is a summary of the results by categorizing past studies:

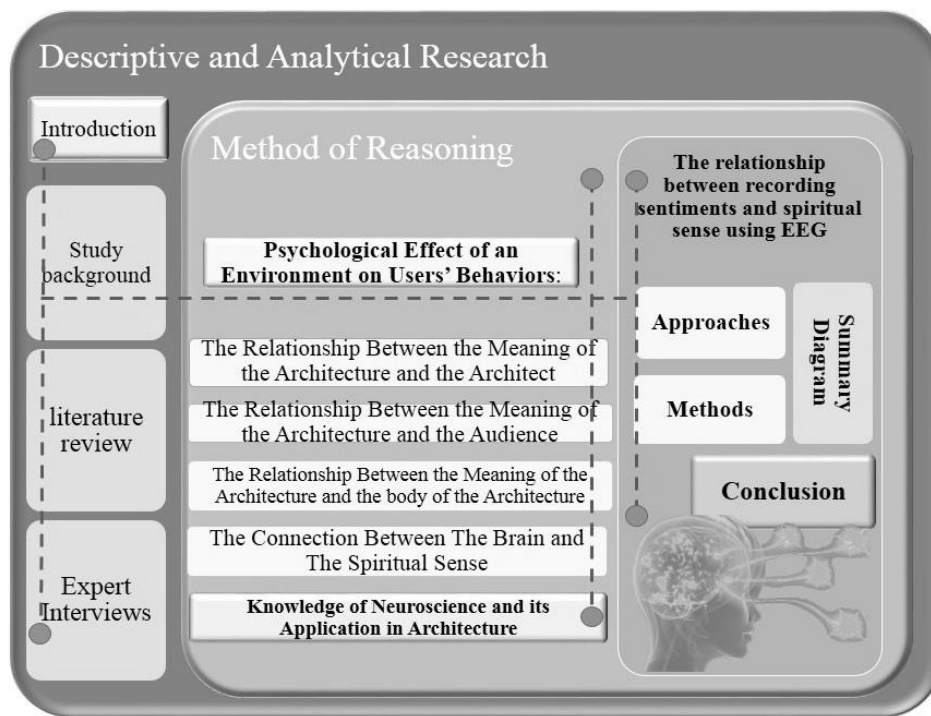


Fig 1. Summary of Research Methods and Steps

Table 1. Research Background by Information Breakdown. Source: Authors

Investigating the relationship between function and meaning in architecture and religious places	
Researcher	Summary, research purpose, and general results
(Imantalab, 2012)	The results show that the mosque is a collection of various arts, creating a sacred space to establish a relationship between God and people.
(M. Bemanian, Jelvani, M., Arjmandi, S, 2016)	This study examines the formal composition of mosque spaces in Esfahan School (ideas) as well as the spatial configuration in zoning the structure of mosques.
(Hejazi, 2014)	This study is based on the fact that meaning, beauty, shape, and structure are the four basic factors in the Islamic architecture of Iran; with the right combination of them, traditional architecture can manifest the impression of the world of meaning in the material world.
(Pinchard, 2005)	The results show that spirituality and symbolism in traditional architecture are the product of this architecture’s attitude towards the cosmos.

(Safdarian, 2017)	The results show that worldview, as the highest layer, directly and indirectly, leads to change at lower levels; the architectural form always reflects these effects.
(Pourjafar, 2009)	Here, an attempt has been made to develop the relationship between the component of meaning and the element of place in architecture by examining expert opinion.
(Nazer, 2016)	In the form of a case study, this study examines the transparency of domes (meaning) in mosques, emphasizing the function of spatial luminance.
(Sahhaf, 2016)	This article addresses the presence of spirituality in Iranian architecture.
(Azimi, 2019)	This article examines the place of the imagination as a mediator of the expression of meanings in architectural design and its role in the process of architectural design.
(Manan Raisi, 2016)	This article seeks to answer the following questions: “What are the components affecting the process of reading and interpreting the meaning of an architectural work?” And “Can it be believed that meaning in architectural works is determined based on these components?”
(Raeisi, 2019)	This research deals with the semantics of architectural works from an Islamic perspective.
(Karipour, 2016)	This article is a semiotic analysis of form and meaning in Vakil Mosque, Shiraz.
(M. R. Bemanian, Pour Jafar, M.R., Ahmadi, F., Sadeghi, A.R, 2010; A. Sadeghi habibabad, Taher Tolou Del, M., Mahdi Nejad, J, 2017)	This article examines the nature of sacred suppositions in Islamic mosques.
<b>Examining the methods and ways of measuring sentiments and spirituality</b>	
<b>Researcher</b>	<b>Summary, Research Purpose, and General Results</b>
(Abboushi, 2019; Amundadottir, 2017; Rockcastle, 2017)	This research introduces the simulation method in virtual and indoor architectural environments and also collects data from users by employing a questionnaire.
(Roe, 2013)	This study is a sentiment analysis of urban landscape and architecture through electroencephalography.
(MahdiNejad, 2021)	This study examines age and gender and their effect on spiritual emotions using EEG tools.
(Papale, 2016)	This research peer-reviews the literature on neuroscience and architecture.
(Mehdinejad, 2021)	This book explores the interrelationships of neuroscience in architecture and introduces existing tools.
(Daneshmand, 2020)	This article introduces methods and tools for measuring the emotional effects of the environment and user’s emotional reactions in architectural environments.
(Cauwerts, 2013)	This research introduces the simulation method in virtual environments, emphasizing introducing panoramic images of space for sentiment analysis.
(Darban Rezaei, 2019)	This article attempts to provide an operational model for measuring sentiments in urban spaces.
(Rezaei, 2020)	This study examines daylight perception in indoor environments.
(Ghaffari Khaligh, 2017)	The effect of spiritual spaces on human brain waves
(Essawy, 2014)	This article examines brain function in the Mosque-Madrassa of Sultan Hassan by electroencephalography.
(Nakamura, 1992)	This research measures user’s sentiment by electroencephalography in landscape architecture.
(Kim, 2010)	This study utilizes electroencephalography and functional magnetic resonance imaging (fMRI).
(Yazdchi, 2014)	This research seeks to improve automatic emotion recognition using EEG signals.
(Zahedi Haghghi, 2019)	This study detects EEG-based emotional states using a deep learning network.
(Chamilothori, 2019; Kuliga, 2015; Moscoso, 2020)	This research introduces simulation methods in virtual environments using 180- and 360-degree images through virtual reality headsets and user data collection.
(Eberhard, 2008) (Mallgrave, 2010) (Robinson, 2015)	This article peer-reviews the foundations of the relationship between neuroscience and emotion measurement in architecture.
(Wolman, 2001)	This article builds the Spirituality Assessment Questionnaire, mainly on spiritual orientation.
(Ghobari Bonab, 2005)	This article assesses spiritual experiences in the form of a questionnaire.

(Sharifi, 2008)	This article measures spiritual orientations in the form of a questionnaire.
(S. Shahidi, Farajnia, S, 2012)	This article standardizes and presents the Spirituality Assessment Questionnaire for future research.
(Azizi Naserabad, 2020)	This study examines the impact of urban elements on users' sentiments.
(Vartanian, 2015)	This study examines the effects of building interior height and open and closed space on users' sentiment with electroencephalography in architectural design.
(Babiloni, 2014)	This study measures the sentiments of users while watching the sculptures by electroencephalography.
(Vecchiato, 2015)	This study measures sentiments by recording the user's brain signal while understanding the interior space through a three-dimensional simulation.
(Mokhtari, 2016)	This thesis examines the effects of spiritual architectural elements on the exterior by electroencephalography.
(Karipour, 2016)	This thesis examines the effect of the skyline of mosques on the creation of a spiritual sense through electroencephalography.
(Naghbi Rad, 2015)	This thesis examines the different effects of patterns on commercial complexes by electroencephalography.
(Maghsoudy, 2017) (Jam, 2020)	This research recognizes the user's sentiments in the visual perception of the facade using face recognition technology.
(A. Sadeghi Habibabad, 2020)	This Ph.D. thesis investigated the effective components in creating a spiritual sense (studying form and color) in the architecture of mosques by recording brain waves.

### 3. LITERATURE REVIEW

#### 3.1. *The Relationship between the Meaning of the Architecture and the Architect*

According to the teachings of the school of Islam, "The effect is a manifestation of one who affects and lies in itself the one who affects" (Javadi Sasani, 2003). Therefore, even if the understanding of effect is limited to discussing the semantic horizons of the audience and the self since the manifestation of manifestation in effect is inevitable, the semantic horizon manifestation (the author) inevitably plays a role in the event of understanding. The manifestation of manifestation in effect is confirmed both in the utterances of Islamic philosophers and in solid religious texts. Among these texts is the narration that Imam Ali says about theophany that the tongue of the wise man is behind his heart (Seyyed Razi, 1994). In another narration confirming the relationship between effect and manifestation, he states that intellects are the leaders of thoughts, thoughts are the leaders of hearts, hearts are the leaders of the senses, and the senses are the leaders of limbs and organs (Majlesi, 1982). According to this narration, what is represented by limbs and organs, i.e., extensions and works, in the previous stages, originated from the world of thoughts and concepts of manifestation (the architect). On the other hand, if we accept that meaning is relatively manifested in extension (i.e., effect) (Noghrehkar & Raeesi, 2012) and extensions carry meanings, we can say that effect, and consequently, its meaning, originates first from the realm of reason and the thought of the architect, according to the above narration (Raeesi, 2019).

It should also be noted that since the semantic horizon manifestation (the author) is a component of the past (albeit a very recent past), its nature is not affected by spatiotemporal evolution, and contingents, in general, have

no effect on its nature. The reason is that the author's idea, as soon as it appears, belongs to the realm of entities, a truth-oriented realm according to the principles of Islamic ontology. Hence, the author's semantic horizon, as a component involved in the genesis of meaning, becomes a fixed and invalid component as soon as the work occurs, which also transmits its demonstration to the perceived meaning of the work (Raeesi, 2019).

