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SELÇUK ÜNİVERSİTESİ

FEN BİLİMLERİ ENSTİTÜSÜ

EVALUATING THE USERS' EMOTIONAL-PERCEPTUAL EXPERIENCE OF PLACE AND ENVIRONMENTAL PREFERENCES: NEURO-ARCHITECTURE APPROACH

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DOKTORA TEZİ

Mimarlık Anabilim Dalı

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KONYA

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İmza

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ÖZET

DOKTORA TEZİ

KULLANICILARIN DUYGUSAL-ALGISAL MEKAN DENEYİMİNİN VE ÇEVRESEL TERCİHLERİNİN DEĞERLENDİRİLMESİ: NÖRO-MİMARİ YAKLAŞIM

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Günümüzde, niteliğin mimari tasarımdaki önemi, insanın algısı ve duygusu üzerindeki etkisi dikkate alınarak tanımlanmaktadır. Bu nedenle, tasarım sürecinde algısal niteliği arttırmak için ve kullanıcılar açısından uygun bir ortam yaratmak için insan ve çevre arasındaki ilişki tanımlanmalıdır. Ayrıca, bilişsel psikolojiye göre, insan davranışı ile insan-çevre ilişkisinin zihinsel süreçlerden etkilendiği bilinmektedir. Belleğin davranış üzerindeki etkisini belirlemek ve bireysel tercihin çevre kalitesine göre ölçülmesi bu bilimin amacıdır. Bu bağlamda, beyin araştırmaları (zihinsel süreç araştırmaları) çağdaş bir konu haline gelmiş ve nörologlar, fizyolojinin temellerine dayanan algılama sürecini deneysel bir yaklaşımla araştırmaya başlamışlardır. Fakat, çevresel psikolojiye dayanarak, mekanın duygusal-algısal deneyimi ve çevre tercihleri ile ilgili olarak kullanıcıların davranışsal, nöral ve zihinsel mekanizmaları temelinde yeterli bilgi bulunmamaktadır. Bu tezin amacı, sinirbilim bulgularını mimari tasarıma veri olarak dahil etmektir. Böylece, Nöro-Mimari adı verilen bu yeni yaklaşımın, mimari tasarım için yeni bir yol/bakış açısı sağlayacağına inanılır. Ayrıca, mimarlığın mekanın kullanıcılarını psikolojik düzeyde nasıl etkileyeceği konusuna da vurgu yapılır. Çalışmanın hipotezine göre, Nöro-Mimari, beyin bölgeleri ve sinir sistemleri arasındaki ilişkiyi, mekanın duygusal deneyimini, çevresel davranışı ve mekan algısını belirlemede yeni bir yaklaşım olarak kullanabileceğini savunmaktadır. Bir başka deyişle, bu yaklaşım, daha nitelikli bir tasarımın parametrelerini belirlemek için bir çözüm aracı olarak uygulanabilecektir. Ayrıca, en önemli konulardan biri olarak, kullanıcının mekanla ilgili bireysel ve duygusal memnuniyetini ölçmek için bir kullanılabilirlik testi olarak da kullanılabilecektir. Bu bağlamda, kullanıcıların görsel ve çevresel algılamaya ilişkin fizyolojik tepkilerini incelemek amacıyla bu çalışma, çevresel ve bilişsel psikolojideki Memnuniyet-Uyarılma Modeli ve fMRG gibi deneysel ve bilimsel yöntemleri kullanmıştır. Özellikle, fMRG tekniği ile duygular vasıtasıyla harekete geçen beyin bölgelerinin aktivasyonunu görüntüleyerek ve kaydederek, kullanıcıların deneyimlerini ve zihinsel görüntülerini somutlaştırarak, çevrenin kullanıcıların psikolojisi üzerindeki etkisini ölçer. Bu şekilde kullanıcıların beğeni durumlarına göre uygun buldukları ve tercih ettikleri mekanları deneyimlerken beyninlerinin nasıl çalıştığını bilmek için de uygun bir fırsat yaratmaktadır. Sonuç olarak, bu çalışma ile kullanıcıların duygusal-algısal mekan deneyimini, çevresel davranışını ve memnuniyetini etkileyen kriterler belirlenip ölçülebilir ve kullanılabilir verilere dönüştürülmüştür.

Anahtar Kelimeler: Algı, bilişsel psikoloji, çevresel psikoloji, duygu, fMRG, mekan deneyimi, nörobilim, nöro-mimari

ABSTRACT

Ph.D THESIS

EVALUATING THE USERS' EMOTIONAL-PERCEPTUAL EXPERIENCE OF PLACE AND ENVIRONMENTAL PREFERENCES: NEURO-ARCHITECTURE APPROACH

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Nowadays, the importance of quality in architectural design and its impact on human perception and emotion is taken into account. Therefore, to create a pleasant environment in the design process, the relationship between humans and the environment must be defined. Moreover, according to cognitive psychology, human behavior and human-environment relationship are affected by mental processes. Determining the effect of memory on behavior and measuring the individual preference according to the quality of the environment is the cornerstone of this study. In this context, brain research has become a contemporary subject, and neurologists investigate the perception process based on the basis of physiology in an experimental approach. Yet, based on environmental psychology, in related to the emotional-perceptual experience of place and environmental preferences, there is no enough information on the basis of users' behavioral, neural and mental mechanisms. The aim of this thesis is to incorporate and include neuroscience findings into an architectural design as data. Thus, it is believed that this new approach, called Neuro-Architecture, will provide a new way for architectural design. It also emphasizes the issue of how architecture will affect us at the psychological level. According to the hypothesis for this study, Neuro-Architecture can be used as a new approach in determining the relationship among brain regions and nervous systems and the emotional experience of place, environmental behavior and place perception. So, this approach is implemented as a solution tool to specify the parameters for a more qualified design. Also, as one of the most important issues, it is a usability test to measure the individual and emotional satisfaction of a person. In this context, to investigate the physiological responses of users related to visual and environmental perception, the research has conducted the experimental and scientific methods in environmental and cognitive psychology such as the Pleasure-Arousal model and fMRI. Especially, by recording the activation of brain areas engaged in emotions, the fMRI technique provided the opportunity to objectify the users' experiences and mental imagery, measure the impact of the environment on users' psyche, and to know how the brain works when user experiencing the pleasant or unpleasant places. As a result, the criteria affecting the users' emotional-perceptual experience of place, environmental behavior, and satisfaction were determined and converted into measurable and usable data.

Keywords: Cognitive psychology, emotion, environmental psychology, fMRI, neuro-architecture, neuroscience, perception, place experience

FOREWORD

As a scientific endeavor, I dedicate this dissertation and its achievements to my future wife, who would know its value and worth from the depth of her beautiful heart.

I offer my endless gratitude to my advisor, Prof. Dr. Havva Alkan Bala, who shaped and opened new windows to my academic point of view with her valuable knowledge and experience.

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CONTENTS

SIGNS AND ABBERVIATIONS

Signs

F(x,y,z): 3 Dimensional Image

Y: Matrix corresponding to an fMRI scan

υ_1 - υ_6: The BOLD value of a voxel

cT: Contrast vector

β: Parameter matrix

X: Design matrix

Abberviations

ANFA: Academy of Neuroscience for Architecture

IPAS: International Association People Environment

BOLD: Blood-oxygen level dependent

CAT: Computerized Axial Tomography Scan

EEG: Electroencephalogram

ERP: Event Related Potentials

MR: Magnetic Resonance

fMRI: Functional Magnetic Resonance Imaging

FWE: Family Wise Error

GLM: General Linear Model

MATLAB: Matrix Laboratory

MNI: Montreal Neurological Institute

SPM: Statistical Parametric Mapping

1. INTRODAUCTION

As a hybrid discipline, architecture has been investigated from different views such as psychology, anthropology, phenomenological, static, etc. Obviously, the scientific criteria and methods used in architecture have emphasized its technical, physical and material aspects, yet there are no adequate researches on how architecture influences user behavior; its emotional and perceptual aspects as well as the understanding of the mental and cognitive process of the brain through an architectural experience. Whereas, the advent of novel findings and techniques in the field of neuroscience, have made it possible for us to have a deeper understanding of biological, psychological, and physiological implications of architecture. Architecture has significant role in individual's brain reactions, satisfaction, environmental preferences, and environmental behavior. In this regard, neuroscientists can open the windows to designers and architects to have an objective observation of physiological and cognitive process of users' brain and how it is influenced by the spatial characteristics in an architectural setting. Recent scientific evidence claim that the brain and neural system approve the multi-sensory nature of users' architectural experience. The relevant experiments of neuroscience reveal and support that architectural perception has fundamental values in mental, sensory, embodied, and biological nature.

Hence, in the present study, in knowing the aspects proposed in the process of place emotional and perceptual experience, process-oriented research was considered. Thus, relying on neuroscience, cognitive, and environmental psychology the Neuro-Architecture approach, which studies the relationship between human mental processes and the environment, was chosen as the research approach. As the insight of this thesis, it is believed that the integration of Neuro-Architecture into the process of emotional-perceptual experience of place and its suggestions can be used as a guideline for architects and urban designers to provide more qualified and responsive environments for individuals. So, evaluating the emotional-perceptual experience of place, determining the effect of memory on behavior, and measuring the individual preference according to the quality of the environment is the cornerstone of this study. In this context, the research aims to investigate the process of place perception based on the basis of physiology and neurology in an experimental approach. Indeed, in this thesis with focus on the issue of how architecture will affect users at the psychological level, it is expected that incorporation of neuroscience findings into an architectural experience as data can create new point of views and solutions for a qualified architectural design, addressing users' emotional responses, and their environmental preferences and satisfaction. Also, it is assumed that using the Neuro-Architecture approach in the theoretical and practical model of the present study can help designers in determining and measuring the relationship among the brain regions and nervous systems and the emotional experience of place, environmental behavior and place perception. To this end, to investigate the physiological and emotional responses of users related to visual and environmental perception, the research has conducted the experimental and scientific methods in environmental and cognitive psychology such as the Pleasure-Arousal model and fMRI (Functional Magnetic Resonance Imaging). Especially, the fMRI technique providing the opportunity to objectify the users' experiences and mental imagery, it could measure the impact of the environment on users' emotion, and clarify how the brain works when user experience the pleasant or unpleasant places.

This chapter is devoted to the generalities of research. Firstly, to get acquainted with the subject of research, the problem and necessity of research are expressed; then, to support the research subject, the aims, questions, and hypotheses of research are explained. Finally, a structure is presented to define the research process in order to answer the questions and test the hypothesis. To know the difficulties of conducting research, the limitations and hardships of research during conducting this process are also discussed.

1.1. Problem Statement

Nowadays, the importance of quality in architecture design and its impact on human emotion and perception is significant. According to the researches made by environmental psychologists, architecture, urban space, and landscape design strongly affect people's emotions, mentality, and mind. To have interaction and communication with the place, individuals should have an understanding of the environment they experience. So, to create an environment that is compatible with the needs of the individuals, it is necessary to understand both the relationship between users and the environment, in the sense of the impact of environmental elements on different levels of users' behavior, emotion and perception. Such an interaction is realized through the process of sensation, perception, cognition, and behavior.

For this reason, the design process should create better environments by addressing dimensions such as safety, health, and aesthetics. According to this idea, since the environment has a multidimensional nature, it should be investigated both subjectively and objectively and this requires architects to determine a set of parameters in the field of psychology. In this context, brain research has become a contemporary topic that explores various methods in important areas such as medical science, engineering, psychology, and art. Neurologists examine the emotional experience and perception process based on physics and physiology in an experimental approach, but based on environmental psychology that is related to place perception and environmental preferences there is no enough information about the basics of users' behavioral, neural and mental mechanisms. Hence, to achieve a successful approach between neuroscience and architecture, new methodologies and neurophysiological measurements for emotional assessment should be developed in architecture design because an objective understanding of emotional and perceptual states enables designers to know how environmental elements affect users.

1.2. The Importance and Necessity of Research

The users' consideration of a pleasant place and elements forming of the place is directly related to their objective and subjective needs. In this regard, environmental quality is the focus of planning and design to ensure a better environment, in terms of safety, health, aesthetics, comfort, and well-being of society. Studies have shown the difference between the users' subjective assessment and the specialists' objective assessment. The design has created a special vision for specialists in the field, which focuses on measurable aspects of environmental quality rather than aspects of personal perception. It can't be expected from an environment that is considered to be pleasant, beautiful and efficient by urban planners and architects, for other people in that community to have a similar interpretation because people rely on their past experiences and knowledge in appreciating the environment.

In terms of users' emotional assessment of the environment, two studies have been proposed: A) emotional quality of place and B) attachment to the place. The measurement of the emotional quality of place focusing on architectural design style is an important topic that is going to introduce a new method to measure environmental experience and provides a platform for dialogue between people and design specialists.

Moreover, neuroscience is accepted as one of the most reliable sciences in the world. The importance of this interdisciplinary field is mostly due to its impact on other scientific and social fields. Therefore, the necessity of investigating this issue is considered. The perception of architectural place is a versatile process in which hands, eyes, and mind work together. Knowing how the brain works and how place affects brain functions could help architects in terms of designing spaces that provide users' well-being, comfort, and environmental behavior. Hence, with the advent of specific techniques, recent studies on the emotional assessment of the environment have shown that the brain reacts to external events in the process of evaluating emotions. Therefore, the human body begins to react and behave according to brain reaction. Psychology and neurosciences help scientists to identify which region of the brain is used for specific purposes. In this regard, nowadays, experts have put brain imaging methods based on "fMRI" technology in order to examine measurable deep emotional processes on the human brain. So, in this study, it is important to examine in detail the brain sciences and mental processes in relation to architectural design, emotional experience, perception and environmental behavior in more robust and comparable data.

1.3. Research Purpose

In environmental design, it is important to define the relationship between the principles of shaping and forming the environment. That is, how it affects the behavioral, emotional and perceptual dimensions of the user. In this respect, the Neuro-Architecture approach, as a new scientific field on architectural design and environmental perception, enables the relationship between 'the brain structure and the nervous systems' with 'emotional experience of the environment and spatial perception' to be determined. This approach explores the mechanism of preference in the brain that originates from the place beauty and the satisfaction of place. Moreover, it examines to determinate criteria related to environmental design, affection, and perception of place. Therefore, this research focuses on the following purposes based on the foundations of physiology in an experimental approach:

1. With recognizing the relationship between the individual and the environment correctly, it will assess the user's emotional-perceptual experience to contribute to the creation of a qualified environment and contribute to the provision of appropriate conditions in responding to individual's needs.

2. After investigating the brain's physiological reactions in relation to place and environment perception, by determining the correct criteria designing of place, the data obtained is the result of a new branch of science known as Neuro-Architecture.
3. With this study, the boundaries of Neuro-Architecture science will be tried to be determined, and the deficiencies of this approach in human physiology-place perception will be detected.
4. The study will determine the main principles of qualified spatial design and transform the data obtained into expandable data for all architectural spaces.
5. Within the scope of behavioral sciences, the reactions of the brain in relation to environment and place perception will be determined especially in the field of environmental and cognitive psychology. Therefore, in related to the place, it will make the perceptual and variable experiences of users turned into measurable data.

1.4. Research Questions

The research aims to find the answer to the following questions by giving importance to the Neuro-Architecture as a design approach in new architectural designs:

1. How should we obtain an appropriate design pattern to ensure the user's emotional-perceptual experience appropriately? And which qualities of such a design can cause a feeling of being pleasant or unpleasant, positive or negative, and nice or ugly? And in such a situation what is the brain's response, and how can the brain activity be measured by an objective assessment?
2. Is there any meaningful relationship between the users' emotional-perceptual experience and the physiological activity of the brain?
3. Can the "Neuro-Architecture" be used as a design approach in new architectural designs as a result of the brain behaviors regarding an architectural experience?
4. What is the importance of Neuro-Architecture in the design process and evaluating the emotional-perceptual experience of place?
5. To what extent do the components of the emotional-perceptual experience of place process affect users' satisfaction and preferences?

1.5. Research Hypothesis

The present study determines important hypotheses based on the process of examining and answering the questions mentioned above:

1. It seems that if a place includes qualifiable spatial features and architectural elements, it evokes the positive emotions on users, provides user satisfaction, and it will be suggested, evaluated as a pleasant place, and more preferred by users. Then, the brain areas engaged in positive emotions will be activated.
2. The sensation and perception of place and environment are not just a visual process. Biological, psychological and conceptual variables also affect feeling and perception. These changes can be clearly observed in the brain. From a cognitive point of view, the mental process plays an important role in giving meaning to sensation and perception, and seriously affects people's behavior.
3. Neuro-Architecture is able to detect the source of processing reward during architecture appraisal, aesthetic judgment, and the emotional experience of visual stimuli, and its findings can convert the users' psychological and physiological responses into the measurable and usable data.
4. There are deficiencies in the findings of neurologists in the field of architecture. Therefore, it has the potential to find solutions to questions about the emotional experience of place and environmental perception through the Neuro-Architectural approach. Considering the potential of Neuro-Architecture, we can apply this approach as a solution to obtain a more qualified design. Indeed, the user evaluates the environment with feelings, perceptions and personal experiences. There is a discrepancy between the subjective assessment of users and the objective assessment of the experts, and Neuro-Architecture can reveal and objectify the subjective experience of place.
5. Each component of the emotional-perceptual experience of place appears to be significantly different in achieving user satisfaction and preferences.

1.6. The Structure of Research

To answer the questions mentioned, the research is divided into two parts; the conceptual (theoretical) approach and the practical approach:

In the conceptual approach of the research, using a qualitative approach, the literature review and theoretical framework of research associated with the fields of environmental psychology, cognitive psychology, and neuroscience are examined. These descriptions include the process of the individual's relationship with the environment, environmental sciences, research methods in environmental psychology; the four-dimensional process of the emotional-perceptual experience of space, cognitive sciences, research methods in cognitive psychology, and approaches in neuroscience. Finally, by changing and completing the theoretical model based on the results of previous studies, the practical model of research is formed and used in the case study.

Components such as sensation, perception, cognition, and behavior as well as the activation of brain areas engaged in emotions, are considered as independent variables, and the emotional-perceptual experience of place is considered as dependent variables. The practical approach of research is formed by examining the relationship among brain activation, the sensory, perceptual, cognitive, and behavioral components of place experience with users' satisfaction and environmental preferences. For this purpose, in the first step, through the targeted case study (faculty of architecture and urban design) is selected to test the practical model of research and subsequently, to test the emotional behavior of brain as well as to test the impact of the relevant components on evaluating the emotional-perceptual experience of place the research method and statistical population is determined. Then, in the second step, the data obtained from the previous step are analysed based on the research model, and the practical and theoretical models of the research are scrutinized. In the final step, to answer the research questions and hypotheses, the results and conclusion are discussed.

1.7. Limitations of Research

The parts of research associated with brain imaging and open and closed questionnaires were such that participants had to be talked to and explained the process and principles of the experiment in details. Therefore, to focus on the components of the process and minimize cultural and social variables, participants were required to be patient and to be interested in to go to the hospital to have a brain functional imaging. So, the faculty of architecture and urban design at the Selcuk University of Turkey was chosen as the case study because both its students were eager to contribute to the study and there are there are trust between the students as participants with the researchers.

Otherwise, choosing another case study and employing local citizens would have set limitations to the research. Since the research is interdisciplinary in nature, there were limitations and problems such as lack of resources and studies in the fields of Neuro-Architecture, cognitive science, and neuroscience. Therefore, the use of resources in the field of brain, neuroscience, cognitive sciences, the difficulty of access to them, and the researcher's unfamiliarity with these scientific fields took a long time. Due to research conducted in several steps using various methods (observation, interview, open and closed questionnaire, brain imaging), a lot of time was spent. Because of the plethora and variety of questions, to increase the validity and reliability of the results and answers as well as to remedy the ambiguity of the respondents, the test was performed in one's presence and one by one by the researcher with each participant.

The problems with fieldwork research were the high statistical population due to the participation of two groups of architecture and urban design students; the unfamiliarity and inability of some participants in answering questionnaires; drawing cognitive maps, and brain imaging; the reluctance of some students to participate due to lack of trust and being worried about brain imaging complications; the high number of survey questions, and the variety of statistical analysis methods and the extent of analysis of findings in four different phases such as observation; and conducting interview, questionnaire, and the functional brain imaging. Doing brain imaging was the hardest and most complicated part of the research. The high number of patients referred to the radiology polyclinic of Selçuklu Hospital (Faculty of Medical Science) during the days of the week caused the researcher to face serious problems in renting an fMRI scanner. In this regard, it took months for the brain scanner to be rented for two days. On 7-8 April 2018, 40 participants in two separate groups of architecture and urban design students were recruited in the hospital for the brain functional imaging, however due to the negligent and inability of the relevant technician to perform anatomical imaging (T1), after eight months break and waiting on 7-8 December 2018 the brain imaging was done again.

2. RESEARCH THEORETICAL FRAMEWORK

Architects face a lot of challenges related to design and its concerns in their professional and academic career. Many designers emphasize the importance of paying attention to users and their needs, but often they neglect to act accordingly so. This is while designers consider users as a mass of similar people of the same merely physiological needs, and they are convinced that they can respond to users' material needs with goals such as climate and service provision. The fact is that although humans have many similarities with each other, psychologically they are different.

The architectural place is as an environment that affects the minds, affection, and mental perception at any moment. Hence, one of the sciences that helps to better understanding of human beings based on his desires and needs is psychological knowledge. Sciences such as environmental and cognitive psychology focus on how and what human environmental behaviors and physiology are. So, the purpose of this chapter is to explain and justify many design ideas based on this point of view; that is, recognizing how people feel and perceive the environment, what mental processes they are going through to understand the environment, how they behave in the environment, and how the environment affects their behavior. In this respect, after investigating a variety of psychological approaches, humans, the environment and how they communicate will be addressed. Subsequently, after providing preliminaries, it will be discussed about individual processes, that is, affection, perception, cognition, and behavior of the environment through the knowledge of environmental and cognitive psychology. Different research methods and related theories and similar research will be presented. Finally, the result of the integration of architecture with environmental, cognitive, and neurosciences, the Neuro-Architecture approach, its principles, and the relevant case studies will be the objectives for this investigation.

2.1. Concepts and Definition of Psychology in Relate to Environment

2.1.1. Approaches in psychology

In psychology, like many other sciences, there are various ways to explain and solve problems. In fact, the interpretation of mental interactions and topics related to human psyche is more complicated than looking at it from just one point of view. Each of these approaches expresses human behavior to a certain extent from different angles. The six approaches briefly described here are major approaches to psychological studies, including biology, behaviorism, cognitive, psychoanalysis and phenomenology (Smith et al., 2003).

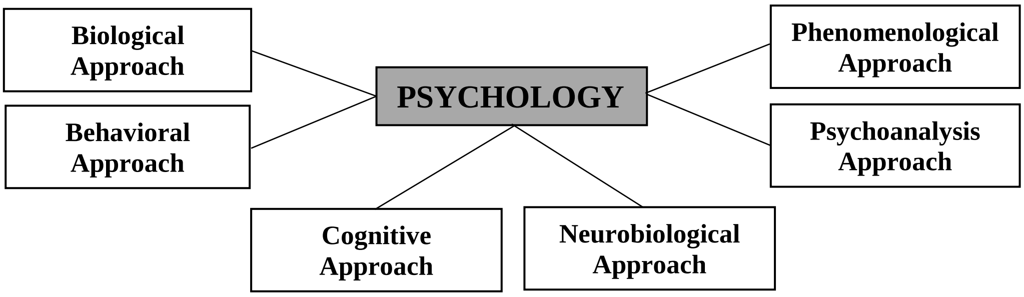


Diagram 2-1: Approaches in psychology, (Author)

- Biological approach: The biological approach seeks to identify the biological – neural processes that constitute the cornerstone of the behavior and the mental processes. In this perspective, mental events that are relevant to the brain and the nervous system are explained. These activities play an important role in our thoughts, affection, and behaviors. In fact, this view is looking at the causes of behaviors, through the brain electrical and chemical processes and the nervous system (Ganji, 2009). For example, when we are afraid, in addition to the external factors that have frightened us, what has happened inside the body (such as secretion of certain substances in the blood and, etc.) causes our fears and its reaction. But what can be the biological explanation in regard to a person’s behavior in an architectural place or urban space? Occasionally, the conditions of the environment are such that it affects our biologic processes that leads to the certain behaviors. For example, in a crowded place where excessive heat causes changes in the body, aggressive and nervous behaviors become more frequent. The tasks that the designer has in this regard is paying attention to these details and biological responses, users’ comfort threshold, taking into the environmental factors affecting these processes, providing optimal conditions to prevent the aggravation of the unpleasant conditions, and balance the environmental features to make the pleasant feeling of being in place for individuals.

- Behaviorism approach: As the name suggests, this approach is relevant to human behavior and finding factors affecting behaviors. In fact, behavioral psychologist seeks out how influential factors affect behavior or what humans do. Accordingly, to examine the behavior from this view, we deal with key concepts as follows (Pakzad and Bozorg, 2012):

- Stimulus: The stimulus is the factor that comes from outside of us and determines when, where, and what response (behavior) is to take. For example, while walking in noon during a hot summer day, the presence of a bench, tree shade, heat, sun, and even the street is considered as a stimulus.

- Response: Response is a reaction against the stimuli. If the response is "acquired", behaviorists referred it to as learned behavior, otherwise, they say "instinctive" response. The instinctive responses are limited to a few potential reactions in humans. But psychologists believe that humans learn their responses from the environment. So, human responses to stimuli are often acquired. In the previous example if someone stays on the bench and shade, he/she responses to the stimulus.

- *Motive:* The purpose of motive is a force that somehow creates a desire for action in an individual. In fact, motive comes from a need and forces individual to move to reduce the intensity of the motive. If under the conditions mentioned in the preceding example, the individual who sits on the bench, he/she has been influenced by his/her motivation to relieve heat or fatigue, and so on.

- Reinforcement or punishment: The person receives feedback after responding to the stimulus is called reinforcement or punishment so that determines how to behave in the next encounter with the same stimulus. In the example mentioned, if the person has felt better after sitting on the bench, it means he/she has received a reinforcement. For this approach, all of our behaviors are dependent on the stimuli that exist in our environment. In fact, this view considers the basis of behavior in the presence of a stimulus and it is believed that without any stimulus, the behavior will not be happen.

- Cognitive approach: From this perspective, mental processes involving attention, learning, memory, experience, and, etc. lead to the formation of a cognitive map, a mental image, that brings meaning to the environment, and our behavior is influenced by these mental processes. This means that we perform our behavior based on what we have in mind and our interpretations of events. For example, an individual avoids going places where he/she has been attacked in the past, while his/her friend may have good memories at that place considered the place as pleasant, fun, and desirable. Obviously, the difference in their mental image makes them judge the place differently and respond differently too. As a matter of fact, theorists such as Apliard and Lynch have made studies that show mentality and image also express the importance of mental image in behavior as well as the judgment of individuals about the quality of the environment.

In any case, this approach is a response to the limitations of the behaviorist approach in the investigation and explanation of human behavior. Therefore, it believes that behavior should be interpreted both according to the basis of stimuli and the basis of mental processes. These mental processes include the classification, organization, and bringing meaning to information. For example, in the case of a neighborhood or urban space individual’s mental image of that place is brought to his/her mind. This mental image includes the expectations and characteristics of that place, and individuals acquire them during their experiences and adjust their behavior accordingly.

- Neurobiological approach: According to this approach in psychology, investigating behavior is the main task of a psychologist, and he/she tries to make a connection among behavior and events that take place within the body especially in the brain and the nervous system. Actually, this approach determines neurobiological processes which underlie behavior and mental reactions (Gifford, 2007). In this framework, perception can be studied by recording the activity of brain neurons when presenting different visual stimuli. For instance, researchers have studied emotional reactions such as fear or anger by electrical stimulation from certain areas of the animal’s brain.

- Psychoanalysis approach: The fundamental assumption of this approach is that all human behaviors are not in conscious, but the more significant bulk of behavior is rooted in unconscious processes. Unconscious processes mean beliefs, fears, and desires that the individual is unaware of, and mainly experienced in the early years of their lives (Ganji, 2009). The benefit of studying this approach is to know that not all behaviors of an individual are in conscious and that all the behaviors cannot be justified and considered as a conscious basis. Though this approach is individual and unique, it refers to personal experiences than aggregation, and knowing it can help researchers in all aspects of human behavior.

- Phenomenological approach: As seen in the previous four approaches, some perspectives regard external stimuli as behavioral causes, assuming that humans behave in the same way in respond to external stimuli (behaviorism approach), and others consider mental processes and memories as the main cause of behavior (cognitive and psychoanalysis approach). But, in the phenomenological approach, the cause of the differentiation of behavior in different people and its causes are discussed. In other words, the proponents of the phenomenological approach want to know why and how human behavior differs despite them being in the same condition. In fact, in the phenomenological approach, it is emphasized that humans are different and understand themselves differently, so they have distinct attitudes and behaviors, whether under the same conditions or different.[1]

The main thesis of this phenomenological method is that it should suggest that the principle of things is the essence of things. This approach does not explain anything according to any principle or rule and does not infer any principles legally, but directly, considers to the subject itself. From this perspective, some designers try to get the place meaning from the perspective of their users; by talking with users, asking for their opinions, or even living and working in that environment, and trying to put their mind in user's perspective to design space on the basis of priorities, values and users' needs.

2.1.2. Environmental and behavioral sciences

Many sciences have been created in the environmental domain. Porteous (1982), based on two basic criteria a) social relevance, and b) methodological rigor, has identified four main active groups in human-environmental issues: activists, humanist, experimentalists and planners. Social activists are mostly involved with community issues and are willing to provide solutions to these issues. This group usually does not seek to prove the ability and success rate of their strategies. Humanists are more value-oriented and are concerned with the cultural life of society. Their methods are fundamentally phenomenological, non-experimental and non-positive based on personal experience and inspiration. Usually, their goal is to understand the relationship between human and environment, without seeking to change it. However, they do not consider the realities of society and the environment.

Experimentalists are essentially engaged in research issues, mainly through testing and observation, seeking to prove assumptions and formulate their own ideas. This group mainly seeks to solve the theoretical complexity and specific theoretical issues. Experimentalists are most concerned with the environment users, and try to find out users' response to the environment both in terms of behavioral and deeper levels of perceptual and emotional aspects. Environmental psychologists and sociologists are in

[1] Some theorists refer to phenomenological theories as humanist, since these theories emphasize the distinctive characteristics of human beings than animals, such as attempts to grow and self-fulfillment.

this group. Finally, urban planners and architects who have an intermediate method are also involved in community issues and have a clear understanding of the value of empirical findings. They can use empirical methods to better understand the current situation and provide the necessary solutions (Rezazadeh, 2006).

An individual's behavior in a certain environment is influenced by the physical, functional, and semantic features of that evoke his/her emotions. A general approach to investigating such an impact necessitates a comprehensive description of the emotion-eliciting qualities of environments. Theories and models presented from the reality of the environment and the relationship between human and the environment are only illustrative; whereas the environmental and behavioral sciences explain the relationships and make models of reality. The behavioral sciences recognize the laws governing the individual and society and accordingly predict the impact of design interventions on the environment. The results of the behavioral sciences studies indicate the implications of design solutions and describe the success of the designer in achieving his goals as much as possible. Thus, behavioral sciences are used to explain the social impact and success of design actions (Rezazadeh, 2006). The purpose of behavioral science is to explain phenomena, to recognize and explain the relationship between their conditions and its implications. In this way, it emphasizes recognizing and explaining the relationship between the physical environment and human behavior.

2.1.3. Environment and environmental behavior

The word environment has a variety of uses and meanings; "surrounding spaces", this is the most basic and innovative definition of "environment". Architects, psychologists, sociologists, and geographers provide different definitions and classification of the environment according to their discipline. An environment is a complex and a compound concept that has different dimensions. Shahrnaz Mortazavi (2001) points out that spatial data, social, cultural, physical, architectural, symbolic, geographic, historical and biological aspects of the environment are considered as important dimensions of the environment. Further, she believes that environment literature distinguishes terms such as the physical environment, the social environment, the psychological environment, and the behavioral environment. Accordingly, the main point of these categories is the distinction between the real or objective world around humans and the phenomenological world that consciously or unconsciously affects the patterns of behavior or mental reactions of people. In an overview, environments are classified into four physical groups, including geographic locations; social, including individuals and groups; psychological, including the mental image, and behavioral, including a set of factors that a person responds to (Gibson, 1966). Lang (1987) in explaining the basics of Gestalt argues that a physical environment involves geographical places; the social environment includes individual and group entities; the psychological environment includes mental images; and behavioral environments involve the factors that individual responses to them. Motallebi (2002) is of the opinion that the interaction between the environment capabilities and the individual and collective needs makes the environment meaning.

The science of human behavior and its role in the environment can be understood in the realm of behavioral geography through the application of psychological ideas and theories. On this basis, individuals match the information and perceptions obtained from the physical and social environment, and the pattern of their mental or cognitive map, to base their actions and behaviors in psychological representation formats. For example, the understanding of a citizen from the city resulted from the his/her observations of the city, with his/her own worldview. Based on popular conclusion of environmental behavior science, regardless of geographical variables, humans behave according to their perception of the environment drawn from their five senses and their mental maps or understanding (Mostaghimi et al., 2015). Traditionally, the interaction between an environment and the body or an organism makes a behavior based on straight stimulus, response, and reinforcement (Moehl, 2011). According to Baum (2004), reaction or reflex is considered as the simplest behavioral response of a body and is influenced by environmental triggers. Sensory perceptions regulating an individual’s behavior are the same his/her permissible facts of the physical and social environment which creates an individual’s mental map of the environment. Therefore, the mental image acts as a filter between the real world and the perceptual world, in the sense that, we only understand some parts of the real world which have become our mental map (Lang, 2004).

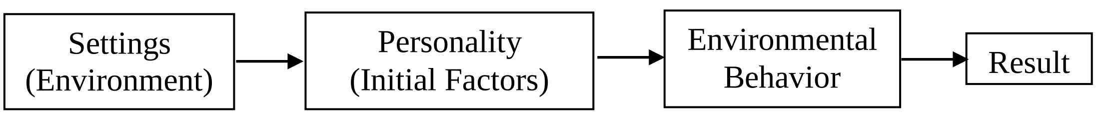


Diagram 2-2: The pattern of human behavior (Mostaghimi et al., 2015).

2.1.4. Human, environment, behavior

Human transforms the environment according to their needs, values, and goals, and they are interactively influenced by the transformed environment around them; especially with advanced technology human actions on the environment is more severe or affective. A fundamental feature of the recent era is the rapid transformation of the environment. It imposes certain behavioral patterns and new social roles on individuals (Mortazavi, 2001). Today, architects and urban planners pay special attention to the psychological recognition of human behaviors because there is a close relationship between human behaviors and physical environment. To investigate the impact of the physical environment on human behavior, environmental psychologists have made examinations about human environmental behavior (Motallebi, 2002).

Human and environment have a bilateral relationship. Both affect each other in a way. The behavioral patterns are in connection with the spaces. (Alexander, 1979). Depending on the culture values of their environment, humans make sense of certain spaces, stimuli, and events to behave in a manner that is appropriate to them. Recognizing, describing and explaining human behavior helps to understand the relationship between environment and behavior. Hence, the understanding of human nature is essential to an architectural design (Emamgholi et al., 2013). Environment and behavior are so intertwined that they can hardly be separated. Behavior cannot be understood independently from its internal relationship with the environment, as behavior must be defined in the environmental context (Altman, 2004).

Today’s living space is defined by the combination of people and the environment. Experts, generally, on the one hand, are trying to understand the human psychology, and on the other hand, are examining the human activities and its environment. Nonetheless, the relationship between them is considered an important issue. Additionally, in architecture and urban design the relationship between human and environment, to establish reasons for this relationship, and the interaction between them is important that it must be considered. Thus, in order to organize the environment and individuals’ activities in the best way based on a user-oriented process, it is necessary to recognize both user and the factors associated with user and the relation between them. The environment around us is full of potential information. An individual firstly, perceives a part of the environment objectively in proportion to his/her physical and psychological abilities. Then, it organizes judgments based on perception, and based on these judgments, makes a subjectivity of the environment for itself. These subjectivities and mentalities are fundamental factors in the individuals' behavior, in the sense that individuals behave and even change or modify the environment based on such factors. The modified environment is also presented as objectivity in the mental processes of individuals, and this cycle will be continued to persist. Furthermore, individual somehow adapts themselves to the characteristics of the environment, and somehow change the environment based on the perceptions that have already been made from the environment (Pakzad and Bozorg, 2012).

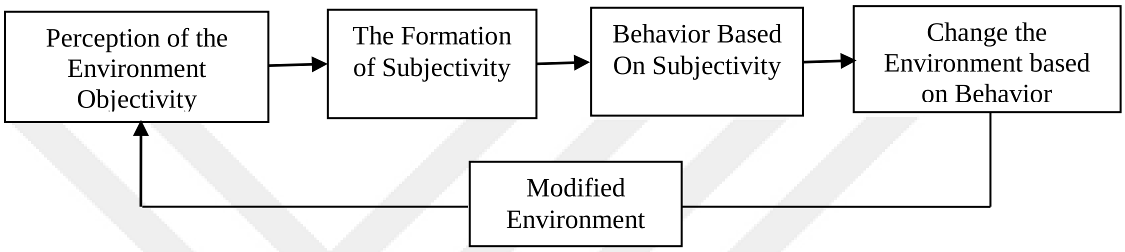


Diagram 2-3: Human-environment communication process (Pakzad and Bozorg., 2012).

Hence, there are three basic factors in the relationship between human and the environment: individual, the environment and the link between them. In this connection, the environment characteristics chiefly affect individual judgments of that environment and behavior based on such judgments. So that, it can be considered as one of the most important factors in determining environmental behaviors. Consequently, it can be said that the environment affects individual through continuous information that it provides. For this impact, the environment provides information in such a way that can be transmitted to the individual. To this end, it is necessary to embed symbols and cues in the environment that represent a transmittable and understandable concept for individuals. In other words, there should be similarity meanings between the information presented by the environment and pre-recorded information in the mind. So that the individual can understand and mean what he/she receives. In this context, as the second element, people play a decisive role in the connection because if there is no one who knows the environment, the connection will be meaningless. Eventually, the factor of communication creates the possibility of exchanging information, forces and applying changes in the people and the environment. In the course of these exchanges, the individual knows the environment, and performs appropriate activities on that basis, and sometimes based on these thoughts, mentalities or activities modify the environment.

2.1.5. Mental images and behavior

There is a meaningful correlation between the system of people’s activities and cognitive images of the physical environment. Any changes in the imagined environment is reflected in people’s perception and this affects their behaviour. Since the formation of a mental image defined as a bilateral process between the person and the environment, it is possible to strengthen the imagination of a particular place, through the enhancement of personal or environmental capabilities. The first method is obtained by training the environment observer, and the second method is obtained by marking the paths or changing the physical organization. Having a clear image of the environment provides a better understanding of the capabilities of the surrounding world (Mostaghimi, 2015). Increasing people’s communication with settings and behavioral places, and creating interactions between others strengthens place attachment and affective foundations. Furthermore, it reduces people anxiety in the environment (Lang, 2004). In the interaction between the environment and human, the environment can be examined in three aspects (Tribe, 1974):

1. The environment is filled with information and is always as a something independent from human (Form).
2. Any perceived part of the environment affects human behavior (View).
3. Related to the perceived space, people behave based on mental image.

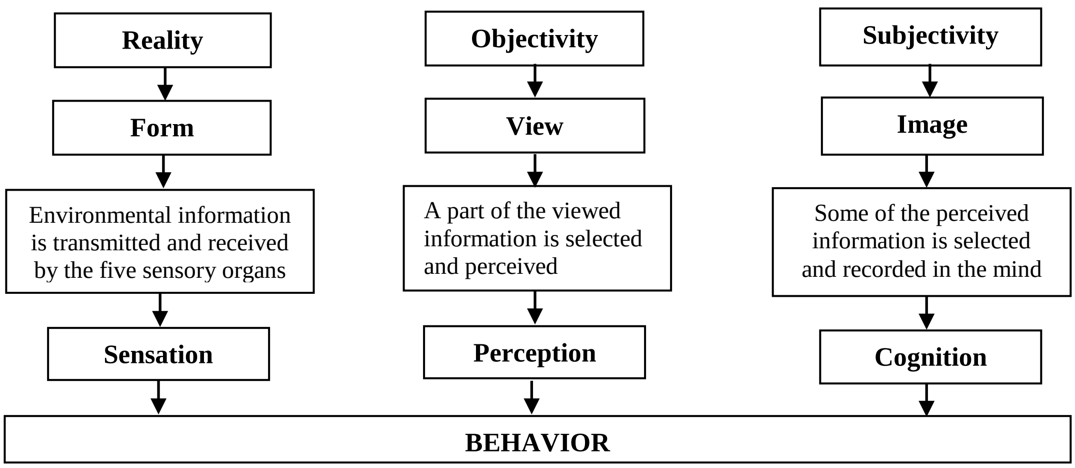


Diagram 2-4: Users’ mental images and behavior in relation to the environment (Author)

2.1.6. Physical environment and human behavior

The physical environment has a great impact on the state of psychology and social behavior (Sanoff, 1971). Barker (1968) states the behavioral setting has two categories of structural and dynamic essential features. In structural features, a behavioral setting includes one or more behavioral patterns and the surrounding environment. In dynamic features, components of a setting such as an environment and behavior have a degree of dependency (Dejdar et al., 2012). Barker's ecological theory reflects the fact that unlike traditional psychology which does not consider to the relationship between human behavior and physical environment, in ecological psychology this concept is increasingly being considered. Accordingly, the ecological model of perception and the recognition of the environment emphasis perception, cognition, and place as three interconnected and related factors. The amount of information received from the environment depends on the variety and degree of contrast between the obtained sensory information and how they differ from each other. The characteristics of the built environment pattern are perceived by five senses and according to the directional system of feeling and perception, but the meaning of it must be learned. Sometimes the learning process is clear and the social norm is taught naturally through the processes of socialization (Shahcheraghi, 2009).

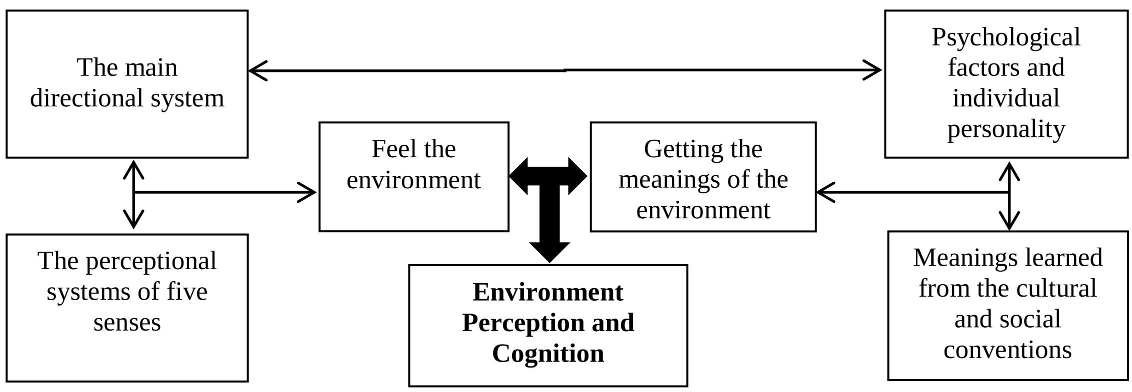


Diagram 2-5: The ecological model of perceptual and environmental recognition (Shahcheraghi, 2009).

There are various theories regarding the impact of the environment on human behavior and the relationship between the physical environment and human environmental experience. Environmental psychology seeks to create theories about human behavior in its conventional environment so that they can be used by architects.

The environments designed by architects can be equipped with the necessary capabilities to meet human needs. Behavior provides a function for the people cognitive imagery of buildings and cities. The physical structure of the environment affects these images and affects the patterns of people’s interaction (Lang, 2004). In the field of interaction between the physical environment and human behavior, Rappaport (1990) has stated three conventional theories which are summarized in the table below:

Table 2-1: Theories of the influence of the environment on behavior (Author adapted from Rapoport).

Tendency	Main Character	Early Advocates
Environmental determinism	Changes in environmental elements lead to changes in behavior particularly in social behavior	Architects and urban planners of the modern period
Environmental permissiveness	The environment does not usually trigger behavior, it is also as a ground for behavior, and people select and behave according to cultural criteria	Sociologists and urban geography scientists
Probabilistic	The effect of the physical environment on behavior is a possible effect, and according to the environmental characteristics, the probability of specific behavioral occurrence in some environments is more or less than others	Environment psychologists

2.1.7. Environmental psychology

In the contemporary era, architecture and urban design are understood as a profession and knowledge that is far from a rigid and a constrained framework, instead, other sciences such as environmental psychology plays an important role as part of the discipline. Let’s take behavioral science, part of the environmental psychology plays an important and this will relate back to architecture and urban design because it represents the effect of the physical characteristics of the environment (Naghizade and Ostadi, 2014). Environmental psychology emphasis on how the behavior, feelings, and well-being are influenced by the physical environment. Aftermath the World Wars, in efforts rebuilding the cities, the study of environmental psychology was incorporated heavily in modern architecture to influence behaviour of the citizens post traumatic events.

The subject of environmental psychology was raised in the 1960’s. In 1970, Proshansky, Ittelson, and Rivilin announced the advent of environmental psychology in a book entitled “Environmental Psychology: Man and his Physical Setting” (Lang, 2004). It is known that this science was founded by Egon Brunswik. According to

Brunswik, humans arrange the images they perceived via their sense perceptions according to their past experience, hence resulting their own interpretation or understanding of the images they are perceiving at present moments (Karimi yazdi et al., 2017). Proshansky defined environmental psychology as a discipline that deals with the interactions between people and the environment (Emamgholi et al., 2013); others have named this science as “human-environment relation”, “environmental sociology”, and “human ecology” (Motallebi, 2001). This knowledge, as a branch of psychology and a subset of behavioral sciences, addresses the study of human behavior in relation to the environment, and the importance of the impact of the environment on human behavior, perception and affection (Rezazadeh, 2006). Therefore, environmental psychology is the study of individual and collective experiences of places that as a fundamental in understanding human behaviours (Motallebi, 2001). In environmental psychology, the environment is the most important source of external perception and is the main source of human awareness and understanding of the surrounding world. In this context, the fundamental process of human behavior is formed based on successive steps of sensation, perception, cognition, and behavior (Naghizade and Ostadi, 2014). In environmental psychology, the issues of sensation and perception are called as sensory perceptions which is based on empirical evidences, especially as found in physiology and empirical psychology (Barati and Soleimannejad, 2011). Barker’s (1968) early studies about behavioral habitat or place-behavior in the field of ecological psychology and the studies of Sommer (1970) and Altman (1980) on personal spaces and social behavior are known as the basis for this field of science. The following table shows the excerpts of the environmental psychology definitions provided by various theorists.

Table 2.2: The definitions of environmental psychology according to theorists (Emamgholi et al. 2013)

Name	Date	Definition
Craik	1970	The psychological study of human behavior related to daily life in a physical environment.
Graumann	1976	Environmental psychology is a complement to general psychology.
Canter	1981	It is a branch of psychology that is relevant to the study and analysis of human interactions, experiences, and considers human reactions in confronting various aspects of the social and physical environment.
Russell	1982	Environmental psychology is a domain of psychology that provides a systematic relationship between the individual and the environment.
Holahan	1982	Environmental psychology studies the relationship between the physical environment and human behavior and experience.
Proshansky	1990	The environment psychology deals with interactions and relationships between people and their environment.

Generally, as mentioned above, environmental psychology discusses the interaction between individuals and the physical setting (Gifford, 2007). According to such interaction, people change their environment, and the environment also influences the experiences and behavior of individuals. So, it can be considered as a theory, approach or tool that aimed to create a pleasant, desirable and humane environment; in addition to improving the bilateral relationship between the individual and the environment. In the book “Psychology’s essential role in climate change”, Gifford (2008) points that environmental psychologists in their analysis consider three aspects; A) fundamental psychological processes filtering and structuring individuals experiences and behaviors like environmental perception, spatial cognition, and personality, B) the management of social space components like personal space, territoriality, crowding, anxiety, solitude and privacy, and C) interaction between individuals and the environment, also the role of psychology in climate changes.

2.1.8. The importance of environmental psychology in architectural design

Environmental psychology has a problem-oriented and interdisciplinary nature related to theoretical subjects and methodological approaches. In the contemporary era, architecture and urban design are understood as a profession and knowledge that is far from a rigid and constrained framework, instead, other sciences such as environmental psychology plays an important role as part of the discipline. Behavioral science especially environmental psychology represents the effect of the physical characteristics of the environment on behavior. Hence, it is significantly applied in the functional aspects of environmental knowledge including architecture and urban design (Naghizade and Ostadi, 2014). Aftermath the World Wars, in efforts rebuilding the cities, the study of environmental psychology was incorporated heavily in modern architecture to influence behaviour of the citizens post traumatic events (Emamgholi et al., 2013). In other words, environmental psychology emphasis on how the behavior, feelings, and sense of well-being of humans are influenced by the physical environment. A psychological examination of how architectural spaces are used by users focus on fundamental elements such as “human”, “environment” and “behavioral mechanisms”. Environmental Psychology is a psychological exploration of human behavior in the architectural and urban environment and assesses the type, amount, and manner in which architectural spaces are utilized by users. Environmental psychology points out that the architectural environment must be consistent with the behavioral needs of users. Hence, architects and urban designers pay particular attention to the psychological understanding of human behavior because these behaviors are closely related to the physical environment. Environmental psychology studies the influence of factors affecting perception and cognition (light, color, sound, climate, landscape, form, geometry, etc.), and represents the impact of the physical characteristics of the built environment on behavior. Therefore, to plan environment responsive to human needs, it must link to fields such as architecture and urban design.

2.1.9. Environment perception theories

- Stimulation theory: Based on this view, the physical environment is defined as a crucial source of sensory information, and individuals adapt to a certain level of environmental stimulation. Wohlwill (1966) conceptualizes the physical environment as the vital source to our comfort. Such an environment includes simple stimuli like light, color, sound, and warmth, as well as more complex stimuli such as buildings, streets, locations and people. Environmental stimulation has two distinct dimensions: first, obvious dimensions such as intensity, repetition, number of stimuli sources; second, the meaning that comes from user psychological assessment of the environmental stimuli, such as thinking. Factors like social reaction, the effectiveness of activities, emotions, and health depend on the pattern of this stimulus and the responses to them.

- William Ittelson’s the interaction of perception theory: Interaction theory emphasizes the experimental role of perception and analyses the dynamic relationship between the individual and the environment. In this theory, the environment, observer, and perception are interdependent. Ittelson (1973) defines the process as follow: “Perception is part of the process of life, by which each of us, from a theoretical perspective, imagines for ourselves a world in which our needs are met” (Lang, 2004). An important role of the theory of interaction in architectural design is to recognize what people care about and consider in the environment because “architecture promotes the quality of life based on sensory perceptions” (Pallasmaa, 2012).

- Gibson’s affordance theory: Gibson’s view is that the combination of materials shaping the world reveals some of the environmental capabilities. People alter natural and artificial environments to change capabilities. In fact, the physical environment involves levels and materials, and human beings alter these levels to build buildings. Thus, changes the meanings of the levels or built environment. For example, a steady horizontal surface maintains continuous movement and a tight vertical surface stops moving (Mortazavi, 2001). In Gibson's opinion, "Building offers something in its own way" (Lang, 2004). Detecting the capabilities of the object or environment is based on the viewer's characteristics, experiences, competencies, and needs. An environment may have specific capabilities for a specific person, but at the same time, it's meaningless for someone else (Motallebi, 2002).

- Berlyne's collative properties theory: According to Berlyne, environmental stimuli have numerous and impressive features such as novelty, inconsistency, complexity and expectancy (Berlyne, 1960). These features make the observer to pay attention, investigate and compare if the environment has features such as a) have a psychological-physical essence (e.g. color, intensity); b) have an ecological essence or c) have a structural and social essence (Variables such as simplicity or complexity, expectation or surprise, Clarity or ambiguity). These characteristics attract human attention and affect "aesthetic judgment" through the need for "pleasure" (being beautiful or giving enjoyment) or stimulating the sense of "doubt". This theory emphasizes the affects on human from architectural images of the environment (Mortazavi, 2001).

- Egon Brunswik's lens theory: The perceptual model of the lens is one of the theories developed in explaining the relationship of behavior-environment by Egon Brunswick, and Kenneth Hammond has been made public. In the explanation of perception, Brunswik's (1956) probabilistic functionalism or lens theory is considered as reliable. This theory argues that sensory information never reflects the real world accurately, and the environment remains vague due to its essence. Individuals should use this incomplete information to make possible judgments about the true nature of the environment. In the Lens pattern, human perceptual processes are very similar to the eye or camera lenses (Mc Andrew, 1997). In this model, perceptual processes receive different types of environmental stimuli, and then they went to be more refined, and converted to regular and integrated perception.

In the Lens model, environmental stimuli are perceived by an individual's perceptual effort. In Brunswick view, the physical stimulus variables are the recipient source of the sensory pattern, and the mental stimulus variables include more complex dimensions, involving additional information and ambiguity about the nature of the world of senses. Some of the important qualities of place, such as beauty, are not directly perceived, but measurable under selective guidelines, as intermediaries that lead to perception. So, an individual's perception of beauty would be formed through these guidelines based on mental image and emotion Gifford (2007). Some of the most important aspects of the Lens theory can be described as there is a correct probabilistic relationship between the environment and cues; also, the environment has many cues that the observer can feel which one is the most important. (Brunswik, 1956).

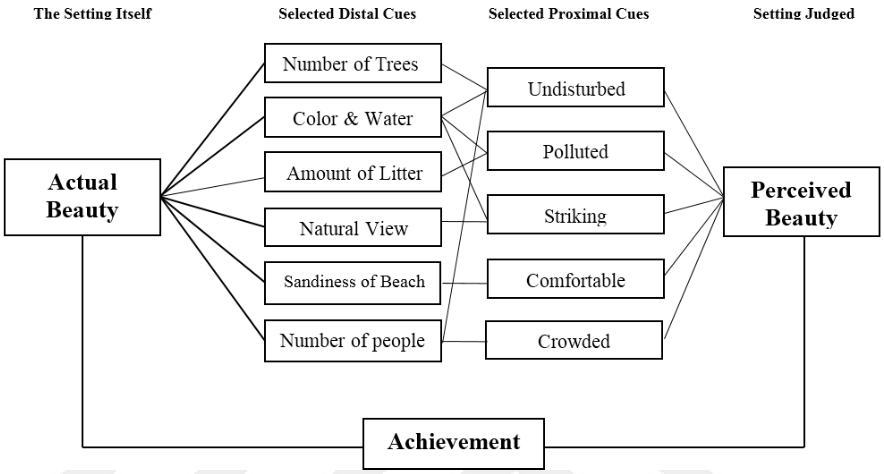


Diagram 2-6: Brunswik's lens model adapted for environmental perception (Gifford, 2007).

In this model, qualitative factors such as water, vegetation, color, and diversity can be a link and guidance code to the natural and privileged nature of the space that reinforces the motivation and preference of presence of a place. In Brunswick's view, psychology describes behavior (Neisser, 1967), and the physical stimulus variables are the receipt source of the sensory pattern. Additionally, the mental stimulus variables include more complex dimensions, carrying additional information and ambiguity about the nature of the world of senses. Some of the important qualities of a place, such as beauty, are not directly perceived, but measurable selective guidelines as intermediaries that leads to perception. Thus, an individual's perception of beauty would be formed through these guidelines based on mentality and affection. (Gifford, 2007).

- Kaplans's environmental preference theory: According to the need for a landscape, sense of place, relation, and interaction with a setting, users prefer an environment or function. According to Kaplan and Kaplan, people typically prefer places that can meet the basic human needs, such as security, finding food and shelter. In the framework of Kaplan's view, people prefer spectacles to engage in, interact and make sense. Of course, the environment may create this feeling in the short term and the longer in the long run (Kaplan and Kaplan 1982; 1987; 1989). Clear views allow the observer to quickly identify and organize landscape components, but complex views do not provide much information, despite the quick understanding of the meaning of complexity. Legible landscapes make sense that the observer will never be lost. Also, mysterious landscape force observer to seek and pay more attention to the environment in order to increase his/her environmental experience. In addition to complexity, clarity, mysterious and legibility, Kaplan and Kaplan have emphasized the role of environmental familiarity in environmental preferences. Therefore, the optimum level of the above factors can lead to the preference of a landscape, place or environment (Gifford, 2007).

Table 2.3: Kaplan's proposed model for environmental preferences (Gifford, 2007).

Information Features	Place Perception and Sensation (Need)	Interaction (Need)
Quick and immediate information	Continuity	Complexity
Predictable and Inferred Information	Legibility	Mysterious

Continuity means the cognition ability of understanding or designing a landscape that ever present. Complexity (an understanding that takes shape in the short term) means the capacity of a landscape affect the person's interest continuously. Legibility (a sensation that is created in the long run) means recognizing the environment for the future through organizing the environment of the present. Mystery (long-term perception) means that if one enters the environment, he can learn and interact more with the environment, and to spend more time there. Existing evidence on the relationship between cognitive capabilities and preferences has increased rapidly (Tyrvainen et al., 2014; Valtchanov and Ellard, 2015). For example, mysterious landscapes are more preferred by people. This has been confirmed in natural landscapes compared to man-made scenery such as urban streets. The reason for the preference of natural landscapes is that it appeared to be less risky for them than urban landscapes. More complexity and continuity are generally reported with more preference. Kaplan also emphasized the importance of environmental familiarity. When a place is assessed anonymously and somewhat dangerous by an observer, the other familiar place is more preferred. Research on green landscapes confirms the preferences of familiar landscapes. (Gifford, 2007).

2.1.10. Research methods in environmental psychology

Theory and method in behavioral science are determined based on research questions. An overview of research on environmental behavior shows the use of a variety methods such as survey, interview, observation, “picture drawing” of the environment, computer simulation, case study, etc. that are briefly described as follows (Gifford, 2016; Divers, 1984; Streufert and Swezey, 1982; Proshansky, 1972):

- Survey and interview experiments: to evaluate users’ expectations, attitudes, and feelings, these are considered as the most common and widely accepted methods. For instance, factual questioning is a main technique for evaluating group needs or characteristics. It has the subjects estimate the amount of time devoted to or the frequency of an especial behavior or other factual data relevant to the study of the environment. Furthermore, in attitude questionnaires, participants indicate their ideas on the different aspects of the environment. In this context, techniques like semantic differentials, Likert scales, multiple choice questionnaires, and adjective check-lists are used (Divers, 1984).

- Observational experiments: to study how users behave in and how they experience the built environment in ways of which they are not aware, using observational methods can be considered because through this method, it is possible to observe the relationships between user behavior and the environment. For example, in systematic observation, to increase objectivity in where behaviors were observed, the “behavioral mapping”[2] technique is used. It begins with a pilot study and then classified into activity types according to places, individuals, and characteristics (Divers, 1984). Using casual, passive, and active observation, it is possible to rely on persuasive cases in ways that questionnaire and other methods do not let. So, given that whatever mentioned above, these methods can provide evidence of causality (Gifford, 2016).

- Experimental studies: such studies have an exploratory-descriptive nature so that individuals’ behavior in an environmental setting is investigated and events are manipulated and controlled to study causal relations during a laboratory setting. To obtain experimental control over independent variables across time, in separate efforts, experimental simulation techniques has been developed. Participants in this form of

[2] Behavioral mapping is a research tool used to observe and record behaviors in a particular setting at a particular time. Behavioral mapping can be either place-based or individual-based, depending on whether the focus of observation is to identify locational or temporal patterns of behaviors (Gifford, 2016).

simulation are led to believe that they are interacting with an ongoing environment and that their actions, behaviors and decisions will affect the environment. Participants in experimental simulations believe that the outcomes to which they will be exposed in the future are in some part direct consequences of their own previous activities. The experimenter may select one or more independent variables and manipulate these variables over time according to the research design. Other variables are held constant. Evidently, such a research technique has great advantages for experimenters who wish to measure effects of multiple controlled variables in complex, real-world environments. (Streufert and Swezey, 1982).

- Free stimulations experiments: in this technique, participants are asked to choose their own courses of action and they are free to alter the environment through their action over time. The result of such activity is a simulated system in which the individuals, groups, teams or organizations that operate as participants in the simulation produce changes in their environment over time. The free simulation represents a model or theory of some behavior under analysis. The goal of a free simulation is most often the prediction of real-world events that might defy understanding by the human mind because of their inherit complexity (Streufert and Swezey, 1982).

2.2. Pleasant Environment Qualities

Quality means the characteristics of anything or any phenomenon that has a certain emotional and rational impact on human beings. The quality of the environment is a complex concept, and involves individuals' mental perceptions, attitudes and values. Christopher Alexander believes that there is a kind of pivotal quality that is the basis of the life, mentality, city, building, and nature. Such a quality is objective and accurate, but it cannot be named (Mirzabeygi et al., 2015). As an important factor, environmental quality is a multidimensional concept that can comprehensively affect the life quality, and is consistent with concepts such as place quality, place perception, user satisfaction, and so on. In this sense, environmental quality considering socio-cultural and physical factors is a measurement for assessing the conditions of the environment that provides at least pleasantness indicators for life, and indicates the degree of satisfaction or dissatisfaction of users with the environment. In fact, a high-quality environment brings a sense of well-being and satisfaction to individuals through the attributes that may be physical, social, or symbolic (Kakavand et al. 2013).

Reviewing and investigating the definitions of environmental quality reflect different approaches. Nevertheless, in theoretical foundations of architecture and design, the lack of a comprehensive definition agreed by the experts from the concept of environmental quality can be seen. Thus, in a general category of Abedi et al (2014), based on the relevant concepts, factors that affect the quality of the environment and its constructive components are classified according to the following diagram.

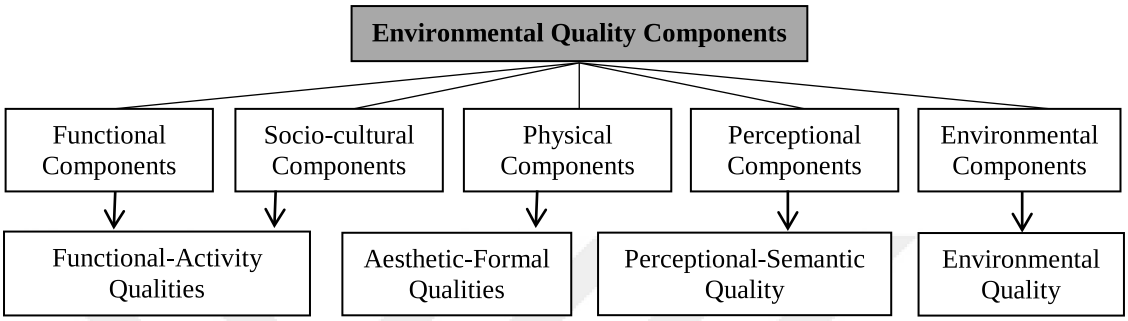


Diagram 2-7: Factors affecting environmental quality (Abedi et al., 2014).

2.2.1. Qualitative criteria affecting satisfaction and environmental preferences

In explaining the relationship between man and the environment, the early ideas refer to the environmental impact on human (Motallebi, 2002); but through time, it has been investigated that human behavior in an environment is interconnected, dynamic, and changing (Altman, 2004). In this regard, environmental quality and capability are examined based on individuals' perception (Lang, 2004). In a later approach, a high-quality environment transmits a sense of well-being and satisfaction through physical, social, or symbolic characteristics (Hajinejad et al., 2011). In architecture and urban design, the relationship between human and the environment, and how it is established has attracted great attention. Individuals organize their behavior in relation to the environment, and the environment also affects behavior. So, in order to organize the environment and individual activity in the best way, based on a user-oriented process, it is necessary to understand both user and environmental factors influencing the individual's satisfaction. Furthermore, how an individual communicates with factors must be identified. In this respect, to communicate and interact with the environment, human requires getting information from the environment. Paying attention to the processes of sensation, perception, cognition, and behavior; also, their role in the experience of the place considered as one of the most important requirements in designing a qualified environment (Pakzad and Bozorg, 2012).

The satisfaction of spaces in a variety of activities depends on the degree of responding to users’ need (Rafeian and Khodaei, 2010). In an overview, three domains can be considered related to affective bond of individual and the environment, sense of place, and satisfaction. The first field, “physical features”, that includes physical environment components such as scale, cue, perspective, landscape, mass and space, permeability, and legibility. The second field, “activity features”, includes noise, vitality, behavior, sociability, solitude, privacy, and comfort. The third field, “semantic features”, includes aesthetic, attractiveness, identity, quality, distinction, image, and sense of belonging (Daneshpour, 2004). Generally, in respect to similar researches conducted by Rafeian et al. (2009), Baba and Austin (1989), and Bentley Ian et al. (2005) factors like visual appropriateness, sensory richness, accessibility, continuity of passages, privacy, landscape, legibility, distinction, permeability, diversity, sociability, flexibility, noise, light, color, and climate are effective in assessing of space qualitative pleasantness and users’ satisfaction. It means the perception and cognition process of users in architectural places both are affected by “symbolic and physical-architectural” features and “individual psychological” features.

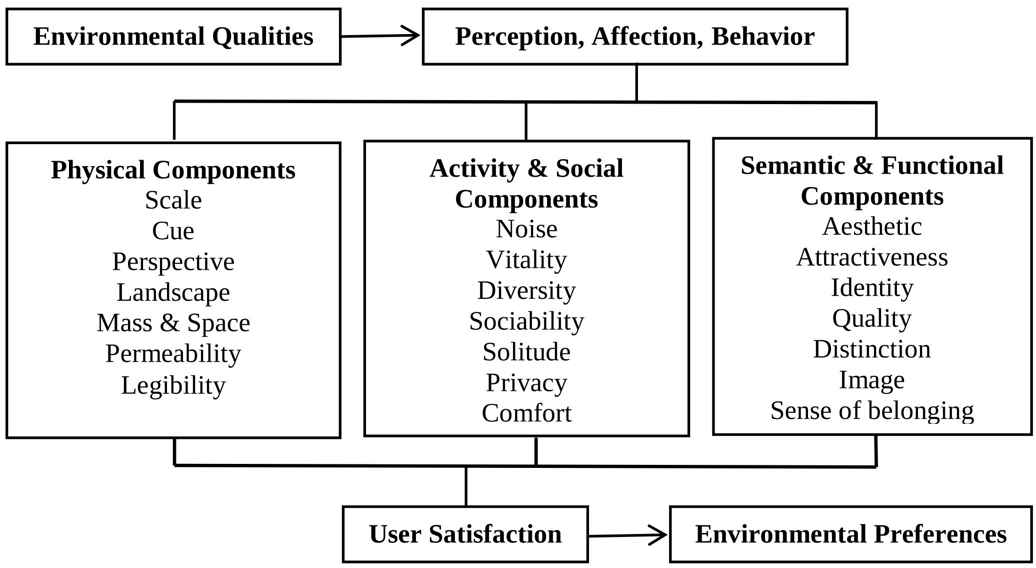


Diagram 2-8: Qualitative and effective criteria for the satisfaction of users from the environment (Khaleghimoghaddam, 2012).

In examining factors mentioned above, it can be seen that as a subset of the psychological and climate approaches, all factors are effective in designing a pleasant environment both individually and continentally. Fulfilling all examined aspects create comfort, privacy, security, and motivation. Consequently, vitality and satisfaction are provided from the environment.

Table 2.4: Proposed environmental qualities from psychological approaches point of view (Author)

Approach	Environment Quality	Proposed Characteristic
Psychological	**Sensory richness**	*Accesses including stairs, elevators, escalators * Landscape, Materials and decoration * Inspiration from the natural elements
	Permeability	* Using light, color, and transparency at the entrance of the building * Use of glass, terrace, staircase * Various entries
	Diversity	* Various furniture * Various materials in floor and ceiling * Form of plan * Plants and water
	Legibility	* The use of transparent surfaces in the crusts * Coordination between physical form and function * Use of legible surfaces and forms * Use of various materials and texture
	Flexibility	* Use of skeletal structure instead of Masonry * Use of truss and space frame to remove columns * Use of structures that provides the possibility to change the building use * Various furniture and arrangement * Multiple assessment, windows, and lighting system
	Visual appropriateness	* Create perspectives with different proportions * Creating systemic lines by structures and increasing visual proportions * Optimal place dimensions
Continental	**Temperature and Ventilation**	* Using double-glazed windows, shutters, thermal insulators * Keeping balanced the temperature of place with heating and air conditioning * Using intelligent heating and cooling systems to optimize energy consumption * Fitting the furniture in proportion to the area of the place and controlling the number of users in the use of oxygen
	Noise	* Minimizing noise pollution through a suitable location of the building, double glazing, green space * Keep the equivalent sound level
	Lighting	* The use of natural light through the dimensions of the openings, the orientation of the building * Creates a bright contrast with the use of reflex windows, shutters, and laminated glass * Uniform Distribution of Light in Space * Use normal light with a fluorescent lamp
	Color	* Use of bright, full color, lively and refreshing colors * Use of opaque colors to reduce the reflection of light

2.2.2. Basic concepts in the interaction of environment and human behavior

Based on environmental psychology, the most important design goals are the awareness of the impact of physical environment on behavior, experience, emotions, climate control, privacy, and interactions in order to satisfy users. There are five stages of planning, design, implementation, using, and assessment that can be evaluated in order to planning and design by using environmental psychological methods. How human behavior in relation to the physical environment reflects the diversity of behavior at any certain moment and the continuous variability in each particular space. In a physical environment, behavior has a dynamic feature, and a change in any stage affects other components like behavioral patterns of the environment. Regarding interaction between the physical environment and human behavior, various opinions have been raised which have been categorized as follow (Mostaghimi et al, 2015):

- **Design and individual differences:** Individual differences in environmental psychology are rooted in personality differences which measuring it can be useful in explaining and predicting behaviors.

- **Climatic features:** High temperatures, light, color, and weather pollution are causes of discomfort and stress, and if these factors are of good quality, they will ameliorate the experience and behavior of individuals.

- **Social transaction:** A person cannot accept a place for group activity unless a common identity and group to be formed among them. The physical environment should provide a space that would meet the social interaction requirements of the group.

- **Emotions and perceptions:** In addition to the physical characteristics (height, width, depth, form, etc.), and sensory factors such as thermal comfort, color, smell and sound considered as important features of a place that affect users' emotion.

2.3. Architecture and Experience

Understanding the place and knowing how to approach the place are considered as keys in understanding architecture. In fact, psychology and architecture historically have a common and intrinsic interest in the nature and perception of place. Along with the advent of modern empirical psychology, in the late 19th century, the place is foremost considered as the matter and essence of architectural experience (Ven de van and Delbecq, 1974). Study on the place and its experience have been the subject of many researches in recent decades which sought to understand and explain how environmental interaction affects people and life quality. For the first time in 1936, Kurt Lewin proposed the place-individual relationship in the form of personality psychology foundations, and also referred to the role of physical place in user behavior and experience. In the 1970s, various disciplines such as geography, sociology, and landscape architecture attempted to measure the relationship between place and person, the experience of place, and its impacts on human behavior. In this regard, concepts such as place attachment, community attachment, social affiliation, place dependency, place identity, place bonding, and rootedness have been expressed (Heidari et al., 2014).

Throughout human history, architecture has been mostly experienced visually. Man, in this inseparable element of nature, is considered as a fundamental factor in the definition of the environment in terms of providing shelter, boundaries, privacy, and built environment. In such a situation, the architectural priority has been to provide conditions for meeting the physical needs of users, but at the same time too, the experiential and emotional role of architecture should not be ignored. Recently, theories on environmental experience, emotion, cognition, and perception have opened the doors towards new designs which emphasis on the role of psychology. Pallasmaa introduced some attributes like multi-sensory experience, material poetics and fragility to experiment new qualities in architecture. According to these qualities, an experience is created based on human emotion and perception. Steven Holl describes stimulating inner and outer perceptions is a challenge for architects to heighten phenomenal experience while simultaneously expressing meaning, and to develop this duality in response to the particularities of site and circumstance. He believes that architecture can be considered as a series of partial experiences which correspond to the perceptual and emotional phenomena of the senses, such in fact that, dimensions such as color, light, proportion, geometry, material, etc. affect perception and emotion (Fortkamp, 2005).

2.4. Emotion and Experience

Emotion is one of the most important parts of the individual’s environmental experience, but having a precise definition of emotion is a difficult task because it refers to a feeling state which involves elements such as thoughts, psychological changes, and an outward expression or behavior. Many psychologists and researchers have tried to find a common and exact definition of emotion, and additionally, to investigate the relationship among mentioned elements. For instance, Douglas Candland defines emotion as a thought contrary to reason and thereby it can subvert motivation or values. Scherer (2001) believes that emotions are in association with the changes of the human body components like cognitive appraisals which evaluate objects, events and behavioral tendencies which are responsible for execution of activities, facial and vocal expressions, physiological reactions, and subjective feelings that monitor the internal state and the organism's interaction with the environment.

In other definitions, emotions involve kind of feelings which include positive or negative affective states and represent motivational phenomena with characteristic neuro-physiological, expressive, and experiential components (Dormann, 2003). According to the “basic emotion” approach, certain categories of biological-based emotions such as anger, sadness, fear, happiness, and disgust, led to specific behavioral and physiological patterns, but according to the “dimensional” approach, those emotions refer to elaborated responses constructed from biological properties such as valence (pleasure/displeasure), arousal (high activation/low activation), and approach-withdrawal (Barret and Wager, 2006). Kleinginna and Kleinginna (1981) consider emotion as a complex set of interactions among subjective and objective factors, mediated by neural-hormonal systems, which can:

- Give rise to affective experiences such as feelings of arousal, pleasure/displeasure.
- Generate cognitive processes such as emotionally relevant perceptual effects, appraisals, and labeling processes.
- Activate widespread physiological adjustments to the arousing conditions.
- Lead to behavior that is often, but not always, expressive, goal-directed and adaptive.

Therefore, an emotion is complex that it will typically involve many different elements: it involves episodes of emotional experience, including perceptions, thoughts, and feelings of various kinds and bodily changes of various kinds; and it involves dispositions to experience further emotional episodes, to have further thoughts and feelings, and to behave in certain ways. Emotions are episodic and dynamic, in that, over time, the elements come and go, and wax and wane, depending on all sorts of factors, including the way in which the episodes and dispositions interweave and interact with each other and with other aspects of the person’s life. There are some theoretical interpretations of how man experiences emotion. In the sense that generally, an event causes emotion in the cognitive state which is raised as a filter of perception, influencing behavior (Fortkamp, 2005):

James-Lange Theory: Event → Arousal → Interpretation → Emotion

Schuster-Singer Theory: Event → Arousal → Reasoning → Emotion

Centralist view: Perception → Cognition → Arousal State

Peripheral view: Perception → Arousal State → Cognition

As seen in the diagram, consciousness serves as a boundary between stimulation from the external worlds and the internal body. Emotions are a part of consciousness and reflect the complex interaction of mind and body. Today, by neurobiological analysis of emotional experience such as neuroimaging, it is possible to claim that a mental representation of emotion neuroanatomicaly and neuropsychologicaly is associated with pleasure or displeasure that affects feeling. Such a claim can be considered as cognitive processes by which mental representations of emotion, identifying factors shaping mental states, and emotional experiences can be measured.

2.5. Environmental Judgments, Individual Emotional Behavior of Places

Having a proper understanding of emotional experience is necessary for functioning effectively in the environment especially in architecture. Thus, today, many researchers are investigating emotional states and mechanisms based on brain activities. In fact, studies aim to determine the relationship or differences between the sensory inputs and the categorical nature of thinking about emotion (Salovey and Mayer, 1989; Whalen and Phelps, 2009). Some people like certain places and do not like other places, and blurt strong affective responses when they are in certain places. Generally, people’s environmental judgments include all kinds of individual feelings like descriptions, evaluations, aesthetic judgments, emotional reactions, and the meanings of danger. Environmental judgments can be linked from time to time but are conceptually completely independent, because a place may be meaningful, not because of pleasant experiences, but because of its miserable experiences. Various types of observations can be examined in environmental reviews, and in this regard, different ways of reporting and responding to emotions can be investigated in different judgments which can be verified by different criteria of arbitration. In order to measure the meaning of the built environment, one of the most important semantic dimensions is proposed by a group of researchers. Although the dimensions presented in the following table include a group of features that are considered in the interior architecture, some dimensions like temperature only indicates limited amount of indoor quality (Gifford, 2007).

Table 2.5: Semantic indicators to measure the meaning of designed environments (Gifford, 2007).

Factors / Concepts	The second scale	Initial Scale
General Evaluation	Good / Bad	Pleasant / Unpleasant
Necessity Evaluation	Useful / Non useful	Friendly / Hostile
Aesthetic Evaluation	Ordinary / Special	Interesting / Boring
Activity	Active / Deactive	Complicated / Uncomplicated
Space	Comfortable / Uncomfortable	Public / Private
Capability	Fragile / Coarse	Smooth / Rugged
Cleanliness	Clear / Dirty	Crowded / Adorned
Organize	Order / Turmoil	Formal / Informal
Temperature	Warm / Cool	Hot / Cold
Light	Light / Dark	Brilliant / Dark

In explaining and identifying the physical qualities that lead to a negative or positive assessment of the environment, Jack Nasar (1998) presents three types of quality: qualitative, symbolic and imaginative. Formal qualities include the complexity of design and order, the symbolic quality including the design style and the quality of the schema, including the ordinary or special design. Different types of evaluation based on the Nassar hypothesis include different qualities. For example, a pleasant building - for more people’s sight - has features such as order, modular complexity, and common styles of architecture. A peculiar building, with an unusual or special design, looks complex or less order. The most important point in this section is that the preference can be explained by physical components such as the number of windows or trees based on conceptual components such as clarity, continuity, landscape, etc. In general, people are more familiar with the flat, smooth and native landscapes (Gifford, 2007).

2.6. Environmental Evaluation and the Users Judgment of Place

Individual judgments about the environment contain dimensions beyond its physical qualities. They judge more about subjective properties of the environment such as calm, security, boredom, fear, etc. that such aspects indicate affective and emotional states of the user. This type of judgment can be called an affective evaluation in which it describes the environmental ability to alter user affection (Russell and Lanius, 1984).

Places, as mentioned earlier, evoke different emotions in people. Evaluation and judgment are different in four areas (Gifford, 2007):

1- Judgments are person-oriented, and focus on individuals' emotion and thought about places around them. Evaluations are place-oriented and focus on place quality from a broader human perspective. To understand how individual judge the environments, their individual experiences about the place being studied.

2- Judgments are more based on the psychological structure (such as affection, meaning, attention, and preference), but in assessments, physical characteristics (such as environmental quality) are often measured. Therefore, judgments and evaluations are conceptually different. For example, judging about the preferences of individuals in a place (a kind of judgment) and judging about the quality of place (a kind of assessment) are two different things. Architectural users may appreciate and evaluate a high-quality city, but never prefer to live in that city.

3- Evaluations are used more than judgments for public policy purposes. For example, more studies of landscapes assessment are conducted to help to decide on the conservation or development of certain types of landscapes.

4- Given that the assessments are place-oriented, generally, they are selected for those who have a certain functional relationship with the place. For instance, landscape architects can assess plants quality of the university gardens.

2.7. Emotional Evaluation and Responses

The emotional qualities of the environment affect user's behavior and emotional response, and it refers to the environmental psychology domain which studies human behavior, wellbeing, and the relationship between human and environment. Studies of affective or emotional evaluation seek to find how users experience and respond to the environments. Actually, affection and emotion are kinds of states relevant to the environment that provide the environmental information to the individual in a cognitive process, and response to events by organizing adaptive reactions to environmental stimuli. Researchers, emphasize the pervasiveness of the affective and emotional dimensions of the relationship between man and environment in the sense that affective qualities of the environment determine user's reactions and behaviors based on the features of the place. In fact, through perceptions and sensation elicited from characteristics of a place, affective qualities constitute a subjective experience that led to response or behavior (Russell and Snodgrass, 1987; Vogles, 2008).

Literature defines affect as the conscious subjective aspect of a mood which is part of bodily changes. Psychological studies define the concept of affect as a subjective aspect of emotion that includes experiences of goodness or badness, pleasantness or unpleasantness. According to Houtkamp, emotion is used for short-term states that typically have an object, meaning that they are directed to something or someone, for example, fear of an attacker. She believes affective qualities of the environment are as the features that determine users' emotion, which through these qualities users assess the environment and emotional respond to it in a process called affective evaluation (Houtkamp, 2012). Russell (2003) has mentioned the concept of affect and emotional evaluation as "core affect" which will be explained in the following sections.

In the emotinal evaluation, it is assumed that subjective behaviors and situations by an individual result in emotional processes with respect to needs, values, and health (Ellsworth and Scherer, 2003). In this respect, unconscious evaluation of stimuli takes place prior to the emotion, whereas conscious attributed to the emotion (e.g. fear) may also take place after the emotion occurs. However, some reviews argue that evaluation does not only take place prior to the emotions, but emotions also shape evaluation. Russell (2003) believes in a primary evaluation which is unconscious and immediate; for instance, if the stimulus is positive or negative, evaluations are conscious, deliberate, and more complex which have a cognition base (Houtkamp, 2012).

2.8. Architecture and User's Emotional Evaluation of Place

Contemporary buildings have been designed based on specialized criteria from the designers. However, since people understand the aspects and signs of buildings differently, they have different interpretations of them (Jencks, 1987). So, it seems that contemporary buildings should represent several aspects such as new, clean and distinct, in the eyes of the public, they are plain, hard and impermeable. When Groat and Wang (2002) was displaying modernist, traditional and post-modernist buildings to architects and non-architects, they found that these two groups have different understandings of the buildings. According to Rezazadeh (2002), an Iranian urban researcher, by focusing on some cases of Tehran's streets, she found that although users' preferences under the influence of cultural preferences are different; factors such as diversity, spatial organization and coherence show similar results were obtained. Kevin Lynch (2002) another hand, who is known for assessing urban environment with emphasis on the concept of cognitive maps, introduces five components in his model; they are paths, nodes, edges, landmarks, and districts. However, his model is not able to explore users' affective experience in the environment. Jack Nasar (1998) argues that, with the improvement of Lynch's environmental cognition idea, we can consider the concept of an environmental assessment by people based on five criteria such as naturalism, cleanliness and maintenance, spatial opening, historical significance, and order.

To understand user emotional experience, and to provide a condition on measuring them, different kinds of literature such as social sciences, psychology, neurosciences, etc. have been investigated. Specialists try to interpret the emotional aspects of the interaction between individual and place by evaluating and comparing various methodologies of measurement (Eun Cho and Kim, 2017). Researchers, such as Rappaport, Kaplan, Alexander, and Ralph believe that using methods and procedures to identify individuals' emotional assessment, besides the environment technical assessment, can develop planning and space design theory (Radberg and Steffner, 2003). Therefore, understanding the emotional assessment of users is considered as a source of useful data collection in creating and developing public spaces. It also can reflect the designers' ideas of what makes pleasant places. For instance, in David Canter's (1977) theory of place, the users' satisfaction in the residential environment has been investigated, and the experience of pleasure has been analysed as an important criterion. Studies on place satisfaction include three psychological components of affection, cognition, and behavior (Rosenberg and Hovland, 1960).

2.9. The Importance of Environmental Design on Users' Emotional Experience

Today, the discussion of different concepts related to place and how it is experienced by users is one of the most important issues in architecture and urbanization, especially in the field of behavioral and environmental sciences (Gifford, 2007; Stokolos and Altman, 1987; Kaplan and Kaplan, 1982). Emotions are an important aspect of the user's experience when using interactive systems and thus emotional behavior needs to be studied in the field of interactive design solutions (Cristescu, 2008). Cacioppo and his colleagues believe that the relationship with our physical world is emotion (Cacioppo et al., 2001). In fact, "Emotion is often described as states characterized by episodes of intense feeling associated with a specific stimulus” (Floyd, 1997; Cohen and Areni, (1991); Ulrich, 1983). To make emotional symptoms accessible to cognitive processes, Cohen and Areni (1991) point that emotions created during an environmental experience emit intensive traces of effects. Nevertheless, there is no enough evidence in terms of architectural design and quality impact on experience, perception, and emotion. Individuals should have an understanding of the effect of environment on their emotion to have an experience of interaction and communication with the place. To create an environment which is compatible with the needs of the individuals, it is necessary to understand both the relationship between users and the environment, in the sense of the impact of environmental elements on different levels of users’ behavior, affection and perception.

According to Rappaport (1983), environmental quality is the result of the focus of planning in ensuring a better environment, in terms of safety, aesthetics, comfort, and well-being of the society. In respect to his thinking, due to the multi-dimensional nature of environmental quality, it should be considered in both objective and subjective assessments. Studies had shown the differences between the users’ subjective assessment and the specialists’ objective assessment (Odemerho and Chokor, 1991; Milbrath, 1978). Lang (2004) believes that designers are impressed by visual aspects. According to him, designers consider architecture as a work of art than a place where people live. Hubbard also has the same idea and said: “Design has created a special vision for specialists in the field, which focuses on measurable aspects of environmental quality than aspects of personal perception. The difference between designers and non-designers is how they think about their environment…” (Carmona et al., 2010).

It can’t be expected from an environment that is considered to be a pleasant, beautiful and efficient by architect, for other people in that community to have a similar interpretation because people rely on their past experiences to interpret environmental information (Barati, 2010). Therefore, the relationship between specialists’ assessment and users’ assessment, and the relationship between technical indicators (the quality of climate) and general indicators (the quality of environment), together with the application of these indicators in evaluating these operations are important (Gifford, 2007). Different methods have been used for the recognition, analysis, and evaluation of environmental quality. Different measurement techniques and models have been proposed which approved the difference between users’ subjective assessment and specialists’ objective assessment (Odemerho and Chokor, 1991; Milbrath, 1978).

2.10. The Emotional and Affective Measurements of Place

2.10.1. Emotional states

Issues related to emotion have been considered in multidisciplinary fields which focus on philosophical, psychological and physiological aspects of emotion (Laurans et al., 2012). In this context, according to the literature, emotion can be regarded as a process of changes in different components rather than a homogeneous state (Scherer, 2001) that is, behavioral reactions (e.g. approaching or avoidance), expressive reactions (e.g. smiling), physical reactions (e.g. heart pounding), and subjective feelings (e.g. feeling amused). Each instrument that is claimed to measure emotion in fact measure one of these components (Desmet, 2003). Emotions can be largely categorized from two perspectives: discrete and dimensional. The discrete emotion approach depends on the categorization reflected in the semantic fields for emotion in natural languages such as emotion-category specific patterns of facial and vocal expressions and physiological responses. The dimensional perspective organizes emotional responses in dimensional models that the valence, arousal, and approach model proposed by Russell and Barrett (1999) are considered as the most common dimensions in the categorization of emotions. The valence dimension is a continuum of states from positive to negative, whereas the arousal dimension is a continuum of states from calm to excited. Approach motivation is characterized by tendencies to approach stimuli, whereas avoidance motivation is characterized by tendencies to avoid stimuli (Eun Cho and Kim, 2017).

2.10.2. Emotional measurement in an architectural place

Reviewing researches conducted related to the interaction between emotion and architecture, (Stokolos and Altman, 1987; Cohen and Areni, 1991; Cacioppo et al., 2001; Radberg and Steffner, 2003; Eun Cho and Kim, 2017) provides an overview of various effective elements in an architectural space which arouse user’s emotion. In these researches, authors regard the components as environmental stimuli that trigger people’s emotional responses in two main aspects, emotional expression, to deal with the user in space, and emotional exchange, to emphasize on the interaction between user and space. Accordingly, for instance, Fritz Steele (1981) has categorized the most important effective environmental stimuli in twelve factors written in the following table. In fact, the pleasure of the sensation experienced from the environment involves the arousal of users' emotion and perception which results from sensations like odor, sound, color, and texture (Eun Cho and Kim, 2017).

Table 2.6: Sensorial environmental stimuli affecting emotional and perceptual experience (Steele, 1981)

Dimensions	Enclosure	Contrast	Proportion	Scale	Volume
Distance	Odor	Color	Sound	Texture	Visual variety

Eun Cho and Kim (2017) have provided a conceptual framework for emotion measurement in an architectural space which can be shown in the following diagram. They classified factors such as morphological, sensory, and perceptual as environmental stimuli which lead to emotional responses through a cognitive interaction.

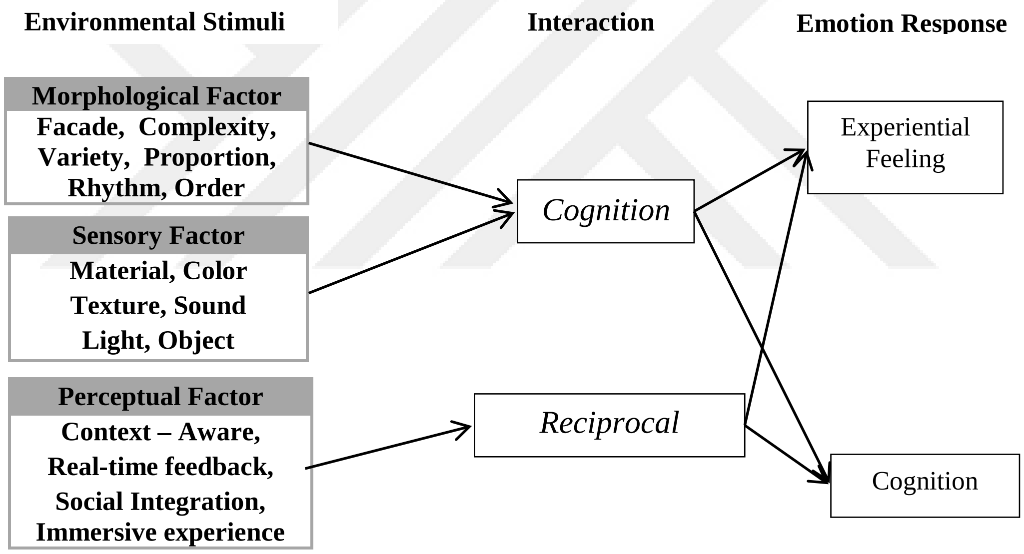


Diagram 2-9: The conceptual framework for emotion measurement in an architectural space (Eun Cho and Kim, 2017)

2.10.3. Environmental stimuli

In experiencing and perceiving an environment or architectural place various stimuli are considered as the root of the user's emotional and behavioral responses. In this case, morphological features such as volume, proportion, order, complexity, and rhythm represent the visual composition of a place in the role of stimuli leading to the arousal of the emotions (Lang, 1988; Nasar, 1997; Sanoff, 1991). Sensory features are related to the pleasure of the sensation received from the buildings which involve the arousal of user’s perception, resulting from the colors, odors, sounds, and textures of the environment. Perceptual features involve from some quantitative characteristics of the environment such as enclosure, dimension, height, scale, etc. to elements like social interaction, immersive experience, etc. which are within a reciprocal action by perceiving human emotion (Eun Cho and Kim, 2017).

2.10.4. Emotional response

Since there are several ways in responding emotionally to the environmental stimuli, it cannot be said that which method is suitable for the emotion measurements because depending on conditions and types of stimuli, there are different emotional responses. In this regard, according to a general classification, A) experiential, B) behavioral, and C) physiological responses are considered as three main components (Eun Cho and Kim, 2017):

A) Experiential Response: Generally, emotional states can be understood and described by verbal instruments like using a set of rating scales or protocols which evaluate the subjective feeling component of emotions. In an architectural place, two scales are constructed for measuring experiential response: the environmental scale -for experiential response to space itself, and the processing scale- for experiential response to the information processes of the space. The former is associated with emotional variables such as memory, attraction, pleasure, stimulation, contents, and satisfaction.

B) Behavioral Response: Any emotion is defined by a specific pattern of expression. For example, anger is accompanied by a fixed stare, contracted eyebrows, compressed lips, brisk movements, and a raised voice. Evaluation of a stimulus seems to be reliably associated with a behavioral tendency to approach pleasurable stimuli and to avoid negatively valence stimuli (Russell and Mehrabian, 1978).

C) Physiological Response: A bodily process occurring due to the effect of some antecedent stimulus or agent. Physiologic measurement includes the use of measurements such as galvanic skin responses (response sweat glands), pupil responses and cardiovascular parameters such as electroencephalograms, etc. Another possibility is to use video to record facial expressions. Some of the limitations of these methods are their lack of precision (Dormann, 2003).

2.11. A Model for the Evaluation of Users' Emotional Experience and Responses to the Environment

As mentioned, the emotions elicited by an environment affect individual behavior and experience. In order to understand such behavior, it had been better if it describe comprehensively the impact of environmental quality on individual emotional states (Russell and Mehrabian, 1978). Although user's emotion and experience in place become critical in buildings, little research exists on user emotion and experience in the architectural domain. Hence, it is very important to assess the affective experience of users in the architectural environment. Emotional evaluation depends on the understanding of the affective quality of objects and the affective quality of places by an individual. To this end, although objective factors arouse desirable or undesirable feelings, they are the result of mental and affective states. In order to understand user emotion and experience, and to develop measurements on them, multidisciplinary literature including psychology, social science, neuroscience, industrial technology, and Human-Computer Interaction are analyzed. By assessing and comparing various methodologies of measurement, authors discuss the affective and emotional aspects of interaction embedded in spaces (Eun Cho and Jeong Kim, 2017). In relation to affective evaluation Russell and Snodgrass (1987) stated: "An affective appraisal is an attribution to some object, event, or place of an affective quality. An affective appraisal can be distinguished from mood, at least in principle, in that affect appraisal is thus always directed toward something. Subjectively, the appraisal refers to the quality of the object appraised: It is the object that appears pleasant or disgusting" (Floyd, 1997).

In the field of environmental psychology, pleasure and arousal are conceived as two basic dimensions of affective responses that indicate peoples' state of feeling (Bakker et al., 2014). Emotions include dimensions of pleasure and arousal (Bigne et al., 2005). Empirical studies have shown that pleasure and arousal are most descriptive of affective appraisal of environments (Floyd, 1997), and it can be said that pleasure and arousal are considered as important dimensions in the definition of individuals' affective assessment of the environment. Physical futures of an environmental setting affect the amount of pleasure and arousal (Hull and Harvey, 1989).

An often applied approach to assess and describe environmental experiences is the environmental psychology method of Mehrabian and Russell (1974). This model provides a theoretical framework to investigate the role of physical environment qualities in people emotion; subsequently the effect of emotion on environmental behavior. It consists of three parts of environmental stimuli, emotional states, and approach-avoidance responses. The environment creates an emotional reaction in people, which, in turn, leads to desirable or undesirable behaviors (Ryu and Jang, 2008). Based on this argument, it is assumed that environmental perceptions are directly related to the user's behavioral tendencies, pleasure, and arousal. Actually, it is the physical environment which considered as stimuli in creating approach or avoidance behaviors. In this vain, pleasure, arousal and dominance as three emotional states are generated by the environment and mediate approach-avoidance behaviors in a wide range of environment. Pleasure refers to adjectives such as good, happy, pleased, whereas arousal refers to adjectives like stimulated, excited or active. Dominance is defined as person states in relation to control (Ryu and Jang, 2007).

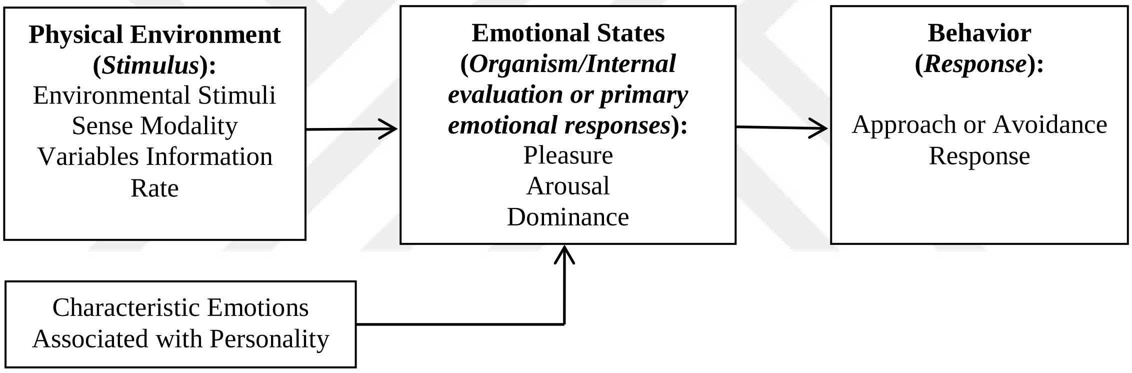


Diagram 2-10: The base of Mehrabian and Russell model (Ryu and Jang, 2007; Houtkamp, 2012).