Formation of the meaning of effect plays its part. "The form and body of artwork depend on the architect's taste and practical and experimental talent. In this way, the artist, in addition to the correct ideas, beliefs, and knowledge of ideas, must have good practical taste and experience in that artistic orientation" (Noghrehkar, Hamzehnejad, & Ranjbar Kermani, 2009). Thus, depending on the creativity and practical ability of the architect, the content of an idea can be realized with various bodies and forms relatively and in different degrees. These manifestations of the one who affects in the effect are what traditionalists like Ardalan emphasize. Ardalan, in a section of *Sense of Unity* called *Degrees of Realization*, introduces the city as containing various material forms "(Noghrehkar & Raeesi, 2012). Degrees of realization of content (i.e., meaning) in the form and body of artworks and architecture is a subject that is affected by different degrees of human life. Man is not limited only to the degree of his soul but has degrees superior to the soul, i.e., the heart or soul, etc.

Nevertheless, if the soul is independent during the action and is not affected by superior and higher degrees of being, the work created by this state can be described as carnality (sensuality); however, in religious art, the artist's soul is not like that. His soul is a low degree of his existence and therefore must be influenced by the higher forces of his existence" (A'vani, 1997). Therefore, depending on the grade of soul that the architect uses in creating his work and inspires his ideas from that soul, the quality and degree of meaning realization in the body

of work also vary. The more transcendental the architect's soul, the higher the degree of meaning realization in the body of work (Raeesi, 2019; Noghrehkar & Raeesi, 2012).

### *3.2. The Relationship between the Meaning of the Architecture and the Audience*

From an Islamic point of view, to deduce the correct and rigid meaning of work, the audience should, as far as possible, avoid interfering only with their foregrasp in the effect of the work with appropriate tools, meaning that is the result of an approach contrary to this approach is the result of a reprehensible eisegesis. In reprehensible eisegesis, the interpreter only bases his foregrasp. Nonetheless, in acceptable subjective interpretations, although the foregrasp interferes in the interpretation, it tries to control it with special tools such as consensus. In other words, in the Islamic approach, the involvement of the foregrasp in the interpretation and understanding of the meaning of the work is acceptable. The foregrasp of the audience is one of the components of meaning, but only if the process of meaning is not merely dependent on this component and is restrained by other appropriate tools expressed in the religious teachings.

It is important to note that most contemporary Western epistemological currents attach the infinite relativity to human understanding. In a fundamental sense, it is one of the results of their incompleteness of cognitive resources and relying solely on human intellect and erroneous sense, because one of the tools of instrumental rationality is to accept the historicization of human values and relativity in understanding facts and knowledge. From this point of view, eternal wisdom and values embedded in real human life have no place in scientific understanding, and human intellectual and cultural life is caught in the turbulence of trial-and-error arising from the limited mind of man. Relying solely on instrumental rationality has caused these currents between relative understanding and relativity to sophistry (fallacy) in understanding, justifying for a given work all the myriad meanings that different audiences infer. However, from an Islamic perspective and relying on comprehensive sources of human knowledge, what is acceptable is relative understanding and not relativity in understanding. This means that the degree of understanding of individuals is different, and in dealing with facts, everyone can benefit from them only to the extent of their own understanding and perception. It should be noted that the different degrees of truth do not harm its unity, and truth can have different manifestations. This creates an important boundary drawn in process meaning between authors' theories and contemporary Western epistemological theories. This means that according to the authors based on Islamic teachings, the understandings of different audiences of work, provided they are obtained in a solid way, are in a longitudinal and monistic relationship. Nonetheless, in most contemporary Western approaches, these understandings form an anti-monistic and pluralistic set

because they are transversely related.

### *3.3. The Relationship between the Meaning of the Architecture and the Body of the Architecture*

There are references in the narrations and hadiths of Islamic sources regarding the relationship between form (body) and meaning (content). Imam Ali says in this regard: "And know that every esoteric appearance has its own proportion; that which is pure in appearance is pure inwardly, and that which is inwardly filthy is inwardly filthy" (Nahj al-Balagha, sermon 154). Nevertheless, the form predicating on the content does not mean the identity of the two and the absolute manifestation of content in the body, but each of the two forms and content is translation of the other. This translation has different grades and layers, and the quality of penetration of these two elements in each other is determined depending on the quality of the translator (Noghrehkar & Raeesi, 2012) (Manan Raisi, 2016)

Evidently, according to the above-mentioned narration, every esoteric (meaning) cannot be attributed to any physical appearance. This is evidence of the negation of what audience-oriented currents claim about the pure relativity of meaning. Thus, although form can never directly represent qualities from an Islamic perspective (Avini, 1998). Nevertheless, this representation is firm and subject to facts that take it out of pure proportion and place it in a certain framework. It is also important to note that there is no specific clause for assigning the narration in the above sermon. Therefore, we must consider the content of the narrative as general, which applies to all phenomena of existence, including architectural works. The general phrase "every appearance" mentioned at the beginning of this article substantiates this claim (Manan Raisi, 2016).

Based on what has been stated, it is concluded that the body of the work has a significant role in the process of reading and interpreting its meaning. The reason is that in the process of interpreting the meaning of the work, it is basically the body of the work that acts as a link between other components (including the architect and the audience). If there is nobody involved, there will be no mediator on which the audience can base their interpretation (manan raisi, 2016).

## **4. PSYCHOLOGICAL EFFECT OF AN ENVIRONMENT ON USERS' BEHAVIORS:**

Human beings are creatures readily influencing and easily influenced by the environment. In the same way that they can change the environment, they can also be influenced by their changing environments and use and metamorphose it in line with their physical and psychological goals and needs (Canter, 1981; Russell & Ward, 1982; Sadeghi Habibabad, MahdiNejad, Azemati, & Matracchi, 2020b)

Environmental psychology, as well, obliges itself to the doing of research about human behavior in its daily environments so that the effects of the contextual

environment on human behavior can be directly or indirectly investigated (Bell, 1996) (Wicker, 1979). Jencks (1969) believes that the meaning of a contextual form is shaped at the same time with its creation and that it is this meaning that relates the human beings to the environment (Jencks, 1969). As put by Rapoport (1982), although the individuals' social position is very effective in their method of behaving and treating one another, the environmental signs transfer the meanings required for regulation of the behaviors; the environment somehow establishes a nonverbal relationship with the onlookers (Rapoport, 1982).

In fact, the environmental psychology emphasizes on the idea that how behavior, feelings, and sense of healthiness in human beings are influenced by the physical environment (Russell & Snodgrass, 1987; Evans, 1998; Sadeghi Habibabad, MahdiNejad, Azemati, & Matracchi, 2020b)

#### 4.1. The Issue of Meaning and Spirituality

Spirituality is a lost human being in the universe who does not know time and place. The term spirituality and its derivatives, although not used in authentic Islamic sources, have become popular in Muslim literature, both in Arabic and in Persian. As the usage of this word has shown, this word is related to "meaning," as the lexical root of spirituality confirms. Meaning refers to a situation that consists of at least two layers, one on the outside, which is narrator, and the other on the inside, which is benchmark. All the theories of scientists, despite their differences, have two points in common. Meaning is something lies within an expression or action and must be discovered, and it is somehow related to the belief system and goals of a particular action. Islam offers a comprehensive view of existence. The relation of the appearance of the world to its interior is a semantic relation. The obvious world is a manifestation of the inner world and indicates the meaning hidden inside it (Mesbah, 2010).

There are various definitions of spirituality, including divinity, spirituality, and sanctity (Oxford Dictionary Shorter, 1989: 2963), the rule of the absolute and dignified soul over the universe (Book Encyclopedia World, 1996: 18). The source of Islamic spirituality is *the Holy Quran* and the sayings of Prophet Mohammad (PBUH) as the Prophet of God. Islam offers the most comprehensive teachings for the spiritual evolution of mankind. "The vacuum of spirit and spirituality in the material world of the West has led the modern world to seek a balance between materialism and spirituality, and Islam can meet this need," writes Loieue Karr, a professor of Islamic civilization at the University of Paris. The issue of spirituality in Islam is fundamental, and therefore addressing it can solve the crisis of spirituality in the present age.

"Spirituality" in Latin comes from the word Spiritus meaning "life" or "way of being" and "experiencing," which arises from the awareness of an immaterial dimension and determines its recognizable values. These values relate to others, self, nature, and life. It is worth

comparing this definition of "spirituality" with that of Alister Hardy. Hardy believes that the main features of man's spiritual and religious experiences are manifested in his longing for a transcendental reality. This longing often manifests itself in early childhood, the sentiment that something (present) can be perceived and perceived "beyond myself". The interest in personalizing this presence in the form of a kind of divinity and the relationship of "I-you" with what is established through prayer and supplication (Shahidi & Farajnia, 2012).

For Vaughan, "healthy spirituality" is about individual freedom, independence, self-esteem, and social responsibility. Healthy spirituality does not deny humanity and does not forbid or deny sentiments. In his view, there is potentially healthy spirituality in everyone. Healthy spirituality is rooted in experiences and can include the following characteristics: originality, letting go of the past, facing fears, insights, forgiveness, love and compassion, sociability, awareness, peace, and freedom (Keshmiri, 2008; Shahidi & Farajnia, 2012)

Emmons states that "spirituality" is the search for sacred elements, meaning, high consciousness, and transcendence. Abraham Maslow also considers spirituality as one of the most important elements of the humanistic attitude. Maslow believed that "spirituality" is a public responsibility that falls on all human beings. He believed that spiritual experiences move us from the realm of conventional consciousness to the realm of the superiority of existence. It allows us to interpret our transcendent values, such as truth, beauty, art, and love, which Maslow calls "being values" (Abdollahzadeh, 2009; Shahidi & Farajnia, 2012)

Some psychologists have defined "spirituality" as a constant human endeavor to answer the whys of life. In other words, the optimal use of creativity and curiosity to find the existing reasons related to survival and living and, consequently, the growth and development of spirituality is an important part. As a result, it can be said that spiritual development begins when the child seeks reason and asks about the phenomena around him (Shahidi, 2000).