As shown in diagram 2-11, they use three affective dimensions - pleasure, arousal, and dominance - to describe human emotional response and perception to physical environments. On the other hand, specifically, they can be respectively related to affective and conative responses (Bakker et al., 2014). In the last four decades, pleasure, arousal and to a lesser extent dominance have been used and are still used by numerous researchers in the field of environmental psychology (Arfin and Cheung, 2007; Kuppens, 2008; Van Hagen et al., 2009; Morrison et al., 2011; Huyn et al., 2011). In the past, this model especially has been used in studies which examine the verbal interpretations of emotion (Bush, 1973), and facial or vocal expressions of emotions (Mehrabian and Ksionzky, 1974). Although pleasure, arousal, and dominance are used as verbal self-report, they are considered as fundamental emotional response factors that include physiological, behavioral and verbal report components (Russell and Mehrabian, 1978). Today, pleasure and arousal are also applied in other disciplines such as the neurological and neuropsychological sciences (Costa et al., 2010; Walter, 2011), marketing research (Ha and Lenon, 2010; Penz and Hogg, 2011), and computer systems (Colomo-Palacios et al., 2011). This evidence shows the validity of proposed dimensions in describing emotional responses to all types of environments.

In this model, more comprehensively, Pleasure-unpleasure introduced as a continuum ranging from extreme unhappiness to extreme happiness, and used adjectives such as happy-unhappy, pleased-annoyed, and satisfied-unsatisfied to define a person's level of pleasure. Arousal-no arousal was conceived as a mental activity describing the state of feeling along with a single dimension ranging from sleep to excitement and used adjectives such as stimulated-relaxed, excited-calm and wide awake-sleepy to define arousal. Dominance was related to feelings of control and the extent to which individuals' feel restricted in their behavior. Mehrabian and Russell used a continuum ranging from extreme feelings of being influenced and controlled by one's environment to feelings of mastery and control over it (Russell and Mehrabian, 1978; Bakker et al., 2014). Later, Russell and Barret (1999) eliminated the dimension of dominance. Unlike pleasure and arousal dimensions that conceived as affective or cognitive and underlie any affective responses, they claimed dominance is neither affective, nor cognitive, but conative, and does not have a significant effect on behavior (Bakker et al., 2014; Ryu and Jang, 2007). So, they modified a model which includes pleasure and arousal.

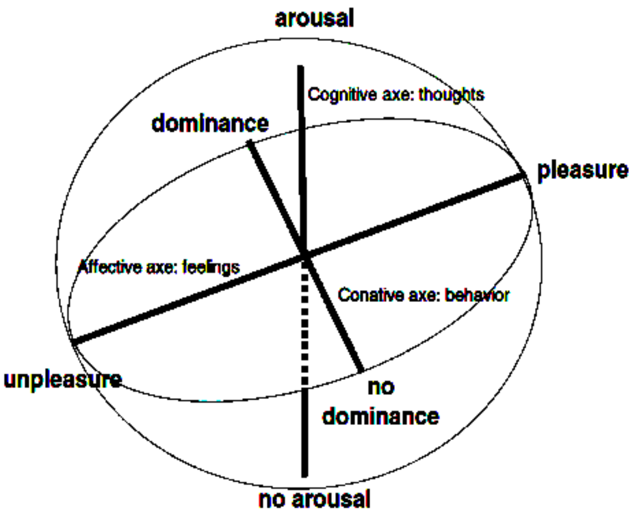


Diagram 2-11: Three-dimensional model of pleasure, arousal, and dominance as the tripartite view of experience proposed by Mehrabian and Russell (Bakker et al., 2014; Bakker and de Boon, 2012).

In completing the present discussion, James Russell (2003) used the concept of core affect to describe states of mood, mentally process, and good or bad feelings which both influenced by internal and external causes, and influences reflexes, perception, cognition, and behavior. He focuses on how emotions are linked to different facial expressions and if there are differences in this between different cultures. Russell has found a number of suggestions for emotional responses to the built environments through surveys. Based on these suggestions and previous psychological research, he has formulated a model based on feelings “arousal” and “pleasant” and its opposites “no arousal” and “unpleasant” (Steffner, 2009).

Figure 2-1: Illustration with facial expression (Steffner, 2009)

Furthermore, he defines core affect as a neurophysiological state that is consciously accessible as a simple, non-reflective feeling that is an integral blend of hedonic (pleasure-displeasure) and arousal (sleepy–activated) values. According to the following diagram proposed at Russell study (2003), the horizontal dimension, pleasure-displeasure, ranges from one extreme (e.g., agony) through a neutral point (adaptation level) to its opposite extreme (e.g., ecstasy). The feeling is an assessment of one’s current condition. The vertical dimension, arousal, ranges from sleep, then drowsiness, through various stages of alertness to frenetic excitement. The feeling is one’s sense of mobilization and energy. Some names for regions of the following model are emotional (*elated*, *upset*, *depressed*) and some are not (*tense*, *calm*, *serene*, *comfortable*, *fatigued*, *bored*, *drowsy*). In fact, Russell proposes that the core effect at any slice in time can be described by two independent dimensions; Degree of pleasantness and degree of activation (Russell and Barrett, 1999).

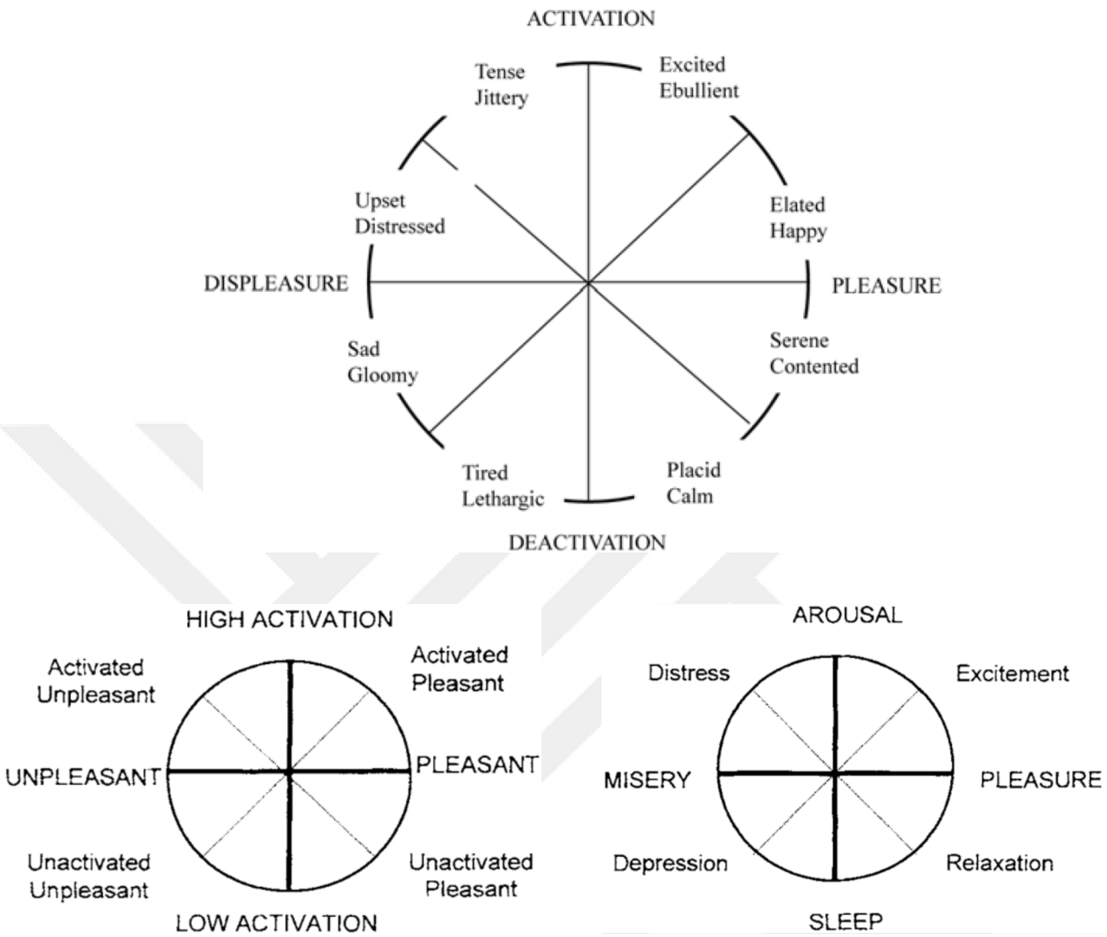


Diagram 2-12: Two descriptive models of core affect (Russell and Barret, 1999)

Since there are a lot of different adjectives which are used to describe the concept of pleasure and arousal, this makes the comparing and understanding of findings related to place perception and emotional experience difficult. That’s why the diagram which is the results of 16 descriptive elements which have been obtained from 105 features proposed by Mehrabian and Russell (1974) and was modified from Russel and Barret (1999) represents the feelings of popular culture with different meanings. The horizontal axis of the diagram shows various adjectives to indicate the level of pleasure (desirable to undesirable attributes), and the vertical axis shows various adjectives of arousal (uniform to impressive attributes). Based on this analytical index the emotional quality of places can be explained. Individuals’ affective responses to the environment include a complex situation of behavioral and cognitive responses which have a continuous and implicit mode. User describe places based on a combination of modes such as desirable, impressive, safety. These feelings are related in Pleasure-Arousal model. So, if a place is both pleasant and impressive, we will be attracted to it.

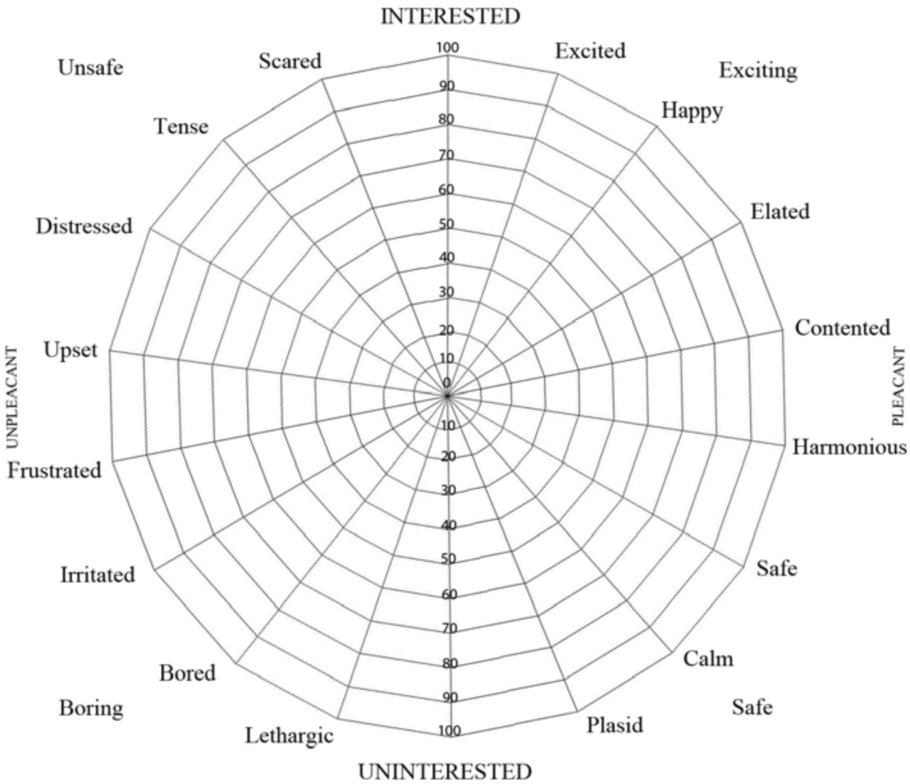


Diagram 2-13: Pleasure and Arousal conceived as two basic dimensions of affective responses that indicate peoples' state of feeling proposed by Mehrabian and Russell, and modified from Russel and Barret (1999).

In assessing the pleasant (horizontal axis), visual factors play a role more than audio factors, but in terms of motivation (vertical axis), both visual and audio factors are important. Also, affective assessment correlates with an individual's compatibility level (Russell & Lanius, 1984) have shown that people's assessment depends on the amount of arousal which they have to be compatible. According to the Harry Helson's adaptation-level theory, if severe emotional assessment (very high or low arousal and pleasure) occurs in people exposed to the environment, such an affective and emotional situation affects the assessment of next or another place, and in this context, the level of compatibility is one of the reasons for differences in affective assessment of a place (Edwards, 2018).

In the framework suggested by Russell and Mehrabian, environmental variables (light, heat, or speed of information reception), as well as individual variables (socialization or mobility), affect the amount of emotion that individuals experience in the environment. These emotions affect behavioral factors such as the tendency to interact or tendency to be away from the place (people's performance in the environment or interactions between individuals). As mentioned earlier, Pleasure-Arousal model has been tested in some studies. To this end, users were asked to say how they react at such a place. For example, they were interested in to approach to places which were different from other places, had a moderate level of arousal and had a high pleasure. As shown in the following graph, increasing arousal level causes to increasing place pleasant so that it creates more willingness to interact with place. Moderate arousal places are more appealing than low arousal places (Gifford, 2007).

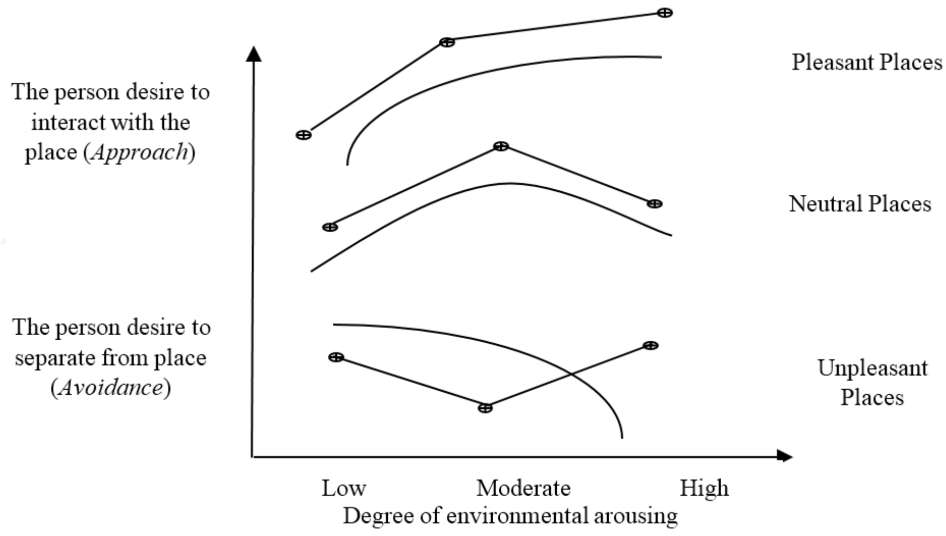


Diagram 2-14: Pleasant-Arousal Hypothesis: The desire for interactivity in the place changes with the quality of pleasant-arousal of the environment. In the context of this hypothesis, we must call for presence in places of high pleasure and moderate arousal (Russell and Mehrabian, 1978; Gifford, 2007).

2.12. Seeking of Underlying Mechanism of Pleasure and Arousal

Having a comprehensive knowledge about the mechanism of pleasure and arousal help us to enrich our understanding of the relationship between stimuli (environmental futures) and responses (human environmental behavior and experience). In fact, this can be considered as an introduction of laboratory studies to know what happens in the mental processes between stimuli and responses (Bakkers et al., 2014). The following figure refers to the pleasure-arousal model presented by Meharabian and Russell (1974) using in valuing people's state of feeling related to the environment. It is assumed that the central square (grey) is as a pleasant and harmonic environment, and the outside area is considered as the unpleasant or non-harmonic environment. According to the diagram, any unpleasant place with low quality leads to feeling disharmony; whereas a pleasant place with very high-quality cause feeling of disharmony as people get lazy and bored (Bakker et al., 2014; Soesman, 2005). A very low degree arousal environment leads to feeling drowsy, and a very high degree of it makes them highly agitated (Bakker et al., 2014; Kandel et al., 2000).

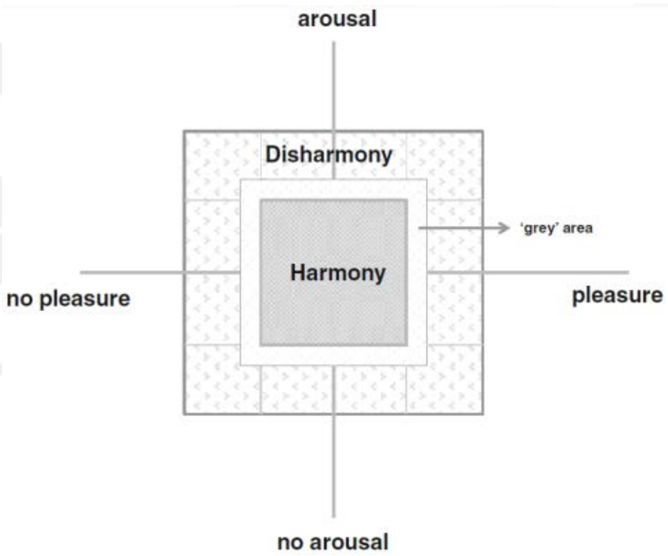


Diagram 2-15: Pleasure and arousal as indicators for harmony and disharmony in the physical environment (Bakker et al., 2014; Bakker and de Boon, 2012)

In Diagram 2-16 which is a prepared model to understand the user state of feeling in relate to the environment; the horizontal axis represents the level of order and the vertical axis represents variation. The grey square is assumed as an environment with a well-balanced level of order and variations that cause harmonious feelings, and the outside area shows disharmony (very low and very much degree of order and variation). Like Diagram 2-15 the central grey squares represent a positive response. Accordingly, it can be said that the environment degree of order and variation is associated with the individual judgments related to pleasure and arousal. In this case, the level of orders and variations can determine the amount of the environment pleasantness; also, explain how the environmental qualities affect user affection (Bakkers et al., 2014).

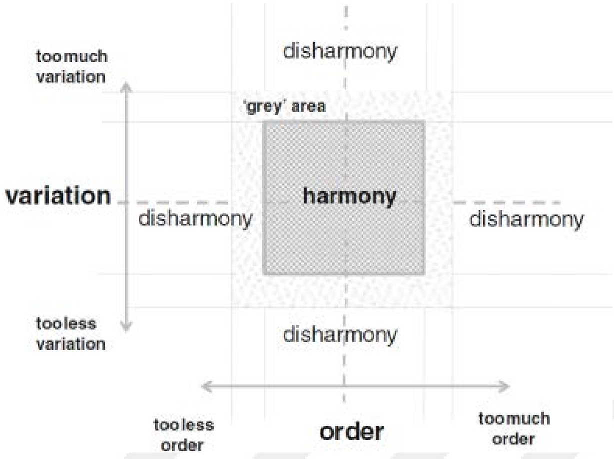


Diagram 2-16: The degree of order and variation as indicators for harmony and disharmony in the physical environment (Bakker et al., 2014; Bakker and de Boon 2012)

After a detailed explanation of affective evaluation of the environment, it is necessary to explain an illustrative example of the research conducted in this regard by Lena Steffner (2009) at Lund University of Technology, from the Department of Urban Planning. In the research, Steffner aims to develop a method that measures the experience of the urban environment. The method used is a systematic way of describing urban characters and measuring how they are experienced through questionnaires and circle diagrams of Russell’s theories of human core effects, and has its focus on the participant’s affective appraisals and personal experiences of specific types of urban characters.

The circle diagrams show to what degree the participants experience a specific urban environment as exciting, pleasant and safe or its opposites; boring, unpleasant and unsafe. The participants mentioned factors that influencing their affective appraisal are exemplified. Investigations of the public’s affective appraisals and experiences are made on five areas with different urban characters; a postmodern suburb and a medieval urban character (in the licentiate thesis) and an industrial city built in a grid pattern with stone houses, a garden city, and a function divided the city. The participants mentioning of factors influencing their affective appraisal are exemplified.

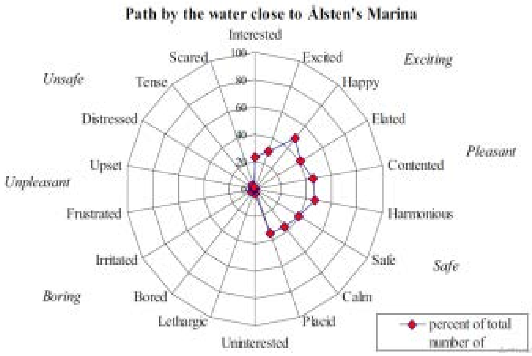


Figure 2-2: Evaluation of path by the water (Steffner, 2009)

Summary of the participant's responses:

- Beautifully situated walking path in the woods near the water.
- Very appreciated suburb.
- I get mental relief here.
- So many good ideas come to you here.
- Better places to sit and meet are needed here.

The participants experience this environment as **pleasant and exciting** due to nature during the changing seasons along the water.

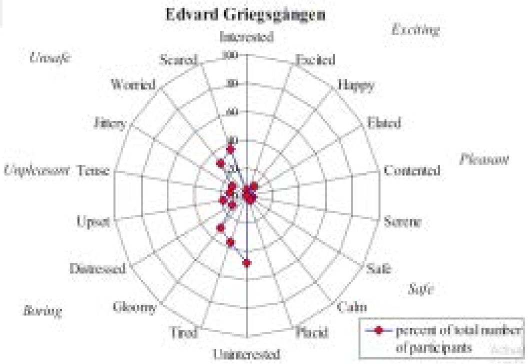


Figure 2-3: Evaluation of path by the water (Steffner, 2009: 157)

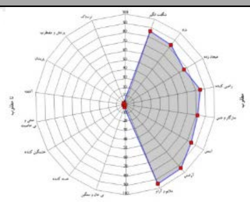
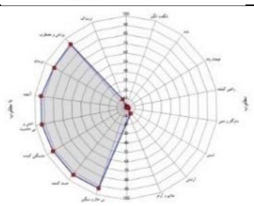
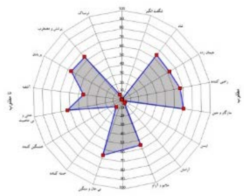
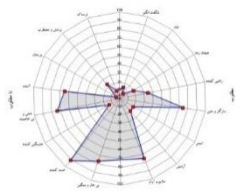
Summary of the participant's responses:

- I would never walk here after dark.
- This is a scary environment.
- Dark and unpleasant place in concrete.
- Very bad architecture.
- I feel unsafe when I walk here.
- Looks boring. Like a ghetto.

The participants' experiences as **boring and unsafe** are due to dull architecture is done in concrete and memories of unpleasant happenings.

In a study we examined the impact of environmental design on user experiences in the educational spaces of Tabriz Islamic Art University in Iran. In the research area, the affective assessment of four different spaces, which have been changed their function, was made. We hypothesized that users' affective experience is influenced by environmental and architectural design. The method applied was the interpretation of the data obtained by the scores of the pleasure-arousal diagram of the affective and perceptional experience of 100 students in 16 educational spaces. As a result of the research, it has been verified that space design style has an active role in the affective experience of students, and there is a meaningful relationship between user's spatial experience and the design style. In this context, it has been revealed that the spatial experiences of students in traditional spaces are positive and satisfactory in terms of interest, pleasuret and security, and that for the other three groups, many changes are required in the architectural design and spatial organization to provide positive motivation and emotional suitability.

Table 2.7: The result of pleasure-arousal diagram of the spaces of Tabriz Islamic Art University

Faculty of Architecture	**Average of Pleasure-Arousal Model**	**Faculty of Computer Arts**
Faculty of Architecture		
Faculty of Computer Arts		
Faculty of Practical Arts		
Leather Factory (Service Building)		

In this way, the results of the study showed meaningful correlation between design style and environmental pleasure experience. The revival of the historical houses as educational space is effective in creating affective pleasure. However, the design of new educational spaces based on uniform functionalism, and on the recycling of industrial buildings without modifying the spatial organization and environmental quality, has been unable to create an affective pleasure. Therefore, it is necessary to make modification in their spatial organization, architectural design and landscaping for arousal and pleasure aspects.

2.13. The Process of Evaluating the Emotional-Perceptual Experience of Place

2.13.1. Individual processes

As mentioned earlier, human behavior or reaction to the environment depends on a bilateral relationship between them. In this context, the part that the architects and urban designers have the most impact on is the surrounding environment which is in this case, is essential for them to have a proper understanding of human characteristics, and to know how and under what processes human response to the environment. Like any other process, the process of the human-environment relationship includes a set of integral steps such as main factors of sensation, perception, cognition, and behavior. At the stage of sensation, which has a completely physiological basis, an individual collects the environmental information and transmits it to the brain. This process conducted by the five senses and the body neural system.

After receiving information in the brain, the process of perception and mental analysis will be started. Actually, in the perception phase, the brain selects and organizes specific information, and adds meaning to them. After organizing the mental data, mental images are created. Accordingly, evaluation, conclusions, and behavior are made. Such a mental exploration is done in the cognition process. These steps take place in a very short and intangible way that forms the base of individual behavior. In fact, based on information perceived from the environment (sensation), and it's analyzing (perception), during a complicated mental process, individually evaluated (cognition) that makes a certain behavior (Pakzad, 2012).

2.13.2. Sensation

Human affects the environment, and also are affected by it. In order to exert such in interaction, firstly, an individual must feel the environment. This is done by environmental stimuli on sensory organs. Aristotle first classifies human senses in five senses of vision, olfaction, gestation, auditory, touch (Grutter, 2007). The stage of sensation can be defined as follows: “transferring the stimuli effect from the sensory receptor to the central nervous system which is objectively trackable”. It does not have cognitive value, and is achieved in a passive way, also has a physiological basis (Khodapanahi and Iravani, 2002). In other words, the process of sensation involves the stimuli conducted by external phenomena on the sensory organs of a human, and converting them into electrical impulses, and transmitting them by the central nerves to the human brain **(**Barati and Soleymannejad, 2011).

As mentioned, in the process of the human-environment relationship, the sensation is considered as the first step. At this stage, the environmental information is received and transmitted to the brain by five senses based on sensory capacity thresholds. In other words, the sensation stage involves from the beginning of receiving information to its transmission to the brain, without any analysis from the brain. Due to the importance of the sensation in the experience of urban space, Bentley et al. (2015) emphasize the richness of sense as one of the pillars of improving the quality of the environment. Lynch (1980) also examines in his book “Managing the Sense of Region” the quality perceived from the environment based on five senses, and the effect of spatial scale on place feeling.

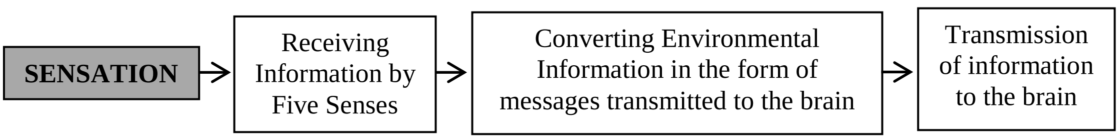


Diagram 2-17: The process of environmental sensation (Pakzad, 2012)

As it is known, the sensation plays an important role in the level of contact with the environment. The sensory system is composed of organs to see, hear, bite, touch and taste (Joedicke, 1985). Actually, each of the sensory organs has a section that is sensitive to environmental stimuli which called “sensory receptors” (Ganji, 2009). The receptors are sensitive to a limited range of stimuli not to all stimuli (Joedicke, 1985).

Biological processes associated with receiving and transmitting environmental information to the brain are also of great importance. To this end, designers and planners must have sufficient information about the frameworks related to sensation. These studies are performed according to Aristotelian classification of sensory organs.

- Vision: In fact, vision is the ability to recognize and visualize environmental phenomena. From the senses, vision is our greatest communication with the environment, and also it is one of the senses through which we can find information that is far from us[3] and is often critical to us. The definitions given by Porteous suggest that vision is the most fundamental sensation compared to other senses, and collects the most information from the surrounding environment to provide it to the brain. He calls vision as an active seeker, selectively and consciously sense. Consequently, it can be claimed that the sense of vision is very complicated, and location in space is usually achieved through this sense. So, environmental factors such as distance, color, shape, texture, and contrast can be achieved with the help of vision **(**Barati and Soleymannejad, 2011). One of the most important issues related to the sense of vision is that this sense is more relevant in terms of its visual and pleasing beauty, or, in other words, based on aesthetic experiences, but it is important to pay attention to this point and how the visual system works in transmitting a pleasant visual message. In other words, what is often overlooked is how the sensory perception affects the pleasant or unpleasant perception of the environment, and what we often address is the importance of the beauty and desirability of the visual environment in creating quality environments (Pakzad, 2012).

Vacilly Fillin, a Russian biologist, in his study of the impact of the environment on the visual mechanism, divides the artificial visual environment into homogeneous, aggressive and ugly comfortable categories. In his opinion, the homogeneous environment is an environment that due to the uniformity and lack of detail and elements, do not have enough information to move the eye and is quickly recognized at a glance. But the aggressive environment is an environment in which a person at a moment sees a large number of elements that are similar to each other. This factor, that is, the density of elements that are similar to each other increases the volatility of the signals transmitted to the brain and causes double pressure on the system of eye movement. Furthermore, this issue increases the amplitude of the oscillation, which also causes pressure on the nervous system.

[3] Vision or auditory receptors that transmit data that is far from them. These receptors are also called distance receptors (Pakzad, 2012).

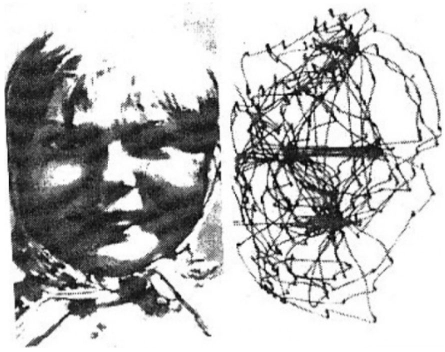
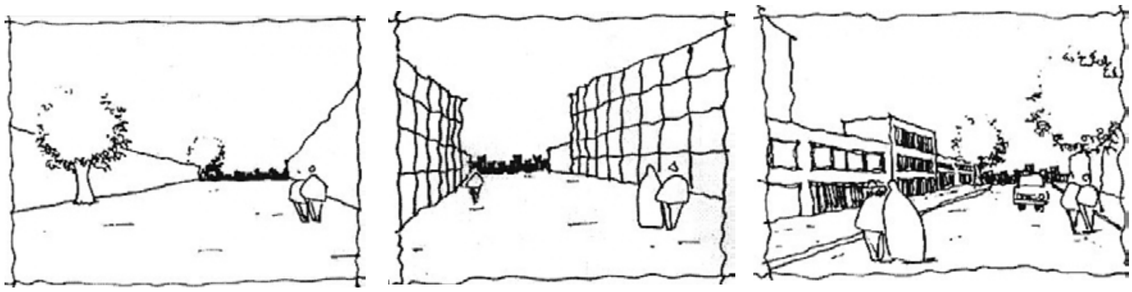


Figure 2-4: Eye movements when looking at the image (Pakzad, 2012)

Fillin considers the comfortable environment in which despite the presence of varied elements, features such as curved lines, color variations, variations in surfaces, shapes, and colors that are closer to the natural environment cause it to be a pleasant environment. Comfortable environments are typically eye-catching. The use of straight lines perpendicular, right angles, rigid geometric shapes, uniformity and similarity in the components make the environment inappropriate for the eyes, characteristics that are not commonly seen in natural environments. He believes that natural environments are more in line with the physiological mechanism of vision, and artificial environments often contradict these factors, and unlike the past, with the development of cities, the environment has changed dramatically and is further away from the natural environment (Pakzad, 2012). Consequently, since individual environmental perception mainly is visual, it is better to use visual stimuli to design communication with the user, and also to be able to enrich visual connection by other suitable sensory stimuli.



Homogeneous Environment **Aggressive Environment** **Comfortable Environment**

Figure 2-5: Artificial visual environment categories according to Vacilly Fillin (Pakzad, 2012)

- Touch: As previously mentioned, environmental information is received in a variety of ways. In this context, touch is one of the ways to get environmental information. Touch sensation has a major difference with other senses, and its receptors are not located in a particular organ but are scattered throughout the body. The skin can be thought of as a large sensory limb that covers the whole body, so that, composed of three distinct skin sensations responding to the thermal sensitivity, paraesthesia and algesthesis (Atkinson et al., 2002). Human skin is very sensitive to temperature, and touch like any other sense has a threshold. Temperature thresholds play an important role in the pleasure and utility of place experience. Although an architectural environment to be beautiful in terms of visual qualities, if it does not provide thermal comfort, its users cannot be satisfied. To do this, it is necessary to provide the climate comfort of the environment.

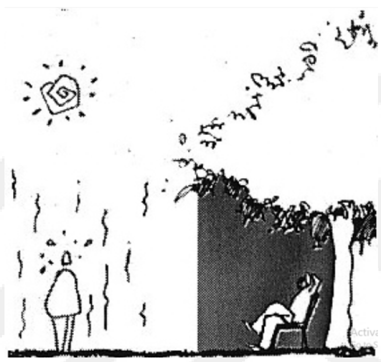


Figure 2-6: Creating climate comfort (Pakzad, 2012: 89)

At the surface of the skin, there are receptors that respond to pressure stimuli (Paraesthesia) or are more susceptible to it. None of senses attracts the individual’s attention as much as a sense of pain (Algesthesis). Pain is considered the most important part of sensory quality that informs the individual about destructive provocations in the organism (Khodapanahi and Iravani, 2002). Touch sensation provides us with an opportunity to improve the quality of the environment. The variation of this sense can enhance the sensory richness of the public space by taking different materials. Porteous believes that many of our experiences from textures forming the environment are derived by foot and sitting. The role of the skin should not be ignored (Carmona et al., 2003). For example, the effect of temperature on sitting on the benches, wall roughness, the intensity of direct sunlight and winter cold should not be forgotten in the design.

- Auditory: Auditory alongside vision is an important tool for information about the environment. Furthermore, the quality and quantity of sound in the environment are one of the factors that greatly affect the quality of the place. While the visual space is determined and defined by objects in spaces; acoustic flows through space without clear boundaries. The sound provides little information to the brain compared to vision, but it is emotionally rich. For instance, the sound of cries, music, thunder, water flush, and wind carry a lot of emotional loads **(**Barati and Soleymannejad, 2011). High noise is always a factor which makes a place to be unpleasant. If the sounds of place are more than the threshold of the auditory apparatus, the continuation of the person's presence will be impossible. Continuous noise is accompanied by hearing loss and a variety of problems, especially high blood pressure and physical damage (Mc Andrew, 2008).

- **Olfaction:** The odor is one of the most elementary and important elements of urban and architectural spaces. Although some consider it to be less important than vision and auditory, well it is not. The olfactory limb occupies a prominent place in the brain. Psychological functions of olfaction such as its effect on learning, association, memory and mental imagery are as cases discussed in the psychology of sensation. In urban and architectural spaces pleasant smells increase the user’s satisfaction and help individuals to reinforce their communication with the environment in other phases. In addition, the smell is very effective in reminding memories. So, the inclusion of olfactory stimuli in design and consequently, the improvement of spaces quality seem to be an affective qualitative approach (Pakzad, 2012).

- **Gustation:** The sense of taste does not have a direct impact on the experience of urban or architectural space, but the taste of bitterness or smoke of cars or soil on the one hand and the cooperation of senses and smells, on the other hand, are noteworthy.

2.13.3. Perception

The concept of perception is based on the achievements of experimental sciences, especially physiology and empirical psychology. In these sciences, sensory perception is a process that begins with the reality of the physical and chemical stimuli of the environment and ends with individual responses and psychological analysis and interpretation which makes it compatible with its environment. The complex nervous system in people due to their position or stimulation causes different behavioral responses. After analyzing and interpreting the stimulus, this system provides the basis for the discovery and perception of the environment (Khodapanahi and Iravani, 2002). Perception can be seen as a purposeful process in which the individual receives and organizes environmental information. As a result of the interaction of sensory perception and cognition, perception is associated with the human perception of the environment, and it is the connecting point of cognition and reality (Lang, 2004).

Human beings have the ability to understand, interpret, and react consciously and intelligently to their surroundings. On the other hand, they are in an environment where is not possible for them to understand all its complexities. So, it is normal for them to choose from information that has been obtained from the stage of sensation. In fact, although at the stage of sensation unconsciously we received only a part of environmental information, in order to use this raw information, it is necessary to convert them into apprehensible information. To convert particular objectivity to subjectivity, and make it as a criterion for evaluation and behavior, it is necessary to pass through an intermediate stage of perception. At this stage, firstly, the received information is identified then the related items are integrated, and classified according to the previous or the new mental concepts. Through perception, the brain interprets sensory systems data and makes sense of them. For this reason, perception is defined as "the mental process of organizing and interpreting sensory information to make them meaningful". In giving meaning to the received messages there are four different dimensions of perceptions that act simultaneously as follows (Carmona et al., 2010):

1. *Cognitive dimension:* Includes thinking about environmental stimuli, organizing and storing information. Such an aspect helps the environment to be meaningful.
2. *Affective dimension:* Includes user's sensation that affects environmental perception; in return, understanding of environment also affects the user's affection and emotion.
3. *Interpretative dimension:* Includes meanings and concepts derived from the environment. In this dimension, users rely on their memories and mental resources to compare and interpret new environmental stimuli.
4. *Valuation dimension:* Includes values and preferences that make it either good or bad. An environment can be considered as a mental structure or an environmental image which is created and valued by different people in different forms.

One cannot imagine a distance between sensation and perception. Perception takes place quickly and immediately after the sensation. To identify the data entered into the brain, they are first checked. After this process, it is important to recognize the compatibility and similarity of data with which concepts of mind. For example, when we perceive a smell, we compare it with the smells which have already perceived and stored as memory in our mind to conclude that if it is a rosette[4] (Ganji, 2009: 163).

Receiving Information → Classification → Integration → Label → Storage → Retrieval

Diagram 2-18: The stages of perception (Pakzad and Bozorg, 2012)

The process of perception is the point of any environmental behavior; because the source of all information is in the environment. The environment stimulates all senses and gives the person with more information than he can process. Therefore, perception is not something like feeling; it is the result of the processing of a person's processing, because of his cognitive experience. In fact, the person is part of the perceptual system. In the process of perception, it is difficult to separate a person from the environment because these two are always in interaction, and perceptions depend on what the person is doing. The behaviors and the objectives of the observer have an essential role in defining the boundaries of the space so that space can be considered as an individual experience, which is the result of human perceptual processes.

From the point of view of environmental psychology, perception, cognition, and environmental conditions are interconnected, especially when the perception of objects is separated from the perception of the environment. In environmental perception, more variables and factors are involved, and perception also has a broader scope, because the person moves in space and faces the environment with regard to certain presumptions and practical goals (Barati and Soleymannejad, 2011). The way of environmental perception implies general approaches that are identical with different expressions. The first approach refers to sensory perception and mental perception. Sensory perception implies visual aesthetics, and mental perception implies symbolic aesthetics, symbolic meanings, and implicit meaning in relation to place. The second approach of perception involves two aspects of direct and indirect perception. Direct perception refers to the direct presence of natural elements in the environment. Indirect perception implies historical, cultural, and human interactions. In addition to that, in order to investigate how people experience the environment, Appleyard classifies environmental perception approaches into three categories: operational mode that focuses on personal activities and behaviors at place; inferential mode that focuses on perceiving information and

[4] Retrieval

meaning from the environment, and responsive mode which focuses on emotional reactions (Daneshgarmoghaddam et al., 2011; Naghizade and Ostadi, 2014). In this regard, the following diagram provides a system for explaining people behavioral responses. This model shows a specific system in which the characteristics of a built environment are related to users' perception in and the formation of behavioral systems.

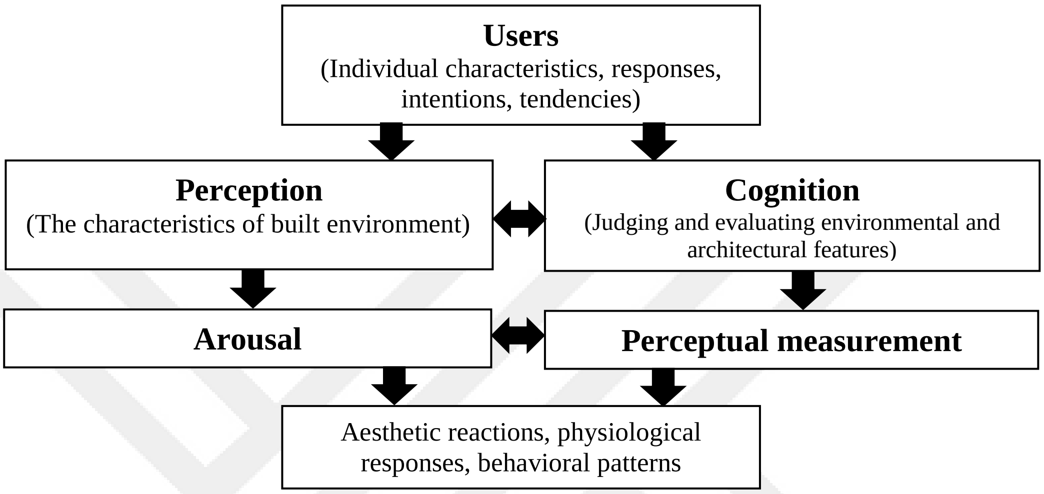


Diagram 2-19: A model of feedback and behavioral responses in explaining the relationship between users and the environment (Daneshgarmoghaddam et al., 2011).

In psychology, perception means an interactive mental or psychological process that actively selects and organizes sensory information and ultimately makes sense to them; in this sense that sensory perceiving and experiences are the main source of environmental perception. In this context, many factors such as age, gender, excitements, previous experiences, expectations, motivational states, different emotional states, decision making, and individual volition, etc. affect perception (Khodapanahi and Iravani, 2001). The perceptual structure consists of a collection of visual elements and viewer mental reception of the environment and its qualitative elements, perceiving physical, spatial, temporal legibility, and recognition of identifying elements. The acquisition of users' perceptual structure can be explicitly pursued in Lynch and Appleyard's research; Lynch according to his research results, conducted in American cities, believes that user mental image is affected by memories, relationships, experiences, individual expectations, and three-dimensional understanding perceived from the environment. In order to understand user mentality, Lynch and Appleyard's visual impression contains two parts: the visible environment identity, and the environmental values perceived by users. Achieving the environmental values perceived by users is as important as perceived exciting qualities (Karimi Yazdi et al., 2017).

2.13.3.1. Visual perception and organization

In the relationship and interaction between the individual and the environment, perception affects the formation of activities in the place. Canter believes that if the reception and experience of a place can be decomposed into recognizable components, it can be used as a reference for perception. This issue illustrates how common senses respond to the environment, and implies the extent of interaction between individuals and their environment (Daneshgarmoghaddam et al., 2011). In this respect, creating communication and understanding of architectural space is possible firstly through the sense of vision and a collection of illustrations of the visual and spatial dimensions of the environment. In fact, through seeing and passing spaces users achieve various messages from the environment. Perceptions derived from messages, play an important role in the observer’s mind and shape his/her relationship with the environment.

More than eighty percent of the individual’s sensory inputs are visual. For this reason, when is talked about perception it means visual perception because in addition to cultural reasons, visibility is more tangible compared with other senses, and its quality is more controllable to the individual (Douglas Porteous, 2003). Referring to the importance of visual experience in people spatial perception, Hedman believes that in urban design projects should be noted that people see their environment in detail. People enjoy the experience of places that are both visually attractive and pleasant and seem to have new spatial relationships and influences (Hedman, 1995).

In order to have a better perception, it is important to pay attention to the role of aesthetics and visual preferences of people in improving environmental quality, and strengthening the human-environment relationship. Consequently, human presence in the architectural environment and the sense of belonging to it, as well as the sense of responsibility for maintaining and improving the quality of architectural spaces, is very important. Man consciously or unconsciously tends to seek patterns which aesthetically involve proportions, and are meaningfully formed based on his/her environmental perception. The structure of each composition consists of organizing a variety of basic elements that can be classified into three sub-patterns (Bell, 2004):

1. *Spatial pattern:* this pattern relates to the relative position and relationships between spatial elements that are relevant to each other, and including similarity, closure, proximity, symmetry, continuity, and Figure-Ground.

2. *Structural pattern:* Includes methods to fit various parts of the design, and tries to create a coherent structure including: rhythm, proportion and scale.

3. *Ordering pattern:* The principles of this pattern are related to the order in design and composition, which includes: axis, symmetry, hierarchy, and deformation.

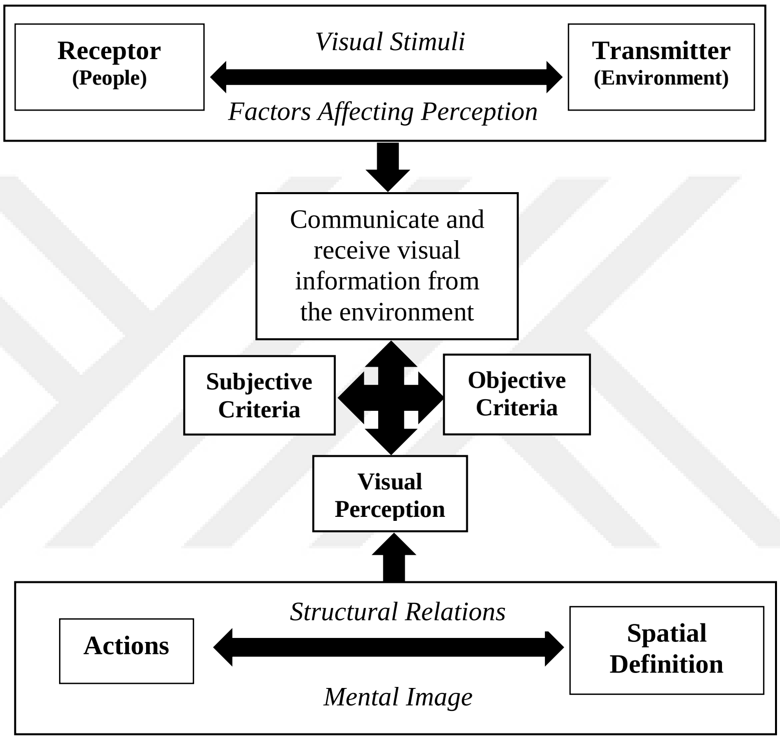


Diagram 2-20: Conceptual framework for the assessment of visual perception (Author)

Table: 2-8: Theories of visual perception assessment (Author)

The basis of analysis	Analysis criteria	Theory	Collection method
Spatial pattern	similarity, closure, proximity, symmetry, continuity, figure-ground	Gestalt	Observation
Structural pattern	rhythm, proportion, scale, balance	Formalism	Observation
Ordering pattern	axis, symmetry, hierarchy, deformation	Formalism	Observation

The process of theoretical foundations of perception, theorists' views, and theories of visual perception, have considered assessing visual objective criteria of space (physical and formal features) in relation to visual mental criteria (perceptual meanings). In fact, the goal is to create a bridge between the results of the evaluation of criteria and what is perceived by users at the moment of visual communication.

2.13.3.2. Place perception

- **Place**

The concept of place has been studied in various sciences such as architecture, urban design, geography, environmental psychology, and so on. In general, place-related definitions can be divided into two general categories (Heidari and Behdadfar, 2017): A) Place as a geographic location and B) Place as meanings to the human mind. The first category focuses more on the physical dimensions of place, while the second category takes into the meanings and concepts within the place and believes that due to these meanings, the place is distinguished from a geographic location. In this approach, the place is characterized as a space in which humans have an interaction with the surrounding environment. In this sense, Place is thus characterized not only in terms of its biological-physical aspects but also in terms of a range of socio-psychological processes, symbolic meanings, and affective attachments that determine place. Tuan (2001) describes place as the center of meaning or focus of attention as perceived by human experiences, social relationships, emotions, and thoughts. The phenomenon of place from the point of view of Christian Norberg-Schulz (1991) is something more than abstraction and is meant to be a general place made of objective phenomena, materials, shape, texture, and color. These objective phenomena express an “environmental character” that is the basis of a place. Hence, the place is a “qualitative and general appearance”.

According to other definitions, a place is a location or part of a space which has a certain and unique identity, value, and meaning through its factors. The mutual relationship and the reaction between the three factors of human behavior, notions and physical characteristics create a place. From the point of view of psychology, the place cannot be separate from the individual. The place is part of a natural or built space that is conceptually and materially defined in a range and is the result of interactions between humans and environmental qualities. Accordingly, the individual’s emotional and psychological experience of place is realized through intimate interaction with the place in which it resides. In such an approach, the place is part of a geographic environment that includes mental and semantic features. In this approach, the environment is regarded as a psychological structure and includes meanings, physical features, current activities, and assessing activities. The study of how the physical environment affects people perception and activities shows that the physical features of the environment are effective by giving meanings and securing specific activities in making sense of place and satisfaction (Daneshgarmoghaddam and Golrokh, 2017).

- **Place meaning**

Due to some "incompleteness" in modern architecture, designers and architects gradually identified the vacuum through the field of interdisciplinary with environmental design and apply them to create environmental meanings and affection. To this end, they minimized the gap between themselves with the users by achieving higher quality environments (Motallebi, 2002). So, today, the meaning of place is one of the most important issues that has been devoted to many kinds of research such as psychology, sociology, architecture, urbanism, and landscape design. In his book "Place and Placeless", Relph (1976) was phenomenologically looking for clues to answer why and how places carry meanings for people. According to him, a place can be defined in three aspects of physic, activity, and meaning that among these, the aspect of meaning is more important, and is more difficult to achieve. In addition, Canter (1977) proposed a model of place which involved three aspects; activities, imaginations, and forms. He believed that the influence of physical and formal aspects on psychological and behavioral views was of paramount importance. However, Canter believed that different people have different perceptions of place and thus, the individual aspects of place perception were of great importance. In the book "A Theory of Good City Form", Lynch (2009) considers the meaning of place as the result of the relationship between the spatial elements and the mental structures of the observer. In this definition, the elements of space are the factors that define the physical environment, and mental patterns embrace all the concepts and values such as culture, character, situation, experience and other users of space. Gustafson (2001) is one of the other people who studied the meaning of place. He presented a three-dimensional model consisting of "person", "others" and "the environment", and believes that the meaning of places are not only the result of the interaction among these three aspects, but from the relations between them some conclusions can be inferred (Heidari and Behdadfar, 2017).

From the literature review, it appears that most researchers have a positivist view of the place and place meaning, and each of which considers various effective factors and parameters in the formation of place meaning. In a general category based on the literature and cases mentioned above, the attitudes and theories related to the components of place and meaning of place can be represented in the following table.

Table 2-9: Views and theories related to the components of place and meaning of place (Author)

Theorist	View
Relph (1976)	The main elements of the place are the physical settings, activities, and meaning
Canter (1977)	The main elements of the place are the physical settings, activities, imagination
Rappaport (1982)	People make sense to the environment through the culture (including values, beliefs, ideology, rituals, etc.)
Lynch (1984)	The meaning of place is the result of the relationship between the physical elements of space and the mental patterns.
Gustafson (2001)	The meaning of the place is obtained from the interaction of the three parameters of person, others, and the environment.
Van der Klis & Karston (2009)	The meaning of the place is based on three parameters of the physical, functional, and social environment.

In the study presented by Heidari and Behdadfar (2017), parameters forming the place meaning are divided into two groups of images and environmental which are classified to “Dimension”, “Funds”, and “Parameter”.

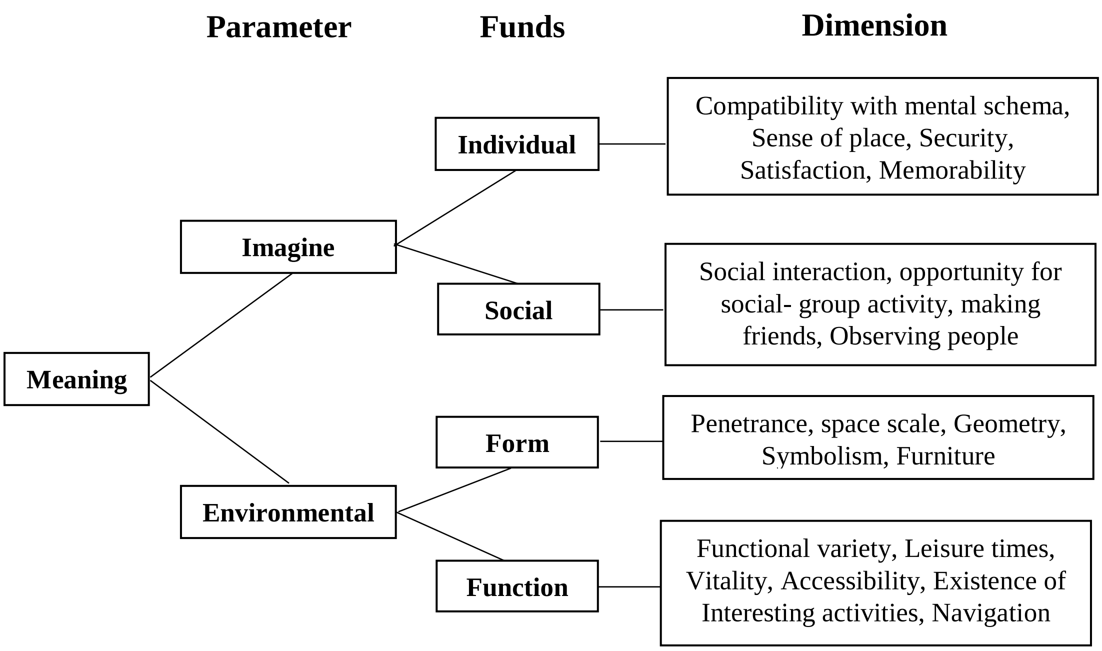


Diagram 2-21: Dimensions and sub-dimensions forming meaning of place derived from the literature (Heidari and Behdadfar, 2017).

➢ **Place meaning from the designers and users point of view**

As previously mentioned, the meaning of a place is a factor which distinguishes a particular place from other places, but how does the meaning of place come about? Some theorists believe in the principle that meaning is created by designing the physical environment. According to this view, the physical structure of the environment acts as a sign and transmits meaning. So, the meaning of place is shaped by the designer's attention to the physical features of the environment, including the combination of form, shadow, brightness, color, sound, light, etc. They also believe that in a building combining these elements, a kind of meaning is created and if the same elements are put together in another place, the same meaning may not be created or the same "sense of place" may not be created. Others believe that the environment does not have a particular meaning by itself and it is humans who give meaning to it. In this regard, there are some who believe that by using symbols and signs, architects create meaning to the environment which could be done physically as reflected in the function. Another group considers the role of users in shaping the meanings of a place.

According to these factors, different people, depending on their different needs, perceive the various capabilities of the environment, and by exhibiting certain behaviors in that environment, that give out the meaning of place. Amos Rappaport is amongst those who have paid attention to differences in meaning as perceived by architects and users of an environment. He believes that this difference is rooted in the schemes that each of them has in mind. According to Rappaport, the human mind, using a classifier of forms and ideas, creates schemes that according to the same schematics give meaning to the world around them (Heidari and Behdadfar, 2017).

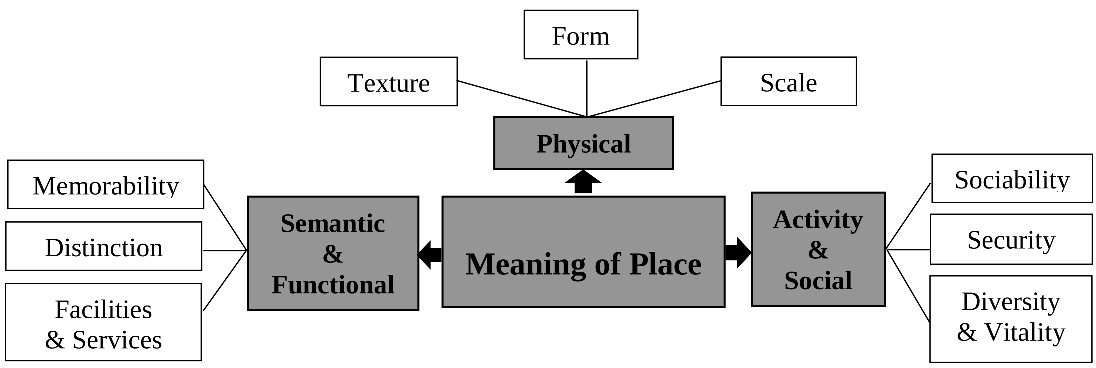


Diagram 2-22: Parameters determining the meaning of place (Author)

➢ Factors affecting perception

Empirical and behavioral sciences have conducted extensive studies in the field of introducing effective factors on perception, and have considered many factors to affect the quality of perceptions and environmental perceiving. Experiences show that environmental perception can be different from person to person. Some of these differences are related to individual characteristics of persons, such as having different experiences, gender, culture, occupation, etc. Some of these factors are related to the different aspects and effects of the environment. In fact, one of the most important issues in environmental perception research is to identify and distinguish the effects of the physical environment from the effects one takes on the process of perception. In this case, what it should be always considered in the context of perception is that despite the system of sensation and perception is similar in all, people have a different perception of their surroundings. Hence, it can be said that a different perception of similar stimuli can be the result of a combination of several factors, and only one effective factor alone cannot determine what we perceive (Gifford, 2007).

According to Fritz Steele (1981), the most important physical factors in the perception of place are the degree of enclosedness, scale, proportion, texture, color, odor, sound, and visual diversity (Mostaghimi et al., 2015). Furthermore, there are several important factors each of which contribute to the formation of perceptions and are generally classified into two categories: Internal factors, related to individual, and external factors, related to the stimuli (environment):

- Individual factors affecting perception: People have perceptual capacity to understand and perceive the environmental information. Each of the sensory organs has a specific domain and function. If the information received from the environment are not consistent with the capacity of the perceptual system, it will be annoying. If the perception of a subject fits into the values and norms of individuals and satisfies the perceptual system, it simplifies the detection and perception of similar stimuli in later situations. If the result of perception creates an unpleasant or negative feeling, it causes to a state of refraining from perception. In such a situation, it may be possible to avoid being in that position. Simply put, people perceive things that they like or have some kind of pleasant and enjoyable experience faster and better than unpleasant ones.

- Environmental factors affecting perception: Perception of the environment is a function of the ability sensory receptors to perceive, which is itself a function of environmental conditions affecting senses such as light, temperature, humidity, wind pressure, noise, odor, and so on. These factors, in most cases, affect the amount of information we receive from the environment, the details of the information received, their clarity, etc., of all which will affect what is eventually perceived. Another thing that should not be forgotten is the impact of scale on space. Defined spaces can have strong emotional references based on their size, scale and perceived proportion. Time, another factor, affects environmental perception in terms of different rhythms which created in the environment. Time can be considered in daily and seasonal periods, short and long-term sequences, regular and irregular rhythms. For example, lighting changes throughout the day, shadows, etc. affect the environmental perceptions (Pakzad, 2012).

Table 2-10: Factors Affecting Perception (Author)

Factor	Dimension	Criteria
External Factors	***Visual***	Visual proportion, Visual pleasant, Visual focus
	Mental interaction with the environment	Openness, Human scale, Siege, Security
	Order	Solidarity, Unity, Continuity, Balance, Compatibility, Harmony, Cadence
	View	Visual permeability, Perspective, Landscape
	Physical pattern	Form, size, proximity, similarity, enclosure, scale, human scale, distance, proportion, rhythm, texture
	Sensory pattern	Individual expectation, unity, variety, pleasantness, odor, color, vision, auditory, olfaction
	Interpretative pattern	Meaning association, flexibility, legibility, navigation, human scale
	Valuation pattern	Aesthetic, memory, image, sociability, sense of place, presence in space
Internal Factors	***Group:*** culture, values, social norms, sensory experiences, history ***Public:*** age, gender, job, education ***Personal***: attitude, goals, mentality	Motivational, exciting, affective, expectations, decision

2.13.4. Cognition

In the section of psychology approach, the “cognitive viewpoint” was partially addressed. This view focuses on investigating human mental processes. These processes can be followed from the beginning of attention to specific stimuli until the stage of remembering and forming the mental image. Receipt, storing and reminding information is done in a complex process. In this process, firstly, a phenomenon is considered, stored in memory, and it is remembered when appropriately categorized in a suitable “file”. In this regard, Gifford writes: in the process of cognition in order to orient and attention to behaviors, we deal with how to get information from the environment, representation methods of information, how it is transformed into knowledge, how it is stored, and how it is used (Gifford, 2007).

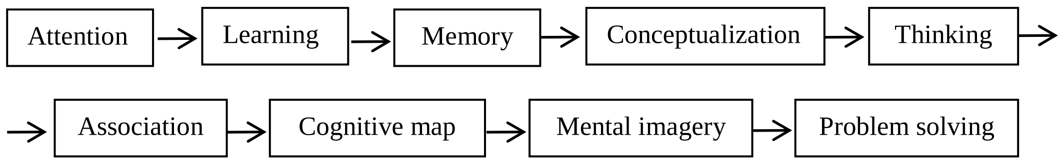


Diagram 2-23: The process of cognition (Pakzad and Bozorg, 2012).

In environmental psychology, the environment is the most important source of external receipts and the main source of human understanding and cognition from the “phenomenal” world. Cognition as one of the main concepts of psychology has a close relationship with perception, and it is the result of the interaction of culture and biology, that is, cognitive abilities depend on the brain behavior and whole organism, and on the other hand, it is achieved through the experience of the physical and social world.

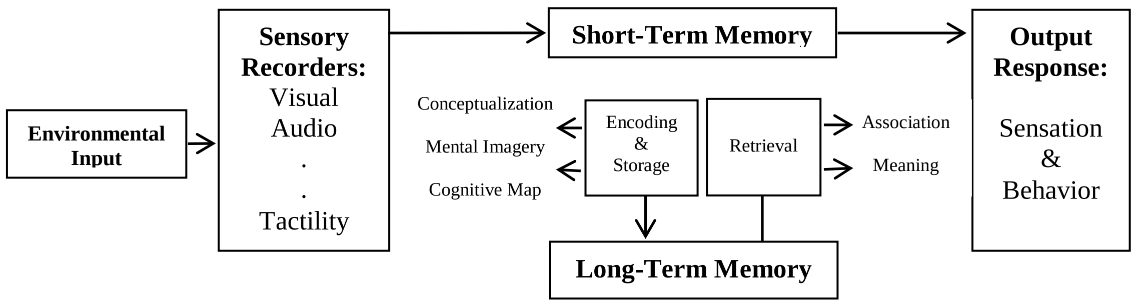


Diagram 2-24: The process of cognition in based on measurable components (Sternberg, 2017).

2.13.4.1. Attention

The first step of cognitive process requires attention. Attention is a kind of concentration of mental effort on sensing environment and mental events. In fact, people have always face bunch of information for them to select some of the most important ones. This is due to the limited capacity of the mind to receive, process, and storing the information. Therefore, “attention” is the result of a limited-capacity information processing system (Solso, 2010). The attention is a means by which we actively process the limited amount of information from an enormous amount of information that holds up the senses, stored memory, and other cognitive processes. Clearly, some environmental stimuli attract more attention and there are many factors involved. In the field of visual attention, a lot of experiments have been done to test what are people more paying attention to. The psychological phenomenon of attention provides a person to use reasonable limited mental resources. Several factors make us to be attentive to certain stimuli. These factors include control over the situation, experiences, goals, and the characteristics of the stimulus (Pakzad and Bozorg, 2012).

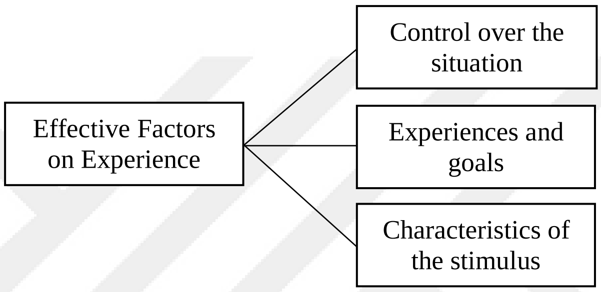


Diagram 2-25: Effective factors on experience (Pakzad and Bozorg, 2012).

An individual's control of the situation in which he or she is in affects attention. The frequent encounter of an individual to an environment leads to the more detailed attention and more control over affairs. The purpose of being in space or the purpose of doing an activity makes it possible to pay attention to certain points. By changing the goals, the considered issues too will also be changed.[5] Some stimulus features such as contrast, movement, and frequency make the particular element being separated from the context and attract more attention than other components. Both apparent features and functional-semantic features are effective in attracting attention. The individual can focus on his/her favorite stimuli by reducing the focus to many other external and internal stimuli. The received information is transmitted to short-term memory by sensory recorders. When the stimulus is not being considered, the process of subjective processing is eliminated and will not be processed at higher levels, and cannot be encrypted and stored in memory to be recalled for later use (Pakzad and Bozorg, 2012).

[5] It should be noted that although individuals focus on specific stimuli depending on the experiences and goals, other stimuli are not entirely out of attention, but the concentration of mind on them is less than other stimuli in the environment.

2.13.4.2. Memory

Like any steps of cognition, storing information in memory is a mental process that includes encoding, storing, and retrieval. The data encoding is a set of mental activities in which perceived information is converted into intelligible data in the mind. In other words, the person makes information from his/her own experience that can be received, stored, and retrieved in the mind. The main differences between encoding in short and long term memory are in the type of encryption. Long-term memory codes are mainly based on meanings. In this sense, decoding long-term memory the meanings of information stored as reminder code, and if the meaning is decoded deeper and more detailed, the content is better remembered (Sternberg, 2017). The process of retention of encoded information in memory is called storage. Storage takes place in the accumulator, but the accumulator’s functions varies in short and long term memory. In the short-term memory accumulator, information collected by the sensory system is stored; then, if necessary, this information is transferred to the long-term memory to be stored and encoded. Concept formation, mental imagery, and cognitive maps are functions of the mind for encoding and storing information (Pakzad and Bozorg, 2012).

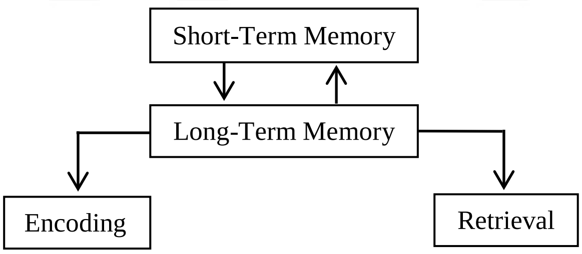


Diagram 2-26: Exchange information in memory (Pakzad and Bozorg, 2012).

Retrieving information begins from long-term memory and transfers to short-term memory and encoded. Retrieving is a process through which information is recalled from memory when needed. At this step, information is recollected from memory. This recollection takes place at a fast pace in short-term memory, but in long-term memory, the retrieving speed varies according to the type of content classified in memory and other factors that affect the time elapsed between storage to recollection. In the long-term memory unlike short-term memory, there is no storage limitation. Thus, oblivion in long-term memory results from lack of access to information, not the loss of information. This means that long-term memory inability is due to retrieving problems rather than storage problems. Association and comprehension are functions of the mind to retrieve information. Two factors that increase the possibility of successful retrieval are the organization of information during encoding and the similarity of the data retrieval location to the situation where the information is encrypted (Atkinson et al., 2002). The retrieved information is transferred from long-term memory to short-term memory and ultimately appears in output responses form (sensation and behavior).

2.13.4.3. Conceptualization

To minimize error in judgement and to understand what is happening, the mind creates order among the information it receives. In this context, the mind uses templates and principles to summarize, simplify, and categorize information meaningfully; then, locate and store them in the mind (Solso, 2010). The purpose of categorization is to determine the position of a phenomenon among other phenomena in the world. In fact, the human mind has gradually created files over time that puts any phenomenon after identification and initial encoding, based on its relationship with other phenomenon of a particular file (Atkinson et al., 2002). Through categorization, the information sent from the environment is categorized by rules, and can be obtained by specific name or code.

The mental process of simplifying and organizing information is called conceptualization. The expression of a concept exemplifies the raises of power to distinguish concepts. Also, the expression and identification of the relevant factors and attributes as well as the differences between them and the unrelated attributes make it possible for us to distinguish different concepts. Knowing the name of a concept is not enough to understand its content. One concept must be properly defined; that is, it should be related to a more general category, as well as it should have identifiable characteristics. Expressing and identifying the relevant factors, characteristics and their differences with the irrelevant features separate the concepts from each other.

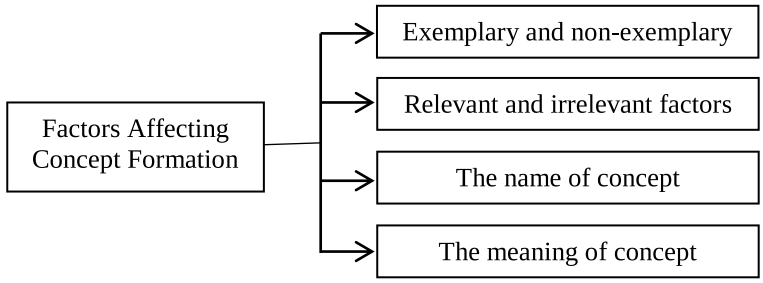


Diagram 2-27: Factors affecting concept formation (Pakzad & Bozorg, 2012: 188).

2.13.4.4. Mental imagery and cognitive map

People behave according to their own mentality. The human mentality about places is mainly formed by two factors; mental image and cognitive map. The mental imagery is an image that a person makes of a phenomenon in their mind. Such an image is influenced by the thoughts, values, and experiences of the individual from the place, and may involve subjective representations in the form of any sensory aspects such as olfaction, gestation, and auditory (Sternberg, 2017). However, most researches who conducted on cognitive psychology in relation to mental imagery have focused on visual imagery. Some cognitive psychologists believe that mental imagery and visual perception have a same function. The mental images are made of, mainly on two factors: Information received from the environment that is perceived as a landscape which is the basis for the mental image; and memories, experiences, aspirations, and expectations that provide a link between humans and the environment. Accordingly, it can be said that the mental image is a collection of images that are formed in an individual mind based on the appearance, function, and meaning of a space. As a result of each of these three aspects of space keep changing, the mental image changes over time too. (Pakzad and Bozorg: 2012).

The cognitive map is part of the mental image that focuses specifically on spatial relationships. Cognitive maps provide internal representations that simulate the specific spatial characteristics of the external environment and also provide an abstract model of the environment as a basis for the individual to act (Solso, 2010). This map can be the result of an individual's presence in the city, a description of others, or even a city map. To create a cognitive map, the environmental information is received, coded, stored (as memory), recollected, and manipulated by the individual. The result of this process is the formation of a cognitive map, which is, in fact, a kind of subjective representation of the information we have gained over time from the environment. Human beings use three types of knowledge in the formation and use of cognitive maps:

1. The first type is the ***Landmark*** knowledge or information about the specific features of a place that may be based on visual representation and proposition.
2. The second type is the ***Route-road*** knowledge which includes specific routes for moving from one place to another one.
3. The third type is the ***Survey*** knowledge which includes the estimated distance between the marks, that is, what is seen in the heuristic maps. This type of knowledge

may be represented imaginatively and propositionally. Thus, individuals use pictorial and propositional ciphers for mental representations, such as image maps.

It seems that sometimes in using these three types of knowledge, mental shortcuts affect individual estimation of distances. In fact, such mental shortcuts are cognitive strategies that named as the so-called ***Heuristics*** methods. For example, in the case of landmark knowledge, it seems that the intensity of the experience affects people's mental image of the region. In particular, with the increase in the density of interference, the estimation of the intervals would increase mutually. In other words, it seems that people distort their mental imagery so that their mental estimates from distances increase based on the number of interventions. In estimating the distances between particular physical places (such as cities), route-road knowledge is often more important than survey knowledge. In general, distortions reflect the tendency of individuals to conceptualizes the mental maps (Alinam, 2014).

2.13.4.5. Association and meaning

In the process of association, when two events repeat consecutively in short intervals, within a neurological interaction, links are created to retrieve them. Hence when one of those events is activated, another is also activated (Solso, 2010). Similarity, contradiction, and proximity are the primary principles of association and provide rules on how associations are formed. Meaning is one of the functions of mind in the process of association that is used in the retrieval process. If the conceptualization is in a convergent process to find similarities, generalization, and summarization, then meaning is a divergent process to remind the attributes, differences, and the extension of a concept in the mind of the individual. In fact, meaning is all what it is which associate with the retrieval of a concept for an individual. Hence, meaning is relatively unique and is dependent on time and place; while concept is common among many people. Previous experience of people, their intentions and their expectations are important in determining the meaning of what they perceive. Therefore, despite the same sensory stimulation, a concept may have different meanings for different individuals.

Understanding the meaning of an environment in a cognitive process can lead to different evaluations of a place. Rappaport believes that people react to their surroundings based on the meanings of the environment, or Lynch describes one of the criteria for a good city is “meaning”. Signs play a significant role in the association of meanings. Most places or events are associated with signs that are experienced (Pakzad and Bozorg, 2012). Signs may appear in a variety of ways and can be felt with different senses. Sometimes signs also provide a combination of different symptoms that are felt and perceived by the various senses. Peirce divides the signs into three categories. ***Iconic signs;*** point to the similarity of the sign with the subject. ***Index signs;*** point to something other than what is seen. In this kind of sign, a spatial meaning is mentioned in an individual mind when he/she sees a sign. ***Symbolic signs;*** are based on semiotic contracts, and are adventitious. Hence, they change in different places over time (Alinam, 2014: 80).

2.13.5. Behavior

As previously mentioned, people are constantly interacting with their environment. During this interaction, individuals receive and perceive the environmental information, and then, process the obtained information in mind, but this is not the end. Human beings are mutually influential in their environment. Such an influence which is a reaction to the environment is called behavior. Therefore, we identify the environment, judge and evaluate it, and behave according to our assessment. Hence, urban planners and architects have to improve the quality of the environment by identifying mental processes that lead to behavior, by studying the factors affecting the behavior of humans in the environment.

Two factors of the environment and the individual are very influential in how to behave. In fact, environmental and individual characteristics are the basis of behavior. So, the behavior is a result of needs, motivations, environment capability, perception, mental image, and meanings that we have created for ourselves from the environment. Behavior is the result of the environment and its interaction with the individual. Various physical factors such as noise, climate, and enclosed spaces affect human reactions. These reactions are called behavior (Altman, 2004). The fact is that a person is not in direct contact with the environment. While to communicate with the environment, a filter between the person and space is used. Such a filter is named as psychological space which involves norms, values, experiences, and so on. To understand anything, a person has to pass it through this filter. Finally, to respond to the environment (behavior), an individual does his/her activities through this mental filter (Pakzad and Bozorg, 2012).

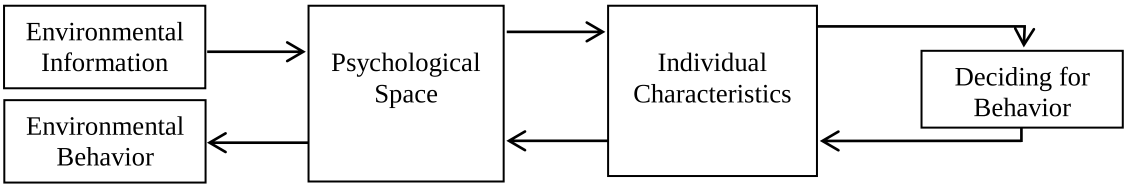


Diagram 2-28: The process of behavior (Pakzad and Bozorg, 2012).

2.13.5.1. Types of environmental behavior

Faced with the environment, a person often compares perceived information with his/her mental state and based on the result of this comparison he/she performs a particular behavior. Choosing the type of behavior is mainly based on our goal on how to behave. In fact, these goals are our determination on how we ought to behave in every situation. Accordingly, behaviors are divided into a variety of different types that each of which has its own characteristics and can be classified according to these characteristics. One of the important aspects of classifying behaviors is their categorization based on the motivation of doing them like conscious and unconscious behaviors. On the other hand, behaviors can be categorized based on those who are involved in it. Based on this kind of categorization, two types of individual and social behavior can be expressed. Finally, behaviors can be divided into two categories based on the importance of space: spatial and non-spatial behaviors. Spatial behavior involves behaviors that are carried out in a place and affected by the surrounding environment. In fact, in investigating spatial behaviors not only human behavior and the behavior between man and the environment, but the interaction between man and the environment are also considered. Obviously, any behavior cannot be imagined without time and place. Since individuals interact with the environment, the study of spatial behaviors is very important as behaviors that are intensively influenced by the environment (Pakzad and Bozorg, 2012). Most research on spatial behavior has been done in environmental psychology. Accordingly, it is necessary to consider more closely the spatial behavior and its importance in architecture and urban design.

2.13.5.2. Spatial Behavior

The issue of how we use the physical environment in establishing social relationships can be studied in the field of investigating human social behavior in relation to the physical environment. From this context, in the book of “The environment and social behavior”, through a socio-psychological approach, Irwin Altman examines how people interact with the environment, and how the physical environment affects this interaction, as well as how to use the physical environment (Altman, 2004). Spatial behavior includes behaviors that affected by the environment. In fact, the physical environment has a great influence on the psychological and social behavior state. In establishing social relationships, the way of using physical environment can be examined in the field of studying the social behavior of the man in the physical environment (Zhang et al., 2009). Roger Barker (1968) believes that every behavioral setting has two essential structural and dynamic features. The structural part of a behavioral setting contains one or more current patterns of behavior and the environment in which they have a homologous relationship with each other. From the dynamic section, the components of the environment and behavior have a degree of dependency. User’s spatial behavior is partly influenced by the mental images of the environment structure. The design of an environment influences behavior in many ways. Behavior is a function of individuals’ cognitive imagination of buildings and cities. Activities also affect the people’s perception. The physical structure of the environment affects these images and the patterns of the interaction of the society (Mostaghimi et al., 2015). In a physical environment, human behavior has a dynamic state. Any change in the environment components causes changes in the behavior patterns. According to Golkar (2001), the physical environment can affect user behavior in three aspects of the functional, empirical-cognitive, and environmental components.

Investigating the individual and social behavior to the effects of the physical structure on the environment provides designers the appropriate and more effective approaches in their work. The interaction of the physical structure of the environment and human, consequently the formation of spatial behavior shaped from the physical environment data (light, color, noise), symbolic data of the environment (cultural values), architectural data of environment (physical conditions), and climate condition. The physical structure should have the ability to respond to the three components, namely; experimental, aesthetic, and environment, that are effective in promoting the environmental quality and user satisfaction. If the physical environment is appropriately organized with the needs of users based on psychological, personality, cultural, and social norms, spatial behavior of people will be evaluated more positively (Mostaghimi et al., 2015).

2.14. Cognitive Sciences

The human need for emotion, cognitive, and behavioral interaction with place is one of the most important dimensions of the relationship between man and the environment that should be considered by architects and designers. In such situation as a multidimensional and interdisciplinary concept, the environment and emotional experience of the individual includes various domains of design, psychology, sociology, and communication. So, the utilization of these can provide different windows to researchers from the theoretical framework for investigating the emotional experience of place (Pirbabaei et al., 2015). Cognitive sciences have developed appreciably into a new science in recent years, and it is expected that along with other new sciences such as biotechnology, information technology, and nanotechnology cognitive sciences have made a profound evolution in human life. This branch of science is an interdisciplinary field of neuroscience, psychology, linguistics, artificial intelligence, anthropology, and philosophy of mind which holds an important place in psychology. Also, relying on experience, it recognizes the brain and its functions and presents valuable information about the ‘roots’ of human behavior to design any optimal pattern through the recognition of the brain patterns (Von Eckardt, 2005; Kharrazi, 2007).

Cognitive science is the scientific study of the mind. In this definition, the mind is the explanatory of any intelligence and consciousness status such as thinking, perception, memory, sensation, reasoning, and also all of the unconscious cognitive processes. The intellectual origin of cognitive sciences dates back to the 1950s; as in varied disciplines, researchers began to develop theories based on complex representations and computational mechanism of the mind. These sciences are the contemporary empirical attempts to answer some epistemological questions, and seek to express the functions of the brain as the process of thinking and mental solutions. Over the past decades, the findings of researchers working in the field of cognitive sciences have created serious upheaval in human understanding of phenomena such as perception, memory, learning, reasoning, judgment, decision making, etc. These developments have accelerated in recent years due to the advent of modern imaging and brain stimulation technologies. So, cognitive sciences have been able to provide valuable services related to diagnosis, treatment of individuals, education, management, and, all areas in which human mental ability plays a role (Pirbabaei et al. 2014; Alinam, 2014).

2.14.1. Cognitive psychology

Cognitive psychology is considered as one of the main branches of cognitive sciences and one of the most important approaches in the field of psychological sciences. Furthermore, the main goal of cognitive psychology is to study the cognitive structures of the mind and brain, thinking, and the processes underlying mental events. How a person understand, recognize, and solve a problem; also how the mind perceive the information received from the senses (such as vision or auditory) and how does memory works or how it is structured; are the most significant issues of this field. The main focus of cognitive psychology is on how the human mind receives, processes, and stores information, as well as in this field, it examines the relationship between personality of individuals with their autobiographical retrieval memory (Pirbabaei et al. 2014; Sternberg, 2017; Conway, 2002).

Table 2-11: Underlying issues in cognitive psychology studies (Pirbabaei et al. 2014; Sternberg, 2009)

Issue	Thesis	Antithesis	Synthesis
Nature versus nurture	Studying innate characteristics of human cognition	The study of the effect of distinctive environmental characteristics on individuals' cognition	Exploring covariations and interactions in the environment adversely affect someone with specific genetic characteristics
Rationalism versus empiricism	Logical reasoning based on current knowledge	The observation and examination of perception and sensation	Combining theories with empirical methods to getting the most possible information about the cognitive phenomena
Structures versus processes	Studying the structures of the mind (contents, attributes, and products)	The study of human thinking process	Investigating the impact of mental processes on mental structures
Domain generality versus domain specificity	Limitation of observed processes to single domains	Generalization of observed processes to single domain across a variety of domains	Exploring which processes might be domain-general and which might be domain-specific
Validity of causal inferences versus ecological validity	Studying cognition by using highly controlled experiments and increase the probability of valid inferences regarding causality	Cognitive study using more natural techniques and increase the ecological validity of the findings	Combine a variety of methods, including laboratory methods and more naturalistic ones and converge on findings that hold up, regardless of the method of study.
Applied versus basic research	Research on cognitive fundamental processes	Studying ways in which to help people use cognition effectively in practical situations	Combine the two kinds of research dialectically so that basic research leads to applied research, which leads to further basic research, and so on.
Biological versus behavioural methods	Study of the brain and its function	Study of the individuals' behavior in the field of cognitive functions	Synthesize biological and behavioral methods to understand cognitive phenomena at multiple levels of analysis

Cognitive psychologists have often developed and deepened their understanding of cognition through studies in the field of cognitive sciences. Cognitive psychology refers to all processes by which the sensory input is altered, reduced, expanded, stored, improved, and applied. In order to manipulate and strengthen the mind and brain through psychological and neurological interventions, cognitive psychologists rely on cognitive psychology and modern technologies (Alinam, 2014; Pirbabaei et al., 2014). The main topics that are considered as the basis of cognitive psychology studies are summarized in seven cases as shown in the table above.

2.14.2. Cognitive psychology and its importance in architectural design

Architecture is considered as one the most effective professions in human life and activity, and as previously mentioned, architecture plays an important role in the combination of humans, environment, and interaction between them. Owing to the necessity of cognitive studies, and since architecture profession deals with individuals' mind and memory, it seems that in order to create an efficient and pleasant environment that meets the needs of users, architects should have an understanding of psychological knowledge about cognitive processes of the human mind. With a look at today's architecture, at first glance, it could be found that users are not satisfied from the spatial qualities, and places are not in line with architectural structure design in terms of providing facilities to meet the affective psychological needs of users. So, cognitive sciences with the dominance of the brain mechanism for perceiving, learning, memorizing, thinking, and the formation of the individuals' minds could suggest practical solutions for architects and designers to change, modify, and strengthen their design approaches. However, cognitive psychological analysis and measurements can link health and its physiological dimensions of psychological processes, and relate it to architectural design with a focus on distinctive characteristics of individuals, places, experiences, and behaviors. Hence, this can play a main role in mental health, well-being, emotional evaluation, and satisfaction.

Designers' acquaintance with sciences that help designing profession directly or indirectly makes the plans become more consistent with the needs and cultures, therefore, the environments designed by them reflects the psychological experience of human life. Because human nature is intertwined and complex, acquaintance with cognitive sciences such as cognitive psychology is increasingly necessary for researchers who interested in environmental studies. Application of cognitive psychology in the environmental researches including architecture and urban design is considered a novel movement in the field of scientific researches that provide a more complete picture and deeper understanding of phenomena. Environmental researchers in the field of architecture could put approaches, guidelines, and strategies to be applied in a single environmental research together. Using different cognitive research methods during the process of architectural design allow for a comprehensive and systematic understanding of human mental processes regarding architectural space, and it will result in creating effective spaces, consistent with the users' needs (Pirbabaei, 2014).

2.14.3. Cognitive psychology doctrines

- Structuralism; understanding the structure of the mind: Structuralism seeks to understand the structure of the mind and its perceptions by decomposition of the perceptions into its constituent parts. German psychologist, Wilhelm Wundt, studied the sensory experiences through introspection. Introspection is internal in regard to information when it is related to human consciousness. Due to his contribution in studying the creative activity of the mind, he is one of the leaders in cognitive psychology (Sternberg, 2017).

- Functionalism; understanding the processes of the mind: In this theory, psychologists focus on the process of thinking rather than its content. Functionalism seeks to understand what people are doing and why they are doing it. Functionalists believe that studying the processes of mind functions will give the possibility to understand the human mind and behavior. Functionalists believe that the validity of knowledge determines its usefulness.

- Associationism; an integrative synthesis: Associationism examines how events or ideas interact with each other in a way that makes learning possible. Association may be caused by factors such as contiguity (associative affairs that occur simultaneously); similarity (associative affairs with similar characteristics or attributes); contrast (associative affairs versus each other). Theorists of this field like Hermann Ebbinghaus, investigate on to know how individuals can learn and remember cases. He believes that, repetition can stabilize mental associations in memory. Edward Lee Thorndike considers satisfaction as the key to the formation of associations. He named this principle the law of effect: Each stimulus tends to produce a specific response over time. If an organism repeatedly gets rewarded for doing something (satisfaction acts as a stimulus to individual behavior), it learns to respond to a particular way in a particular situation (effect) (Alinam, 2014).

- **Behaviorism:** From the behaviorists' point of view, psychology should focus only on the relationship between behavior and environmental stimuli. Behaviorists consider mental content as useless and believe that psychologists should focus on studying observable behavior.[6] They interpret all modes of human behavior based on behavior which manifested in response to the environment.[7] In fact, behaviorism created a radical change in psychology in the sense that it withdrew consciousness from the field of psychology for almost 50 years (Alinam, 2014).

2.14.4. Research methods in cognitive psychology

Cognitive psychologists seek to understand something more than what cognition content is, like the understanding of thinking process, as they are seeking the ways to explain and describing cognition. To this end, they use distinct research methods that are briefly described as follows:

- Controlled laboratory experiments: Experimenters conduct their researches in the form of controlled exploratory plans based on the laboratory conditions. In this method, the participants are exposed to experimental conditions, and their behavioral responses to changes are investigated. In this empirical method, the experimenter should use a sample representing the statistics of the population. If such precondition is provided on an empirical basis, the experimenter may be able to deduce the probable causation. This inference refers to the effects of the independent variables on the depended variables.

- Psychobiological research: By conducting psycho-biological research, the researcher studies the relationship between cognitive functions, events, and brain structures. The goal is to obtain information about the brain through a cognitive process.

[6] John Watson (1878-1958), a fanatic behaviorist, focuses on observable behavior. For more information, see: Doyle, C. L., 2000, Psychology: Definition. In A. E. Kazdin (Ed.), Encyclopedia of psychology, Washington, DC; American Psychological Association: 375-376.

[7] B. F. Skinner (1904-1990), expanded his empirical analysis of behavior into many psychological phenomena such as learning, language acquisition, and problem-solving. By the 1950s, due massive contributions by Skinner, behaviorism was largely the most important school of thought in the field of psychology.

This method of presenting objective evidence of the relationship between cognitive functions and physiological activities provides the possibility of valid causal inferences.

- Textual and narrative studies: In such studies as verbal biographies, daily notes, etc. users' reports are interpreted from their current knowledge of the environment or their memories. The verbal reports are often used in the study of complex cognitive processes such as problem solving or decision-making. To provide a verbal report, participants describe aloud their thoughts and ideas while doing a cognitive assignment or they report specific information related to certain aspects of their cognitive process.

- Naturalistic observation: The researcher observes individuals' behavior in a given environment. Then, he/she considers inferences about the processes which underlie the behavior. These inferences are sometimes tested with more controlled experimental plans. This cognitive research method has high ecological validity.

- Case studies: In this method, multiple sources and evidences are used to examine cognitive processes. By implementing intensive studies on subjects and matching case examples, the researcher is seeking to underpin cognitive processes. A case study is especially useful for formulating the hypothesis. Also, this method can be used to complete the finding of laboratory experiments.

- Computer simulations and artificial intelligence: In this method, after recording the real status of the environment and the performance of individuals, a fictitious model is created by the computer to simulate the cognitive function of individuals to predict the behavior of users in the environment. Sometimes the distinction between simulation and artificial intelligence is not so clear. An example is some of the programs designed to simulate human performance and to maximize its function. Based on the core logic of research, study methods in cognitive psychology can be categorized into four groups of causal attribution, interpretive, contextualization, and prediction. The logic of research is directly related to the research purpose. Therefore, the most relevant logic of research should be chosen to explain and analyze the question. Causal attribution-based researches are usually done quantitatively and according to scoring and statistical analysis. Furthermore, to facilitate the process of proving, they need systematic and controlled procedures. In interpretive research, humans are considered as social, autonomous, and dynamic creatures that always interact with the environment, and distinctive concepts are created in certain parts of their mind. In contextualization-based researches, multiple sources and evidences are used to study the phenomenon in its real field. These researches intended to contextualize case studies. Prediction logic is typically used in modeling or simulating studies to predict future operations and changes (Toit, 2010; Alinam, 2014; Pirbabaei et al., 2014).

Table 2-12: Research methods in cognitive psychology (Pirbabaei et al., 2014 based on Sternberg, 2009)

Research Methodology	Research Methodology Subspecies	Research Core Logic	Methodological Tools[8]
Controlled Laboratory Experiments	-	Causal attribution	- Direct observation - Instrumental observation
Psychobiological Research	-	Causal attribution	-Advanced hardware and software programs
Textual and Narrative Studies	Content/textual analysis	Interpretation	- Survey attitude instruments - Interview techniques
	Discourse/conversational analysis		
	Biography; Historiography		
Naturalistic Observations	-	Interpretation	- Direct observation -Instrumental observation
Case studies	Single/multiple case studies	Contextualization	- Direct observation - Instrumental observation - Survey attitude instruments - Interview techniques (Appropriate tools are used to fit the research question)
	Comparative case studies		
Computer Simulations and Artificial Intelligence	-	Prediction	-Advanced hardware and software programs

Any of the types of researches mentioned has different advantages and defects. For this reason, cognitive psychologists study cognition through a variety of scientific methods that seek a common understanding. Then they use different types of convergent evidence to support their hypothesis.

[8] Methodological tools in environmental studies are divided into two groups of self-reports and non-self-reports methods. The first is done by the subject and the second is done by the researcher without the awareness of the subject.

Table 2-13: Advantages and disadvantages of research methods in cognitive psychology (Pirbabaei et al., 2014 based on Sternberg, 2009)

Research Methods in Cognitive Psychology	Strength	Weakness	Opportunity	Threat
Controlled Laboratory Experiments	-Easy to administer, score, and do statistical analyses -Controlled laboratory setting - Representative samples of the population	- Difficulty in generalizing results beyond a specific place, time, and task setting - Random assignment of subjects - Individual differences are de-emphasized	- High possibility of drawing valid causal inferences - Possibility of controlling of independent variables	- Probable Discrepancies between behavior in real life and in the laboratory - Probability of losing control over the characteristics of participants
Psychobiological Research	- "Hard" evidence of cognitive functions through physiological activity - Alternative view of cognitive processes - Information about Individual differences	- Need for appropriate subjects and expensive equipment - Small and nonrepresentative samples of the population	- High possibility of drawing valid causal inferences	- Probability of Limited accessibility for most researchers - Probability of Decreased generalizability of results
Textual and Narrative Studies	- Access to introspective insights from participants' point of view - Information about Individual differences	- Inability to report on processes occurring outside conscious awareness - Dependence of data reliability on the candor of the participants	- Possibility of testing hypotheses - Possibility of interpreting verbal protocols and diaries	- Probable Discrepancies between actual cognition and recollected cognitive processes and products (Misperception of the interview and survey resultsdishonesty of participants in answering question)
Naturalistic Observations	- Access to rich contextual information -Environmental distinctions are emphasized	- Lack of experimental control - Individual differences are deemphasized	- Possibility of testing hypotheses -Possibility of interpreting observations	-Probable influence on behavior due to presence of observer
Case Studies	- Access to detailed information about individuals, including historical and current contexts - High ecological validity for individual cases	- Small and non-representative samples	- Possibility of testing hypotheses -Possibility of contextualizing studies	- Probability of decreased generalizability of results
Computer Simulations & Artificial Intelligence	- Exploration of possibilities for modeling cognitive processes - Full control of variables of interest	- Limitations imposed by the hardware and the software - Simulations may imperfectly model the way that the human brain thinks - Individual differences are deemphasized	- Possibility to predict the results of the hypothesis testing	- Simulations may imperfectly project the way that the human brain thinks

2.15. Cognitive Psychology and Relations to Neuroscience

2.15.1. Cognitive neuropsychology

To have an understanding on the nature of cognition and brain, is also to approve visions related to thinking, memory, mind, etc., hence knowing neurobiological constraints is indispensable. In this context, since neurosciences involve vastly and more complex studies from neuroanatomy to neurophysiology, it can provide numerous conceivable remedies and physical evidences to the cognitive explorations. Cognitive psychologists seek to know how anatomy (body physical structures) and physiology (body functions and processes) of the nervous system affect human cognition, and how the nervous system is affected by human cognition. Cognitive neuroscience is a study of the brain associated with other aspects of the nervous system, especially the cognitive processing and behavior of the brain. To study the human brain, scientists can utilize the variety of methods each of which provides important information about the structure and function of the brain. Currently, researchers tend to focus on techniques which provide information about the mental functions of humans at the time of occurrence.

Nowadays, techniques like EEG, PRT, fMRI, etc. have been used to measure and diagnose activated areas of the brain in many activities, such as vision, attention, and memory. For instance, fMRI has been used to demonstrate the necessity of lateral prefrontal cortex for working memory. This part of the memory is used to process information which is actively used at a certain time. Understanding how certain cognitive functions associated with specific brain processes or structures, gives the possibility to infer that there is some evidence of a relationship. Doing a profound analysis can further help to infer more accurate about the relationships, but hard to determine the causation relationship between brain processes and specific cognitive function. Certain functions may be affected by structures, areas or multiple brain processes. Ultimately, such technologies, along with other empirical methods, provide the best data to understand the complexities of cognitive functions. (Sternberg, 2017).

2.15.2. Cognitive studies of the brain fundamental structures and processes

The human brain reacts, manages and controls many important basic affairs such as feeling, thinking, imaging, and body movement. An average, the weight of a mature brain is about 1250-1400gr, and it involves 1-100 billion neurons. The brain can be considered by dividing it into three main areas of forebrain or upper part (Neo Cortex), midbrain or middle part (Old Mammalian), and hindbrain or inner part (Reptilian) which cause to essential functions of permanence, thinking, sensation, and perception.