"Spirituality," from the point of view of Ghobari Bonab and his colleagues, is the connection between the transcendent being and the belief in the unseen. Belief in human growth and development in overcoming the ups and downs of life and regulating personal life based on the connection with the transcendent being and understanding the permanent presence of the transcendent existence in a meaningful, organized, and directional divine existence (Ghobari Bonab, 2005).

From the perspective of the Qur'an and Islam, "spirituality" has a special definition. The view of Islam on man is that he has set foot in this world to achieve a specific goal, which is achieved by his own behavior and will. Every thought, belief, and behavior, even mental imagery, has an exterior and real effect that takes a person aside. In general, in Islam, spirituality is the understanding of the relationship with the transcendent being, which is achieved and intensified day by day through the practice of special programs during life on Earth, and makes him a special being who is inherently desirable in the universe

and is manifested by God's remembrance (Narouei Nosrati, 2011) (S. Shahidi, Farajnia, S, 2012).

## **5. THE CONNECTION BETWEEN THE BRAIN AND THE SPIRITUAL SENSE**

The basic human emotion can be detected through facial expression or body movement, but what about the specific type of emotion? Emotional identified in this study either through EEG neuroimaging, functional magnetic resonance imaging (fMRI) and others are still in the early stages. They detect a range of emotion shown by humans (Ismail, 2016).

Emotion is a communication method for describing inner feelings through the physical and real world in the form of body language involves facial expressions and body movement (Ismail, 2016). However, emotions have been interpreted in different fields (Kendra, 2013). Different emotions involve different areas in the brain (Niemic, 2004). Based on the findings obtained through a process carried out revealed that facial reaction alone cannot describe or reveal the real emotional person, but with this brain wave analysis, we will be able to know the true emotions of a respondent, although it is trying to hide (Ismail, 2016).

Many studies have been done to identify individuals' emotions using EEG signals. Some of them are mentioned in the continuation of the article. (For Further Reading: Gannouni, 2021; Bekkedal, 2011; López-Gil, 2016; Suhaimi, 2020; Lee, 2014).

Some studies show that parts of the brain, are activated when creating a spiritual experience. Since these areas are related to cognitive activity, it can be said that spiritual experience is not a sentimental experience but the result of reflection and thinking (Azari, 2001). In this regard, Newberg and d'Aquili (2000) found that, in their study of people with mystical experiences, two commonalities can be observed in all deep spiritual experiences, especially mystical experiences, modes of unity or a sense of oneness with the whole universe, or its origin, and experiences such as euphoria, cheerfulness, dread, hope, and the like. Thus, according to this view, religious experience is a sentimental, cognitive experience. These researchers believe that the activity begins focusing on an external object with an internal subject in some meditation practices. This focus activates the right prefrontal cortex, inferior temporal lobule, and superior parietal lobule. By continuing to focus through the lower temporal lobe, parts of the limbic system are activated. The result is ergotropic responses and the emergence of desired sentiments. The feedback of this sentiment activates the whole system, and after a while, the "trophotropic" responses are activated (Beyrami, 2016).

## **6. KNOWLEDGE OF NEUROSCIENCE AND ITS APPLICATION IN ARCHITECTURE**

Neuroscience studies the neural correlates of human cognitive functions. It plays an underlying role in the

cognitive sciences as one of the new sciences. Cognitive sciences and technologies in recent decades, as interdisciplinary fields, have been considered by professors in various fields of basic sciences, medicine, engineering, social and behavioral sciences, art, and humanities (Mehdinejad, 2021).

Today, new methods are used to adapt architectural structures to the needs of users. One of these methods is neuroscience, which has had a tremendous impact on various scientific fields in recent decades. Extensive advances in this knowledge have paved the way for its application and its connection to architectural knowledge. By applying this knowledge in architectural studies, the effects of architectural structures on the neural activities of the brain system of users of different urban spaces can be studied. These studies also lead architects to understand customers' behavioral, psychological, and sentimental reactions to building design (Mehdinejad, 2021).

In Mansouri's (2018) study, the application of neuroscience for architects is described as follows. Garland calls "neuroscience" a branch of life science that addresses "mental processes" (brain processes: sentiment, perception, learning, memory, movement, and organizing purposeful behavior and adaptation to environment).

Regarding the applications of neuroscience in architecture, Edelstein refers to "the cognitive process of the present process, the rhythm of sentiments, and the individual's familiarity with architecture and the effect of the man-made environment" on brain function (Nanda, 2013). Eberhard introduces neuroscience-based architecture to increase the quality of life by reducing stress, increasing cognition, long-term productivity, and a more desirable psychological and sentimental response (Eberhard, 2009). The results of Mormede study also indicate the activation of a part of the autonomic nervous system under the influence of physical environment properties (Mormede, 2002). Wilson and Sternberg point to the findings of neuroscience and the extraction of its concepts by architects who step into the optimization of hand-made environments to respond to mental processes. These studies address environment properties, which trigger various physiological and neurological reactions, such as easy sentiment in a physical environment or induce a sense of anxiety. In architectural designs based on neuroscience principles, they strive to promote creativity, better cognition of space, and the comfort of their space users (Sternberg, 2006; Mehdinejad, 2021).

Users of architectural spaces also identify the environments around them through their features, such as form, color, proportions, geometry, etc. Surrounding environments are full of visual stimuli. They receive visual receptors for information and transmit them to the nervous system. What is transformed from the environment into semantic information is also called environmental perception. Humans can interact with the environment around them through perception. Designers today seek to advance their design process to provide users with a good understanding of the environment to feel comfortable in that space. From a biological point of view, environment perception can also be considered mental experiences of

the environment, including various elements and components, usually caused by the stimulation of the body's sensory receptors. These stimuli are converted into neuronal activity by mechanisms and then sent to the central regions of the nervous system, where neurons further process them. This stage is the final stage of neuronal processing in the brain, which forms the basis of human perceptions of the surrounding environments. This is where the important role of the human brain and nervous system in the process of environment perception is recognized so that we can use it to examine and measure sentiments in the environment (Mehdinejad, 2021).

The findings of F. Cage and Peter Erikson showed that the human mind responds to stimuli and therefore how environments are constructed affects users' brain activity and sentiments. Artificial or dummy elements significantly affect the brain and nervous system's function and activities and human sentiments. In some cases, the effects may be beneficial, while in others, the form, composition, and structure of the structures may induce adverse reactions at certain brain levels. Also, according to John P. Eberhard (2004), specially designed environments encourage the proliferation of new brain cells. Nancy Kanwisher and colleagues (1999) published an article on neurons that paved the way for research into brain communication with architectural experimentation. This paper found that the areas around the hippocampus give the most significant response to landscapes and environment elements. According to Kanwisher, when humans see more complex places and landscapes, the hippocampal region of their brain becomes significantly more active (Maleki, 2017).

In general, the purpose of linking neuroscience and architecture is to create design teams of architects, neurologists, psychologists, and landscape designers, etc., to create the interior spaces and environments of buildings, and in general, to design the building components to improve general health and assess sentiments in the environment. The desired goals can be achieved by gaining more awareness about the interaction between humans and surrounding environments and employing futuristic designers in the fields of architecture and psychology, and neuroscience (Mehdinejad, 2021).

### 6.1. Human Brain Waves

Human brain waves were first measured in 1924 by Hans Berger. Today, the electroencephalogram (EEG) is one of the most useful tools in diagnosing epilepsy and other neurological diseases. The fact that a device can read brain signals has led scientists, artists, and researchers to fantasize. The cerebral cortex has huge amounts of neurons. The activity of these neurons is partially coordinated with regular activation rhythms (brain waves). Pairs of electrodes placed on the skull can record changes in the electrical potential resulting from these brain activities. EEG signals are affected by the state of sleep or wakefulness of the cerebral cortex and show characteristic changes in different stages of sleep. EEG signals are also affected by exterior environment stimuli, and brain waves

can be generated following exterior stimuli (Mehdinejad, 2021).

The human brain is the center of the human nervous system and is a very complex organ. This organ, enclosed in the skull, has a general structure similar to that of other mammals but is more than three times larger than the brain of a mammal of the same body size (Daly, 1990). The cerebral cortex is almost symmetrical on the outside and has two hemispheres, right and left. Anatomists typically divide each hemisphere into four lobes: the frontal lobe, the parietal lobe, the temporal lobe, and the occipital lobe. Electrical activity in the brain can be recorded using an electroencephalogram (EEG). Signals include five types of waves: delta, theta, alpha, beta, and gamma (Johanson, 1996).

Alpha waves are a type of brain wave that can be detected by electroencephalography (EEG) and are usually produced in the occipital lobe when resting awake with the eyes closed. Alpha waves decrease with open eyes and drowsiness and drowsiness. These waves are thought to represent visual cortex activity in idle mode. Occipital alpha waves are the strongest EEG signals in the brain during periods of eye closure. These signals are usually detected with the naked eye. An alpha-like species, called  $\mu$ , can be found in the motor cortex, which decreases with movement or intention to move. Alpha waves do not appear until the age of three (Kolev, 1994).

Beta waves, on the other hand, range from 13 to 30 Hz. Beta waves are the normal waking rhythms of the brain associated with active thinking, intent, or solving real problems. They are usually found in normal adults. Rhythmic beta activity is mainly seen in the frontal and central regions, with amplitudes typically below 30 microvolts and less than 20Vvpp.