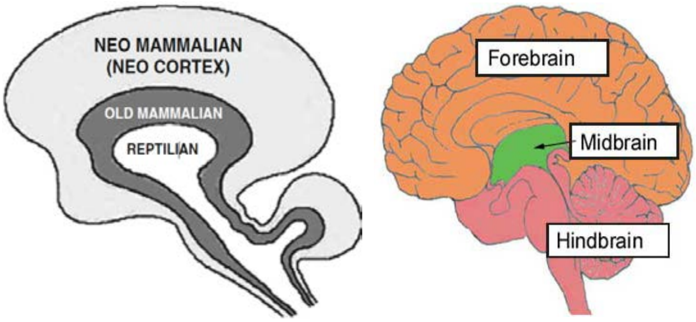


Figure 2-7: The main areas of the brain

-Forebrain: The forebrain is part of the brain which located on the front and above of the brain, and helps with reasoning, problem-solving, autonomic endocrine (logic process). It includes the cerebral cortex, basal ganglia, limbic system, thalamus, and hypothalamus. The *cerebral cortex* contains the outer layer of the brain hemispheres. This layer plays an essential role in thinking, memory, attention, perception, awareness and other mental processes. Furthermore, this part of the brain has composed of four major sections such as the frontal lobe (controlling movement and behavior), the parietal lobe (sensory process, attention, language), the temporal lobe (auditory processing), and the occipital lobe (processing visual information).

The *Basal ganglia* are a collection of cells that are vital for motor function. Any defect in basal ganglia can lead to motor disorders. The *limbic* system is important in basic emotions such as excitement, arousal, fear, anger, sex, and makes it possible to adapt our behavior in response to the variable environment. This system consists of three interconnected brain structures of the amygdala, septum, and hippocampus. The amygdala plays an important role in emotions, especially anger and violence. Amygdala stimulation results in fear that it can be exposed in a variety of ways such as palpitations, horrible illusions, etc. The septum is involved in anger and fear. The hippocampus plays a major role in the formation of memory. Regarding the exact role of the hippocampus, one hypothesis is that the hippocampus provides a cognitive map representing the space navigation. The *thalamus* transmits sensory information through the various nerve cells to appropriate cortical regions. Most sensory inputs pass through the thalamus. It is in the middle of the brain and the eyes. To enable accommodate all input data thalamus is divided into several groups of neurons with similar functions. Each core receives a certain sense of information. Then the information is transferred to the specific area in the cortex. The *hypothalamus* regulates the manner of permanence and survive (fight, eat, escape). The hypothalamus interacts with the limbic; it is also active in regulating and responding to stress (Sternberg, 2017; Lee, et al., 2009).

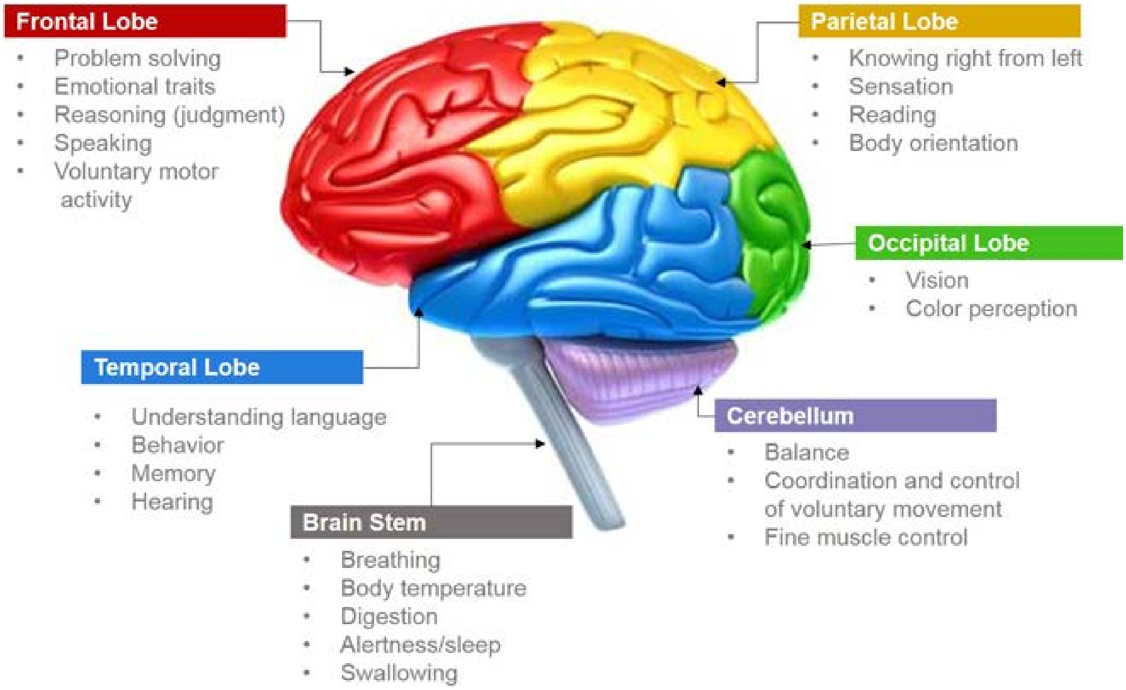


Figure 2-8: The main functional areas of the brain

-Midbrain: The midbrain controls eye movements and it is important for conscious awareness, body control, regulating movements, processing auditory and visual information.

-Hindbrain: The hindbrain is composed of the cerebellum, pons, and medulla oblongata which have a vital role in consistency and equilibrium, awareness, regulating autonomic functions, coordinating movement, and providing neural transferring from one part of the brain to another part of it; involving facial nerves, digestion, and swallowing. This part of the brain in mainly related to primary emotions such as seeking, fear, anger, etc.

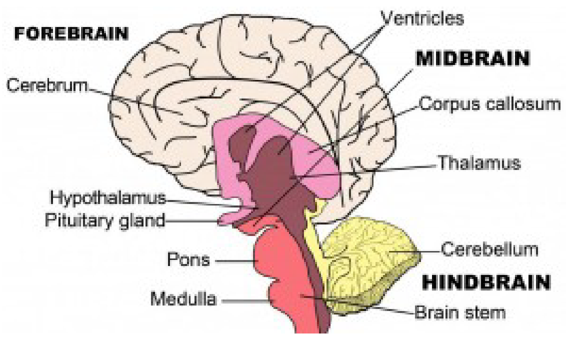


Figure 2-9: The main three areas of the brain

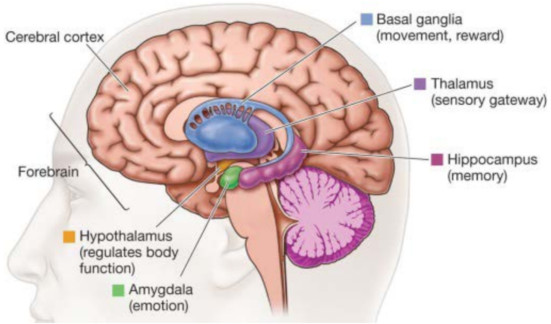


Figure 2-10: The main emotional areas of the brain

Table 2-14: Main structures and functions of the brain (Sternberg, 2017)

Brain region	Major structures in the regions	Structures function
Forebrain	Cerebral cortex (the outer layer of the brain hemispheres) • The frontal lobe • The parietal lobe • The temporal lobe • The occipital lobe	Involved in the reception and processing of sensory information, thinking, attention, language, auditory, other cognitive processes and the planning and sending of motion information.
	Basal ganglia (a collection of cores and neurons)	Vital for motor function
	Limbic system • Amygdala • Septum • Hippocampus	Involved in excitement, arousal, memory, motivation, emotion and learning (amygdala: anger and violence; septum: anger and fear; hippocampus: learning and memory)
	Thalamus	Transferring entered sensory information (vision, audio, etc.) to the certain regions of the brain through neurons.
	Hypothalamus	Controlling endocrine system, the internal temperature of the body, appetite. Regulating emotional reactions, pleasure, pain, pressure, survive (Fight, feed, escape and mating).
Midbrain	Superior Colliculi	Vision
	Inferior Colliculi	Audio
	Reticular activating system (RAS)	Awareness control, Arousal, Attention, Respiratory and motor function
	Grey matter, Red nucleus, Substantia nigra, Ventral region	….
Hindbrain	Cerebellum	Consistency and equilibrium
	Pons	Providing neural transferring from one part of the brain to another part of it; Involving facial nerves
	Medulla Oblongata	It works like a crossroad in which the nerves go from one side of the body to the opposite side of the brain. Involving digestion and swallowing

2.15.3. The neural basis of emotional state in the brain

Sensory experiences can involve emotional states. Perception is the process by which the brain selects and interprets emotions, and includes two physical and emotional parts. The physical part is stored in the hippocampus and the emotional part is stored in the amygdala. The new perceptual experience combines with the previously experience stored in memory. A concept is formed based on various dependent perceptions at different times and places. Concepts make beliefs, and individuals make decisions according to their beliefs which cause to selective attention and these are commutable over time (Boshra et al., 2015). Nowadays, based on advanced and detailed imaging studies and electromagnetic recordings of a functioning brain, emotion-cognitive interactions have evolved from an inferential and psychological subject to an intuitive subject in neuroscience. Studies have shown that when an individual is exposed to negative emotions, the relevant emotional centers are activated, and if he/she does not want to divulge his/her feelings, cognitive centers do not play a role that much; but if one wants to make a change in their emotions voluntarily, cognitive strategies come into play. The amygdala, central pole of the emotional network (limbic system), is in the bilateral relationship with different parts of the prefrontal cortex. The prefrontal cortex is enriched with receptor of different senses, the transmitter of motor decision making, and is linked with behavioral-emotional response controller. So, decision-making in response to the environment is under the interconnectedness of the prefrontal cortex and the limbic system with sensory and motor centers (Crocker et al., 2013).

The activity of these centers varies in the aspect of intensity, duration, and sequence in each perceptual experience which indicates that the emotional and cognitive system is dynamic. Therefore, sensory experiences play an important role in shaping a person's personality and the amount of attention and appreciation humans have for events around them. Structurally, it has been proven that the amygdala is the core of emotion and the lateral prefrontal cortex (LPFC) is the core of cognition. An important component for emotion is the amygdala area (ACC-VMPFC-OFC), whereas for cognition, it is the parietal area (ACC-LPFC) (Boshra et al., 2015). With the activation of the amygdala, several basic actions took place: it inhibits the nuclei that affecting the hypothalamic function and activates the hypothalamus to initiate autonomic and hormonal behaviors related to an increased emotion. The ACC (anterior cingulate cortex) encompasses predictive-motor aspects and OFC (orbitofrontal cortex) related predictive aspects of autonomic behaviors in emotional response. The OFC is in bilateral communication with the VMPFC (Ventromedial prefrontal cortex) which has a significant relationship with the stress response. Therefore, the amygdala (OFC-VMPFC) may be the focus of stress in increasing the activity of negative neurons.

2.15.4. The structure of emotion from neuroimaging studies

As mentioned previously, the specific point of emotional assessment studies is to investigate whether the basic elements of emotional life are discrete emotion categories like pleasure/displeasure, high activation/low activation, positive activation/negative activation, and approach - avoidance mechanisms. Meta-analytic and neuroscientists studies to identify the brain inner activities to make it possible to find out and reveal the mysteries of emotion mechanism during the contact with stimulus. Furthermore, they provide the possibility of an overview of the main brain areas involved in processing emotions. As discussed before, to describe the mental representation of bodily changes and feelings of hedonic pleasure and displeasure (happiness, fear, disgust, anger, etc.), the psychological concept of core effect is used. In fact, it is realized by visceral control systems that help organisms deal with salient stimuli motivated by the environment. In this context, the main areas of the brain that are sensitive to emotional reactions and stimuli (e.g., orbitofrontal cortex, amygdala) are involved in core affect, and they are in connectivity with the visual cortex. According to evidences, individuals' core affective states formulate activities in primary visual cortex that shapes and affect visual perception ranging from contrast sensitivity to visual awareness[9] (Lindquist et al., 2012).

The results of numerous studies show that emotions are produced by specific parts of the brain. Special places of brain record the individual's mental emotions known as orbitofrontal cortex which is associated with emotions and also is activated by emotions. The recording is classified into specific codes at the emotional level (pleasant, admire, good and bad, etc.), that enables the brain to create a wide range of mental emotions. In fact, neurons able to measure negative and positive or good and bad emotions. In this context, all environmental stimuli are considered as important factors that make feeling in the human being as reflected from that particular areas of the brain.

[9] For more information refer to: Damaraju et al., 2009; Phelps et al., 2006; Anderson et al., 2011.

It signifies that the brain uses a standard code on the emotional language. For instance, Murphy et al. (2003), Wager et al. (2003), and Phan et al. (2002) have studied the emotional activation such as happiness, sadness, anger, fear, and disgust. They concluded that basal ganglia, supracallosal anterior cingulate and dorsomedial prefrontal cortex are activated with happiness. Furthermore, the amygdala is activated with fear, and anterior cingulate cortex and dorsomedial prefrontal cortex are activated with sadness. The lateral orbitofrontal cortex is activated by anger; also, basal ganglia, insula, operculum and globus pallidus are activated with disgust. Generally, they also concluded that related to positive affect, the left lateral frontal cortex and basal ganglia are activated and related to negative affect, the insula is activated. Additionally, they found that the left lateral frontal cortex and anterior medial prefrontal cortex are activated the brain is engaged to approach an object or subject, and amygdala, left medial prefrontal cortex and rostral anterior cingulate, right striatum (basal ganglia), left insula, left fusiform and superior occipital cortices are activated the brain signals to avoid an object or subject (Barrett and Wager, 2006).

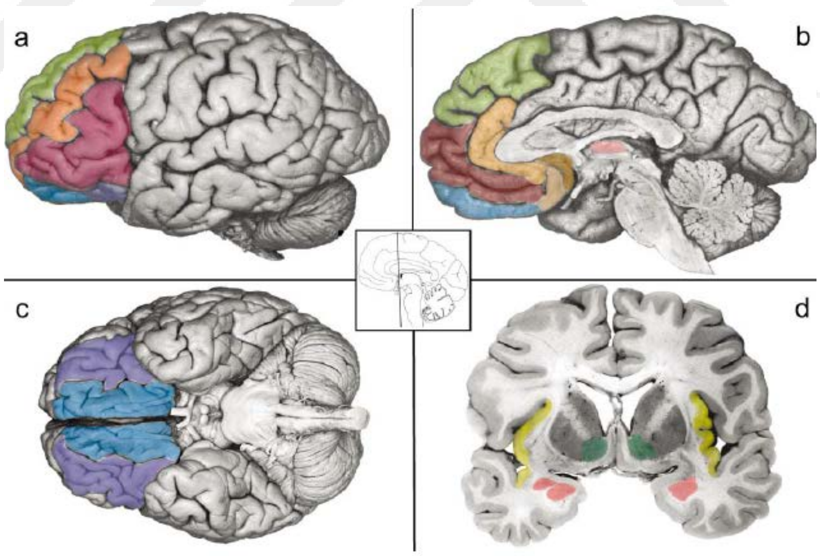


Figure 2.11. Locationist Hypotheses of Brain–Emotion Correspondence. The ventral system for core affect includes two closely connected circuits that are anchored in the orbitofrontal cortex (the entire ventral surface of the front part of the brain lying behind the orbital bone above the eye. The sensory system involves the lateral sector of the orbitofrontal cortex (OFC) and includes the lateral portions (*a*, *c*, *purple*). It is closely connected to the anterior insula (*d*, *yellow*) and the basolateral complex in the amygdala (*d*, *rose*). The visceromotor circuitry includes the ventral portion of the ventromedial prefrontal cortex (VMPFC), which is closely connected to the amygdala (*d*, *rose*) and the subgenual parts of the anterior cingulate cortex (ACC; *b*, *copper* and *tan*). The dorsal system is associated with mental state attributions (*b*, *maroon*), the anterior ACC (*peach*), and the dorsomedial prefrontal cortex (DMPFC)(*a*, *b*, *green*). Ventrolateral prefrontal cortex (VLPFC) is shown in *red* (*a*), and Thalamus (*b*, *light pink*), the ventral striatum (*d*, *green*), and the middle frontal gyrus in the dorsolateral prefrontal cortex (*a*, *orange*) (Lindquist et al., 2012).

Lindquist et al. (2012) focused on the models which hypothesize single brain regions associated with different emotional categories, and they depict the most popular locationist hypothesis of the brain as seen in the following figure: Fear: amygdala (d, *rose*); Disgust: insula (d, *yellow*); Anger: Orbitofrontal cortex (a,b,c, *blue*); Sadness: anterior cingulate cortex (b, *peach*). The areas of the brain involved emotional responses can be explained as follows (Lindquist et al., 2012; Barrett and Wager, 2006; Murphy et al., 2003; Phan et al., 2002):[10]

- ***The Frontal Lobe and Orbitofrontal Cortex;*** is the centers for many higher functioning aspects of behavior, such as language, thinking, deciding, planning, generating ideas, problem-solving, working memory, and personality. Furthermore, it is responsible for abstract analysis, cognitive analysis, controlling movement, behavior, and the exercise of judgment. This part of the brain is engaged in feeling like *happiness* (the right frontal), *fear* (the left frontal), *disgust* (the left inferior frontal), *anger* (the right and left frontal), and *surprise*.
- ***The Occipital Lobe;*** is involved with the brain's ability to recognize objects, and is responsible for visual processing. An area called Brodmann area that is the primary visual cortex, residing in the mid part of the occipital lobe. Areas located in occipital lobe mediate the perception of forms, movement direction, location, color discrimination. Generally, the occipital lobe of the brain is engaged in feeling like *sadness* (the right occipital lobe).
- ***The Temporal Lobe;*** has an important role in processing and transforming sensory information into memory, emotions, and language functions as well as in processing sounds. It is composed of some parts each of which is responsible for the different processes such as visual stimuli, recognizing objects (fusiform gyrus), and identifying locations or landscapes (parahippocampal gyrus).
- ***The Parietal Lobe;*** organizes the information process, and involves some significant functions like identifying the position, location, touch, understanding spatial orientation,

[10] For more information refer to:
https://www.whoami.sciencemuseum.org.uk
http://www.neurologytimes.com
https://www.bestpsychologydegrees.com
https://www.allpsychologycareers.com
http://www.cerebromente.org.br
https://www.health24.com
https://psychology-info.com
https://www.allpsychologycareers.com
https://www.spinalcord.com

visual perception, and mathematical computation.

- *The Amygdala;* as a very important area in feeling, controls emotions when we are *happy* or *mad*, and acts as the emotional processing center of the brain, responding to stimuli, especially danger like a built-in alarm system. Without it, we feel nothing, and wouldn't be happy. The amygdala plays an important role on controlling major affective activities like friendship, love, affection, and the expression of moods such as *happiness* (the left amygdala), *fear*, *sadness, disgust* (the left amygdala), *anger,* and *rage*.

- ***The Anterior temporal lobe;*** It supports language as a heteromodal association area involved in the representation of concepts and the right anterior temporal lobe has been implicated in the representation of abstract social concepts. Increased activity in the left anterior temporal lobe is more likely when experiencing an instance of *anger* than any other emotion category.

- *The Ventrolateral Prefrontal Cortex;* The ventral visual pathway provides detailed information on object identity, including color and shape, and receives motivational and emotional information from the orbitofrontal cortex and subcortical areas; this information can be used for elaborate decision making or design of goal-directed behavior. This area is engaged in *disgust*.

- ***The Dorsolateral Prefrontal Cortex;*** As a region of the frontal lobe, the dorsolateral prefrontal cortex is associated with executive functions including working memory and selective attention and is engaged in *anger*.

- *The Hippocampus;* forms, stores and retrieves memories. It reacts to *anger* (the right hippocampus), *sadness*, and *surprise*.

- *The Thalamus;* is responsible for relaying sensation, spatial sense, and motor signals, and is engaged in *sadness* (left thalamus), and *fear*.

- *The Hypothalamus;* controls your body temperature, emotions, hunger, thirst, appetite, digestion, and sleep. Specifically, its lateral parts seem to be involved with *pleasure* and *rage*, while the median part is likely to be involved in *fear*, *aversion*, *displeasure* and a tendency to uncontrollable and *loud laughing*.

- *The Insula,* as a small region of the cerebral cortex, is located deep between the frontal and parietal lobes. The insula provides emotional context to experience and interprets bodily states such as hunger and cravings, and is involved in *fear* (anterior insula), *disgust*, *anger*, *sadness* (left insula), and *happiness* (left insula).

- ***The Basal Ganglia*** refers to a group of subcortical nuclei responsible primarily for motor control, as well as other roles such as motor learning, executive functions, behaviors, and emotions. It involved in *disgust*.

- ***The Cerebellum*** controls balance contributes to the learning of coordinated movements, and processes sensory information used by motor systems, and in engaging in *fear* and *happiness.*

- ***The Cingulate and Anterior Cingulate Cortex***, an important part of the limbic system, the cingulate gyrus helps regulate emotions and pain. It is also involved in predicting and avoiding negative consequences and is engaged with *sadness*. Generally, pregenual anterior cingulate cortex (pACC; BAs 24, 32) and subgenual anterior cingulate cortex (sACC; BA 25) are the brain area for sadness.

- ***The Certain Brainstem,*** like the nuclei of the cranial nerves, stimulated by impulses coming from the cortex and the striatum (a subcortical formation), and is responsible for the physiognomic expressions of *anger*, *joy*, *sadness*.

- ***The Subcallosal;*** is connected to the medial orbital frontal cortex, and is associated with autonomic control, and is implicated in sadness.

- ***The Supracallosal;*** is associated with attention and working-memory functions, and is implicated in *sadness* and *happiness*.

- ***The Periaqueducal Gray;*** regulates the autonomic substrates like reproductive, fleeing, etc., and is implicated in *anger*, *fear*, *sadness*, and *disgust*.

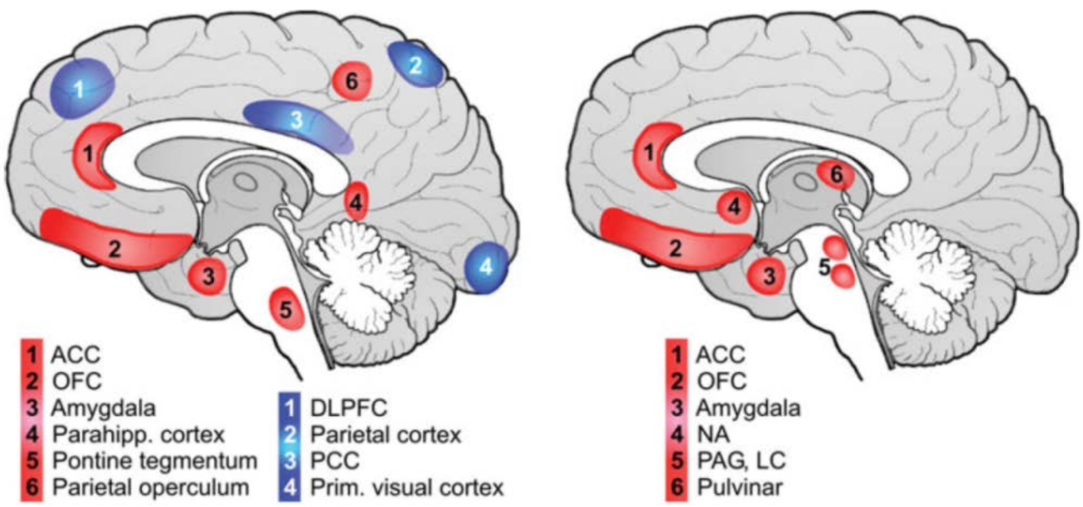


Figure 2.12. The areas of the brain involved emotional responses

Tablo 2-15: Summary of emotion category-brain-area activation correspondences (Author, according to Lindquist et al., 2012; Barrett and Wager, 2006; Murphy et al., 2003; Phan et al., 2002).

Feeling	**Happiness**	**Sadness**	**Fear**
The Brain Region	Cerebellum Anterior Cingulate Left Insula Right Frontal Prefrontal Cortex Left Prefrontal Cortex Basal Ganglia Dorsolateral Prefrontal Cortex Dorsomedial Prefrontal Rostral supracallosal cingulate Nucleus Accumbens Left Peristriate	Right Amygdala Insula Anterior Cingulate Cingulate Hippocampus Left Thalamus Prefrontal Cortex Right Prefrontal Cortex Right Occipital Lobe Right Middle Temporal Subcallosal Cingulate Dorsolateral Prefrontal Dorsomedial Prefrontal Rostral Supracallosal Left & Right Entorhinal Periaqueductal Right Putamen	Amygdala Insula Cerebrum Hypothalamus Left Hippocampus Thalamus Cingulate Frontal Lobe Left Frontal Left Prefrontal Cortex Orbitofrontal Cortex R&L Middle Temporal Left Anterior Temporal Anterior Mid-Cingulate L & R Occipitotemporal Left & Right Entorhinal Right Peristriate
Feeling	**Anger**	**Disgust**	**Surprise**
The Brain Region	Left Insula Hippocampus Frontal Lobe Right & Left Frontal Orbitofrontal Cortex Lateral Orbitofrontal Cortex Left Anterior Temporal Lobe Right Occipitotemporal Right Dorsomedial Prefrontal Dorsal Entorhinal Right Entorhinal Cortex Dorsolateral Prefrontal Cortex Left Ventrolateral Prefrontal Right Parastriate Left Peristriate Periaqueductal gray Entorhinal Cortex	Right & Left Amygdala Right & Left Insula Hypothalamus Frontal Lobe Left Inferior Frontal R&L Lateral Orbitofrontal Ventrolateral Prefrontal Anterior Mid-Cingulate Left Occipitotemporal Basal Ganglia Dorsal Entorhinal Entorhinal Cortex Right Peristriate Operculum and globus pallidus Periaqueductal gray	The Frontal Lobe The Hippocampus

Table 2-16: Summary of the brain regions showing consistent increases in activation during mental states (Lindquist et al., 2012: 139).

Variable	**Activated Area**
High arousal emotions	Right Amygdala; Lateral Orbitofrontal Cortex Periaquedcal Gray
Pleasant emotions	Fusiform Gyrus; Frontal & Middle Frontal Medial Prefrontal; Precuneus; Anterior Cingulate Cortex; Right Calcarine Fissure
Unpleasant emotions	Peristriate; Fusiform Gyrus
Positive affect	Left lateral Frontal Cortex**;** Basal Ganglia
Negative affect	Insula
Approach	Left Lateral Frontal Cortex; Anterior Medial Prefrontal Cortex
Avoidance	Amygdala; Left Insula; Left Medial Prefrontal Left fFusiform; Superior Occipital, Basal Ganglia

2.16. Brain Imaging Methods and Electrical Recording

With the advent of techniques that provide the possibility to directly monitor neurons throughout the body, understanding the brain has been advanced. These techniques provide high resolution to measure the activity of the brain both under resting and active states. In this respect, the researchers and clinical specialist often record brain electrical activity. This activity is shown as a waveform with frequency and intensity or three-dimensional imagine.

2.16.1. EEG

Electroencephalogram (EEG) method records the frequency and electrical intensity of the brain, which is usually recorded over a relatively long period of time. The brain waves activity representing the change of mental states can be studied through the EEG system. To record the EEG, electrodes are placed in different parts of the brain along the scalp and skull surface. Then the electrical activity of the underlying area of the brain is recorded. In such a in such a situation, the received data are very sensitive to changing mental states over time. To associate electrical activity with a particular event (such as light exposure or listening to sentences), it is possible to determine the average EEG waves in multiple experiments (for example, 100 cases), and reveal event-related potentials (ERP). Waveforms show the characteristics of the time of the electrical activity, but it shows only very general information about the place of activity due to the low accuracy of the electrodes on the skull (Sternberg, 2017). The most important point to consider in using EEG is that which area of the brain we would need to place electrodes to measure the brain waves. Electrode location and names are specified by the 10-20 system for most research applications (Lee, et al. 2009).

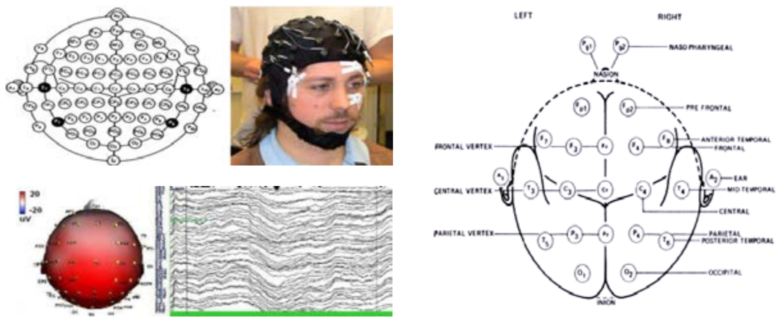


Figure 2.13. EEG system and its futures

2.16.2. ERP

Since the ERP technique has a very high time precision, it is mostly used as a complementary method to other techniques. Researchers have used this method to determine the areas of the brain involved in words association. Using ERP, researchers found that participants showed more activity in some parts of their brain (left lateral frontal cortex, ventrolateral prefrontal, insular). This method also represents only part of the brain's activity, and it is more useful when used in conjunction with other methods to focus on a specific area of the brain that is involved in cognition (Sternberg, 2017). As the main components of ERP waveform, the P300 is related to positive voltage deflection (occurring approximately 300ms after stimulus commence), and N400 is related to negative voltage deflection (400ms). The magnitude, topography and time of this signal are considered as determinative parameters of cognitive function in decision-making processes (Lee, et al. 2009).

2.16.3. MRI

In order to provide fixed imagery which reveals the brain structures, psychologists use a variety of methods such as angiogram, computerized axial tomography scan (CAT), and Magnetic Resonance Imaging scan (MRI). Methods based on X-ray application (angiogram and CAT) make possible to observe the large brain abnormalities such as stroke or gland damage. However, in terms of accuracy and precision, such images are limited, defective, and unable to provide more detailed information about brain damages and concussion. Perhaps the most interesting method of fixed imaging used by cognitive psychologists is MRI. This method provides a clear and sharp image of the brain structure by calculating and analyzing the energy changes of the atomic nodes in the body molecules. In the MRI method, a very strong magnetic field passes through the patient's brain, and revolving scanner of the system traces various patterns of electromagnetic changes in the brain molecules. These molecular alterations are analyzed on a computer to get a 3D image of the brain. The resultant image involves detailed information about brain structures and provides measurable data about the physiological process (Sternberg, 2017).

There are two important advantages of MRI which make the use of it widespread. The first one is called multiplanar imaging, unlike other imaging modalities; which has the capability to change the section plan without changing the patient's position. In this way, the three-dimensional image of the area to be examined can be obtained in three different sections. The second important advantage is that no ionizing radiation is used in this method. Head scan is one of the most commonly used applications of MRI. This application is used to create detailed images of the brain and nerve tissues around it. Nowadays, through the MRI technology brain imaging is performed in two different structural and functionally ways. Anatomical details of the brain can be achieved by structural imaging, and functional MRI provides detailed images of brain activations. MR images are formed using the signals from the tissues under the influence of the magnetic field. In MRI, images are obtained in three different planes called axial, sagittal and coronal (Özmen, 2018).

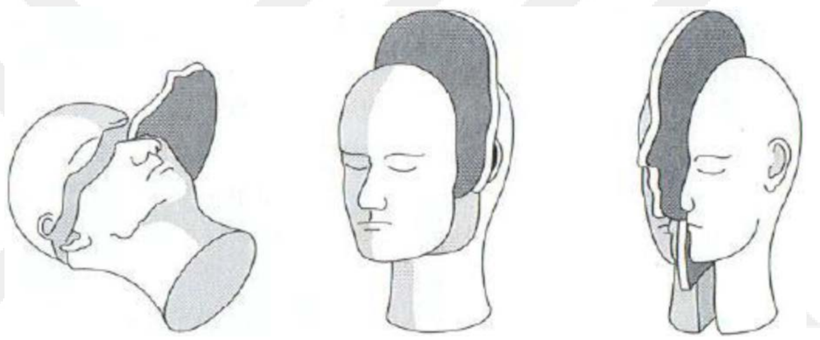


Figure 2.14: Cross-sectional planes in MR technique (Özmen, 2018)

The smallest volumetric unit of these three-dimensional images is called voxels. In addition, the two-dimensional area of the voxel reflected on the screen is called pixel. The voxel and pixel image of the three-dimensional brain MRI is shown in the following figure. Many MRI systems consist of a 128x256, 192x256 or 256x256 matrix. The spatial resolution increases as the number of pixels used to create the image increases.

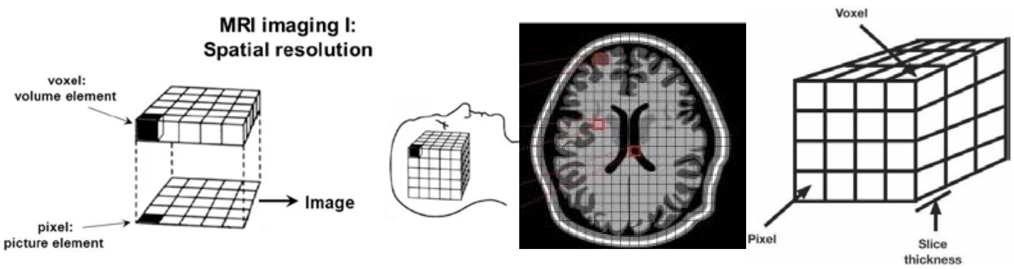


Figure 2-15: Voxel and pixel image of three dimensional brain MRI

2.16.4. fMRI

Structural imaging methods cannot provide information about functional changes in the human brain. So, functional neuro imaging methods are needed to examine the behavior of the brain during cognitive processes. Functional brain imaging does not directly provide information about the brain, and it is necessary to use statistical analysis to create a map of the brain. The development of technology has led to an increase in the performance of MR imaging methods and result in an increase in temporal resolution. Such a situation led to the development of functional MRI method which enables the functional map of the brain to emerge (Karakaş, 2008).

The latest technology, Functional Magnetic Resonance Imaging (fMRI), is a technique used to determine which parts of the brain are activated by physical stimuli and cognitive activities. fMRI provides an indirect measurement of neural activity in the brain through a change in the blood-oxygen level. With this method, researchers have the opportunity to record brain images while a subject performs a cognitive or sensory task (Özmen, 2018). It is neural imaging that uses the magnetic field to create a more detailed and three-dimensional representation of the activity of different parts of the brain at a given time. This technology installs on MRI and utilizes increasing oxygen consumption to make brain activity images. The most important advantage of fMRI is measuring neural activation with the high spatial resolution. Furthermore, this technology does not require the use of radioactive particles and creates a magnetic field which causes changes in the atomic particles of oxygen. However, in addition to these advantages, there are some disadvantages to fMRI. First of all, it is very sensitive to body movement errors and has a limited temporal resolution. The brain's more active areas absorb more oxygenated blood than less active regions. The measurement criterion for fMRI is the differences in oxygen consumption. The computer analyzes these measurements to provide the most accurate information about the physiological function of brain activity during the task. This technology has higher precision and can measure activities that take only a fraction of a second (Sternberg, 2017).

2.16.4.1. Features of working with fMRI technique

The fMRI consists of 3D images recorded over a period of time, contribute to noise, and provides high data. By analyzing these images statistically, the active areas of the brain and the number of active voxels are determined. fMRI works by detecting changes in blood oxygenation and flow which emerges in response to neural activity. When brain voxels are activated, they consume more oxygen. To meet this increasing demand, blood flow increases towards the active brain area. Oxygen is transmitted to the neurons by hemoglobin. As a result, when neural activity increases, oxygen and hemoglobin rise in the blood. Depending on the degree of oxygenation, such a magnetic change leads to a difference in the MRI signal in the blood. Since blood oxygenation varies according to the levels of neural activity, these differences can be used to detect brain activity.

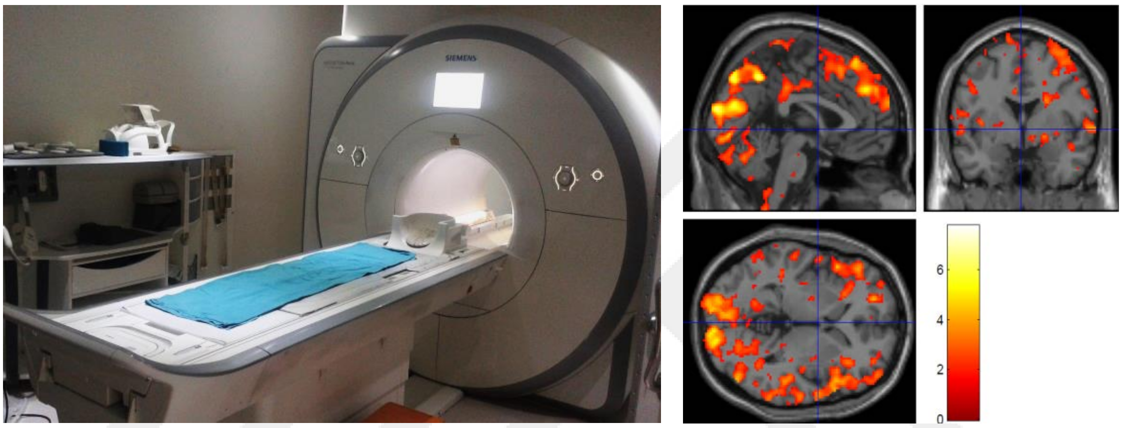


Figure 2-16: MRI machine and the brain functional imaging (Author)

One of the most important facilities of fMRI is to reconnoiter the regions of the brain with increased blood flow. In this regard, relevant regions (BOLD) can be identified due to the disruption that hemoglobin causes in magnetic imaging. The fMRI measures the signals produced by the oxygen level change, known as the blood-oxygen level dependent (BOLD) signal. An increase in the oxygen level in the blood causes an increase in the BOLD signal. As neurons use oxygen, its concentration decreases from previous levels. The dynamic regulation of this blood flow is called the Hemodynamic Response. The following figure shows the hemodynamic response that occurs 1-2 seconds after a sensory stimulus which is delivered in an fMRI experiment. fMRI data can be recorded in two different ways for use in psychiatric or neurological studies. The first one consists of a task-based approach and the second one consists of resting state fMRI. Rest state fMRI measures instantaneous, low-frequency fluctuations in the BOLD signal to investigate the functional architecture of the brain. (Özmen, 2018).

2.16.4.2. The acquisition of functional MRI

For accurate analysis of fMR images, it is extremely important to obtain the images correctly. At this stage, the patient must learn the tasks to be performed correctly on the MRI device and remain stationary during the experiment. In the stage of obtaining fMR images, experimental drafts are designed for the desired brain function. Task-based fMRI attempts to identify signals related to experimental manipulation, such as a sensory stimulus, motor action, or cognitive process. For this purpose, it is examined to find if there is any significant difference in activated voxels between task and control states. Task-based fMRI is performed in two ways: block design and event-dependent design. Block design experiment paradigms, a simple and effective approach, are used to improve the sensitivity to task-related signals. The block design experimental paradigm is realized by applying successive rest and task blocks to the subject on the MR device. The following figure shows the sequence of task and control states in the block design experiment paradigm.

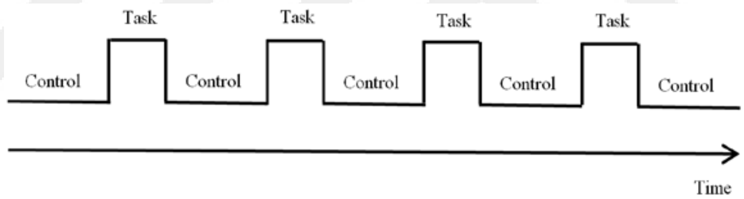


Figure 2.17: fMRI block design experimental paradigm (Özmen, 2018).

In fMRI experiments, stimuli consisting of task and control (or rest) states are repeated for approximately 5 minutes in a row, and these stimuli are expected to produce BOLD activity in the respective regions of the brain. As seen in the following figure, the impact of the reaction to the stimulus on voxels is examined by recording the brain images during response times. The time-dependent fMR volumes obtained in an fMRI experiment is shown below.

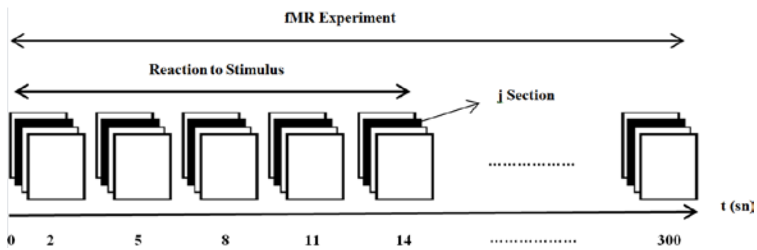


Figure 2.18: Time-dependent acquisition of fMRI volumes (Özmen, 2018).

fMRI data is formed by recorded three-dimensional brain images over a period of time. In the analysis of fMRI, all voxels are examined one by one in three-dimensional space, and the density changes in the voxel are examined during the experimental period. These intensity changes are used to determine the time series of voxels. The following figure shows the change in intensity value of an active and passive voxel according to the cross-sections.

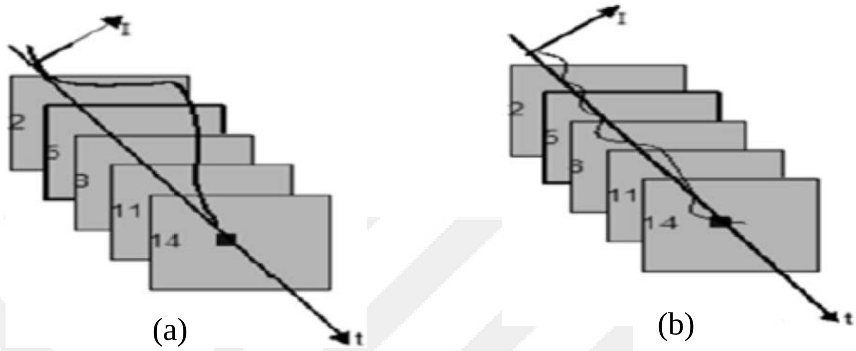


Figure 2.19: (a) Variation of density value of an active voxel with respect to cross-section (b) Variation of density value of a passive voxel with respect to cross-section (Özmen, 2018: 29).

2.16.4.3. Pre-processing of functional MR images

- **The evaluation of filtering method with fMRI data**

fMRI data analysis consists of image acquisition, pre-processing, and statistical analysis. As a result of the statistical analysis of fMRI, activations occurring in brain regions can be detected. In order to determine the activations correctly, the correct application of preprocessing steps is as important as the analysis stage. In the following figure the preprocessing and analysis steps of the fMRI data are listed visually. After recording step, some preprocessing steps must be applied to the obtained fMR images. The main ones are; realignment, slice timing, coregistration, spatial normalization (Chen & Glover, 2015).

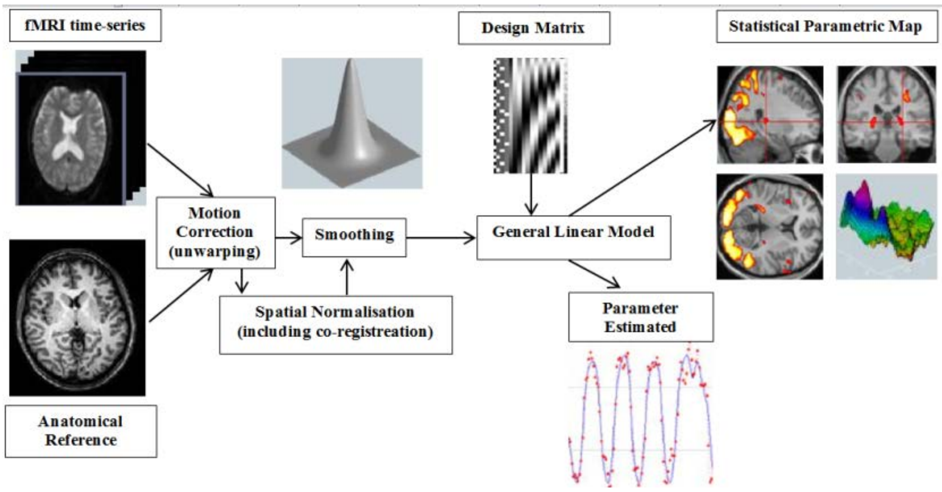
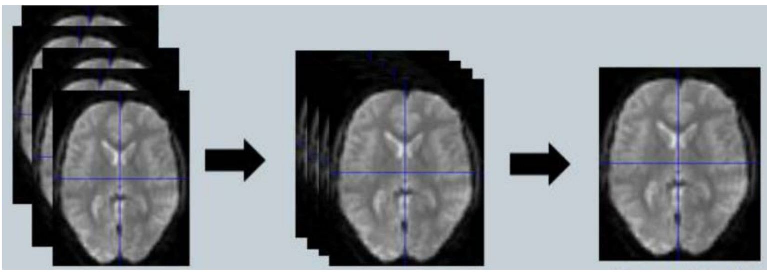


Figure 2.20: Preprocessing and analysis steps for fMRI data (Özmen, 2018)

-Realignment: One of the most important factors that cause problems in the analysis of fMRI is the subject's head movements within the device. The effects of head movement can be divided into two classes. Firstly, the head movement may cause the position of the voxels to match incorrectly. A sudden movement of the head leads to sudden changes in the value of voxels (Freire and Mangin, 2001). The second type of head movement on fMR images is the spin-history effects which are considered as a distortion effect. Such an effect is due to proton movements in different slices near the target voxels, resulting in an unexpected signal bearing false information. Motion correction in fMR images is achieved by realigning the consecutive recorded volumes to a reference volume. After realignment, averaging aligned images are used for reconciliation. The following figure shows an example of the average image generated after the realignment process. In the following figure, the preprocessing and analysis steps of the fMRI data are listed visually.



Time Series　　Realignment　　Average Image

Figure 2-21: Realignment process and averaging aligned images (Özmen, 2018)

-Slice timing: Exact timing is an important element for functional MRI data analysis. Data sets generally measured using repeated two-dimensional imaging methods. As two-dimensional images classify consecutively, a transient shift occurs between sections. In order to eliminate the timing difference between the sections, the section timing correction is used as the pre-treatment step. With this method, each section is temporarily aligned to a reference section, depending on the appropriate sampling method.

-The coregistration of structural and functional images: the recorded 3D structural and functional images do not match with each other depending on different MR contrasts and voxel resolution. This leads to problems when activations are desired to be displayed on the anatomical image. The process that matches the functional and structural images is called functional structural coregistration. This is typically accomplished by first resampling anatomical data to the spatial resolution of functional data. The following figure shows low- resolution fMR and high-resolution MR image.

- Spatial Normalization: The analysis of fMRI data can be performed on an individual or group basis. It is inevitable that the head structures and dimensions of the subjects are different in the studies which were recorded from different subjects. In these analyses, the process of displaying fMRI data in a common template is called normalization. Standard templates such as Talairach or MNI are used for normalization (Özmen, 2018).

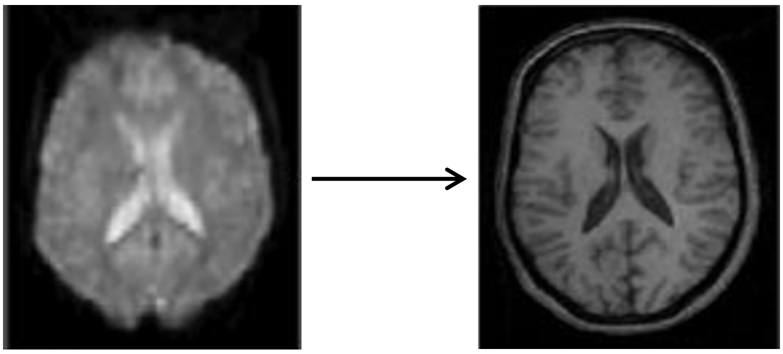


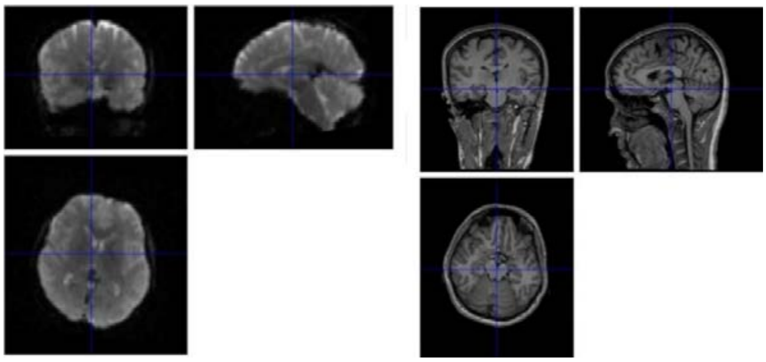
Figure 2-22: Low- resolution fMRI and high-resolution MR image (Özmen, 2018).