## 7. THE RELATIONSHIP BETWEEN RECORDING SENTIMENTS AND SPIRITUAL SENSE USING ELECTROENCEPHALOGRAPHY

One of the modern sciences that studies the effectiveness of methods based on spirituality and religion with scientific methodology is spiritual neuroscience (Majidzadeh Ardabili, 2018). Neurotheology deals with the relationship between the human brain and religion (Aaen-Stockdale, 2012). Research shows that not just one area of the brain is associated with religious practices, but various parts of brain structures are associated with this function (Majidzadeh Ardabili, 2018). According to neuroimaging studies, different areas of the brain, such as the right medial orbitofrontal cortex, right medial temporal cortex, right superior and inferior parietal lobules, right caudate nucleus, left prefrontal cortex, and left anterior cingulate cortex, are associated with religious practices and spirituality (Beauregard, 2006).

In the study of Abdullah and Omar (2011), conducted to develop research on the effect of religious activities on the human brain, EEG signals related to the resting subject as well as different cognitive states (listening to the recitation of *the Qur'an* and hard music) have been measured and analyzed. Statistical analysis was performed



using SPSS software to test the validity of the obtained data. The results of the analysis of this study show that listening to the recitation of the Qur'an compared to listening to hard rock music can lead to the production of alpha waves and help a person to be in a relaxed state (Abdullah, 2011).

In the study by Vecchiato et al. (2015), individuals' perceptions of the interior design of a bedroom in a traditional and modern way were assessed using the recording of brain signals. Their mental imagery of the designed space was assessed from various perspectives, including familiarity, novelty, comfort, pleasure, excitement, and repetition (Vecchiato, 2015).

Regarding electroencephalography regarding spirituality, we can refer to the research of Hazem Doufesh et al. (Doufesh, 2012) on 9 Muslims while praying. The results showed that the alpha range increased in all four modes, namely X, genuflexion, prostration, and profession (of the unity of God and the apostleship of Muhammad),

and the relaxation mode increased. However, the highest theta and alpha signals were recorded in the right frontal lobe (creating a spiritual dimension) during prostration, indicating a further increase in spirituality in the prostration state (Figure 2).

In another similar study on electroencephalography in the face of spirituality in the study of Harne et al. (Harne, 2018) and the issue of mindfulness can be examined. In this study, the Mantra (OM), the highest sacred symbol of Hinduism, was examined (Mantra: words and sounds that are repeated many times with a certain melody). In this study, 23 people who believe in this religion were asked to perform their rituals with their eyes closed. By recording brain signals before and after the ceremony, the results showed that theta and alpha waves during the ritual by these people, as well as the peace and sense of spirituality of these people, increased compared to before and had a positive effect on the body and soul (Figures 3 and 4).

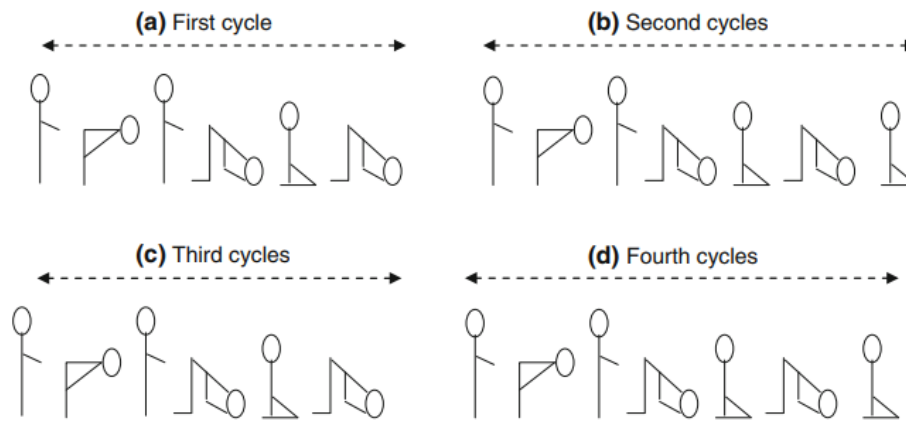


Fig 2. Signal Recording Scenarios (ibid)

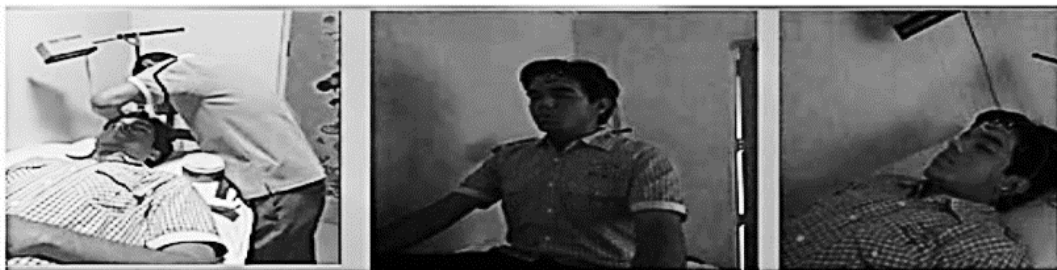


Fig 3. Experiments during Mantra (ibid)

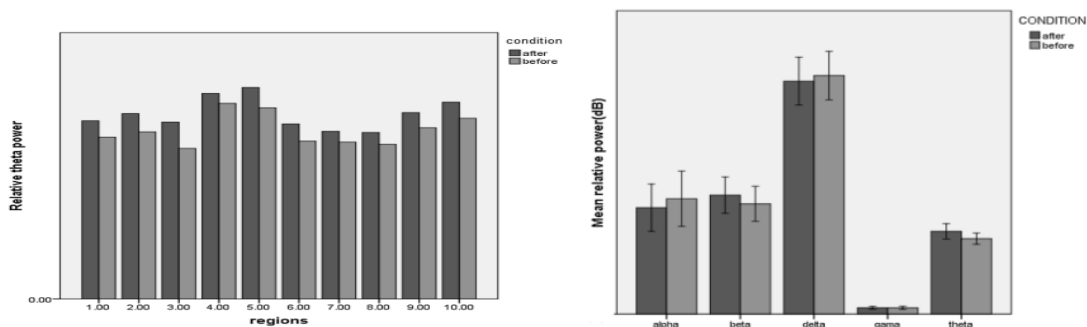


Fig 4. Results of Relative Strength before and after Mantra OM Meditation (ibid)

In Sally Essawy's (2014) study, the spiritual sense of users of the interior space of Mosque-Madrassa of Sultan Hassan was analyzed using an EEG device. The results showed that alpha and theta waves were activated and produced in the brain when placed on the mosque porch. This issue was effective in creating spiritual emotions in the mosque. The research gave a scientific tool to architects to measure the physical effect of buildings on their users. Figure 5 shows an image of the tested users (Essawy, 2014).

When it comes to brain performance or brain wave changes, two major values are considered, the strongest indications of that effect. The first of which is the Theta/Beta ratio, which indicates the state of concentration, (sometimes called relaxed awareness). The less the Theta/Beta ratio gets, the more relaxed and concentrated the human brain gets. The second value is that of the Alpha peak frequency, which indicates the

state of calmness and relaxation of the brain, the opposite of which is scientifically the state of anxiety and stress. The increase in this value indicates the decrease of human stress. Through comparative experiments, measurements should be taken to Alpha, Theta, and Beta brain waves in an attempt to identify the effect of these buildings on the relaxation and concentration abilities of the users. This procedure follows the steps of measuring stress levels in terms of brain waves in meditation places (Essawy, 2014; Vijayalakshmi, 2010)

In the study of (Sadeghi Habibabad, MahdiNejad, Azemati, & Matracchi, 2020a), with the user's electroencephalography, while viewing images of the porch space in Isfahan Imam Mosque, theta and alpha waves in the right frontal part, as well as the effects of peace and spiritual sense, increased. Figures 6, 7, and 8 show the image tested in this study:

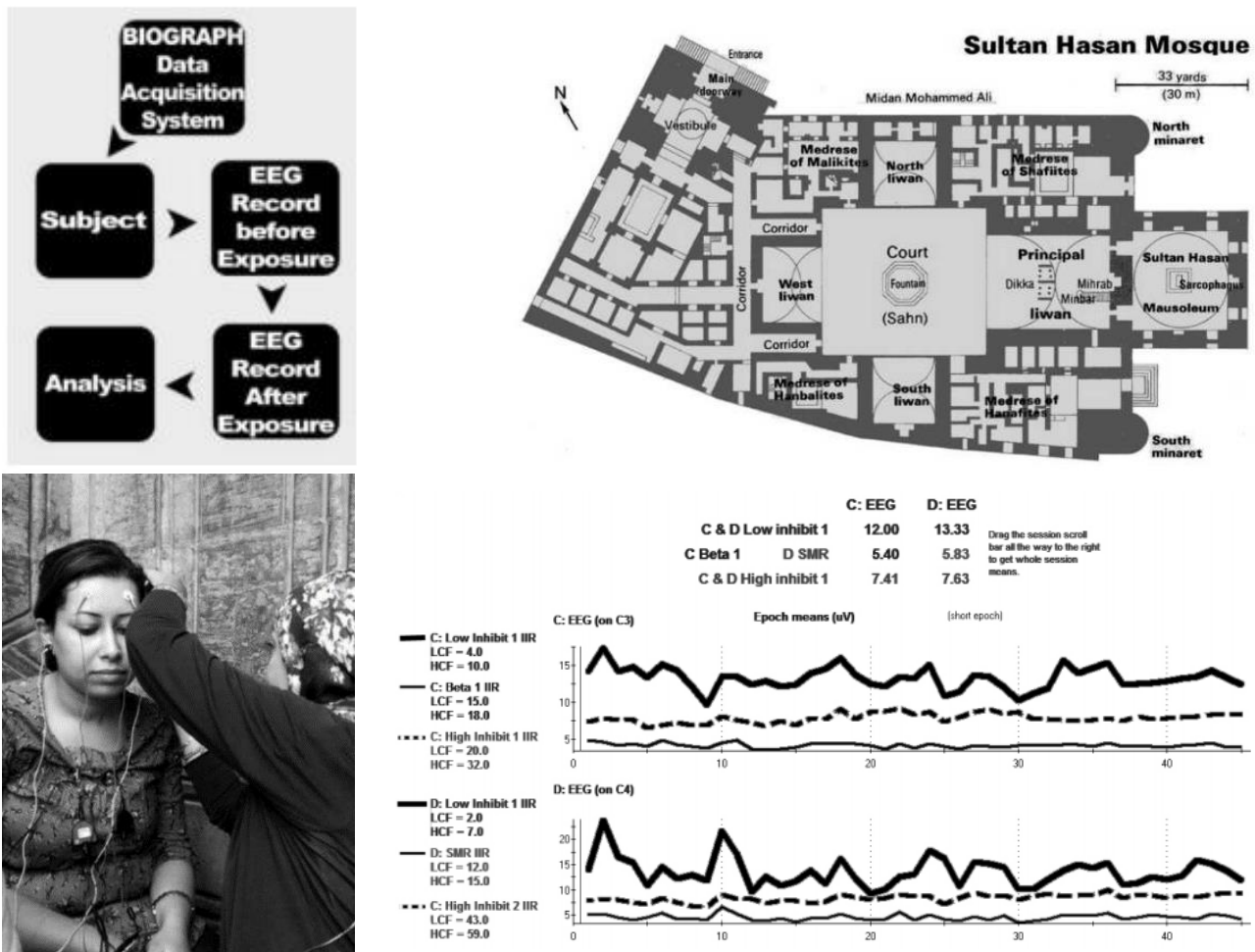


Fig 5. Sally Essawy's Photograph of the Research Test Site (The Experiment Steps of Measurements) (ibid)

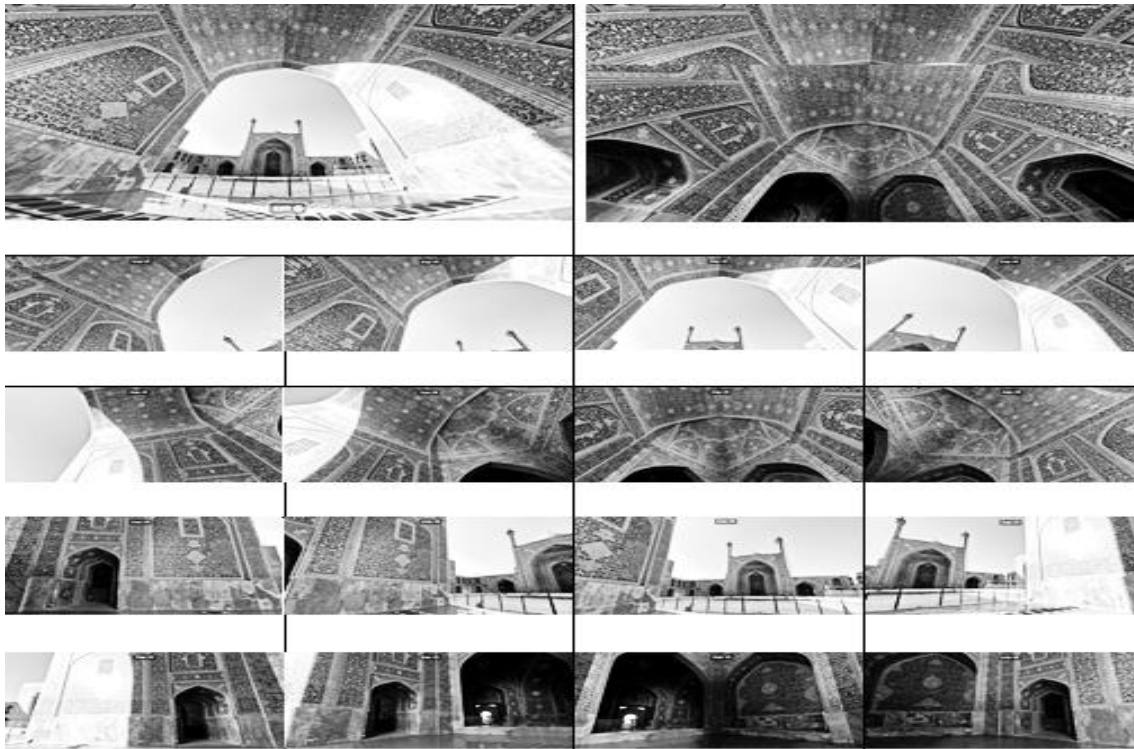


Fig 6. A 360-degree Image of Imam Mosque of Isfahan (ibid)

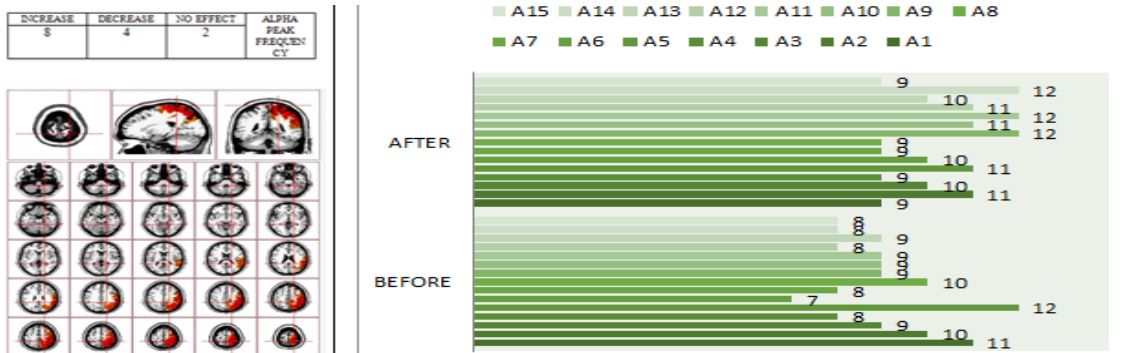


Fig 7. Ratio of Alpha Brain Waves before and after Viewing the Building of Imam Mosque of Isfahan (ibid)

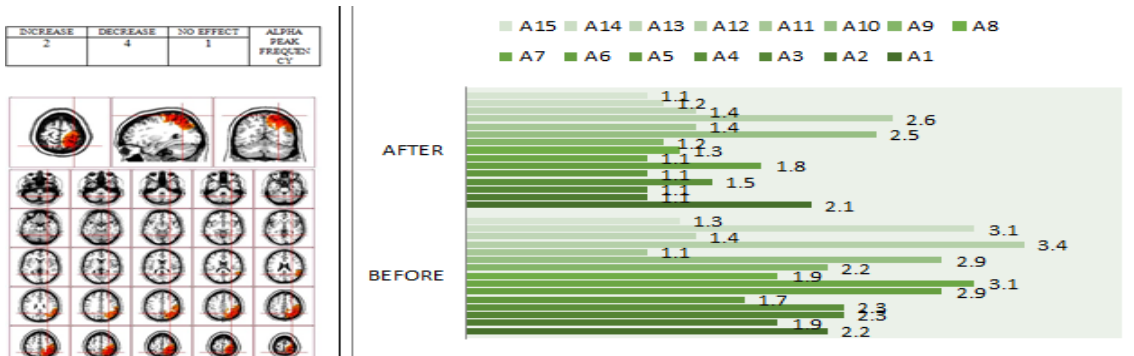


Fig 8. Ratio of Theta to Beta Brain Waves before and after Viewing the Building of Imam Mosque of Isfahan (ibid)

The study of Babiloni (2014) examined the brain waves of visitors to the Mosè, made by Michelangelo in San Pietro, Rome. The results showed that sentimental and perceptual judgments would be different when viewing architectural artifacts and sculptures according to points of

sight and type of light radiation, and natural light has a richer effect on people's perception of space, Figure 9 shows the image tested in this study:

The study of Sadeghi Habibabad, MahdiNejad, Azemati, and Matracchi, 2020b tries to analyze the

psychological effects of such an indicator as form (dome's pattern) in architectural designing of the religious environments like mosques so as to investigate the creation/enhancement of spiritual sense and come up with the best pattern for the construction of such environments in an order of priority, Figure 10 shows the image tested in this study:

Sadeghi habibabad et al, (2019) investigated the interior space of Shiraz's Vakil Mosque in terms of color in their study and evaluated its effect on the enhancement of the sense of spirituality. It has been demonstrated in the obtained results that colors with turquoise and green spectra have the highest effect on the enhancement of spirituality. Figure 11 shows the image tested in this study:



Fig 9. The Moment of Recording Brain Waves When Seeing the Sculpture (in the Form of the sculpture, at a distance of 5 mt from the Moses) (ibid)