Functional MR images are often distorted by random noise. So, preprocessing on fMRI is considered as one of the most important steps to prevent these distortions. Furthermore, before starting the analysis with fMRI, any slipping of the head movements must be corrected in the “realignment” process. With the realignment process, each volume is rearranged according to the first volume and the average image is obtained using the aligned volumes. The second of the preprocessing step is the reconciling process in which the structural (anatomical) and functional images are superposed. This process is done after the realignment of the standard T1-weighted series of the three-dimensional structural MR image and is achieved by superposing the average T2 images obtained (Coregistration). At the final stage, all images are normalized to a standard Talairach three-dimensional coordinate system. The preprocessing steps performed in the current study were done by SPM 12. The following figure shows the MR images obtained as a result of the realignment, reconciliation and normalization processes used in a sample study (Özmen, 2018: 86).

Generally, preprocessed fMR images are filtered with Gaussian smoothing. However, in these studies, as an alternative to the Gaussian smoothing algorithm, the Matlab program is used for developed filtering and smoothing algorithms. First of all, to apply the classical smoothing algorithm, some experiments are made in different Gauss core sizes with SPM which works harmoniously with Matlab. The process steps applied to the recorded fMRI data can be seen in the following figure. After filtering methods are applied to the data whose preprocessing is completed, the feature extraction, feature selection, and classification processes are performed.

- **Preparation of structural and functional images**

The fMRI data obtained is usually taken in DICOM format and each record is classified and filed according to its category. At this step, firstly, the data must be prepared for analysis. Various package programs are used for this purpose. The first one is the Mediplus DICOM viewer program used to access and classify DICOM images. Based on this program, the data received on CD are sorted according to their names recorded in the radiology clinic, thus providing easy access to the data. Secondly, the Dtistudio program was used in obtaining sagittal section T1 images from structural MR images and converting them to .img + .hdr format. Finally, functional images recorded with spurred .dcm were recorded with the SPM12 software in .img + .hdr format. In the following figures, section (a) shows axial sagittal and coronal sections of the 60th volume of a participant’s functional MR image and the (b) section shows the T1-weighted structural MR image of the same subject (Özmen, 2018: 86).



(a) **(b)**

Figure 2.23: (a) functional MR image and (b) T1-weighted MR image (Özmen, 2018).

➢ Pre-processing steps of functional MR images

The re-alignment, time correction, correlation, segmentation, spatial and structural normalization phases will be applied to the fMRI data used in this study with the SPM12 program. To correct errors caused by head movements, successive image volumes are aligned to a single reference volume with the re-alignment. In functional MRI, the brain regions close to each other are recorded at different times. By making use of the information at the time points, the time differences between the sections are eliminated by calculating the amplitude of the MR signal at each time point in the TR. In functional-structural reconciliation, functional and structural images are made compatible with each other. Functional images are blurry, and structural images provide a more transparent brain image. Functional images need to be linked to structural images due to different cross-sections and motion-related differences. The recorded T1 is performed separately for each participant with structural MR images. Then, the segmentation process consisting of separating the brain anatomical structure as white matter, gray matter and cerebrospinal fluid are applied. Spatial Normalization; It is the process of matching the images taken from different subjects to the same coordinate system. It allows for group statistics and generalization of the findings. In the study, spatial normalization is done by using the SPM program and matching the MNI template. Besides, structural normalization is performed by matching the obtained structural images to the same coordinate system. Finally, with the use of ultimate spatial filtering, the distorting effect in the image is eliminated and false-positive results are reduced and the error becomes more normal (Özmen, 2018).

2.16.4.4. The statistical analysis of fMRI images

In the statistical analysis of fMR images, the intensity changes of the voxels in the brain regions can be determined by comparing the signal changes occurring with the tasks used in the experimental paradigm to the changes in the control state. The commonly used method for assessing the statistical significance of neural correlations in the brain is known as Statistical Parametric Mapping (SPM). SPM is a voxel-based and single-variable approach based on the General Linear Model (GLM). GLM, which is used in the analysis of fMRI data, is considered as an analytical method that allows each voxel to separately investigate transient changes in hemodynamics. The first step in statistical analysis is to create an estimation model of the recorded data. In the GLM method, this prediction equation is based on the linear regression equation: $T = X\,\beta + \mathcal{E}$. In this model, Y is a matrix corresponding to each fMRI scan. X is the design matrix. The design matrix contains the information of the task states in the experiment. β parameter matrix; It is the matrix estimated by the GLM and shows how much each variable affects the received signal. $\mathcal{E}$ corresponds to errors. In this statistical method, two-level analyzes are performed (Poline and Brett, 2012). For the first level of analysis, functional images of each individual are analyzed separately. For the second level analysis, the average results of individuals of the same group are calculated. Thus, the activities of the group are evaluated statistically. In general, the analysis is performed using rest conditions in response to task situations. In the fMRI data, there are statistical analyses of thousands of voxels leading to a statistical correction. Therefore, using multiple comparisons significant activations are given by calculating the “p-value”. Accordingly, in group analysis, the correction threshold of multiple comparisons is set at $p<0.05$, $p<0.01$, or p-FWE<0.05. In the analysis of functional MR images, the X matrix referred to in Equation 2.16 is called a design matrix and is often used to represent the experimental structure (Özmen, 2018).

Take a simple block design experiment to understand the analysis of fMRI. In this experiment, the first three tasks are expressed in motion and the last three tasks are expressed by visual stimuli. In this case, the columns in the design matrix are defined by the tasks performed. In addition, the lines consist of the scan times used for recording (TR=4). For rows representing the motion task, the column is set to 1, and the remaining columns are set to 0. Similarly, for rows that represent the visual task, the corresponding column is set to 1 and the remaining columns to 0 (Oğuz, 2016). A simple block design is formed of six blocks that the first three blocks represent motion, the last three blocks represent the visual stimulus and equation 2.16 (GLM equation) to 2.17 for a single voxel “υ”.

$$\begin{bmatrix} 10 \\ 10 \\ 10 \\ 01 \\ 01 \\ 01 \end{bmatrix} = \begin{bmatrix} \upsilon 1 \\ \upsilon 2 \\ \upsilon 3 \\ \upsilon 4 \\ \upsilon 5 \\ \upsilon 6 \end{bmatrix} [\beta 1 + \beta 2] + \begin{bmatrix} e1 \\ e2 \\ e3 \\ e4 \\ e5 \\ e6 \end{bmatrix} \tag{2.17}$$

According to equation 2.17, the first column of the X matrix represents the motion task, the second column represents the visual task, and υ1 - υ2 represents the BOLD value of a voxel recorded at regular intervals. When the predicted β matrix is calculated by an ordinary least-squares method, a contrast vector such as cT = [1 -1] can be used to obtain results with different effects. In cT = [1 -1] contrast, ‘1’ value is used for positive activation, ‘-1’ value is used for negative activation and 0 value is used to eliminate the results completely. The following figure shows the activation map generated by the statistical analysis of fMRI data obtained with a visually stimulated block design subject paradigm. Statistical analysis was performed with SPM. According to the experimental paradigm, fMR images were recorded from subjects on MR device in order of ‘rest-task’. The tasks consist of positive and negative pictures. This experimental paradigm was designed in contrast to cT = [1 -1] and investigated in which regions the positive-negative visual activations were significantly greater than the resting state. Significance value was selected p=0.05. In the design matrix shown in the following figure, the task and rest contrasts listed according to the experimental paradigm, are shown together with the statistical brain map obtained by coloring the regions where three active voxels come together.

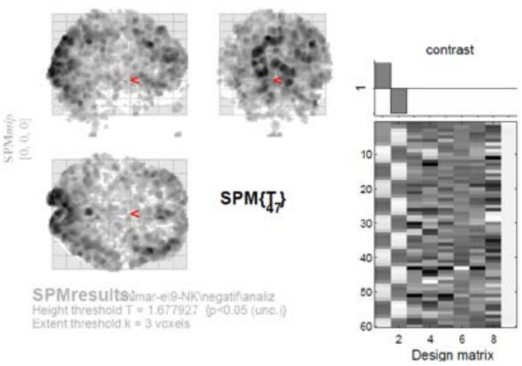


Figure 2-24: Results of statistical analysis after preprocessing steps were applied to fMR image (Author).

2.17. Neuroscience and Architecture (Neuro-Architecture Approach)

2.17.1. Applying neuroscience to architecture

A glance at the past and history reminds us that two extensive and rich disciplines, neuroscience and architecture do have a common point. There was Imhotep (2655-2600 BC), the first architect and doctor who was from Egypt and Leonardo da Vinci (1452-1519 AD), the Italian genius whose approaches to science and architecture are noteworthy (Arellano, 2015).[11] Rather than architectural researches that generally are conducted based on observation and intuition, studies in the field of cognitive neuroscience are experimental, biological, and involves the understanding of the structure of the brain and mental activities. The purpose is to know the role of the brain in performing specific mental activities.

Recently, the advancements of neurosciences have opened the doors to combine this field with other disciplines such as chemistry, computer science, art, engineering, linguistics, mathematics, medicine, and psychology. Some neuroscientists are trying to identify the part of the human brain that responds to perception and thereby through functional brain imaging which enables human aesthetic and spatial experiences to be measured. For instance, in the field of architecture, the built environment affects the neural activity inside our brains and through neuroscience, it is possible to interpret the process of human perception, sensation, emotion, mood, and neural activation. Such an interdisciplinary composition (neurology + psychology + architecture) probing human affective and cognitive response to the environmental stimulus is called Neuro-Architecture and it provides facilities for planners and architects to take into account the users' emotional effects and criteria for creating a pleasant place in the design process.

Neurologist researchers in the early 20th century have reached a profound understanding of the interaction between the environment and behavior, brain mental processes and its susceptibility to the environment. Studying on sensation, perception, and emotion, neuroscientists show that each certain areas of the brain are responsible for specific functions. Indeed, neuroscience (cognitive science) provides the possibility of identifying the brain principles which suggest useful to boost ideas for design.

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[11] Besides, neurophysiology and design closely linking and influencing goes back to the Renaissance. Descartes and Vesalius working on characteristics of the central nervous system shared and incorporated their findings with artists like Da Vinci or Mantegna who working on anatomical observations, painting, and architectural design.

Cognitive neuroscience investigates the ways which explain the relationship between environmental experience and behavior. In addition to that, it examines data to test hypotheses and their relationships with the brain mechanism, structures, and function.

Eduardo Macagno considers neuroscience as a biological base for architectural design and believes that architecture affects people's spatial experience such that challenges neuroscience (Arbib, 2019). On the other hand, architecture plays an important role in brain responses related to different environments. Furthermore, architects can follow neuroscientists' principles to input them in the design process, and to understand scientifically the intuitive observations (Arellano, 2015). Indeed, emerging neuroscience to architecture would be unique from this aspect as it provides scientific and technical facilities to investigate the relationship between people and the built environment. Therefore, neuro-architecture findings assist in answering questions on how people respond to the environmental stimuli in spaces, the design process, strategies, and decisions. So, it can be said that in the Neuro-Architecture approach, the goal is to know how the environmental variables affect the brain's cognitive processes and subsequently user behavior and well-being. In this case, it would be known that how the design of faculty can support students' cognitive activities, the design of a health clinic can boost the recovery of patients and so on. To have a profound understanding of an environment influences on well-being, attention, memory, emotion, etc., the combination of architecture, psychology, and neuroscience seems to be important. In this context, using techniques as a tool to promote neural evidence-based methods and design strategies can be an effective solution.

Jonas Salk and Norman Koonce, leaders in neuroscience and architecture, being aware of the importance of such incorporation called for the cooperation of architects and neurologists. They thought that by using powerful and controlled laboratory experimental approaches, it could be possible to have a completely scientific assessing of the built environment and its impact on the brain system for emotion, perception, and memory. As mentioned earlier, one of the research methods of cognitive psychology is the controlled laboratory experiments. These experiments provide opportunities of high possibility of drawing valid causal inferences, the possibility of controlling independent variables, and statistical analyses. In general, they are accomplished by using techniques such as fMRI which measures brain activation by the detection of changes in blood flow, and EEG which relies on electrical signals to explore how the brain responses.

In 2003 at San Diego, with the support of the American Institute of Architects (AIA), the Academy of Neuroscience for Architecture (ANFA) was established to support “neuro-architecture” as a way to promote, advance, and connect neuroscience and the study of behavioral responses to the built environment (Papale, 2016; Arellano, 2015). Significantly, the purpose of the ANFA principals is to explore ways to merge neurological researches in architecture practically to improve users’ experiences in the built environment, interpret how an architectural place can affect feelings of good or bad, pleasant or unpleasant, how the ceiling height, color, geometry, etc. affect the user’s psychology, or how users remember and feel the sense of security climbing stairs with wooden fences, sound of footsteps on gravel or the smell of the wet plants.

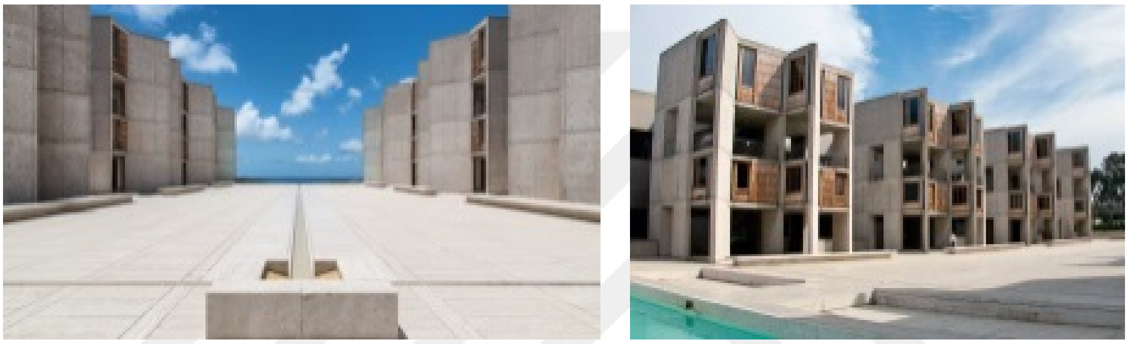

Figure 2-25: The Salk Institute (ANFA) has designed by Louis Kahn, and is considered as one of the early examples involving neuroscience in work environments (Arellano, 2015:10).

2.17.2. Neuro-architecture

Hitherto, the emotion and perception have been a challenging subject in different sciences, and novel methodologies to explore the neurobiological bases of mind and behavior have inspired the fields of architecture (e.g., Papale, et al., 2016; Albright, 2015; Mallgrave, 2001), planning and urban studies (e.g., de Lange, 2013), art studies (e.g., Nalbantian, S. 2008), geography (Anderson and Smith, 2001), etc. Novel interdisciplinary fields with the “neuro-” prefix have thus recently emerged, such as neuro-economy, neuro-law, neuro-marketing, and even neuro-architecture (Papale, et al., 2016). In recent years, with the development of fields such as neuroscience and its linking to the field of perception and aesthetics, some neurologists have begun to study the phenomenon of perception and emotion from this perspective. Neurologists deal with the concept of perception empirically, and express the physiological basis of perception. They deal with the physical reactions of the brain in the field of perception and seek to introduce this approach as a science called the neuro-architecture.

As a new scientific field, neuro-architecture aims to answer questions than can affect human health and experience in an expanded scale. Moreover, it deals with empirical studies of place perception, place emotional evaluation and creating architectural pleasant space. It examines the relationship between brain areas and the nervous system with place emotional experience and perception. Researchers working on this field believe that architecture should have a scientific and neurological explanation to place perception. Additionally, they consider the biological originality of emotional experience and perception, and relying on scientific documentation. The researchers would need to approve the perception scientifically, investigate the relationship between sensory experience and architectural perception, and determine the criteria for creating architectural space by detecting the aesthetic and emotional agents in the brain (e.g., Pallasmaa, et al., 2016; Mallgrave, 2011; Sternberg, et al., 2006). For example, nowadays, studying non-visual perception and touch is considered as an interesting topic (e.g., Pallasmaa, 2012). Architects like Steven Holl, Juhani Pallasmaa, and Peter Zumthor have emphasized on the key role of the brain in interpreting spatial information during an experience process which implies that architectural experience can be augmented by the understanding of brain function (Arellano, 2015).

In an overview, the notion of neuro-architecture can be described as an approach by which an environment designed based on neuroscience tenets, and provides spatial capabilities to encourage memory, stress relief, and stimulate the brain. Such an approach incorporates neuroscience and architecture to present a scientific justification of linking emotions and architectural design by studying individuals' responses and preferences and measuring the relevant areas of the brain. fMRI evidences have demonstrated that architectural parameters like visual and spatial characteristics are associated with *the occipital areas* (respond to perceptual information regarding architecture), *the superior* and *the middle temporal gyri* (are involved in the motion required for visuo-spatial exploration), *the fusiform gyrus* (contains neural representations of architectural styles), and *the precuneus* (Zhang et al., 2019).

In this context, the activation of areas such as *the cerebral cortex* (is implicated in expressing emotions), *the hippocampus* (is implicated in memories), *the thalamus, the parahippocampal* (is implicated in architectural experience and respond selectively to places, and the representation of large-scale places and scenes), *the hypothalamus* (is implicated in receiving messages), *the nucleus accumbens* and *medial prefrontal cortex* (are implicated in emotional perception, pleasurable stimuli and learning) are expected. Specifically, spatial perception such as height, depth, geometry, etc. takes place in *the occipital*, *parietal*, and *temporal lobes*. (Arellano, 2015; Mallgrave, 2011; Costa et al., 2010). Furthermore, it has been shown that evaluating the aesthetic value of architecture, *the orbitofrontal cortex* and *subcallosal cingulate gyrus* are more activated in architects rather than non-architects (Vartanian, 2013).[12]

In the book of "The Architect's Brain", Mallagrave (2011) has pointed that from the regions of visual cortex, the perceptual image passes out into other areas in the brain: *the temporal lobes* (for form, color, recognition of objects) and *parietal lobes* (for space, motion, depth). Recently, an fMRI study results showed that visual stimuli activates *the occipital* and other areas. Furthermore, tactile stimuli led to activation in the *frontal*, *insular*, and *parietal cortex*. According to Ackerman, *the left prefrontal cortex* has a higher activation in happy people, whereas in sad people *the amygdala* and *right prefrontal cortex* have more activation. Additionally, *the frontopolar* region has been shown to be activated in the beauty judgment of geometric patterns and the activation of *the parahippocampus*, *middle occipital gyrus*, *precuneus*, and *superior frontal gyrus* are engaged in aesthetic assessments of paintings, sculptures, scenes, etc. Besides that, in relation to pleasantness, *the anterior cingulate cortex*, *precuneus*, and *middle frontal gyrus* are activated (Vartanian, 2013).[13] To summarize what was mentioned related to the neuro-architecture and its views, and aims, it can be said that:

- Neuroscience is a branch of biology and today as an interdisciplinary science, it combines with chemistry, engineering, linguistics, art, and psychology. Neurologists can identify the brain reactions during the perception process by research on the brain and the way it works. Thus, human aesthetic, emotional, and perceptual experiences become measurable. This kind of interdisciplinary association emerges new approaches such as Neuro-Architecture.

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[12] For more information see: Kirk U, Skov M, Christensen MS, Nygaard N (2009) Brain correlates of aesthetic expertise: A parametric fMRI study. Brain Cogn 69(2):306–315.

[13] For more information see:

Jacobsen T, Schubotz RI, Höfel L, Cramon DY. (2006), Brain correlates of aesthetic judgment of beauty. Neuroimage, 29(1):276–285.

Vartanian O, Goel V. (2004), Neuroanatomical correlates of aesthetic preference for paintings. Neuroreport 15(5):893–897.

Fairhall SL, Ishai A. (2008), Neural correlates of object indeterminacy in art compositions. Conscious Cogn 17(3):923–932.

Vessel EA, Starr GG, Rubin N. (2012), The brain on art: Intense aesthetic experience activates the default mode network. Front Hum Neurosci 6:66.

- Making a connection between users' emotional experiences of architecture and considering the brain cognitive processes as a design tool, Neuro-Architecture empirically seeks to find how the body and psycho affected by environmental stimuli, and how would architectural design benefits from such a finding. In this respect, Neuro-Architecture provides the opportunity to understand and measure the perceptual and emotional attributes of place experience through the novel brain imaging techniques.
- The Neuro-architecture approach is evaluated as a new scientific field in architectural design, emotional experience of place, and environmental perception. This approach allows determining the relationship among the brain areas, nervous system, and spatial perception. In this regard, to investigate the physiological responses of people related to visual and environmental perception, neuro-architecture researchers are using experimental and scientific methods of performing brain imaging via EEG, MEG, and fMRI techniques.
- The Neuro-architecture approach could be used to assess the impact of the built environment on the brain neural process, the mental mechanisms of design, and to have an objective of understanding the brain's emotional-perceptual responses within an architectural experience.
- The Neuro-architecture approach explores the pleasure in the brain which arises from the beauty of space (aesthetic aspects) and user's place satisfaction. It also examines the determination of criteria for spatial design and perception.
- According to Neuro-Architecture principles, factors and qualities such as space dimension, proportion, distance, texture, color, odor, sound, ventilation, water, etc. affect the perception and the quality of the place. Furthermore, these affect the user's spatial preferences and satisfaction as well.

Figure 2-26: The spatial qualities of architecture

2.17.3. Neuro-architecture, sensation, perception, memory, and emotion

The human perception changes when experiencing different environments because spatial elements evoke different activities in the brain. The brain is constantly in a perceiving mood which tries to superpose meaningful and pleasant environmental experiences. As described earlier, a common theme discussed in environmental and cognitive sciences is the human well-being and relevant studies results show that the brain responses to sensory stimuli like sound, vision, touch, etc. In this regard, as an important fact, architectural setting including materials, landscape, light, color, etc. affects individuals' behavior, mood, psycho, etc. Hence, merging architecture to environmental and cognitive fields presents an efficient way of promoting well-being throughout the spatial and environmental experience. Juhani Pallasma believes that architectural experience and perception are a multi-sensory process including emotion, memory, visual, and tactile experiences, each of which affects the mental processes, environmental behaviors, and psychological-biological responses. Such a process is measured based on spatial qualities such as scale, proportion, height, color, material, etc., and the eye, skin, ear, nose, tongue, and muscle (Pallasma, 2012). Therefore, architecture has an effect on evoking reactions from individuals, and through their experience encourages them to perceive their relationship with the environment.

-Memory; provides the ability of the mind to encode, store, and recall the surrounding world, and has a significant role in assessment, emotions, decision-making, and provide meaning to experience. From the neuro-architecture point of view, the most important part of the brain that is engaged in memory concerning architecture is the hippocampus which is responsible for analyzing data transmitted to the long-term memory. Besides, the brain area that concerns the architectural experience and uses the recognition of scenes in creating long-term memory is parahippocampal. Russell Epstein (1999) reported that parahippocampal region reacts to viewing of scenes and spatial settings, and this region is more active when users exposed landscape, furniture, and city spaces rather than when they exposed typical pictures like face, animal, etc. (Eberhard, 2009).

-Emotion; is known to have tripartite. Physiologically it is defined as body responses. Neurologically it is defined as a result of a certain brain activity, and cognitively it results from thoughts and different mental activities. As a reaction to an experience and an initial expression of affective states, emotion manifests in states ranging from anger to happiness, moods, feelings, etc. In this context, according to Joseph LeDoux, determining the value of stimulus is the main task of an emotional process.

-Vision; as previously mentioned, it is the most important factor in perception. Since architecture involves objects and places, visual perception provides the ability to understand the architectural qualities and spatial components (form, texture, color, surface, light, etc.). In interpreting environmental information, the eye plays an important role in transferring perceived visual stimuli to the brain. The brain then uses top-down and bottom-up processing which is a direct pathway from the retina to the visual cortex (Arellano, 2015).

2.17.4. Effective elements in neuro-architecture

Neuro-Architecture implies understanding the impact of sensory factors such as color, light, touch, etc., and natural elements like water, greenery, sunlight.

-Touch; is an intimate sense in creating a stronger relationship with the environment, enticing individuals' curiosity to explore environmental elements by providing them to have better experience and understanding the world of architecture through groping material, texture, depth, hardness, etc. The Holocaust Memorial in Berlin is an obvious example in this regard where visitors enable to experience and perceive history through touching, sitting or walking on concrete slabs or anthropoid metal locks.

Figure 2-27: Holocaust museum and the sense of touch

-Nature; is one of the effective factors in neuro-architecture principles. Neuroscience research on the impact of nature and its importance on human physical and mental health is an apparent fact. Researches done in Neuro-Architecture indicates that exposure to nature is able to reduce stress, fear, anger, and activation of brain areas that are engaged with empathy and love (Ryan, et al., 2010).

-Water; is another important factor that affects human's physical states, creates a sense of privacy and tranquility, reduces stress levels, and renewed state of mind. Being beside natural materials like wood, greenery and stone, water can provide a sense of warmth and comfort. Such materials and landscape provide users to experience different pleasant states of mind (Arellano, 2015). An example which can expose the link of neuro-architecture principles with nature is Thurston Chapel located in the middle of the nature in Honolulu of Hawaii and provides an opportunity of connecting directly to nature.[14] Architectural features such as natural lighting, subdued light, and light color are used in the chapel that affects users' mood positively and makes a pleasant atmosphere. The variety of used local materials (stucco, copper, tiles, and wood) promote the sense of calmness, tranquility, and sense of place.

Figure 2-28: Thurston Chapel

-Light; is the cause of vision. The light shines on the surface of the material and makes the eye perceive the environment. Therefore, this affects the physical features and emotion. Furthermore, light affects the body physiologically and psychologically as it stimulates higher cognitive brain activity.

-Color; part of the sensory qualities that plays an important role in distinguishing environmental objects and psychologically, it enriches individual perception. For example, the red color affects physically raising the heart rate. Unlike red color, the blue color has an impact on mental and calms the mind. Besides that, yellow color is considered as the more effective color in psychologically aspects. Finally, the green color adjusts restfulness and balance.

[14] Neuroscientists' findings show that being in nature and connect to natural facilities such as water, greenery, wood, odor, sound, etc., affect people psyche positively.

2.17.5. Study approaches and methods in the field of the neuro-architecture

The Neuro-Architecture and neuro-aesthetic researchers have studied, examined, and worked on the functions of neural circuits in responding to aesthetics (e.g., Kirk et al., 2009a; Kawabata and Zeki, 2004), determining and creating patterns that are pleasing to the brain (e.g., Carbon, 2010), identifying different parts of the brain in response to visual processes such as motion, color and form (e.g., Sayim, 2011; Silvia and Barona, 2009), formal aesthetics and visual perception in architecture and product designing (e.g., Vartanian, et al., 2015; Vartanian, et al., 2013; Kirk, et al., 2009b). They have also presented results that show in the process of visual perception, the nervous system of the brain follows a bilateral function (Livingstone, 2008) and different parts of the brain work. Therefore, Neuro-Architecture researchers generally believe that with the advancement of these experiments, the application of their results and following neuroscience principles, it is possible to assign defined rules for architectural design. They have found that neuroscience providing psychological precision promotes the quality of architectural evaluation and the emotional-perceptual experience of space. Also, the neural mechanisms filter external data to have a profound, real, and objective understanding of behavior.

Novel technologies have a fundamental quota in the approach of Neuro-Architecture. Developed techniques such as monitoring, magnetic recording and Visio-virtual reality can accomplish the aims of the Neuro-Architecture because researchers and designers have opportunities to study the neural activities, mental state, anxiety levels, and physiological mechanisms as users interact with the architectural spaces. That is why the Neuro-Architecture experiments are primarily conducted by using illustrations and case examples provided to the participants. Then, subjects are surveyed about their interests and feelings related to shown works through interview or survey and brain imaging (fMRI, EEG, MEG, PRT). Finally, the results of these experiments are compared. In fact, the investigation of the relationship between neural circuits of vision and brain stimulations in determining the aesthetic criteria and pleasant place design is the main aim of the Neuro-Architecture researchers. For instance, researches conducted in aesthetic perception have shown that curved lines create pleasing states in the brain rather than sharp lines (Bar and Neta, 2006) or the symmetry shapes involve more aesthetic criteria than the non-symmetry shapes (Jacobsen and Hofel, 2003).

Ramachandran (2008) conducted an experiment on patients and found that “seeing” is not a simple process. Although it seems to be an effortless and momentary action, what we see regardless of mental activities, is just a vitiated and reversed image of the world in every eye. Such an image stimulates the optical transceiver modules in the retina, and then messages are transmitted through the optic nerve to the back of the brain where they are analyzed in thirty different areas. After that, we can recognize what we have seen. Since the center of vision is connected to the amygdala (emotional center), this shows that the vision plays an important role in our emotion and such a connection cause to visual perception. For example, we have an emotional feeling about our mother’s face. Otherwise, the image reflected on the retina lacks any emotional sense induction.

2.17.6. Cases studies and similar fields

As mentioned previously, currently, research in design and architecture is exploring new alternatives to understand the user. Specifically, these two disciplines are interested in how physiological signals can measure the user’s emotional response during their interaction with products or spaces. There are several published studies whose objective is emotional detection through technological equipment to measure physiological signals. These technologies, many of which come from the clinical area, have their names and methodologies to measure different physiological aspects of people. In this regard, the most popular measurement techniques applied to neuroscience are electrocardiogram (ECG), electroencephalography (EEG), magnetoencephalography (MEG), and functional magnetic resonance imaging (fMRI).

-Example 1: An fMRI study conducted by Vartanian and colleagues (2013) to detect the brain responses to architectural design, aesthetic judgments, and approach-avoidance decision. Participants were shown photographs including architectural spaces in an MRI scanner (fMRI), and by viewing each stimulus, they were asked to respond either “beautiful” or “not beautiful”. In the approach-avoidance, they were asked to respond “enter” or “exit” to indicate if this is a space they would like to enter or leave. Results demonstrated that users judge curvilinear spaces as more beautiful and pleasant than rectilinear spaces. In this context, the *visual cortex* and *anterior cingulate cortex* of the brain - a region responsive to the reward properties and emotional salience of objects, are activated. For the approach-avoidance run, the contrast of curvilinear-rectilinear contours revealed significant activation in a *single cluster* in the visual cortex that included the *left lingual gyrus*. Moreover, previous studies have suggested that *the anterior insula* and *basolateral amygdala* are engaged in avoidance behavior, and *mesial prefrontal cortex* elicits approach behavior.

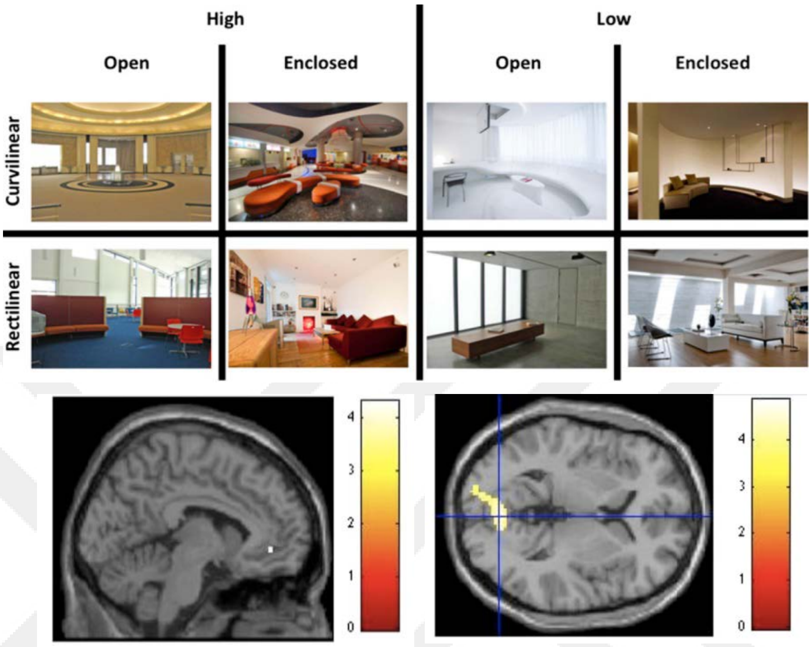


Figure 2-29: The brain activation in architectural places, recorded by fMRI (Vartanian et al. 2013).

Their results demonstrated that judgment of beauty for curvilinear spaces is underpinned by emotion and reward networks of the brain (anterior cingulate cortex) consistent with the role that emotion is known to play in aesthetic experience. Additionally, they suggested that regions such as *superior frontal gyrus*, *precuneus*, *parahippocampus*, *globus pallidus*, and *middle occipital gyrus* are activated in beauty ratings. Furthermore, regions such as *precuneus*, *middle frontal gyrus*, and *anterior cingulate cortex* are activated in relation to pleasantness.

-Example 2: In another research, Vartanian and colleagues (2015) considered evaluating the impacts of ceiling height and openness (perceived enclosure) as two important variables in architectural design, aesthetic judgments and approach-avoidance decisions. In fact, using the fMRI technology, they seek to understand the mechanisms underlying behavioral effects and neural activations throughout a spatial perception. For this, as the stimuli, 200 photographs of architectural spaces were chosen and shown to the participants recording fMRI (n=50 were used in each condition such as beauty judgment, approach-avoidance, enclosed and open spaces): open high ceiling, open low ceiling, enclosed high ceiling, and enclosed low ceiling.

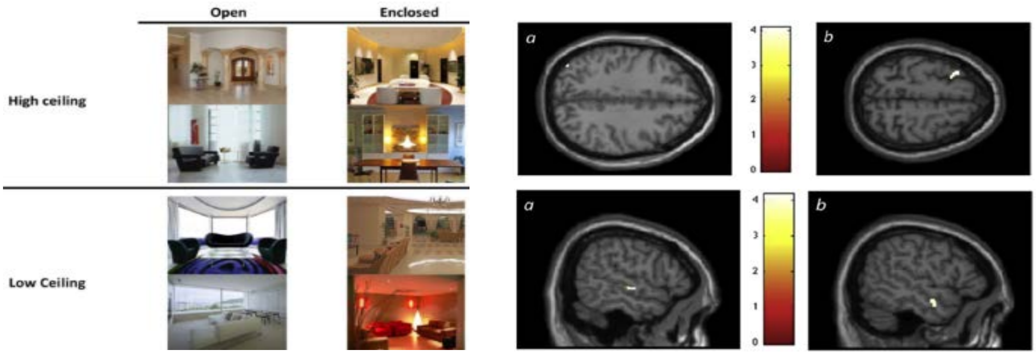


Figure 2-30: The brain activation in architectural places, recorded by fMRI (Vartanian et al. 2015)

According to the results, in the beauty assessing spaces with the contrast of high ceiling-low ceiling, spaces with high ceiling judged beautiful than low ceilings and the *left precuneus* and *left middle frontal gyrus* were significantly activated. Previous studies have verified that these two areas play well-established roles in virtual spatial navigation, beauty judgment of spaces, visuospatial processing (especially the involvement of *the temporal lobes*), and linear relationship with pleasantness.[15]. In this context, related to the open-enclosed assessing *the left middle temporal* and *the right superior temporal* gurus were activated. Participants were more likely to judge open spaces more beautiful than enclosed spaces. In the approach-avoidance with the contrast of high ceiling-low ceiling, there is no any activation, in this context, related to enclosed-open contrast revealed activation of *the anterior midcingulate cortex* which receives direct input from the amygdala and involved in fear processing. Participants were more likely to avoid enclosed spaces rather than open spaces.

These findings confirm that the impact of ceiling height on beauty judgments is dissociable from its impact on approach-avoidance opts. In fact, the analysis of many neuroimaging studies has shown that activations in the cingulate gyrus are associated with fear, and in this study, it can be said that part of the reason for opting to exit enclosed spaces might be related to the experience of fear. It appears that aesthetic

[15] For more information se:
Cavanna, A. E., & Trimble, M. R. (2006). “The precuneus: A review of its functional anatomy and behavioral correlates.” Brain, 129, 564e583.
Kravitz, D. J., Saleem, K. S., Baker, C. I., & Mishkin, M. (2011). A new neural framework for visuospatial processing. Nature Reviews Neuroscience, 12, 217e230.

preference related to ceiling height is associated with activation in *parietal* and *frontal* structures located in the *dorsal stream* which supports visuospatial exploration and attention. Hence, it suggests that aspects of spatial cognition might contribute to the computation of aesthetic preference for these spaces.

-Example 3: Kirk and colleagues (2009a) in their study used the fMRI technique to examine aesthetic judgments of architectural spaces between two groups of architects and non-architects through presenting photos as visual stimuli. They wanted to explore the relationship between being expert and neural activity in brain regions and its association with memory and perceptual processing and reward processing. In fact, they hypothesized that in beauty judgment, art experts experience different neural processes than non-experts. The results showed that in aesthetic judgments *the bilateral medial orbitofrontal cortex* and *subcallosal cingulate gyrus* are differently recruited by architects and non-architects. Furthermore, more significant~~ly~~ activations were revealed in the *hippocampus* and *precuneus* which are engaged in memory and perception. Therefore, they suggested that expertise modulates both cognitive processing and the response in reward-related brain regions.

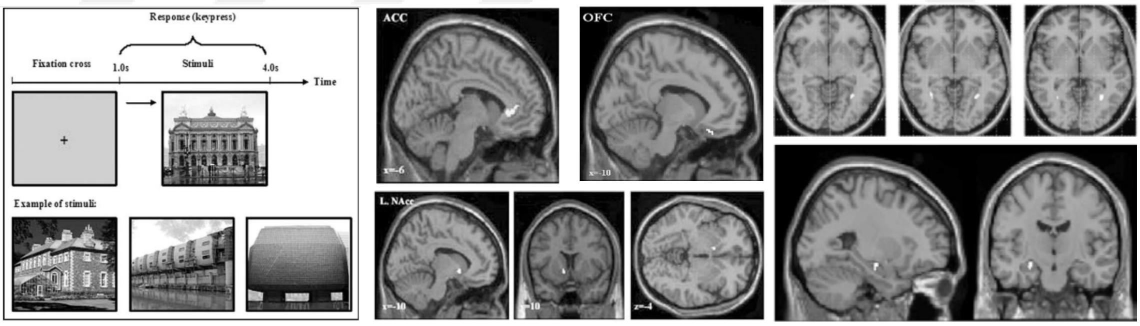


Figure 2-31: The brain activation in related aesthetic judgments of buildings (Kirk et al. 2009)

To accomplish this study, Kirk and colleagues asked participants to rate the aesthetic value of presented architectural pictures in MRI machine. 24 participants (11 experts; graduated architecture students /13 non-experts; undergraduate in other fields) were scanned. The fMRI analysis provides them the possibility to concentrate on voxels which are different between the responses of the two participant groups. In the relation of the aesthetic judgments of buildings, architects had considerable activation in *the subcallosal cingulate gyrus* and *medial orbitofrontal cortex*. Moreover, they have found that the subcallosal cingulate is positively activated in architects unlike non-architects whereby the activation was reported negatively. According to previous studies, the subcallosal cingulate implicates in such forms of emotional processing, including the recall of happy autobiographical memories. Compared to non-architects, the activation of orbitofrontal cortex was higher and significant in architects. Indeed, the relative reward value of stimuli is reflected by the amplitude of neural activity in *the orbitofrontal cortex*.

In addition to that, results showed that *the left nucleus accumbens* which plays a role in encoding was significantly activated in both groups. An interaction analysis showed distinct specificity for buildings in architects relative to non-architects in *the bilateral hippocampus* (engaged in memory retrieval & preference judgments), *left precuneus* (engaged in memory retrieval & preference judgments), *cerebellum*, *bilateral calcarine*, *fusiform gyrus*, and especially in *the parahippocampal* place area which responds selectively to houses, landscapes and other environmental sceneries. Consequently, this study confirmed that expertise has an important role on cognitive and perceptual systems, and also modulates the response of brain areas associated with the processing of reward and aesthetic judgment. However, in the previous studies, it has been demonstrated that the reward processing of the brain includes the activation of *the ventral tegmental area*, *ventral striatum*, *orbitofrontal cortex* and *amygdala*.

-Example 4: Wiesmann and Ishai (2011) used fMRI to examine how architecture students respond to buildings rather than students from other disciplines. Their findings showed that since architects respond expertly, they could encode stimuli at a lower neural cost, but non-architects had to recruit additional regions to respond to the building stimuli. Generally, 24 healthy subjects (7 males and 5 females were architecture students, and the other 12 subjects were students from different fields) were asked to participate in the research. 320 photographs of buildings were exposed to them and their brain activities were recorded via an MRI scanner.

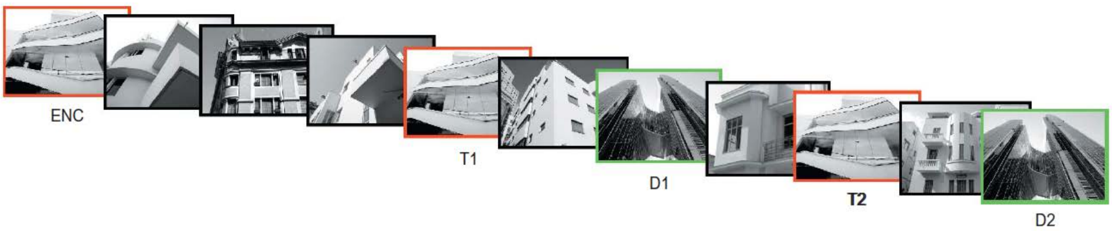


Figure 2-32: Stimuli and task. In each trial, a target building was presented for 4 s (ENC), followed by 10 buildings, each presented for 2 s., (Wiesmann and Ishai, 2011).

The results showed significant increase of activation in *the fusiform gyrus* and *the parahippocampal* in the architecture students than other students from different fields. Moreover, they found that non-architect students recruit the *cuneus*, *lingual gyrus*, *inferior parietal lobe, insula*, and *anterior cingulate cortex*. Furthermore, based on the results from the previous studies, architects were found to be showing stronger neural response within the areas such as *prefrontal*, *orbitofrontal cortex*, *subcallosal cingulate gyrus*, *ventral temporal*, and *nucleus accumbens*.

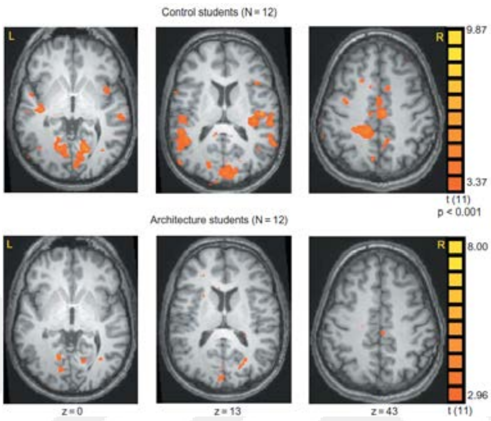


Figure 2-33: Correlations between responses with activation in a network of regions that includes the cuneus, lingual gyrus, inferior parietal lobule, insula and anterior cingulate cortex.

-Example 5: In an aesthetic approach, using the fMRI technique, Reimann and colleagues (2010) investigated the behavioral, neural, and psychological properties of package design. The results showed that although unknown products in standardized packages were expensive, they were chosen and preferred to buy rather than the well-known products. Moreover, this has resulted in more significant activation in the areas like *nucleus accumbens* and *the ventromedial prefrontal cortex.* 80 different product packages prepared in aesthetic condition and other 80 products prepared in standardized condition were presented to 16 undergraduate students. Then, participants were asked to categorize each picture as being aesthetic or standardized.

Figure 2-34: Choice task used in aesthetic and standardized condition

For standardized products, *the ventromedial prefrontal cortex* was activated. However, aesthetic products resulted to the activation of *the ventromedial prefrontal cortex* (is related to reward value and illustrates that aesthetic packaging design have a reward value that is significantly stronger than a well-known brand), *the striatum* (is related to reward and beauty judgment), *the right nucleus accumbens*, *the primary visual cortex* (suggesting a greater visual processing when viewing aesthetic products compared with standardized products.), *the precuneus*, and *the anterior cingulate cortex* (is consistent with aesthetically preferred stimuli). Moreover, findings showed that participants experiencing aesthetic condition engaged certain emotional regions of the brain especially *the striatum* which is related to reward and results in aesthetic preferences, decision, and judgment. These findings are consistent with other studies that claimed that beautiful faces activate *the nucleus accumbens* as a part of the striatum (Aharon et al., 2001), or *the ventral striatum* (Kampe et al., 2001).

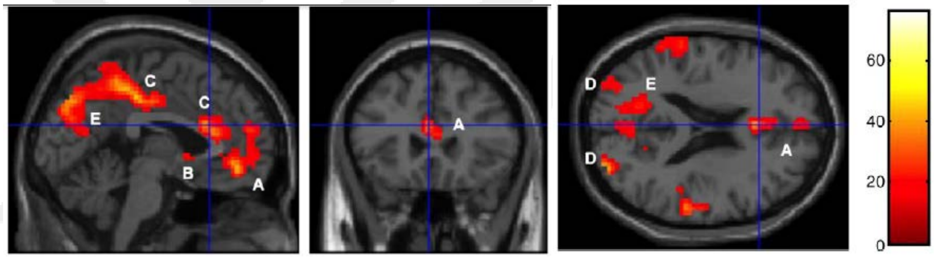


Figure 2-35: Choice task used in aesthetic

-Example 6: Lee and colleagues (2009) used fMRI and EEG to study the response of the brain towards good or bad designs. 25 Participants were asked select good or bad designs through exploring 50 classified (25 good, 25 bad) pictures by clicking the mouse button. The result of fMRI showed more significant activation in the frontal and occipital lobe. The EEG results showed that the amplitude of bad design is greater than good design, and the brain responds stronger facing bad design.

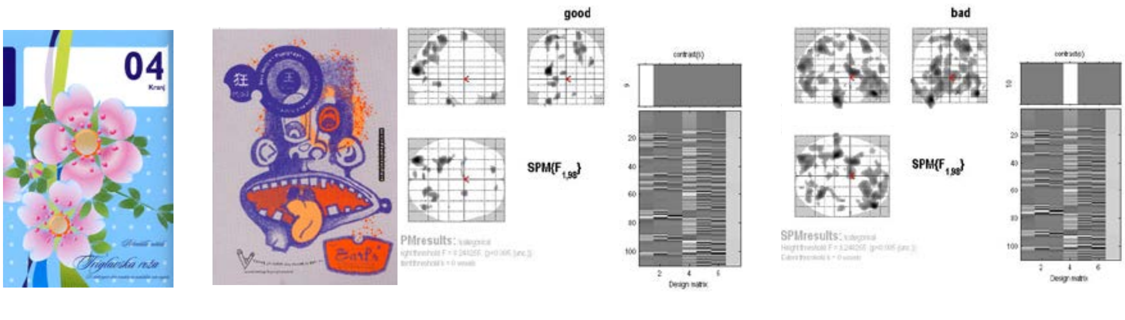


Figure 2-36: Design image examples for experiment and the fMRI response of good and bad design

According to the fMRI results, the most activated areas related to the good design were in *the occipital lobe, parietal lobe, the prefrontal lobe,* and *the frontal lobe*. The activated parts of the brain when the participants observed the bad design was *the occipital lobe,* the *parietal lobe,* and the *prefrontal lobe*. Furthermore, the results suggested that the brain reaction of participants assessing the bad design was much stronger than the good design. In addition to that, there was only a small difference between the function of right and left brain in assessing the good design. However, the left brain has a stronger action in assessing the bad design. More importantly, this study showed that the perceptions of a different feeling for designs are associated with *the frontal lobe* which is responsible for the function of vision and *the occipital Lobe* which is responsible for functions like thinking, planning, and deciding.

-Example 7: Di Dio and colleagues (2011) evaluated the aesthetic judgments in an fMRI study by comparing the brain activations associated with viewing classical sculptures and young athletes postures. The images which act as stimuli were categorized accordingly and presented to the participants. (the images of canonical sculptures, proportion-modified Sculptures, canonical real human bodies, proportion-modified real human bodies). Indeed, the study was conducted to examine the relation between esthetic judgment and proportion. Participants were asked to rate the stimuli on a scale from 0 (ugly) to 7 (beautiful).