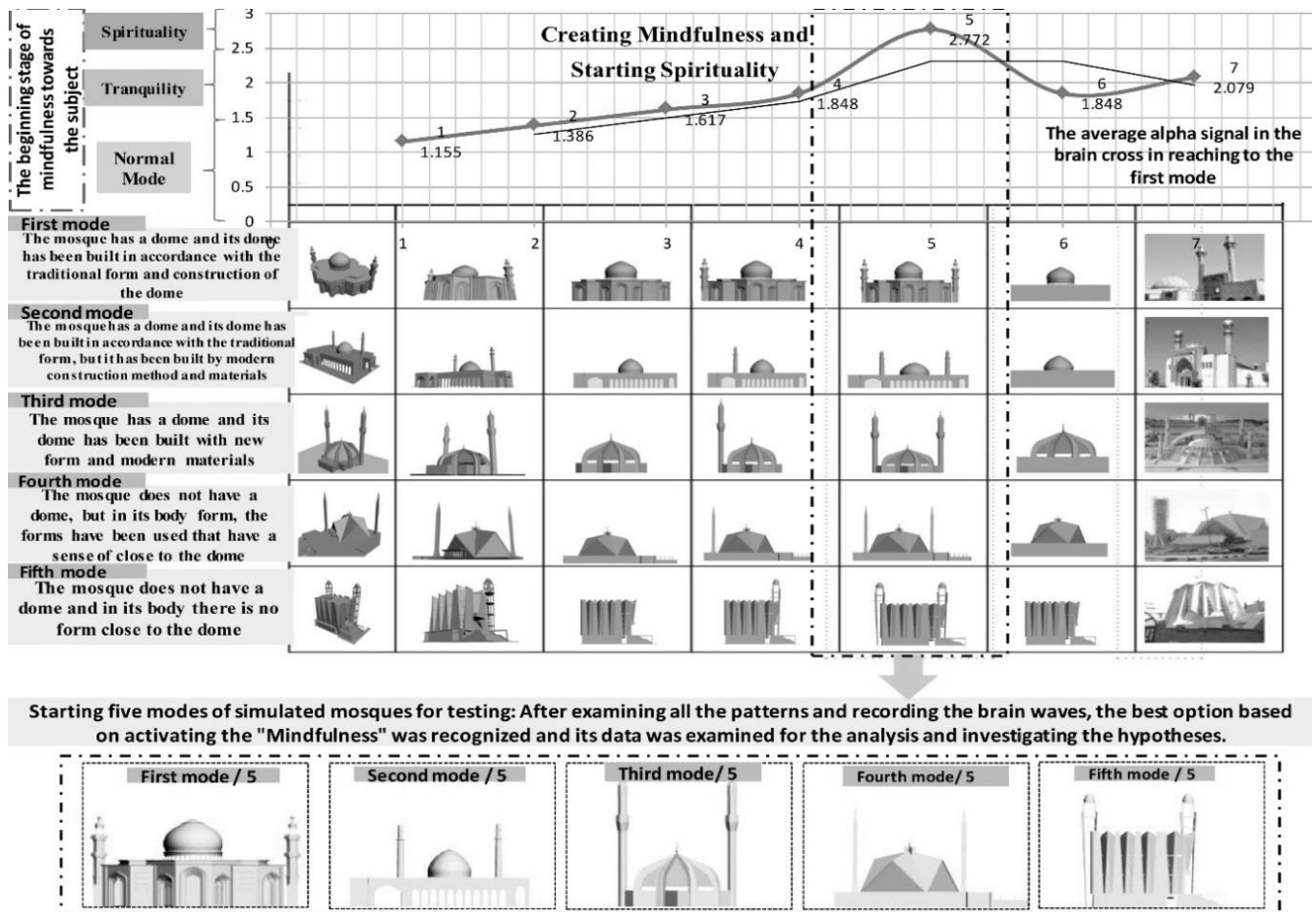


Fig 10. Analysis of Brain Signals and Selection of the Best Architecture (ibid)

In light of the above explanations, the measurement of spiritual sense and sentiment through the electroencephalography system has been approved by many thinkers. Also, many studies have been conducted in this field, some of which were addressed in this study.

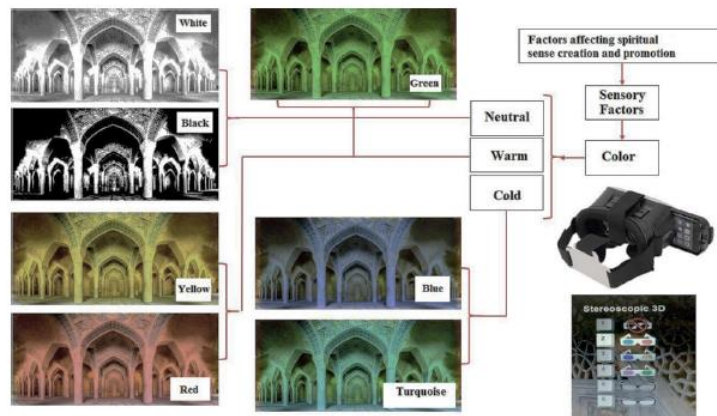
**8. CONCLUSION**

One has to note that the effects of the architectural body and buildings built affect people's minds. Thus, if this issue is ignored, the created space will cause confusion and a negative effect on the minds of the users of the space for sure. In the field of sensory factors in architecture, architects and urban designers can answer most of the hypotheses by using cognitive sciences. The interaction between neuroscience and architecture has great potential to improve the quality of our environment. Any scientific proof of mental phenomena and their results regarding the environmental features of our lives will certainly help prove the claims of a better quality of highly acceptable

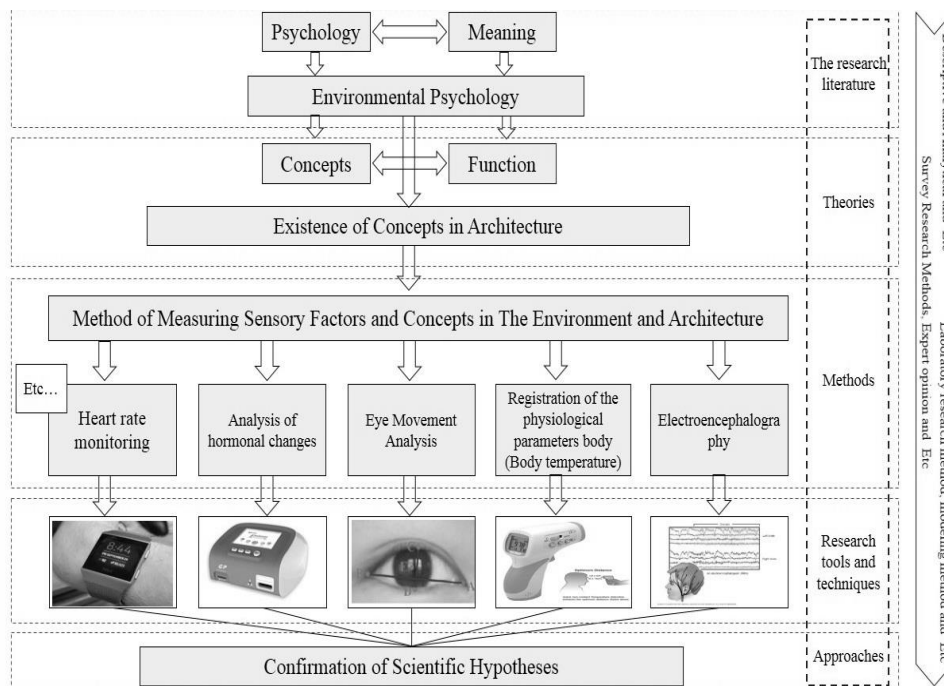
architecture. This topic is in its infancy and, so far, has been mainly advanced by neuroscientists. Clearly, neuroscience research on architectural experiences and meanings must be based on an in-depth dialogue between scientists and architects.

What seems necessary in the architecture of religious places such as churches and mosques today are the efforts that must be made to re-read and preserve identity and spiritual peace by entering into the realm of religion and spirituality. Architecture is not in the modern sense but a value that restores spirituality to the society. Islamic architecture can be the vanishing point of architecture and spirituality because it creates an atmosphere in which man is free from everything but love and beauty and provides the reason for its peace and permanence.

This research is the first part (a brief section of the research literature) of the authors' postdoctoral project on recording users' brain waves in spiritual spaces. It is noteworthy that the authors are already researching and experimenting and will address this subject in their future studies.



**Fig 11.** Simulated Images with 7 Color Spectrums Watched by Subjects with Virtual Reality Glasses and Smart Mobile Phones (ibid)



**Fig 12.** Summary of the Topics

## REFERENCES

- A'vani, G. (1997). Spiritual wisdom and art. *Tehran: Garoos*.
- Aaen-Stockdale, C. (2012). Neuroscience for the Soul. *Psychologist*, 25(7), 520-523.
- Abboushi, B., Elzeyadi, I., Taylor, R., & Sereno, M. (2019). Fractals in architecture: The visual interest, preference, and mood response to projected fractal light patterns in interior spaces. *Journal of Environmental Psychology*, 61, 57-70. doi:<https://doi.org/10.1016/j.jenvp.2018.12.005>
- Abdollahzadeh, H., Boujmehrani, S., Lotfi, M., Bagherpour, M. (2009). spiritual intelligence. *Tehran: Psychometrics Publications*.
- Abdullah, A. A., Omar, Z. (2011). The effect of temporal EEG signals while listening to Quran recitation. *International Journal on Advanced Science, Engineering and Information Technology*, 1(2), 372-375.
- Amundadottir, M. L., Rockcastle, S., Khanie, M. S., & Andersen, M. (2017). A human-centric approach to assess daylight in buildings for non-visual health potential, visual interest and gaze behavior. *Building and Environment*, 113(5-21). doi:<https://doi.org/10.1016/j.buildenv.2016.09.033>
- Avini, M. (1998). *The Magic Mirror*. Tehran: Saghi Publishing, 1.
- Azari, N. P., Nickel, J., Wunderlich, G., Niedeggen, M., Hefter, H., Tellmann, L., & Seitz, R. J. (2001). Neural correlates of religious experience. *European journal of neuroscience*, 13(8), 1649-1652. doi:<https://doi.org/10.1046/j.0953-816x.2001.01527.x>
- Azimi, M. (2019). Explaining the Role of Meaning and Imagination in Architectural Design Process. *Iran University of Science & Technology*, 7(3), 77-90. doi:<http://jria.iust.ac.ir/article-1-1228-fa.html>
- Azizi Naserabad, A., & Shahroudi, A. (2020). The effect of an urban element (bridge) on function of brain Citizens. *Advances in Cognitive Science*, 22(2).
- Babiloni, F., Cherubino, P., Graziani, I., Trettel, A., Bagordo, G., Cundari, C., & Vecchiato, G. (2014). The great beauty: A neuroaesthetic study by neuroelectric imaging during the observation of the real Michelangelo's Moses sculpture. In *2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, 6965-6968.
- Beaugard, M., & Paquette, V. (2006). Neural correlates of a mystical experience in Carmelite nuns. *Neuroscience letters*, 405(3), 186-190. doi:<https://doi.org/10.1016/j.neulet.2006.06.060>
- Bekkedal, M. Y., Rossi III, J., & Panksepp, J. (2011). Human brain EEG indices of emotions: delineating responses to affective vocalizations by measuring frontal theta event-related synchronization. *Neuroscience & Biobehavioral Reviews*, 35(9), 1959-1970. doi: <https://doi.org/10.1016/j.neubiorev.2011.05.001>
- Bell, P. A., Greene, T. C., Fisher, J. D., & Baum, A. (1996). *Environmental psychology*. Harcourt.
- Bemania, M., Jelvani, M., Arjmandi, S. (2016). Spatial Configuration and the Islamic Philosophy in Isfahan Madrassah-Mosques (Case studies: Aqanur, Sheykh-Lotf Allah and Imam Mosques). *Journal of Iranian Architecture Studies*, 5(9), 141-157.
- Bemania, M. R., Pour Jafar, M.R., Ahmadi, F., Sadeghi, A.R. (2010). Rereading spiritual identity and sacred suppositions in the architecture of Shiite mosques. *Journal of Shiite Studies*, 8(30).
- Beyrami, M. (2016). The effectiveness of spirituality education on promoting obstinacy and psychological well-being. *Journal of Psychology and Religion*, 9(3).
- Canter, D. V., Craik, K. H. (1981). Environmental psychology. *Journal of Environmental Psychology*, 1(1), 1-11. doi: [https://doi.org/10.1016/S0272-4944\(81\)80013-8](https://doi.org/10.1016/S0272-4944(81)80013-8)
- Cauwerts, C. (2013). Influence of presentation modes on visual perceptions of daylight spaces. *Université catholique de Louvain (UCL)*.
- Chamilothori, K., Chinazzo, G., Rodrigues, J., Dan-Glauser, E. S., Wienold, J., & Andersen, M. (2019). Subjective and physiological responses to façade and sunlight pattern geometry in virtual reality. *Building and Environment*, 150, 144-155. doi:<https://doi.org/10.1016/j.buildenv.2019.01.009>
- Daly, D. D., Pedley, T. A. (1990). *Current practice of clinical electroencephalography*. New York: Raven Press, 289.
- Daneshmand, S., Fattahi, K. Asgari, F., Seyedi, SM., Shahin, E., Soltani, M. (2020). Technology-Based Psychological Interventions: Introducing Methods and Tools for Measuring the Effects of Sentiment Environment and Sentimentary Reactions User. *National Conference on Research in Psychology*.
- Darban Rezaei, E., Rezazadeh, R., Ostadi, M., Akbari, H. (2019). An Operational Definition of Affects in Urban Space in the Light of a Methodological Approach. *Geographical Researches*, 34(1), 73-85.
- Doufesh, H., Faisal, T., Lim, K. S., & Ibrahim, F. (2012). EEG spectral analysis on Muslim prayers. *Applied psychophysiology and biofeedback*, 37(1), 11-18. doi:<https://doi.org/10.1007/s10484-011-9170-1>
- Eberhard, J. P. (2008). Brain landscape the coexistence of neuroscience and architecture. *Oxford University Press*.
- Eberhard, J. P. (2009). Applying neuroscience to architecture. *Neuron*, 62(6), 753-756. doi:<https://doi.org/10.1016/j.neuron.2009.06.001>
- Essawy, S., Kamel, B., & El-Sawy, M. S. (2014). Sacred buildings and brain performance: The effect of Sultan Hasan Mosque on brain waves of its users. *Creative Space*, 8(2). doi:<https://doi.org/10.15415/cs.2014.12001>
- Evans, G. W., & McCoy, J. M. (1998). When buildings don't work: The role of architecture in human health. *Journal of Environmental Psychology*, 18(1), 85-94. doi:<https://doi.org/10.1006/jev.1998.0089>
- Gannouni, S., Aledaily, A., Belwafi, K., & Aboalsamh, H. (2021). Emotion detection using electroencephalography signals and a zero-time

- windowing-based epoch estimation and relevant electrode identification. *Scientific Reports*, 11(1), 1-17. doi:<https://doi.org/10.1038/s41598-021-86345-5>
- Ghaffari Khaligh, H., Alipour, A. (2017). Investigation of the effect of music on brain waves: Quantitative Electroencephalography (qEEG) study. *Shabak Journal*, 3(10).
- Ghobari Bonab, B., Lavassani, Gh.A., Mohammadi, M. (2005). Construction of a Student Spiritual Experience Scale. *Journal of Psychology and Religion*, 9(3).
- Harne, B. P., Hiwale, A. S. (2018). EEG spectral analysis on OM mantra meditation: A pilot study. *Applied psychophysiology and biofeedback*, 43(2), 123-129. doi:<https://doi.org/10.1007/s10484-018-9391-7>
- Hejazi, M., Mehdizadeh Saradj. F. (2014). Relation among Meaning, Aesthetics, Shape and Structure in Islamic Architecture of Iran. *Iran University of Science & Technology*, 2(1), 9-24.
- Imantalab, H., Gerami, S. (2012). Relationship between meaning and form, an adaptation of mosque architecture and prayer morphology. *Journal of Islamic Art Studies*, 16(8).
- Ismail, W. W., Hanif, M., Mohamed, S. B., Hamzah, N., & Rizman, Z. I. (2016). Human emotion detection via brain waves study by using electroencephalogram (EEG). *International Journal on Advanced Science, Engineering and Information Technology*, 6(6), 1005-1011.
- Jam, F., Azemati, H., Ghanbaran, A., Ebrahimpour, R., Esmaily, J. (2020). Analyzing the Impacts of Color on Aesthetic Judgment and Eye Movement Indicators of Experts and Non-experts in Architecture Case Study: Residential Building Façades in Tehran. *Journal of Architecture and Urban Planning*, 12(26), 97-115. doi:<https://doi.org/10.1037/aca0000377>
- Javadi Sasaki, A. (2003). Hadj wine. *Qom: Asra*.
- Jencks, C. (1969). Semiology and architecture. Signs, symbols and architecture. *Chichester*.
- Johanson, D. E., Johanson, D. C., Edgar, B., & Blake, E. (1996). From Lucy to language. *Simon and Schuster*.
- Karipour, S. F., Shahroudi, A.A., Khanbabaee, Sh. (2016). Evaluating the shape and skyline of mosques to induce a sense of spirituality using neuroscience. *M.Sc. Thesis in Architecture*.
- Kendra, C. (2013). Theories of Emotion.
- Keshmiri, M., Arab Ahmadi, F. (2008). Preliminary standardization of spiritual intelligence test in students of Gorgan University of Natural Resources. *Master Thesis*.
- Kim, T. H., Jeong, G. W., Baek, H. S., Kim, G. W., Sundaram, T., Kang, H. K., Song, J. K. (2010). Human brain activation in response to visual stimulation with rural and urban scenery pictures: A functional magnetic resonance imaging study. *Science of the total environment*, 408(12), 2600-2607. doi:<https://doi.org/10.1016/j.scitotenv.2010.02.025>
- Kolev, V., Başar-Eroglu, C., Aksu, F., & Başar, E. (1994). EEG rhythmicities evoked by visual stimuli in three-year-old children. *International journal of neuroscience*, 75(3-4), 257-270. doi:<https://doi.org/10.3109/00207459408986308>
- Kuliga, S. F., Thrash, T., Dalton, R. C., & Hölscher, C. (2015). Virtual reality as an empirical research tool— Exploring user experience in a real building and a corresponding virtual model. *Computers, environment and urban systems*, 54, 363-375. doi:<https://doi.org/10.1016/j.compenvurbsys.2015.09.006>
- Lee, Y. Y., & Hsieh, S. (2014). Classifying different emotional states by means of EEG-based functional connectivity patterns. *PLoS one*, 9(4). doi:<https://doi.org/10.1371/journal.pone.0095415>
- López-Gil, J. M., Virgili-Gomá, J., Gil, R., Guilera, T., Batalla, I., Soler-González, J., & García, R. (2016). Corrigendum: method for improving EEG based emotion recognition by combining it with synchronized biometric and eye tracking technologies in a non-invasive and low cost way. *Frontiers in computational neuroscience*, 10, 119. doi:<https://doi.org/10.3389/fncom.2016.00085>
- Maghsoudy, M., Seyedian, S., Mahnam, A., Shahroudi, A. (2017). Face Recognition Technology and Emotional Intelligent Architecture: A New Approach toward Visual Perception of Intelligent Building Façades. *Journal of Architecture and Urban Planning*, 9(18), 99-116. doi:doi: 10.30480/aup.2017.514
- MahdiNejad, J., Azemati, H., Sadeghi habibabad, A., & Matracchi, P. (2021). Investigating the effect of age and gender of users on improving spirituality by using EEG. *Cognitive Neurodynamics*, 15, 637–647. doi:<https://doi.org/10.1007/s11571-020-09654-x>
- Majidzadeh Ardabili, K., Rostami, R., Kazemi, R. (2018). Electrophysiological correlates of hearing the recitation of the Holy Quran. *Shafaye Khatam*, 6(2).
- Majlesi, M. B. (1982). Seas of lights (Bihar al-Anwar). *Beirut: Vafa Press, 1*.
- Maleki, M. R., Bayzidi, Q. (2017). Application of Neuroscience on Architecture: The emergence of new trend of Neuroarchitecture. *Kurdistan Journal of Applied Research*, 2(3), 383-396. doi:<https://doi.org/10.24017/science.2017.3.62>
- Mallgrave, H. F. (2010). The architect's brain: Neuroscience, creativity, and architecture. *John Wiley & Sons*.
- manan raisi, M. (2016). Text/Architecture Semantics Based on Islamic Teachings. *Theology of Art*, 1395(6), 53-86.
- Mehdinejad, J., Sadeghi habibabad, A. (2021). Knowledge of Neuroscience in Architecture. *Qazvin: Jahad Daneshgahi Publications, 1*.
- Mesbah, A. (2010). Conceptual Analysis of Spirituality and the Problem of Meaning. *Journal of Medical Ethics*, 4(14).
- Miller, L., Balodis, I. M., McClintock, C. H., Xu, J., Lacadie, C. M., Sinha, R., & Potenza, M. N. (2019). Neural correlates of personalized spiritual experiences. *Cerebral Cortex*, 29(6), 2331-2338. doi:<https://doi.org/10.1093/cercor/bhy102>
- Mokhtari, M., Shahroudi, AA, Saffarinia, M. (2016). The impact of spiritual architectural elements on the