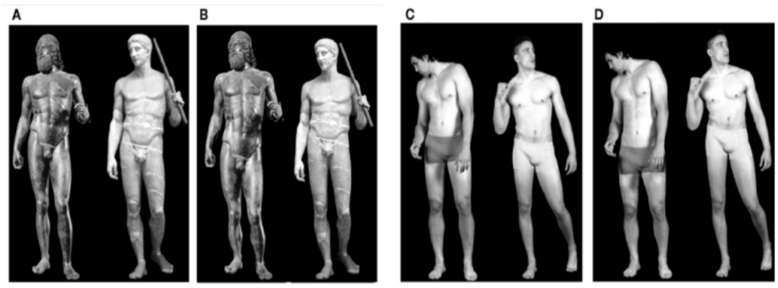


Figure 2-37: Activations for (A) sculpture and (B) real human body

In the first experiment, the effect of viewing the sculpture and the real human bodies was evaluated, and more significant activations were found in the regions such as *the occipital lobe, inferior and middle temporal lobe, inferior frontal gyrus,* and *ventral premotor cortex.* Also, BOLD signal increases were observed in deep structures like *the hippocampus, amygdala,* and *insula*. In the second experiment, the effect of viewing the canonical sculpture and canonical real human body were evaluated. The results showed enhanced activation in *the fusiform gyrus* and *anterodorsal*.

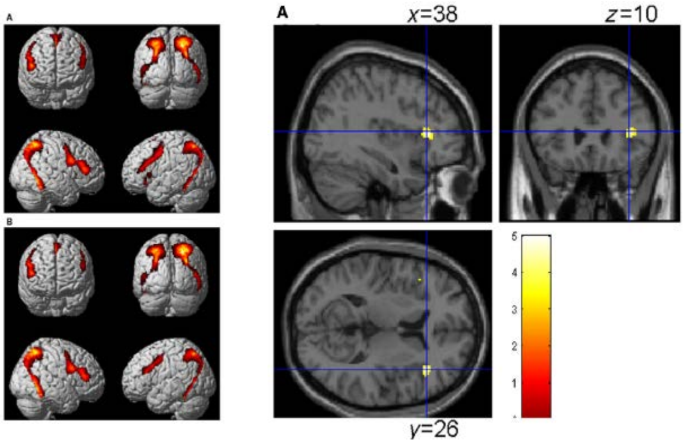


Figure 2-38: Activations for the experiments. Images (A-B) in the left side are in associated with the first experiment and image A in the right side is associated with the second experiment.

In the third experiment, the effect of viewing the canonical and modified real human body images were evaluated. The results revealed enhanced activation in *the left amygdala*, *insula*, *hippocampus*, *parahippocampal gyrus*, and *posterior cortical* area straddling the inferior and middle temporal gyrus during esthetic judgment condition. In the fourth experiment, the effect of viewing the canonical real human body and canonical sculpture images were evaluated. The results revealed enhanced activation in *the right thalamus* and *right superior temporal sulcus*.

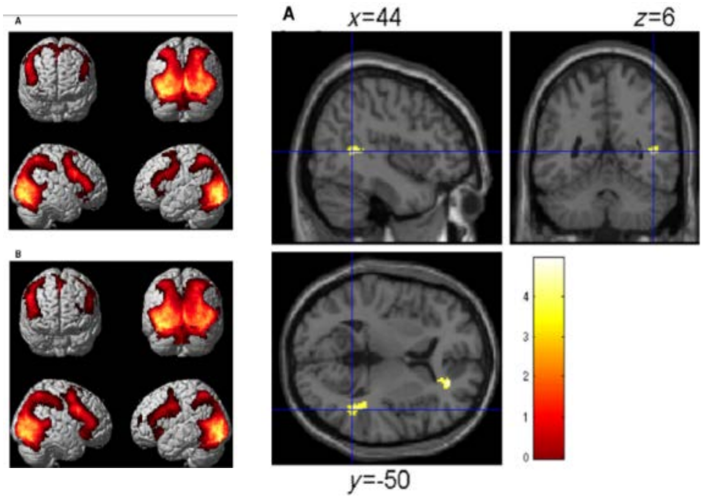


Figure 2-39: Activation in the contrast canonical real human body minus canonical sculpture images during esthetic judgment condition.

Consistent with what is mentioned previously in the part Neuro-architecture and the results obtained from the review of case studies, the more significant brain areas activations which we expect to see them in the present study are classified as follows:

Table 2-17: The brain regions engaged in architectural experience (Author according to case studies)

<table>
<tr><td>Occipital Lobe</td><td><u>Function:</u>
Respond to perceptual information regarding architecture / The perception of forms, colors, height, depth, geometry / Spatial movement direction, location / Visual processing, recognizing objects.</td></tr>
<tr><td colspan="2"><u>Subdivision Tasks:</u>
Middle occipital gyrus (aesthetic assessments of artworks & beauty ratings) / Inferior occipital (the processing of the configuration and shapes of objects) / Visual cortex (aesthetic assessments of artwork & beauty ratings) / Bilateral calcarine (visual processing) / Lingual gyrus (modulating visual stimuli) / Cuneus (responsive to the appreaciation of representational material) / Superior occipital (avoidance)</td></tr>
<tr><td>Frontal Lobe</td><td><u>Function:</u>
Reward processing / Beauty judgment / Thinking, deciding, planning, problem solving, working memory, behavior</td></tr>
<tr><td colspan="2"><u>Subdivision Tasks:</u>
Orbitofrontal cortex (evaluating the aesthetic value of architecture) / Prefrontal lobe & frontal lobe (good & bad design) Middle frontal gyrus (pleasantness & beauty judgment & approach behavior) / Superior frontal gyrus (aesthetic assessments of artwork & beauty rating) / Left middle frontal gyrus (beauty judgement) / Frontopolar (the beauty judgment of geometric patterns) / Medial orbitofrontal (processing of reward during architecture appraisal, aesthetic judgment, emotional experience of visual and musical stimuli) / Ventromedial prefrontal (reward value) Inferior frontal gyrus</td></tr>
<tr><td>Temporal Lobe</td><td><u>Function:</u>
Visual object discrimination and recognition / visual perception (form, color, and recognition of objects) / Spatial perception (height, depth, geometry) / Processing and transforming sensory information, memory, emotions, sounds.</td></tr>
<tr><td colspan="2"><u>Subdivision Tasks:</u>
Parahippocampal (architectural experience and representation of large-scale places and landscape and location) / Parietal temporal lobes (spatial perception such as height, depth, geometry) / Inferior temporal gyrus (semantic memory processing, visual perception) / Middle temporal (perceiving motion in an architectural space involved in the motion required for visuo-spatial exploration) / Left middle temporal (semantic memory processing, visual perception, aesthetic judgment) / Fusiform gyrus (neural representation of architectural styles and recognizing and identifying locations) / Superior temporal sulcus (visuo-spatial exploration of architectural space, processing of social cues and interpersonal touch) / Ventral occipitotemporal (visual perception) / Ventral temporal (Visual object recognition and categorization & the representation of conceptual knowledge) / Posterior cortical (esthetic judgment)</td></tr>
<tr><td>Parietal Lobe</td><td><u>Function:</u> Understanding spatial orientation and visual perception (depth, height, width, geometry) / cognition, identifying the position, location, touch (tactile)</td></tr>
<tr><td colspan="2">Posterior parietal cortex (coordinating movement and spatial reasoning, attention) / Superior parietal / Right parietal lobe (spatial mapping) / Posterior intraparietal / Angular</td></tr>
<tr><td>Cerebellum</td><td><u>Function:</u> Plays a key role in motor function, affect and cognition</td></tr>
<tr><td colspan="2">Basal ganglia (executive functions, behaviors, and emotions) / Globus pallidus (beauty ratings, regulating movement) / Posterolateral fissure / Flocculonodular lobe</td></tr>
<tr><td>Subcortical</td><td><u>Function:</u> Complex activities such as memory, emotion, pleasure</td></tr>
<tr><td colspan="2"><u>Subdivision Tasks:</u>
Amygdala (avoidance behavior) / Insula (anterior insula: avoidance behavior) / Hypothalamus (regulating emotional responses) / Hippocampus (implicated in memories, perception) / Parahippocampus (aesthetic assessments of artworks & beauty ratings; beauty ratings) / Cingulate cortex (is involved in the emotional processing and the avoidance decisions of architectural spaces, aesthetic judgments, processing emotions and behavior regulation, and fear) / Anterior cingulate cortex (is involved in emotional processing of architecture, pleasantness; avoidance; reward properties, judgment of beauty, and emotional salience of objects) / Precuneus (aesthetic assessments of artworks, pleasantness; memory, perception) / Left precuneus (engaged in memory retrieval & preference judgments) / Subcallosal cingulate (evaluating the aesthetic value of architecture) / Posterior cingulate gyrus (spatial memory & spatial orientation of objects) / Nucleus accumbens (reward circuit; pleasant memory and scenes; pleasurable stimuli) / Bilateral hippocampus (engaged in memory retrieval & preference judgments) / Anterodorsal (spatial learning and memory) / Striatum (aesthetic preferences; beauty judgements, reward processing) / Hippocampal / Basal ganglia</td></tr>
</table>

3. THEORETICAL AND PRACTICAL MODEL OF RESEARCH

A research paradigm[16] consists of three main components such as epistemology, ontology, and methodology. The ontology is assumptions of a particular approach to research on the nature of reality. The epistemology of research refers to assumptions about understanding the existing knowledge that has been accepted. The methodology is the analysis of assumptions, principles, and methods of implementation in a particular approach to research (Alinam, 2014). In this chapter, to examine the place of the Neuro-Architecture approach in the context of place perception and the emotional evaluation of spatial experience, the content of environmental and cognitive psychology assumptions is analyzed. By examining the factors affecting the components of the neuro-architecture approach in the context of perception and emotional experience of place, the applications of cognitive and environmental psychology are identified. Also, by examining the possibility of evaluating cognitive components via cognitive tools, the application of cognitive psychology research methods in this process has been identified. In addition to that, the theoretical model of research is defined to determine the place of the neuro-architecture approach in studying the theoretical framework of place perception process and emotional evaluation of place. Finally, the practical research model is presented based on the theoretical model of research to clarify the factors affecting the components of place perception and emotional experience of place.

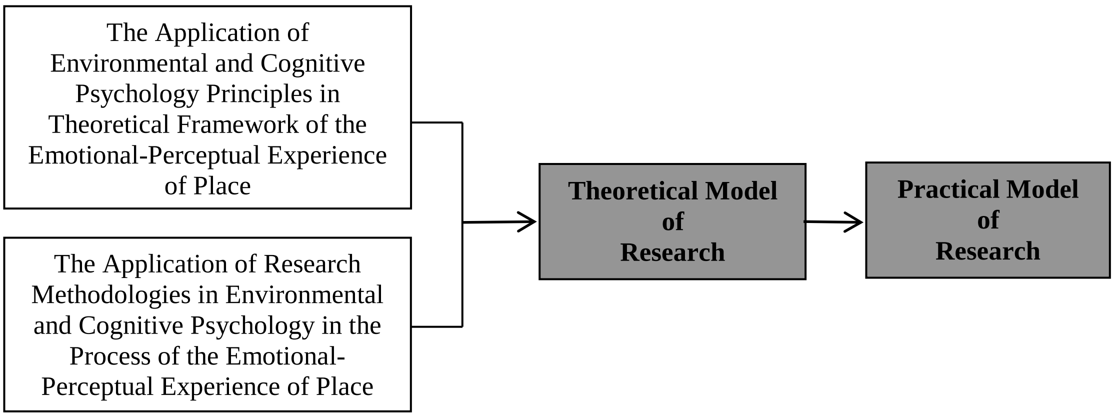


Diagram 3-1: The structure of chapter three (Author)

[16] A paradigm is a set of fundamental beliefs that illustrates a form of the world. Paradigms are the basis of human perceptions and actions.

3.1. The Application of Environmental and Cognitive Psychology Principles in Theoretical Framework of the Emotional-Perceptual Experience of Place

It is not possible to evaluate the emotional-perceptual experience of place as well as understanding the individual factors involved without considering and assessing the experience and meaning of place. Indeed, the analytical model of evaluating such an experience will be completed when the key elements, process of formation, and results come together in the form of factors that can be evaluated in environmental studies. Therefore, evaluable factors in environmental studies are put forward, and it can lead to making more accurate indexes in assessing the emotional experience of place and presenting design strategies and guidelines. In this regard, neuroscience and cognitive psychology by studying the brain’s mechanism for learning, thinking, revising, and forming the mind of a person can propose ways to influence, alter, modify, or enhance the mind. Integrating these sciences with architecture (Neuro-Architecture approach) by defining the cognitive process in perception and affective experience of place, finding and promoting the physical, semantic and social components provides a emotional-perceptual appraisal of place experience. Regarding the socio-physical significance of the architectural and urban spaces, it strongly emphasizes the necessity of considering to place meaning and identifying its booster factors.

Relying on environmental and cognitive components, paying attention to the process of emotional-perceptual experience of place leads to making deeper levels of place meaning in the built environments. Each of the cognitive components such as *attention*, *conceptualization*, *cognitive mapping*, *association*, and *meaning* are somehow influential in studying the cognitive process. For instance, users’ attention to the physical and social factors of the architectural spaces provide valuable information to designers by taking into account users’ experiences of the architectural space.

Examining the mental concepts of users about the importance of the physical, functional and social characteristics of architectural space enables designers to identify the mental expectations of users from the architectural spaces. Indeed, examining the mental concepts of users reflect~~s~~ their views and desires regarding the pleasant architectural space. The cognitive map studies the factors influencing the formation of abstract patterns of the environment in the minds of individuals. Also, it reveals the difference between citizens’ mental image of architectural space and pleasant status. Understanding the environmental meanings and cues that associate public memory is considered the opportunity to adapt such a mental image to the needs and expectations of the users related to the architectural space. In general, the factors affecting the components of the environmental and cognitive process related to the emotional-perceptual experience of place are divided into two groups of individuals and spatial factors in the context of perception and emotional experience of place. Table 3-1 examines the individual and spatial factors affecting the components of the cognitive process in the context of environmental studies and presents evaluable factors in the architectural space.

3.2. The Application of Research Methodologies in Environmental and Cognitive Psychology in the Process of the Emotional-Perceptual Experience of Place

Research methods in environmental and cognitive psychology can be applied to the process of the emotional-perceptual experience of place, utilizing data collection and analysis tools, and by the nature of research questions and goals. Applying appropriate cognitive methods at each stage of this process provides the researcher with more comprehensive information about the phenomenon under study (Table 3-2). The results obtained from causal attribution-based research methods such as laboratory experiments and psychobiological research, by investigating cause and effect relationships, provide valid data to evaluate the factors influencing attention and mental imagery. These data serve as criteria for analyzing information. Contextualization-based research methods provide valuable ecological information to researchers by studying the cognitive components of individuals and adapting case examples. Textual-narrative study and naturalistic observations are part of interpretation researches in cognitive psychology which investigates the codes and passwords of an environment (mental images, cognitive map, association, and meaning) in the user mind. Studying spatial properties to form a mental image and to attract the attention of different social groups requires being within the space. The naturalistic observations by observing the behavior of users in the environment make inferences about the processes underlying that behavior. Prediction-based methods utilizing computer simulations and artificial intelligence tools to simulate the user’s cognitive performance based on information obtained from previous research. Investigating the factors affecting the attention and formation of mental images makes it possible to predict future users’ performances in modeled designs.

Table 3-1: Factors affecting the components of the environmental and cognitive process in related to the Neuro-Architecture approach of the emotional-perceptual experience of place (Author based on: Alinam, 2014; Sternberg, 2017; Pakzad and Bozorg, 2012; Gifford, 2016)

PROCESS		INDIVIDUAL			PLACE		
		Effective Factors		Examples of Evaluable Factors In an Architectural Place	Effective Factors		Examples of Evaluable Factors In an Architectural Place
SENSATION	**Sensory Factors**	**A1**	- Experiences - Mood - Satisfaction	- Duration of stay in place - Needs & Expectations - Individual Features (Gender, Age, Field)	**A2**	- Color - Light - Sound - Odor - Texture - Material	- Pleasant and unpleasant places (Interior, exterior, and open spaces)
PERCEPTION	**Physical Factors**	**B1**	- Experiences - Mood - Satisfaction	- Duration of stay in place - Needs & Expectations - Individual Features (Gender, Age, Field)	**B2**	- Largeness - Height - Depth - Width - Proportion - Geometry - Order - Rhythm	- Pleasant and unpleasant places (Interior, exterior, and open spaces)
COGNITION	**Attention**	**C1**	- Control over the situation - Experiences	- Duration of stay in place - Transport mode - Individual Features (Gender, Age, Field)	**C2**	- Characteristics of the stimulus	- Appearance Façade - Public Spaces - Functional Spaces
	Conceptualization	**D1**	- Concept definition - Experiences	- Socio-cultural background - Individual Features (Gender, Age, Field)	**D2**	- Concept definition - Applicable & not applicable - Relevant & irrelevant	- Physical Features of Place - Functional Features of Place - Social Features of Place
	Association & Meaning	**E1**	- Needs & Expectations - Experiences	- Users' needs & expectations of the architectural space - Socio-cultural background - Individual Features (Gender, Age, Field)	**E2**	- Environmental signs	- Symbolic & Iconic Signs - Index Signs (Spaces Name) - Public Spaces
	Cognitive Map	**F1**	- Needs & Expectations - Control over the situation	- Users' expectations of the architectural space - Duration of stay in place - Transport mode - Individual Features (Gender, Age, Field)	**F2**	- Characteristics of the stimulus	- Landmark Knowledge - Route-road Knowledge - Survey Knowledge
BEHAVIOR	**Approach-Avoidance**	**G1**	- Control over the situation - Experiences - Mood - Satisfaction	- Duration of stay in place - Needs & Expectations - Individual Features (Gender, Age, Field)	**G2**	- Approach-avoidance assessment	- Pleasant and unpleasant places (Interior, exterior, and open spaces)

Table 3-1: Environmental and cognitive research methods in the Neuro-Architecture approach of the emotional-perceptual experience of place (Author based on: Alinam, 2014; Sternberg, 2017; Pakzad and Bozorg, 2012, Gifford, 2016)

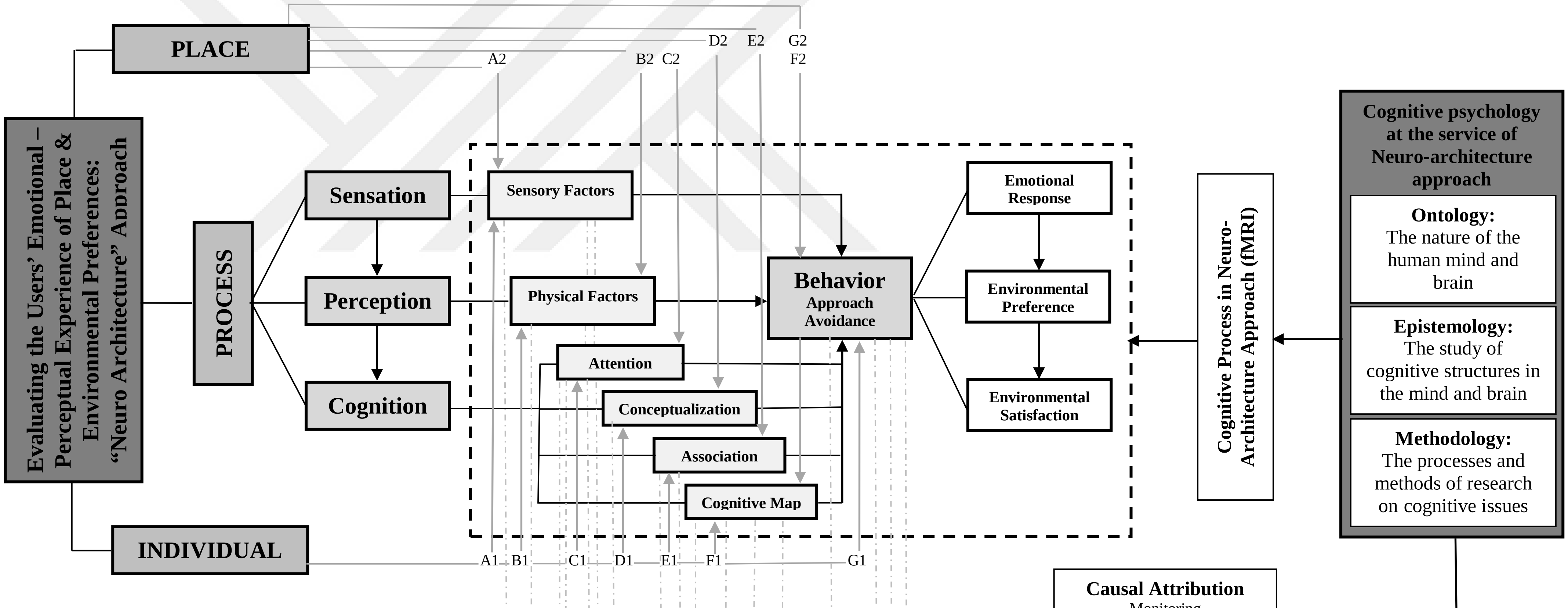
Process	Research Core Logic	Causal Attribution	Contextualization	Interpretation	Prediction
SENSATION	**Sensory Factors**	- Controlled Laboratory Experiments - Psychobiological Research - Survey & interview	Case studies	- Textual and Narrative Studies - Naturalistic Observations - Survey & interview	---
PERCEPTION	**Physical Factors**	- Controlled Laboratory Experiments - Psychobiological Research - Survey	Case studies	- Textual and Narrative Studies - Naturalistic Observations - Survey	---
COGNITION	**Attention**	- Controlled Laboratory Experiments - Psychobiological Research	Case studies	- Textual and Narrative Studies - Naturalistic Observations	- Computer Simulations and Artificial Intelligence
	Conceptualization	---	Case studies	- Textual and Narrative Studies	---
	Association & Meaning	---	Case studies	- Textual and Narrative Studies	---
	Cognitive Map	- Controlled Laboratory Experiments - Psychobiological Research	Case studies	- Naturalistic Observations - Textual and Narrative Studies	- Computer Simulations and Artificial Intelligence
BEHAVIOR	**Approach-Avoidance**	- Controlled Laboratory Experiments - Psychobiological Research - Survey & interview	Case studies	- Textual and Narrative Studies - Naturalistic Observations - Survey & interview	- Computer Simulations and Artificial Intelligence

3.3. The Theorectical Model of Research

Based on the studies done in the previous chapter, it can be seen that the cognitive psychology approach has a significant role and quota in the integration of neuroscience and architecture (Neuro-Architecture). From a scientific approach, cognitive psychology consists of three main components of ontology, epistemology, and methodology. The ontology of this approach deals with assumptions about the nature of the human mind and brain. The epistemology of this approach is the study of cognitive structures in the mind and brain. As for the methodology of this approach, it includes the processes and methods of research on cognitive issues. Following a review of theoretical foundations and content analysis in the two fields of neuroscience and architecture, the role of cognitive psychology in the theoretical framework of perception and emotional experience of place can be examined from both epistemological and methodological perspectives.

From the epistemological point of view, this approach defining the cognitive process that provides researchers a different perspective in studying the process of perception and experience of place to fill the void in this context. Cognitive psychology introduces the components of attention, conceptualization, cognitive maps, and association in the study of the cognitive process. These components can be evaluated by identifying the effective individual and spatial factors in the context of environmental studies including architecture and urban spaces (Table 3-1). From the methodological point of view, this approach introducing cognitive psychology research methods that provides researchers with a variety of scientific methods and tools for studying the cognitive process and its components. The presented research methods can be applied to the study of different stages of the cognitive process based on the logic and nature of the research and can be effective in responding to cognitive problems (Table 3-2).

In diagram 3-2 the conceptual model of the relationship between the framework of place emotional-perceptual experience (including the three dimensions of individual, place, and process) in environmental studies and cognitive research assumptions of cognitive psychology are presented. Defining the components of experience, concept, cognitive mapping and meaning, cognitive psychology communicates with the dimension of the process of architectural experience and evaluating each component with its appropriate research methods. It provides the possibility of the emotional-perceptual appraisal of place experience within the Neuro-Architecture approach.



A1	Experiences, Mood, Satisfaction	**A2**	Color, Light, Sound, Odor, Texture
B1	Experiences, Mood, Satisfaction	**B2**	Largeness, Height, Depth, Width, Proportion, Order, Geometry, Rhythm
C1	Control over the situation	**C2**	Characteristics of the stimulus
D1	Concept definition, Experiences	**D2**	Concept definition, Applicable & not applicable, Relevant & irrelevant
E1	Needs & Expectation	**E2**	Environmental signs
F1	Needs & Expectations, Control over the situation	**F2**	Characteristics of the stimulus
G1	Control over the situation, Experiences, Mood, Satisfaction	**G2**	Approach-avoidance assessment

Diagram 3-2: The theorectical model of research (Author, the extended version of model presented by Alinam, 2014)

3.4. The Practical Model of Research

To empirically evaluate the theoretical model and formulate the practical model of the research, the meaning of place was evaluated using three criteria such as pleasant place, place preference, and place suggestion (these criteria were taken from parameters determining the meaning of place and environmental qualities and satisfaction discussed in chapter 2). Then, it was integrated with the three-dimensional model of assessing the emotional-perceptual experience of place. To estimate the contribution of each component to the evaluation process (sensation, perception, cognition, behavior), the three-dimensional model of evaluating the emotional-perceptual experience of place (individual, process, place) was supplemented with information extracted from the case studies. Then, measurements were defined for each sub-component of individual, process, place, and practical model of research formed (Diagram 3-3).

3.4.1. Individual

As discussed in the previous chapter, in the process of place experience, the person dimension is considered in both individual and group levels. At the individual level, this category includes the individual's personal relationship with the place. In studies conducted to examine individual factors affecting the place perception, individual variables such as gender, age, occupation, education, housing status, length of residence, mode of transportation, and walking rate have been considered. At the group level, place perception includes symbolic meanings shared between members. Groups, families, members of the community and similar cultures share the experience of a particular place. Hence in order to study a place, besides the addition of cultural issues, the collective experiences are also shared between them and it is not possible to investigate and apply group measurements (Alinam, 2014: 95).

3.4.2. Place

Since the place component in this research is fixed, it is not included in the practical model of research as a group-cultural subcomponent. In other words, place and place meaning measurements such as pleasant place, place preferences, and place suggestion are evaluated by users in a cognitive process.

3.4.3. Process

- **Sensation**

Satisfaction with a place or preferring a place is the result of the positive emotions that one expresses in the process of interacting with the place and giving meaning to it. The sensation dimension expresses one's feeling about a geographical location that emotionally binds the person to that place. Case studies show that the semantic components of pride, happiness, place defense, prejudice, and loyalty to the place are emotionally responsive to the experience of place. Physiologically, the experience of components such as color, light, sound, odor, and touch are presented as emotional responses to the place, which are emphasized in this thesis. In assessing the sensation component in the process of the emotional and perceptual experience of place, these measurements can be users' sensory manifestations.

- **Perception**

Perception and visual communication are some of the constructive layers of the architectural appearance that influences the individuals' understanding and the formation of place identity in their minds. Based on the reviews done in Chapter 2, the components of place perception are generally divided into two categories of external factors and internal factors. External factors considered physical patterns of a place like size, height, depth, width, proportion, geometry, order, and rhythm that the present thesis study has focused on this aspect. Internal factors have considered patterns such as culture, ethnicity, values, social norms, and history on a group scale, also, patterns like age, gender, job, education, goals, mentality, and memory on a public scale.

- **Cognition**

According to the theoretical model of research (see diagram 3-2), the definition of the cognitive process in cognitive psychology is used in evaluating the cognitive component in the process of the emotional-perceptual experience of place. Thus, the components of attention, conceptualization, association, and cognitive mapping are assessed as sub-components of the cognitive process in the relevant place. Person-related factors are evaluated in the form of individual variables and place-related factors are considered in the form of measurements to assess attention, conceptualization, association, and cognitive mapping to prove the dimension of place in this research and to measure it from the perspective of users.

-Attention: Spatial factors affecting the component of attention include stimulus features (see Table 3-1). Based on the concepts discussed about the meaning of place, place characteristics as stimuli can be categorized into three groups of physical, social and functional characteristics. Physical factors: appearance facade, scale, texture, etc. Social factors: sociability, security, etc. Functional factors: uses, facilities, and services. Thus, physical factors <u>appearance facade</u> of place, social factors the <u>public spaces</u> of place, and functional factors such as <u>functional spaces</u> of the place were considered as three measurements to assess attention in architectural place (Diagram 3-3).

-Conceptualization: as spatial factors affecting conceptualization, the three factors such as concept definition, exemplary-non exemplary and relevant-irrelevant are considered in the conceptualization component (see table 3-1). Measurable examples of these factors can be summarized in three <u>physical features</u>, <u>functional features</u>, and <u>social features</u> measurements to assess the meaning of place in the users' mind. Evaluating the importance of each of these features allows users to define the concept and characteristics of the place (diagram 3-3).

-Association and meaning: association and meaning is a divergent process to recollect the characteristics and developing a concept in one's mind. For example, as stimuli, signs are effective in the association of meanings. To examine the meanings associated with retrieving the concept of place for users, signs were defined in the three groups of <u>symbolic buildings</u>, <u>spaces names</u>, and <u>public spaces</u> (iconic signs and index signs) as associative and semantic measurements.[17] Each of these signs can be associated with their physical, social, or functional characteristics (diagram 3-3).

-Cognitive mapping: Cognitive mapping is a part of the mental image that focuses specifically on spatial relationships. The place stimuli properties in cognitive maps can be assessed by <u>landmark knowledge</u>, <u>route-road knowledge</u>, and <u>survey knowledge</u> (Alinam, 2014: 97). Landmark knowledge includes symbolic buildings in a place that are marked as visual or written on the cognitive map. Route-road knowledge includes

[17] Symbolic signs are based on cognitive conventions and associate mutual meanings between members of a community whereas ionic and index symptoms may have various meanings from different individuals' point of view.

passages and streets that determine the motion paths. Survey knowledge enables the assessment of estimated distances between landmarks that are visualized or written on the map.

➢ Behavior

Behavior is another manifestation of the emotional-perceptual experience of place. According to studies evaluating behavior in place experience, the study of the approach to or avoidance from the place has been considered more than anything else, leading to satisfaction and preference. Tendencies to approach or avoid a place are considered as the main aspect of emotion which provides the possibility of responding to the various environmental stimuli.

➢ Summary

Evaluating the emotional-perceptual experience of place in the environmental studies based on the neuro-architecture principles consists of four elements of sensation, perception, cognition, and behavior. In this regard, cognitive psychology, with its knowledge of mental processes, defines the stages and processes of cognition in the human mind, and relying on neuroscience supports the neuro-architecture approach by introducing effective factors as well as diverse research methods. Hence, cognitive psychology providing scientific evidence makes the evaluation of place emotional-perceptual experience scientifically to be acceptable. The theoretical model of research suggests that in the context of epistemology, cognitive psychology defining the process of cognition can be scientifically at the service of the neuro-architecture approach. Also, in the context of methodology, by providing cognitive research methods to study the process of emotional-perceptual experience of place, it becomes effective in providing a more complete perspective and deeper understanding of place experience. To compile the research practical model, three criteria of the pleasant place, place preferences, and place suggestion were defined to appraisal the meaning of place, and measurements were taken to assess the three-dimensional model of evaluating the emotional-perceptual experience of place and their sub-components:

- Individual dimension: gender, age, job, education**,** marital status, etc. were defined as individual factors influencing the place emotional-perceptual experience.

- Process dimension: ***A) sensation:*** components such as color, odor, sound, texture, etc. were considered as sensory measurements in assessing place experience. ***B) perception:*** components such as height, width, depth, geometry, size, order, proportion & scale, rhythm etc. were considered as perceptual measurements in assessing place experience. ***C) cognition:*** attention, conceptualization, association, and cognitive map are the components of the cognitive process that obtained from examining the cognitive process in cognitive psychology. To make the research theoretical model operational and evaluate the mentioned cognitive components, factors affecting the components of cognitive process were defined as measurable sub-components in the architectural place. Place appearance facade, public spaces, and functional spaces were considered as three spatial factors influencing attention in the architectural place. Physical features, social features, and functional features of place were considered in evaluating conceptualization. Place associating factors were classified in three groups of symbolic & iconic buildings, spaces name (index signs), and public spaces. Also, landmark knowledge, route-road knowledge, and survey knowledge were considered in evaluating cognitive map. ***D) behavior:*** approach-aviodance factor was considered as behavioral response to the place emotional-perceptual experience of place.

- Place dimension: Since the place component in this research is fixed, the place component and the subgroup / cultural component of the individual component are not mentioned in the research operational model.

After compiling the research practical model in this chapter, to examine the amount of contribution of each component by introduced measurements. The introduction of the case study and research method are performed in another chapter.

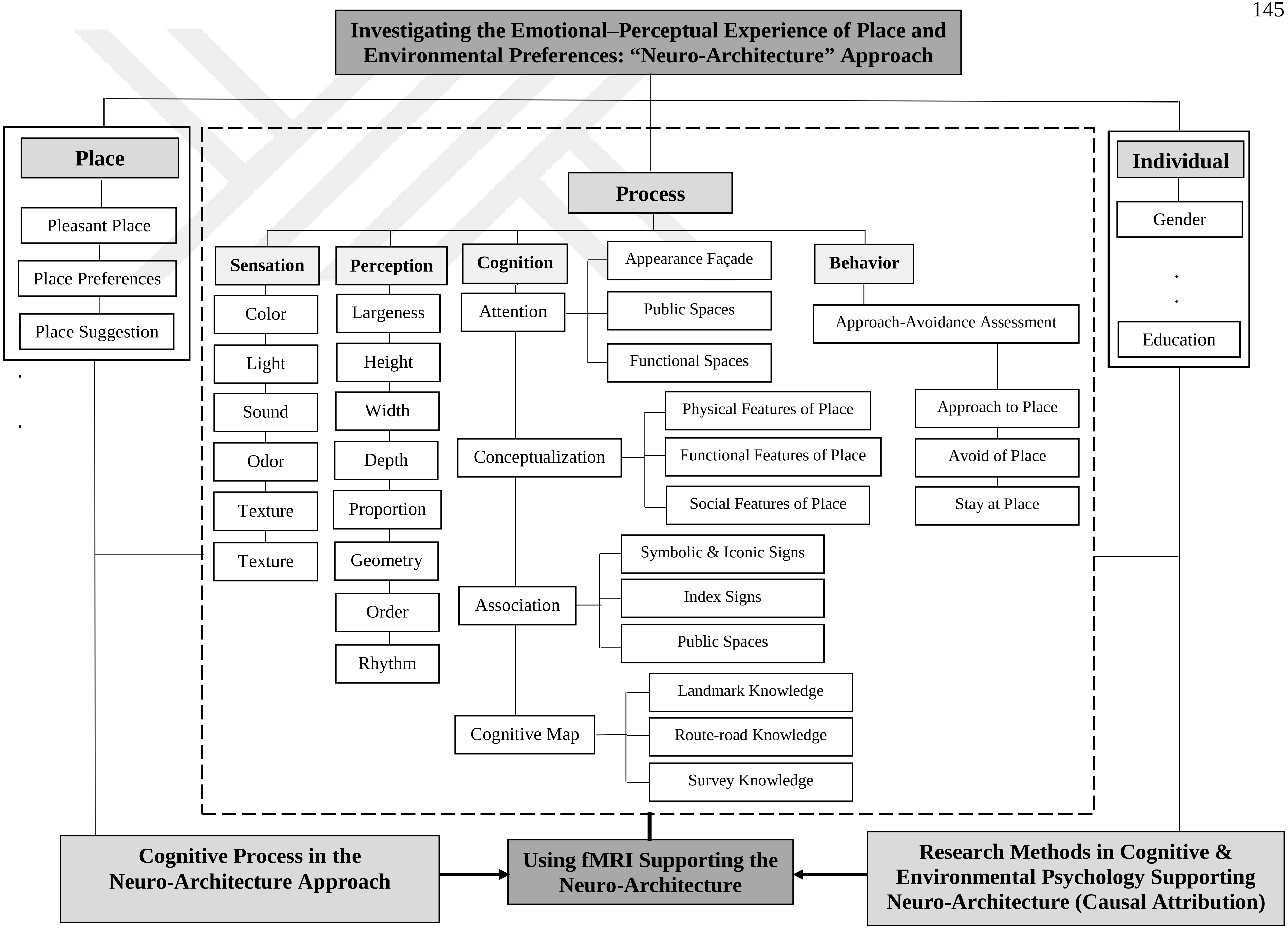


Diagram 3-3: The practical model of research (Author)

4. CASE STUDY AND RESEARCH METHODOLOGY

With major changes in lifestyle, fundamental changes have been made to the architectural and urban structures. Hence, architecture and urban texture, in general, have lost their relevance to the minds of users and have faced a serious identity and psychological issues in respect to users' experiences. The "emotional-perceptual experience of place" as one of the sources of identity, satisfaction, and attachment to place is of great importance from the pathological point of view of architectural issues. In this regard, studying users' mentality and psychology allows designers to understand and explore the users' mental expectations of the architectural and urban spaces. This reflects the views and desires of the users regarding the pleasant architectural space. Applying environmental and cognitive research methods with diverse core logics, and using appropriate cognitive tools, allow for a comprehensive assessment of such an issue. In addition, it provides more holistic information on the phenomenon under study. In this chapter, to test the practical pattern of research, firstly the research case study is examined. In this context, the selection criteria for the case study and related information are presented in terms of physical, functional, and environmental characteristics. Then the research method and tools used in the research are presented along with the statistical population and the validity and reliability of the research.

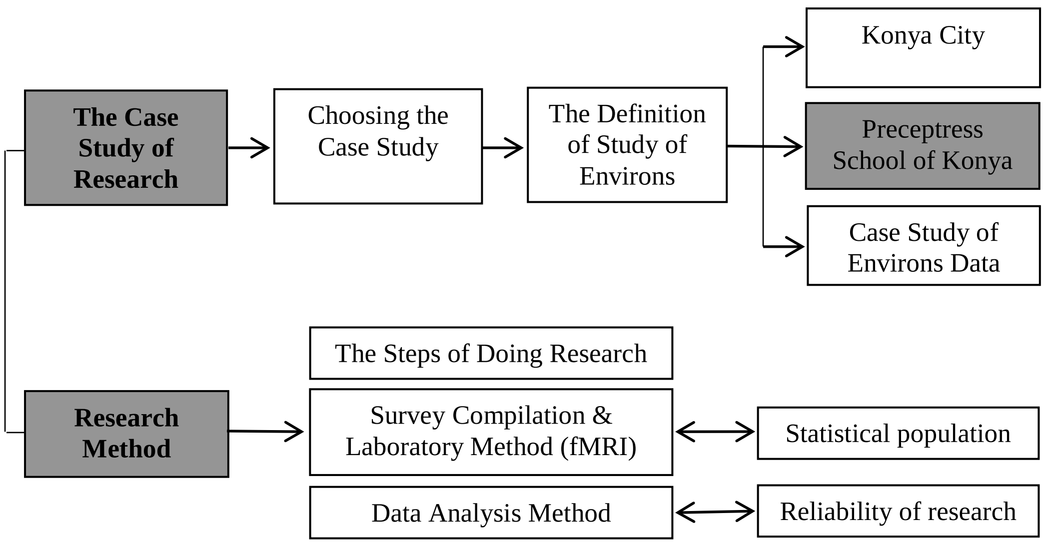


Diagram 4-1: The structure of chapter four (Author)

4.1. The Choice Criteria of Case Study

Since the purpose of this research is to evaluate the cognitive and environmental components of place emotional-perceptual experience, the individual's environmental cognition and behavior are studied to examine the spatial variables and to focus on individual's cognitive components. The following criteria for selecting the case study of "Kız Muallım Mektebi" (Konya Preceptress Teaching School) for research were considered:

1. Choosing a school as a case study to minimize cultural and social variables affecting the process of emotional experience of the place.
2. Since the relevant school has undergone various uses after the restoration works, and has eventually become a school of architecture and urban design, so in terms of concept, meaning, social factors, and memory, it involves values.
3. Given the nature of this study and the research method (using laboratory research to measure brain emotional responses and physiological activities), choosing other architectural settings is confined or impossible due to the limitations of the work like asking users or citizens to participate in the laboratory research section. For this reason, the chosen case study considering its function and involving students of architecture and urban design could be a very good option for conducting the present research.
4. The vicinity of the case study with the historical context and the monuments of the city has a good potential for examining the components of the cognitive process (see diagram 3-3) and can provide valuable information in this regard.

4.2. The Definition of Study of Environs

- **The city of Konya**

Konya is one of the biggest cities in Turkey. Throughout history, Konya has existed as one of the most important ancient cities in the world and has witnessed important civilizations historically. The city of Konya is located in the south and southwestern of the Central Anatolia Region in the middle of the Anatolian Peninsula. Konya with an area of 38,873 km^2 has a population of 2,205,609 people in 2018. Konya is cold in winter and hot in summer. The geographical location of the city, as well as its history as the capital city of Seljuk empire, and the location of Rumi and other Sufi tombs in this city, have made Konya the confluence point of ancient civilizations to contemporary era, economic, political, and cultural events.

Figure 4-1. The location of Konya city. (http//www.turkiye.harita.com, 2018).

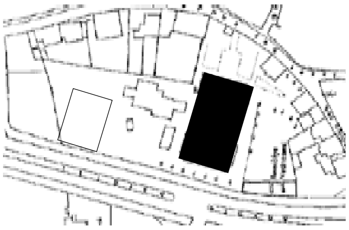
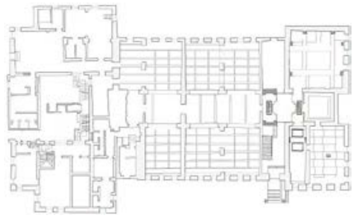
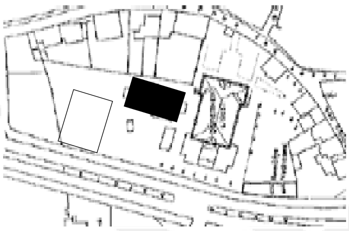
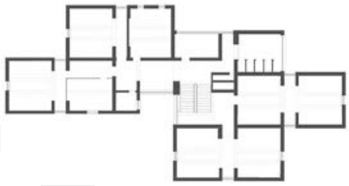
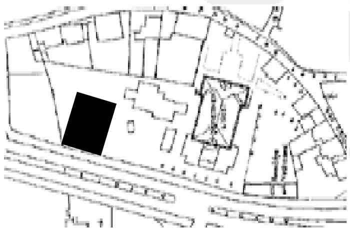
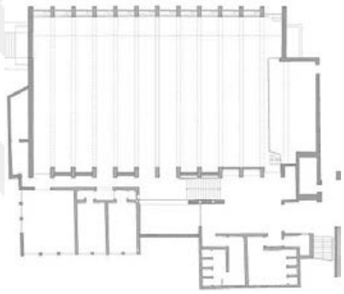
- **The “Preceptress School” of Konya (Case Study)**

The “Preceptress School” of Konya, designed by the architect Muzaffer, was opened as a school only for women and as a teaching training center in 1925. The building is located on the land of Kemaliye (Küçük Karatay), in the northeast of Alaaddin Hill behind the smaller Karatay Madrasah. The building has three floors and is set in a large courtyard. In the original design, the plan resembled a (T) shape but due to later additions, this could not be observed. Apart from the basement, the other two floors have the same plan. The structure has a rectangular plan in the east-west direction. The facade is enlivened with colored stones and arched window series with the horseshoe. It served as a “Preceptress School” until 1979 and was later changed into “Preceptress Art Teaching” School. After restoration works, the building was used as Selcuk University Rector Building in recent past years. From October 2017, this building has begun to be used by the Faculty of Architecture and Urban Design. Besides this building, two other buildings have been converted into educational buildings (Sözen and Dülgerler, 1978).

Figure 4-2. The location of the Faculty of Architecture, Selcuk University, Konya. Top raw: Konya city map, and the location of the case study (http//www.turkiye.harita.com, 2018); Middle raw: images from left to right are about the site plan of the case study (Google Earth with the modification of authors. 2018). Down raw: the site plan, elevations, and vicinities of the “Preceptress School” historical building (Sözen and Dülgerler, 1978).

In the city center of Konya, the faculty of architecture and urban design buildings can be grouped into two. **1) Old and historical building:** As mentioned above, the old educational building was used for the girls-only education center, but nowadays, it has been changed and used as studios, lecture halls, dining halls, and a library. **2) New buildings:** The buildings of this group are classified into two categories, and were built not too long ago. One of these buildings was built in the past for the girls’ dormitory which is being used today as studies and teachers’ room. Another building was previously used as a sports hall, but now it is being used as big studios.

Table 4-1. Faculty of Architecture & Urban design buildings, Selcuk University of Konya (Author)

Place	View	Plan
Old & Historical Building (Preceptress School) 		
New Building 1 (Dormitory in the Past) 		
New Building 2 (Sports Hall in the Past) 		

➢ Case Study of Environs Data

The land of Karatay district is the central part of the city. This part of the city has many important uses, including educational, historical, sports, administrative, therapeutic, religious, cultural, and green spaces. The case study considered in the present study is situated in the vicinity of the most famous and important uses as follow:

- **Alaaddin Hill** (Alaaddin Tepesi): this mound is situated in between Rumi museum and the new city center, and is surrounded by important historical places like “Preceptress School”, “Karatay Museum” and other functions such as hotels, public transportation stations, cafes, clubs, etc. The mound was built during the Seljuk Empire, and includes an old mosque and castle which are visible from every side especially from the case study of this thesis.

Figure 4-3: The Alaaddin Hill, mosque and the old castle structure (http://konyalife.com.tr)

- Karatay Madrasah: It was built in 1251, during the Seljuk Empire era, as a school and was opened to visitors as “Tile Works Museum” in 1955. This historical building is situated in front of the case study, Alaaddin Hill, and city forum.

Figure 4-4: The Karatay Museum (http://konyalife.com.tr)

Figure 4-5: Case Study Environs Data

4.3. Research Method

As extensively explained in the previous chapter, the nature of the present study is that it requires the use of three methods such as interview, questionnaire, and laboratory studies. Therefore, a combination of quantitative and qualitative strategies is used to describe, extract and measure the criteria. In this research, to gather converging evidences to support research hypotheses, environmental and cognitive research methods with diverse core logic are used. The case study method (with the core logic of contextualization), the naturalistic observation method and the textual & narrative studies method using interview and survey techniques (with the core logic of interpretation), and the laboratory experiments (with the core logic of causal attribution) are used in this study. Each of these methods can be used in the research process based on data collection, analysis tools, and the nature of the research questions and goals.

4.3.1. The Steps of Doing Research

The research was conducted in two **conceptual** and **exemplary** sections. In the **conceptual** section of the study, the literature review and theoretical basis of research in areas such as place experience, emotional and perceptual assessment of the environment, environmental psychology, cognitive psychology, and Neuro-Architecture were examined. Then, through content analysis and relying on cognitive psychology principles, the place of the Neuro-Architecture approach in the process-oriented assessment of place emotional-perceptual experience was examined and presented in the form of a theoretical and practical model.

The **exemplary** part of the research involved several steps. ***Firstly,*** to choose the case study, the method of the case study was experimented and after direct observations and semi-structured interviews with users, the relevant educational building was selected as the case study because of its compliance with the required criteria. Then, according to the practical model of the study, in assessing the process of the emotional-perceptual experience of place, to have a profound understanding of place was necessary. So, ***in the second step,*** investigating the meaning of place was done considering three criteria such as pleasant place, place preference, and place suggestion. In this context, to explore users' environmental preferences and behavior, **observations** were conducted in three different periods; morning, noon, and evening considering the following questions:

1- How does the identification and explanation of environmental factors affect the users' behavior patterns?

2- Which components play a more important role in user activity and satisfaction?

3- How can place preferences be effective in users' sense related to being pleasant of a place.

4- What can be the physical, functional, and social elements of the case study?

After identifying spatial preferences and indicator elements of the case study, to ensure the reliability of the estimates made and to know how users perceive the meaning of place, ***in the third step*** in applying the textual & narrative studies method, exposing places' pictures obtained from the observation step, the users' mental image was assessed through deep interviews in general. Indeed, the **interview** was a way to evaluate the users' method of thinking from their answers to the following questions:

1. Which dimensions of the meaning of place are more significant for users?
2. What is the mode of thinking of users in the interpretation of a place?
3. What are the components involved in promoting place perception with an emphasis on the emotional-perceptual experience of place?