- exterior of the building with a cognitive science approach. *Master Thesis in Architecture*.
- Mormede, P., Courvoisier, H., Ramos, A., Marissal-Arvy, N., Ousova, O., Desautes, C., ... & Moisan, M. P. (2002). Molecular genetic approaches to investigate individual variations in behavioral and neuroendocrine stress responses. *Psychoneuroendocrinology*, 27(5), 563-583. doi:[https://doi.org/10.1016/S0306-4530\(01\)00093-2](https://doi.org/10.1016/S0306-4530(01)00093-2)
- Moscato, C., Chamilothoni, K., Wienold, J., Andersen, M., & Matusiak, B. (2020). Window size effects on subjective impressions of daylight spaces: indoor studies at high latitudes using virtual reality. *Leukos*, 1-23. doi:<https://doi.org/10.1080/15502724.2020.1726183>
- Naghbi Rad, P., Shahroudi, A.A., Lashgari, R. (2015). Commercial and Administrative Complex Design with Neuroscience Approach. *Master Thesis in Architecture*.
- Nakamura, R., Fujii, E. (1992). A comparative study of the characteristics of the electroencephalogram when observing a hedge and a concrete block fence. *Journal of the Japanese Institute of Landscape Architects*, 139-144.
- Nanda, U., Pati, D., Ghamari, H., & Bajema, R. (2013). Lessons from neuroscience: form follows function, emotions follow form. *Intelligent Buildings International*, 5(1), 61-78. doi:<https://doi.org/10.1080/17508975.2013.807767>
- Narouei Nosrati, R. (2011). Religion and spirituality, a religious-psychological view. *Proceedings of the Conference on Theoretical Foundations and Psychometrics of the Religious Scale*.
- Nazer, Z., belali oskoui, A., keynejad, M. A. (2016). A study of transparency behaviour of domes in Islamic mosque with emphasis on the notion of the spiritual lighting. *Iran University of Science & Technology*, 3, 94-112
- Niemic, C. (2004). Studies of Emotion: A Theoretical and Empirical Review of Psychophysiological Studies of Emotion. *Journal of Undergraduate Research*, 1(1).
- Noghrehkar, A., Hamzehnejad, M., Ranjbar Kermani, A.M. (2009). An introduction to Islamic identity in architecture. *Tehran: Payame Sima*.
- Noghrehkar, A., Raeesi, M.M. (2012). Realization of Islamic identity in architecture. *Stud Iran Islam City*, 2(7), 5-12.
- Papale, P., Chiesi, L., Rampinini, A. C., Pietrini, P., & Ricciardi, E. (2016). When neuroscience 'touches' architecture: From hapticity to a supramodal functioning of the human brain. *Frontiers in psychology*, 7, 866. doi:<https://doi.org/10.3389/fpsyg.2016.00866>
- Pinchard, B. (2005). Symbol and space according to Rene Guenon, in edited book entitled: Mathematics and the Divine – A historical Study.
- Pourjafar, M., Sadeghi, A. R., & Yousefi, R. (2009). Recognition of the meaning effect on perpetuity of place: A case study of Hawraman-E-Takht village in Kurdistan. *Journal of Housing and Rural Environment*, 17(2), 2-17.
- Raeesi, M., Noghrehkar, A. (2019). Semantics in Architectural Works Based on Islamic View. *Naqshejahan*, 8(4), 259-266.
- Rapoport, A. (1982). The Meaning of the Built Environment.
- Rezaei, S., sharghi, A. (2020). Perceptual performance of daylight; a systematic review of the role of daylight patterns on occupants perceptions in interior spaces. *Journal of Architecture in Hot and Dry Climateis*, 8(11), 211-251. doi:10.29252/ahdc.2020.1988
- Robinson, S., Pallasmaa, J. (2015). Mind in architecture: Neuroscience, embodiment, and the future of design. *Mit Press*.
- Rockcastle, S. F. (2017). Perceptual Dynamics of Daylight in Architecture. *THESIS*.
- Roe, J. J., Aspinall, P. A., Mavros, P., & Coyne, R. (2013). Engaging the brain: the impact of natural versus urban scenes using novel EEG methods in an experimental setting. *Journal of Environmental Sciences*, 1(2), 93-104.
- Russell, J. A., Snodgrass, J. (1987). Emotion and the environment. *Handbook of environmental psychology*, 1(1), 245-281.
- Russell, J. A., Ward, L. M. (1982). Environmental psychology. *Annual review of psychology*, 33(1), 651-689. doi:<https://doi.org/10.1146/annurev.ps.33.020182.003251>
- Sadeghi habibabad, A. (2020). Explaining and Measuring the Factors Affecting the "Sense of Spirituality" in the Mosques Based on Improving the Architectural Quality Using Cognitive Neuroscience. *PhD Thesis* doi:<https://doi.org/10.13140/RG.2.2.15645.74725>
- Sadeghi habibabad, A., MahdiNejad, J., Azemati, H., & Matracchi, P. (2019). Using neurology sciences to investigate the color component and its effect on promoting the sense of spirituality in the interior space of the Vakil Mosque of Shiraz (using quantitative electroencephalography wave recording). *Journal of religion and health*, 1-18. doi:<https://doi.org/10.1007/s10943-019-00937-0>
- Sadeghi habibabad, A., MahdiNejad, J., Azemati, H., & Matracchi, P. (2020a). Examination of the psychological impact and brainwaves functioning of the users of buildings and environments built based on promoting relaxation and spiritual sense. *Journal of Spirituality in Mental Health*, 1-18. doi:<https://doi.org/10.1080/19349637.2020.1738311>
- Sadeghi habibabad, A., MahdiNejad, J., Azemati, H., & Matracchi, P. (2020b). Recording the Users' Brain Waves in Manmade Religious Environments Based on Psychological Assessment of Form in Creation/Enhancement of Spiritual Sense. *Integrative Psychological and Behavioral Science*, 1-34. doi:<https://doi.org/10.1007/s12124-020-09567-8>
- Sadeghi habibabad, A., Taher Tolou Del, M., Mahdi Nejad, J. (2017). Recognition of Durability of Sacred Images' Nature in the Iran Islamic Traditional Architecture Based on Identification of the Stable identity of Iranian Congregational Mosques. *Journal of Sustainable Architecture and Urban Design*, 4(2), 17-30.



- Safdarian, G. (2017). Explaining the impact of paradigm on changes in form in contemporary architecture. *Hoviatshahr*, 11(3), 81-96.
- Sahhaf, S. (2016). Meaning in Iranian Architecture. *Hoviatshahr*, 10(1), 51-60.
- Seyyed Razi, M. (1994). The pinnacle of eloquence (Nahj al-Balagha). *Beirut: Dar al-Osveh Press*.
- Shahidi, S. (2000). Psychotherapy and spirituality, monthly lecture of the Iranian Psychological Association.
- Shahidi, S., Farajnia, S. (2012). Construction and validation of the "Spiritual Attitude Assessment" questionnaire. *Journal of Psychology and Religion*, 5(3).
- Sharifi, E., Mehrabi, H., Kalantari, M., Meftagh, D. (2008). Designing and examining psychometric features of Spiritual Tendencies Questionnaire among Isfahan University students. *Studies in Islam and Psychology*, 2(2), 59-77.
- Sternberg, E. M., Wilson, M.A. (2006). Neuroscience and architecture. *Cell*, 127(2), 239-242. doi:10.1016/j.cell.2006.10.012
- Suhaimi, N. S., Mountstephens, J., & Teo, J. (2020). EEG-Based Emotion Recognition: A State-of-the-Art Review of Current Trends and Opportunities. *Computational intelligence and neuroscience*. doi:<https://doi.org/10.1155/2020/8875426>
- Vartanian, O., Navarrete, G., Chatterjee, A., Fich, L. B., Gonzalez-Mora, J. L., Leder, H., ... & Skov, M. (2015). Architectural design and the brain: effects of ceiling height and perceived enclosure on beauty judgments and approach-avoidance decisions. *Journal of Environmental Psychology*, 41, 10-18. doi:<https://doi.org/10.1016/j.jenvp.2014.11.006>
- Vecchiato, G., Jelic, A., Tieri, G., Maglione, A. G., De Matteis, F., & Babiloni, F. (2015). Neurophysiological correlates of embodiment and motivational factors during the perception of virtual architectural environments. *Cognitive processing*, 16(1), 425-429. doi:<https://doi.org/10.1007/s10339-015-0725-6>
- Vijayalakshmi, K., Sridhar, S., & Khanwani, P. (2010). Estimation of effects of alpha music on EEG components by time and frequency domain analysis. *In International Conference on Computer and Communication Engineering (ICCCCE'10)* 1-5.
- Wicker, A. W. (1979). An introduction to ecological psychology.
- Wolman, R. (2001). Thinking with your soul: Spiritual intelligence and why it matters.
- Yazdchi, M., mahnam, A. (2014). Designing an Experiment to Improve Automatic Emotion Detection Using EEG. *JSDP*, 10(2), 21-34
- Zahedi Haghghi, S., Sakhaei, S., Daliri, M. (2019). EEG-Based Emotional State Recognition using Deep Learning Network. *Iranian Journal of Biomedical Engineering*, 13(2), 95-104. doi:10.22041/ijbme.2019.97535.1419

#### AUTHOR (S) BIOSKETCHES

**A. Sadeghi Habibabad.**, Department of Architecture (DIDA), University of Florence, Italy  
Email: [A.sadeghi@sru.ac.ir](mailto:A.sadeghi@sru.ac.ir)

**P. Matracchi.**, Department of Architecture (DIDA), University of Florence, Italy  
Email: [pietro.matracchi@unifi.it](mailto:pietro.matracchi@unifi.it)

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