All of the interviews were conducted inside the three selected places of the Architecture Faculty at the Selcuk University of Konya (Preceptress School building) so that individuals would have the opportunity to express their true feelings. Each interview lasted in twenty to thirty minutes. Interviews were conducted in the same manner during different hours of the day. 40 interviewees were randomly selected. Of these, 10 were professors and 30 students of architecture (15 male and 15 female). The relevant questions were designed to achieve the qualitative aspects and elements of the place meaning which can be seen in the following Table.

Table 4-2. Questions related to shaping qualitative dimensions of place meaning (Author)

An example of asked questions
• Does the building remind you of an old/new memory or experience? Why? • Does the design of the hall appeal to you? Why? • Is the space easily recognizable? Why? • Is the design of this building suitable for a scientific environment? • Do you feel secure in this place? Why? • Are the dimensions of spaces and the height of the ceiling appropriate? Why? • Are the plan and geometry of this building well designed for an educational space? Why? • Are you satisfied with the furniture and the symbols used? Why?

Later, ***in the fourth step***, to investigate the influence and contribution of each qualitative components of place obtained from the interview results on the emotional-perceptual experience of the users, the Pleasure-Arousal model proposed by Mehrabian and Russell (1974) was used as open questionnaire, and the pictures of spaces which obtained from the observation step and students emphasized on in the interview were shown on the survey. In this step, we tried to answer the third question of the interview and analyze the content of thinking of users. In this context, 60 photographs about the internal and external places of three buildings in the faculty of architecture were prepared based on interview results and were presented to students. To determine the appropriate number of participants, the first pretest was performed as a pilot study on 35 students and after the estimation of variance for the initial sample (*S2*) at the confidence level of 92%, the number of the sample was increased to 140 (architecture group: 35 boys & 35 girls and urban design group: 35 boys & 35 girls). An overall alpha for all 16 emotional components (pleasure-arousal model) in the 35 tested samples and then for each of the qualitative norms in perceptual semantic aspects were calculated. In the pilot stage, the reliability of the questionnaire in the Bogardus scale was determined in Cronbach's alpha test which defines the validity of research results at the same time and place. 20 photographs belong to one place each, namely 10 photographs related to the outdoor environment and 10 photographs related to the indoor environment, were selected. Then, students were asked to express their affective and perceptual experiences related to these places of the faculty. The time spent on each survey ranged from 25–30 minutes.

Participants were with similar educational backgrounds and experience, aged 20 and over were recruited for the field survey that was performed in January 2018. To this end, the answers were recorded in the format of the Pleasure-Arousal model (diagram 4-1) which shows the percentage (%) of participants evaluating attributes such as displeasure, lethargic, and stressed, etc. or pleasure, calm, and excited, etc. Also, to match the factors obtained from the interview and survey, users were asked to indicate effective factors in environmental experience. In total, 16 attributes and affective characteristics were measured related to the environment. Students individually, while viewing the pictures, pointed out their emotions and perceptions from the pictures based on their interview experience in the previous step, and marked it on the diagram (model) for each image and the aroused emotions were marked from 0 to 100 points. The obtained qualitative data were collected and combined. Then, analyzing and matching results with other assumptions and findings were fulfilled. The respondents were selected mostly from undergraduate students (70%), preferably who passed the fourth and fifth semesters, and graduate students (30%). 50% of the students were females and 50% were males. Questions were answered in the specific area of each building, and most of the students were asked during the middle hours of the day because they were at university at noon. Questions were answered in groups of 3 or 4 people, and interviewers did not make any statements about the results and questions.

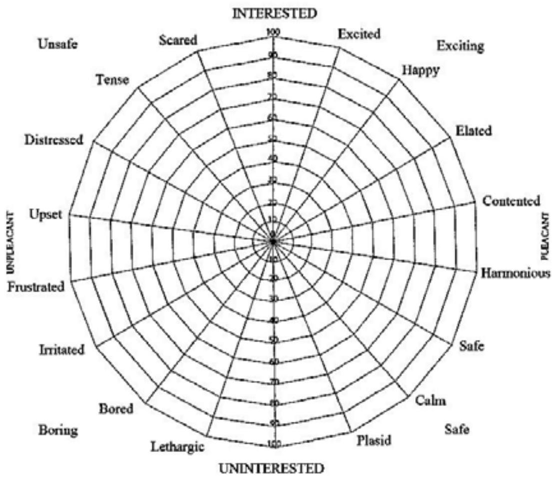


Diagram 4-1. Pleasure-Arousal model proposed by Mehrabian and Russell (1974).

In the fifth step, a questionnaire was developed and distributed among users to measure the contribution of each measurement in the process of evaluating the emotional-perceptual experience of place in determining the pleasant or unpleasant desirability of each place as were presented in the previous step (Pleasure-Arousal Model). This phase of the study was conducted using the contextual-narrative studies method and mediating variable so that to validate the answers as well as to eliminate the ambiguity of the users, the test was conducted one by one. Furthermore, filling survey of short interviews were conducted to find out the reasons why users chose the answer. The survey questions were arranged in eight sections (Table 4-4), and participants were asked to rate questions and photographs on a 5-point scale. The first section contains the participants' statistics. The second part is a checklist of 17 questions. 2 questions consist of sub-components of sensation (both for pleasant and unpleasant places), 2 questions for sub-components of perception (both for pleasant and unpleasant places), 10 questions for sub-components of cognition, and 3 questions for sub-components of behavior.

Questions in the sensation part include image checklists that evaluate the sensory components mentioned in the theoretical model of research such as color, light, sound, smell, and so on. Questions in the perception part include image checklists that evaluate the physical components mentioned in the theoretical model of research such as height, depth, width, geometry, order, etc. Questions in the cognition part were classified into four categories of image checklists. 3 questions were exposed to evaluate the sub-component of attention and 3 questions for conceptualization sub-component, and 3 questions for association sub-components were exposed. Additionally, 1 question was presented about drawing cognitive maps to evaluate three sub-components of landmark knowledge, route-road knowledge, and survey knowledge. All images used in this questionnaire were selected according to assessing 16 attributes and affective characteristics of each place based on the Pleasure-Arousal Model results which presented in the fourth step to determine the pleasant–unpleasant places of the faculty by relying on participants' experiences and emotional evaluations. The 30 most-rated images were used in the questionnaire which extracted from the results of assessing the Pleasant-Arousal Model. 15 images represented the pleasant spaces and 15 images represented the unpleasant spaces.

Table 4-4: Evaluating the sub-components of the emotional-perceptual experience of place (Author)

<table>
<tr><th>Component</th><th>Sub-component</th><th colspan="2">Component question</th></tr>
<tr><td rowspan="2">Sensation</td><td rowspan="2">Sensory Factors</td><td colspan="2">Pleasant Place: Rate the positive emotions (Harmonious, Safe, Calm, Placid) you feel from the photos below by giving the highest score to the most liked of the following criteria.</td></tr>
<tr><td colspan="2">Unpleasant Place: Rate the negative emotions (Scared, Tense, Distressed, Upset) you feel from the photos below by giving the highest score to the most disliked of the following criteria.</td></tr>
<tr><td rowspan="2">Perception</td><td rowspan="2">Physical Factors</td><td colspan="2">Pleasant Place: Rate the positive emotions (Harmonious, Safe, Calm, Placid) you feel from the photos below by giving the highest score to the most liked of the following criteria.</td></tr>
<tr><td colspan="2">Unpleasant Place: Rate the negative emotions (Scared, Tense, Distressed, Upset) you feel from the photos below by giving the highest score to the most disliked of the following criteria.</td></tr>
<tr><td rowspan="12">Cognition</td><td rowspan="3">Attention</td><td>Appearance Façade</td><td rowspan="3">How much of each of the following groups of images attracts your attention?</td></tr>
<tr><td>Public Spaces</td></tr>
<tr><td>Functional Spaces</td></tr>
<tr><td rowspan="3">Conceptualization</td><td>Physical Features of Place</td><td rowspan="3">How important is each of the following images to you?</td></tr>
<tr><td>Functional Features of Place</td></tr>
<tr><td>Social Features of Place</td></tr>
<tr><td rowspan="3">Association</td><td>Symbolic & Iconic Signs</td><td rowspan="3">How much of each of the following groups of images associate memories in your mind?</td></tr>
<tr><td>Index Signs (Spaces Name)</td></tr>
<tr><td>Public Spaces</td></tr>
<tr><td rowspan="3">Cognitive Map</td><td>Landmark Knowledge</td><td rowspan="3">Draw your school map based on your mental imagination considering the shape of the boundary, vicinity, streets, squares, and important elements.</td></tr>
<tr><td>Route-road Knowledge</td></tr>
<tr><td>Survey Knowledge</td></tr>
<tr><td rowspan="2">Behavior</td><td rowspan="2">Approach-Avoidance</td><td rowspan="2">Pleasant and unpleasant places (Interior, exterior, and open spaces)
-The Old Building
-The New Building
-The Sports Hall Building</td><td>Approach: 'how much time would you like to spend in this place? how much would you want to explore this place?</td></tr>
<tr><td>Avoid: how much would you want to avoid looking around or exploring this place and 'how hard would you try to avoid ever having to return to this place?</td></tr>
</table>

The sub-components of sensory and physical factors were presented as a group of pictures of all three buildings in the faculty. The relevant images were categorized into two groups evoked positive emotions such as *harmonious*, *safe*, *calm*, and *placid* representing pleasant spaces. Attributes and negative emotions such as *scared*, *tense*, *distressed*, and *upset* representing unpleasant spaces were considered as the second category. The following figures represent the pleasant and unpleasant spaces obtained from users' emotional rating of pleasure-arousal model.

Figure 4-6: Images represented the pleasant spaces, obtained from users' emotional rating of Pleasure-Arousal Model, and used in the questionnaire to determine the contribution of sensory and physical sub-components in the process of assessing the emotional-perceptual experience of place (Author).

Figure 4-7: Images represented the unpleasant spaces, obtained from users' emotional rating of Pleasure-Arousal Model, and used in the questionnaire to determine the contribution of sensory and physical sub-components in the process of assessing the emotional-perceptual experience of place (Author).

As mentioned in the theoretical model of research, sub-components such as place appearance facade, public spaces, and functional spaces were considered as three spatial factors influencing attention in the architectural place. In addition, physical features, social features, and functional features of the place were considered in evaluating conceptualization. So, sub-components of the appearance facade of place (physical features) were presented to the participants as pictures showing the historical or modern appearance of relevant places to give users the right choice. Given the commonality of measures of attention and conceptualization, the images used for questioning these two components overlapped.

Figure 4-8: The appearance facade of place of the case study (Author)

The sub-components of public spaces (social features) were presented to the participants as pictures showing the sitting, gathering, or chatting places and activities. These photos were extracted from observation and interview results.

Figure 4-9: The public spaces and collective activity places of the case study (Author)

The functional features and spaces were presented to the participants as a group of pictures (based on information obtained from interviews and observations) related to the major available functions of the case study including the dining hall, head of department room, prayer room, and toilet belonging to the old and historical building of the faculty; the entrance spaces and corridors of the sports hall building; and café which is belonging to the backyard of the faculty.

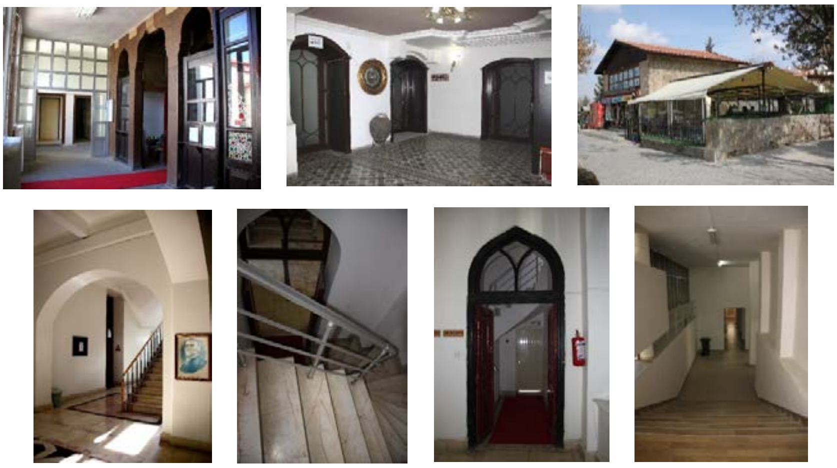


Figure 4-10: The functional spaces of the case study (Author)

Place associating factors were classified into three groups of symbolic & iconic buildings, spaces name (index signs), and public spaces. Symbolic buildings were presented to the participants as pictures showing historical or modern buildings of the case study and its vicinity. Images of the names of places built on the case study, including the names of alleys, streets, paths, and roads, were also considered to be index signs. The image of collective and public spaces overlaps with the image of this measurement in the conceptual and conceptual components. Cognitive maps were drawn to understand the users' mental imagery of the case study and were evaluated and scored based on three components of landmark knowledge, route-road knowledge, and survey knowledge.

Figure 4-11: Top raw: symbolic & iconic buildings. Middle raw: spaces name (index signs). Down raw: public spaces (Author).

In related to the component of behavior, the approach-avoidance factor was considered as a behavioral response to the place as the emotional-perceptual experience of place. In this regard, the capability of place to keep the user away from the daily routine, spending time inside of it or force to avoid it were evaluated. For all three buildings on the case study three image groups were presented to be answered by participants (three questions).

Figure 4-12: Top raw: old & historical building. Middle raw: new building (Dormitory in the Past; today is used as teachers' room & stodyos). Down raw: new building (sports hall in the past; today is used as two big stodyos & cafe) (Author).

All quantitative data of questionnaire were conducted by SPSS 20. The independent samples *t*-test was used to analyze the data. Indeed, to compaire the responses from two groups of women-men and architects-urban designers, is also to determine the role of gender and the field of study (discipline) in assessing the components of place experience. The *t*-test is an efficient statistical method. In this regard, the quantities used in the *t*-test were *p*-value and sig. (2-tailed). The "confidence level" of the test is considered as 95% and the extent of p-value<0.05 which shows significant difference. In other words, if the extent of sig. or p is less than 0.05, it means that the mean responses of the two groups were significantly different.

In the sixth step, to record brain activations when encountering pleasant places (positive images) and unpleasant places (negative images), 32 right-handed participants between 20 and 22 years of age (mean age = 21.25) were recruited. All of the participants were architecture and urban design students from Selçuk Univerity of Konya (architecture: 14 men & 6 women; urban design: 5 men & 7 women), and none of them had a history of neurological or psychiatric disorders. They all had a normal or corrected-to-normal vision and normal color vision. The study conducted on 7-8 December 2018. Imaging data were acquired with a 1.5-Tesla Siemens Area MRI scanner at the radiology polyclinic (MR2) in Selçuklu Hospital (Faculty of Medical Science) of Selcuk University in Konya, Turkey. To record fMRI images simultaneously, the TELEMED device which serves functional MR experiment paradigms was used. Several trial imaging was performed to obtain the standard fMRI data. Then, the data were analyzed and the experimental procedure for 32 subjects was finalized. The participants were completely informed about the experimental procedure. They especially asked not to move their heads and bodies and no to carry any metal objects with them inside the scanner. Indeed, head movements were minimized using foam padding and headphones with earplugs were used to dampen the scanner noise.

In the first level, the volumetric structural imaging, T1, was performed. The T1-weighted anatomical images recorded in this study consisted of 160 sections and were obtained by anatomical scanning of the brain lasting for a total of 4 min & 42 sec. It was acquired with 3-D magnetization prepared from rapid gradient echo (MP-RAGE) sequence (TR: 2400ms, TE: 3.54ms, TA: 4.42, Voxel size: 1.3×1.3×1.2mm, FOV: 240mm, Slice thickness: 1.20mm) from each participant at the beginning of the experimental session. In the second level, participants were asked to wait on the MRI scanner without thinking about anything in order to obtain T2 resting state images. T2 weighted EPI, the recorded resting state, lasted 5.54 min (TR: 2400 ms, TE: 3.54 ms). In the literature, an experiment was prepared using visual stimulus for task-based fMRI imaging. For this purpose, in the third level, using prepared experimental paradigm of positive and negative images were shown to the participant on MRI scanner.

Accordingly, the block-design experiment paradigm used in the present study is shown in the following figure. According to the block-design paradigm shown in Figure 4-13, fMRI recording was started with a 40 sec resting state. At rest state, the subject was allowed to look at the white “+” sign in the center of the black screen. At the end of the rest block, participants were shown 5 positive images (pleasant places of the case study), each 4 sec, and after 40 sec rest time, 5 neutral images, each of which 4 sec were shown to the participants. At the end of the showing of the 3 blocks from the first file, the same procedure was done for the second file which was in related to negative images (unpleasant places of the case study). The recording time was totaled 8 minutes and 28 sec (each file 4 min and 14 sec). During this period, a 14-second time which is called "Dummy" does not contain any information about the functional images. To distinguish the "Dummy" time from the recording time, a neutral image was shown for 14-second at the beginning of the experimental paradigm and before the rest state.

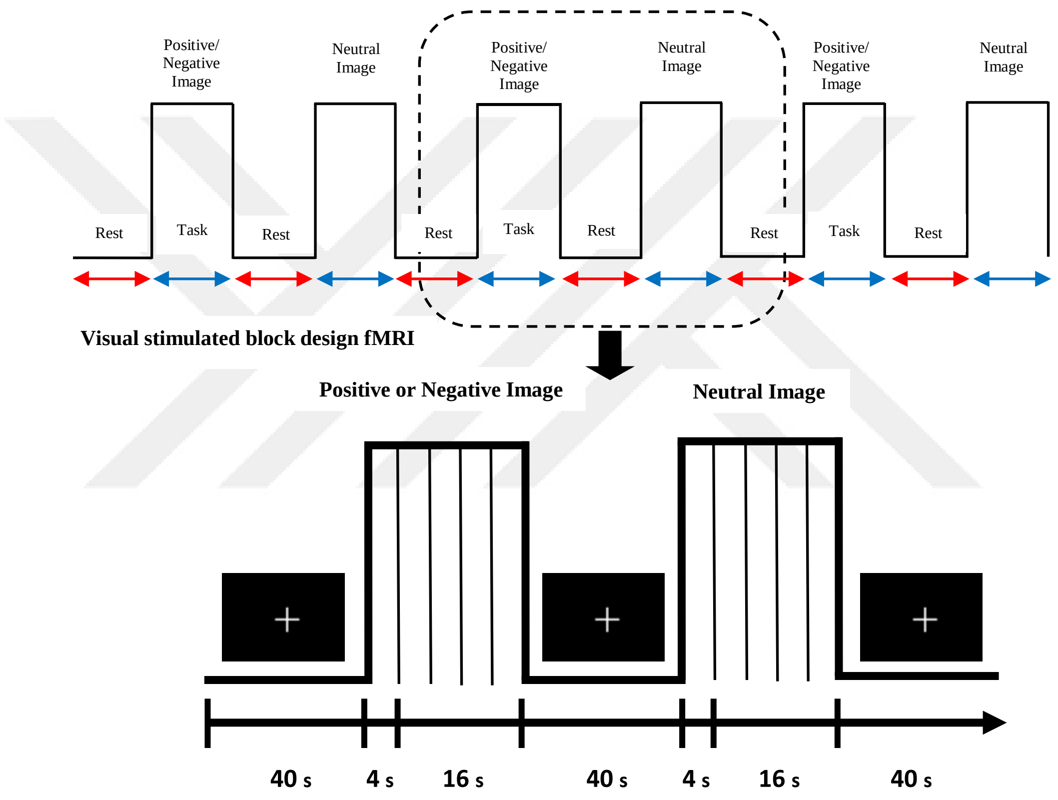


Figure 4-13: Experimental design, procedure of stimuli. Two types of tasks were performed in separate blocks, namely, the positive images judgment (the pleasant places of case study) and the negative images judgment (the unpleasant places of case study).

Since any images was not recorded during the surplus time, a total of 120 functional MR images, each scan lasting 4 seconds was obtained in 360 seconds (TR: 4000ms, TE: 50ms, TA: 4.14, Voxel size: 3.4 × 3.4 × 3.0mm, FOV: 220 mm, Slice thickness: 3.0 mm). Accordingly, each block consists of rest images + positive/negative images + neutral images. This experimental paradigm was designed as three blocks.

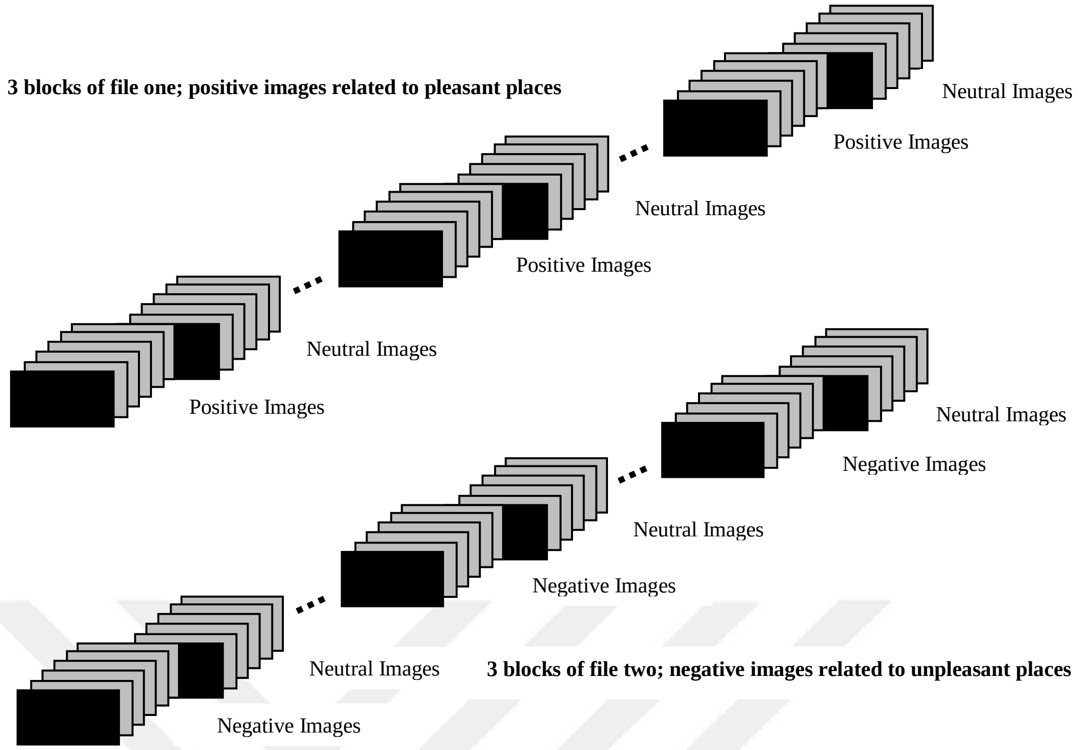


Figure 4-13: Experimental design, procedure of stimuli. Two types of tasks were performed in separate blocks, namely, the positive images judgment (the pleasant places of case study) and the negative images judgment (the unpleasant places of case study).

Of the 60 color photographs assessed 30 photographs with the highest scores belong to 3 buildings of the architecture faculty of Selçuk University were selected from the results of assessing the Pleasant-Arousal Model to be shown to the participants. 15 photographs contained the pleasant spaces evoking positive emotions, and the other 15 images contained the unpleasant spaces evoking negative emotions. Besides, 15 neutral photographs were selected to ensure the brain rest time and to create a time interval between the end and beginning of showing the main slides of each block. To get the right and optimal results and to have an effective examining of the brain's behavior in the face of pleasant and unpleasant places, the photographs of pleasant and unpleasant places were arranged in two separate file formats (Positive images & Negative images). The relevant files were shown to the participants separately. Firstly, the file containing the pleasant places (positive photographs) were shown. Then, the file containing the unpleasant places (negative photographs) were shown. Each file was designed into 3 blocks and representing rest time slides, positive or negative slides, and neutral slides). It took 4 minutes and 14 sec to show each file (3 block). Each block contains five slides related to rest time (black screen with + sign), five slides related to pleasant (Positive) or unpleasant (Negative) places, five slides related to rest time, and five slides related to neutral figures. Recording the brain activations in MR scanner, the images were shown to the participants via an LCD monitor screen (800 × 600 pixels) located at the behind of the scanner which reflects images on a mirror inserted on a head-mounted apparatus. According to the developed experimental paradigm, necessary adjustments were made on the MR device, and the experimental standard was determined with all the records and imaging were performed based on this standard.

Imaging data were preprocessed using SPM12 implemented in MATLAB 2014b with the extension software data processing and analysis of brain imaging. To control against false positives, a combination of voxel-level and cluster-size correction were adopted. A *t*-statistic was used to evaluate the mean difference in signal intensity (minimum cluster size of 3 voxels), and to localize the effects of the analysis on the brain. In this regard, a factor was considered to be relevant, if it shows a significance level of $p < 0.05$. The extent of activation in each area was calculated as the number of active voxels (determined by the *t*-test). To check the number of false positives, and to increase the reliability and validity of the neurological investigation of the present study, and in addition to using p-uncorrect<0.05 value in statistical analyzing of the brain activation, the two other statistical values such as p-uncorrect<0.01 and p-FWE<0.05 were applied. As a statistical method, the FWE (Family Wise Error) is one of the strictest statistics used in fMRI analysis for multiple comparisons, and p-unc<0.01 is used as more sensitive with high statistical value. fMRI analysis was also conducted to evaluate the effect of experiencing pleasant and unpleasant places on the brain functional activity in discipline (architects and urban designers) and gender (women and men) differences in order to determine whether variables show different response to emotional pictures.

5. FINDINGS

In this chapter of this research thesis, data obtained from observations, interviews, questionnaires, and the brain functional imaging (laboratory studies) are analyzed in both quantitative and qualitative terms. Based on the example given from the research mentioned in chapter four which is in theoretical and practical model of research, to assess the users' emotional-perceptual experience of place, three factors of individual, process, and place with their components were considered. In this regard, the qualitative and quantitative analysis of the effect of each of these elements was evaluated. The analysis began by examining users' environmental preferences and the understanding of the meaning of place from their point of view, and ended with evaluating the brain's emotional activity and behavior in the process of emotional-perceptual experience of place.

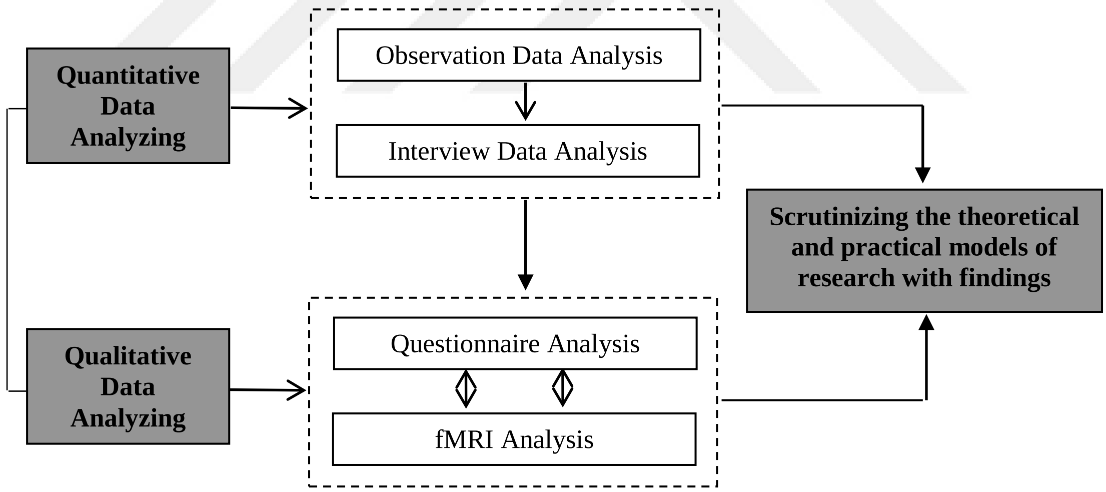


Diagram 5-1: The structure of chapter five (Author)

5.1. Findings of Observation

➢ Findings of observation in exterior spaces

After choosing the case study, in the process of assessing the emotional-perceptual experience of place and to explore users' environmental preferences and behavior, to have a profound understanding of place was necessary. So, by considering three criteria such as pleasant place, place preference, and place suggestion (refer to the practical model of the study) observations were made. In analyzing behaviors, field observation, sketching, section, drawing cognitive-behavioral maps, and recording images of the exterior spaces of the faculty have been used. Cognitive maps have been prepared at various times, and users' social behavior patterns have been reviewed on those maps. The reasons for and the reasons of presence in various places have been monitored, evaluated, and analyzed. Finally, the reasons for place preferences or not preferences, and the results have been shown according to the criteria.

The first area to be observed is the outer and open spaces of the faculty which include greenbelt, educational buildings, services buildings, and parking. The following figure shows the rate of users' approaches and preferences to the spaces mentioned above. Field observations were conducted in three different periods such as morning, noon, and evening. The densities of black dots represent the volume of referrals and approaches to the respective areas.

Figure 5-1: Exterior spaces preferred by students (Author).

In the environmental experience, the factors that have a positive or negative effect on users' feelings and behavior are associated with their preferences and satisfaction with the environment. From Rapport's point of view, individuals evaluate a place in order to approach or avoid that place based on attractive and repulsive factors, and often prefer a place that is more in line with their needs and desires (Khaleghimoghaddam, 2016). In the present study as shown in the figure above, in relation to the points marked on the map with numbers 5, 6 and 7, it was observed that the lack of an appropriate portal or entrance and the steady stone wall on the west side of the yard made an unpleasant effect on users' feeling and visual perspectives. In fact, the relevant wall caused them to be avoided from the street-mounted side, and it has completely blocked the view to the outside of the faculty. In addition, in terms of accessibility, the lack of specified paths and defined entrances for the sports hall building, the lack of landscape and seating areas as well as the merging of the pedestrian route and parking area, made users leave that area and not preferring it. Hence, it is clear that the north and west sides of the faculty (sport hall building area) are poor and unpleasant in terms of users' spatial experience and environmental quality assessment (using quality elements of design such as materials, color, vitality, variety, sociability, etc.), and those sides need more investigation to provide optimal architectural design approaches.

Related to the point marked with numbers 4, it was observed that high-quality elements such as plant, grass, trees, pergola, and bench make this part of the site beautiful. In addition, locating this part of the site along the route between the old and new buildings has made it a safe place to sit and to relax for social interaction is preferred by users. In relate to the point marked with numbers 1, 2 and 3, it was observed that these part of the site in terms of accessibility, geometry and dimension are very favorable as they involve qualified elements such as convenient path, various materials, plant, grass, trees, sitting areas. Therefore, they provide pleasant places to have appropriate views and landscapes. Besides, the presence of national and unifying elements such as the Turkey Flag, Mustafa Kemal Atatürk's (founder of the Republic of Turkey) statue as well as the entrance of the historical building of "Konya Preceptress School" (faculty of architecture) in this area have made the place suitable for the congregating of the students. So, it results in the enhancement of environmental preferences, sociability, legibility, vitality, collective memory, sense of belonging to place and identity.

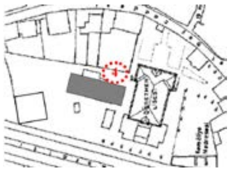
Table 5-1: Assessing the users' environmental preferences and pleasantness (Author)

Place		Exterior Spaces	Abstract of Findings
	**1**	 	These parts of the faculty have good accessibility, geometry and dimension, involve qualified elements such as convenient path, various materials, plant, grass, trees, sitting areas which provide pleasant places to have appropriate views and landscapes. National and historical elements play an effective role in the enhancement of environmental preferences, sociability, legibility, vitality, collective memory, sense of belonging to place and identity.
	2	 	
	3	 	
Place		**Exterior Spaces**	**Abstract of Findings**
	**4**	 	Elements such as plants, grass, trees, pergola, and benches make this part of the site beautiful and promotes safety and social interaction. So, it is preferred by users.
Place		**Exterior Spaces**	**Abstract of Findings**
	**5** **6** **7**	 	These places are not evaluated as pleasant and are not preferred because of the lack of suitable access, path, defined entrances, landscape, architectural materials, sitting areas, and the merging of the pedestrian route and parking.

In general, what can be acknowledged about the findings of this step (observing users' behavioral patterns and environmental preferences) is that users have a particular capacity in searching, storing and discovering the environmental information. If the environmental information of a place provides the users' emotional-perceptual needs, meaningful interaction with the environment will be possible and users will be satisfied with their presence in the environment and will exhibit rational, collaborative and interactive behavior. For example, in this study, it was found that good spatial clip and geometry is an appropriate practical strategy for facilitating social interactions, enhancing the quality of the environment, providing more and better opportunities for sitting and improving sociability. Also, it is concluded that high-quality areas characterized by their distinctive and diverse elements in terms of shape, view, landscape, color, security, convenience, and novelty (Brunswik's Lens model) are considered as selective activities, and the result in user satisfaction ~~(~~answers the question 2 & 3 considered in the beginning of the observation step~~)~~.

Lastly, we found that considering the environmental factors such as sociability, legibility, landscape, accessibility, permeability, diversity, vitality, and continuity which form the physical (materials, landscape, pergola, etc.), functional (paths, sitting, walking, playing, etc.), and social (historical and national features, gathering, making ceremonies, etc.) elements of the case study have a significant impact on users' environmental preferences, behavioral patterns, and satisfaction (which answers the question 1 & 4 considered at the beginning of the observation step). Then, to evaluate the place meaning from the users' point of view, based on the observation records, the more and less preferred open spaces of faculty were categorized into 3 groups in the following table.

Table 5-2: Places provided to evaluate in Pleasure-Arousal Model (Author)

<table>
<tr><th>Place</th><th colspan="2">Exterior Spaces</th></tr>
<tr><td rowspan="3">Old & Historical Building
(Preceptress School)
</td><td>1</td><td></td></tr>
<tr><td>2</td><td></td></tr>
<tr><td>3</td><td></td></tr>
<tr><th>Place</th><th colspan="2">Exterior Spaces</th></tr>
<tr><td>New Building 1
(Dormitory in the Past)
</td><td>4</td><td></td></tr>
<tr><th>Place</th><th colspan="2">Exterior Spaces</th></tr>
<tr><td rowspan="3">New Building 2
(Sports Hall in the Past)
</td><td>5</td><td></td></tr>
<tr><td>6</td><td></td></tr>
<tr><td>7</td><td></td></tr>
</table>

➢ Findings of observation in interior spaces

After observing users' environmental preferences and behavioral patterns in exterior spaces of the case study, with the same criteria such as pleasant place, place preference, and place suggestion, observations were made in interior spaces of the faculty buildings. Like the exterior spaces in analyzing spatial behaviors and preferences, field observation, sketching, drawing sections and cognitive-behavioral maps, and recording images of interior spaces have been used. Cognitive maps have been prepared at various times, and users' social behavior patterns have been reviewed on those maps. The reasons for and the objectives of presence in various places have been monitored, evaluated, and analyzed. Finally, the reasons for place preferences or not preferences, and the results have been shown according to the criteria.

Figure 5-2: Interior spaces preferred by students. 1: Old & Historical building [Preceptress School], 2: New building (studios & teachers' room), 3: New building (Sport hall & studios) (Author).

➢ Findings of observations in interior spaces of the historical building

The first area to be observed is the interior spaces of the old and historical building (Konya Preceptress School) is shown in the figure above with number 1., which includes classrooms, studios, dining hall, conference hall, management room, academic staff rooms, prayer room, official rooms, and some service rooms. The following figure shows the rate of users' approaches and preferences to the spaces mentioned above. Field observations were conducted in three different periods such as morning, noon, and evening. The densities of black dots represent the volume of referrals and approaches to the respective areas.

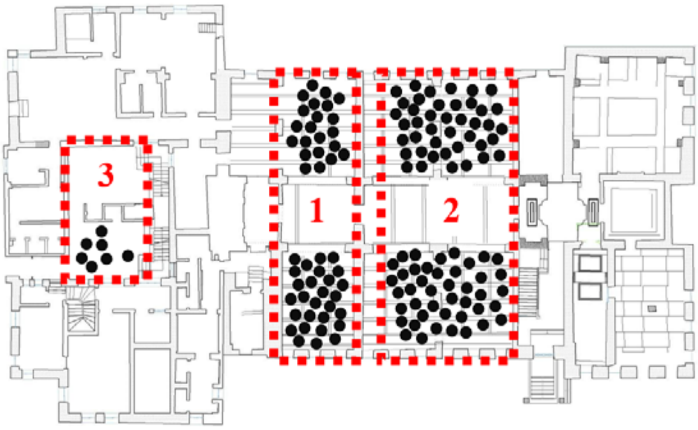


Figure 5-3: Interior spaces in the basement floor of the historical building preferred by students (Author).

In the present study as shown in the figure above, in relation to the dining hall which marked on the map with numbers 1 and 2, it was observed that using architectural qualities such as various materials (local stone, wood, etc.), natural and artificial lighting, warm colors, pure geometry, appropriate proportions, etc., have created a pleasant and intimate atmosphere so that users prefer to stay there, gap and sit for hours. Concerning points with number 3, it was observed that this place which is used as a west point entrance, nobody wanted to spend time there more than a few seconds due to the lack of spatial qualities such as defined path, using cold colors and loin materials. It seems that this place is a little scary and there is no sense of security.

The following figure is related to the observations of the ground floor. Number 4 is the backbone of the ground floor that studios have organized around it. So, the relevant hall involves a large number of visits and references during the day. Further, physical features of the hall such as appropriate dimensions, proportions, depth, height, geometry, rhythm, etc., also qualities like materials, wooden doors, flooring design, arches, etc. make the hall pleasant so that even during non-lesson hours, users prefer being in this place. The place marked with number 5 plays an important role as a joint in connecting three places such as the management room, dining hall, and second floor. Therefore, it is more preferred and involves a large number of visits and references during the day. The place marked with numbers 6 and 7 are related to the head of the architecture department room, urban design academic staff room, and the west point entrance. So, the relevant part of the faculty involves a large number of visits and references during the day, but records showed that these places were preferred just for administrative purposes and are not attractive in terms of quality and pleasantness.

Figure 5-4: Interior spaces in the ground floor of the historical building preferred by students (Author)

The following figure is related to the observations of the first floor. Number 8 is the backbone of the first floor that studios are arranged around it. So, the relevant hall involves a large number of visits and references during the day. Furthermore, appropriate physical features of the hall such as dimensions, proportions, depth, height, geometry, rhythm, etc., also qualities like materials, using wood in walls, doors, and ceiling, flooring design, etc. make the hall pleasant so that even during non-lesson hours, users prefer being in this place. The places marked with number 9 are two nice studios which were more preferred by students in terms of providing a good and natural view to outer landscape, natural lighting, geometry, proportion, and having pleasant interior design and architectural materials. In contrast, although places numbered 10 and 11 provide a good view of the backyard, they don't include a high-quality atmosphere in compared to other mentioned studios and are not more preferred by students. Number 12 is the seminar room which includes wooden architectural materials and makes an intimate space. This place is opened to users in especial academic programs.

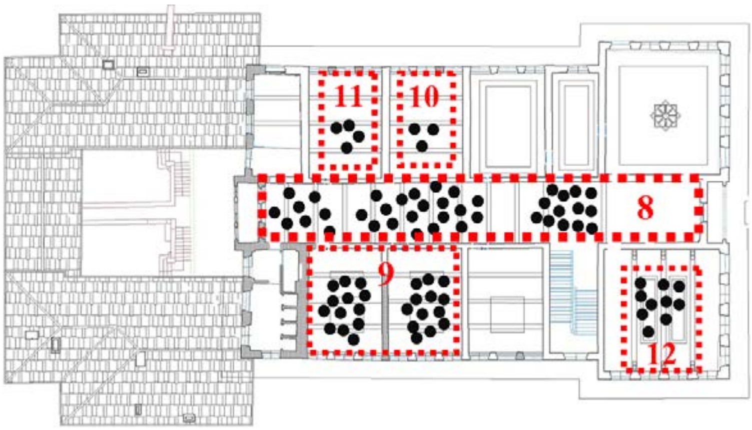
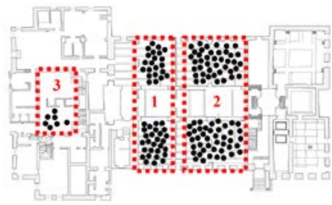
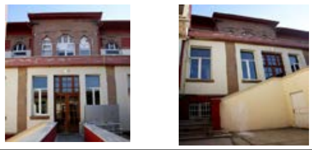
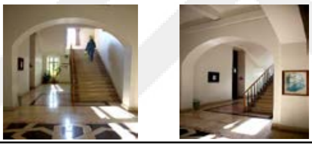
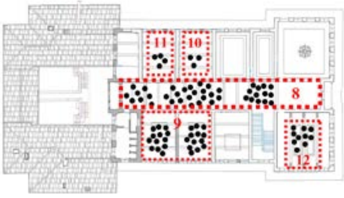
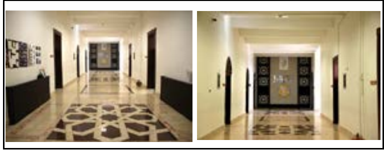
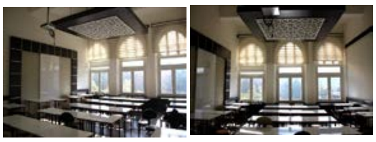


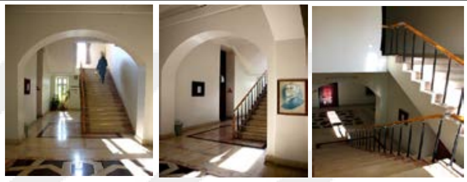
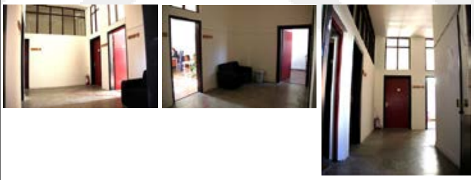
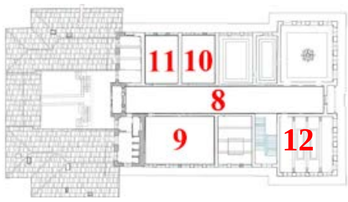
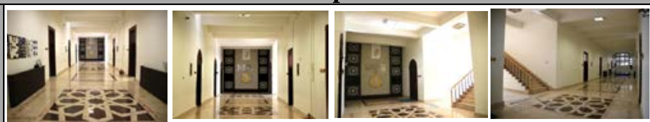
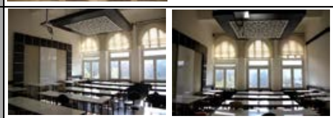
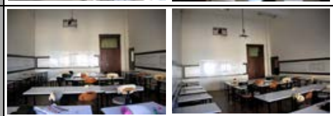
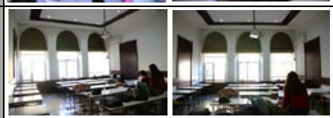
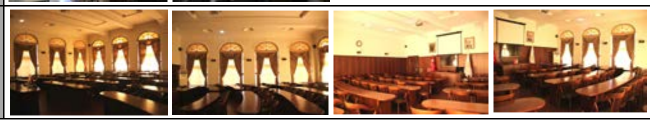
Figure 5-5: Interior spaces in the first floor of the historical building preferred by students (Author)

Table 5-3: Assessing the users' environmental preferences and pleasantness (Author)

<table>
<tr><th>Basement Floor of Old Building</th><th colspan="2">Abstract of Findings</th></tr>
<tr><td></td><td colspan="2">Using architectural qualities such as various materials (local stone and wood, etc.), natural and artificial lighting, warm colors, pure geometry, appropriate proportions, etc., have created a pleasant and intimate atmosphere so that users prefer to stay at there, gap and sit for hours. In contrast, the lack of spatial qualities such as defined path, using cold colors and loin materials make a place to be unpleasant.</td></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><th>Ground Floor of Old Building</th><th colspan="2">Abstract of Findings</th></tr>
<tr><td></td><td colspan="2">physical features of the hall such as appropriate dimensions, proportions, depth, height, geometry, rhythm, etc., also qualities like materials, wooden doors, flooring design, arches, etc. make a place pleasant and more preferred.</td></tr>
<tr><th>4</th><th>5</th><th>6   7</th></tr>
<tr><td></td><td></td><td> </td></tr>
<tr><th>First Floor of Old Building</th><th colspan="2">Abstract of Findings</th></tr>
<tr><td></td><td colspan="2">Places providing a good view, natural lighting, geometry, proportion, and pleasant interior design and architectural materials, are more preferred.</td></tr>
<tr><th>8</th><th>9</th><th>10   11</th></tr>
<tr><td></td><td></td><td> </td></tr>
</table>

In general, it is concluded that high-quality areas characterized by their distinctive and diverse elements in terms of shape, warm material, color, and lighting make intimate and pleasant places to use and preference. Based on the observation records to evaluate the place meaning in the next step (using Pleasure-Arousal Model), the more and less preferred interior spaces of the historical and old building of the faculty were categorized in the following table:

Table 5-4: Places provided to evaluate in Pleasure-Arousal Model (Author)

Historical Building		Interior Spaces
Basement Floor 	**1 2**	
	3	
Place		**Exterior Spaces**
Ground Floor 	**4**	
	5	
	6	
	7	
Place		**Exterior Spaces**
First Floor 	**8**	
	9	
	10	
	11	
	12	

➢ **Findings of observation in interior spaces of the new building**

The second area to be observed is the interior spaces of the new building which is shown in the figure 5-2 with number 2., including teachers' room and studios. The following figure shows the rate of users' approaches and preferences to the spaces mentioned above. Field observations were conducted in three different periods such as morning, noon, and evening. The densities of black dots represent the volume of referrals and approaches to the respective areas.

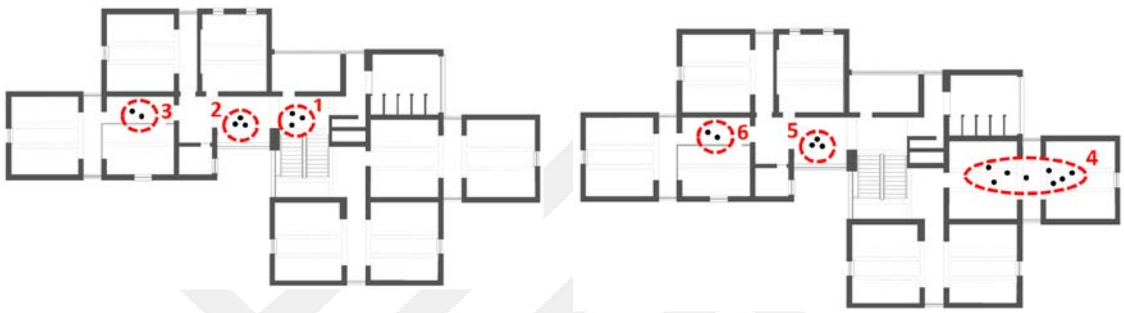


Figure 5-6: Interior spaces in the first & second floor of the new building preferred by students (Author)

As shown in the figure above, it was observed that the spaces of this building are usually vacant except for certain hours of the day such as meeting teachers or taking classes in studios, and no visitors use these places. Further, the relevant spaces do not have any quality in terms of using materials and architectural features (geometry, proportion, view, legibility). The lack of appropriate lighting in corridors, the use of cold colors in walls and cold materials in the flooring and stair railing, and because of the dark rooms make these places unpleasant and scary. Hence, the rate of preferences is very little during the day, and it was observed that the users tended to avoid the place.

Place numbered 4 is one of the studios that usually is vacant. This place is made by bulky concrete and rough beams that feels cold and scary. Also, the uniform color and geometry cause users to feel uneasy and uncomfortable. Although the places marked with numbers 2 and 5 provide light, view, and sitting area, they are not more preferred because of the use of unsuitable materials and geometry. Besides, number 3 and 6 are related to the teachers' rooms which located in a dark, scary and narrow corridor. The number 1 shows the staircase of the floors which is surrounded by hard and rough fences so that creates an unpleasant feeling.

Table 5-5: Assessing the users' environmental preferences and pleasantness (Author)

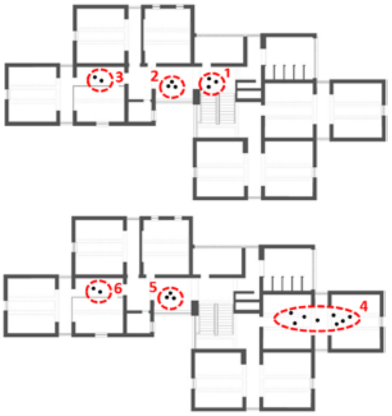
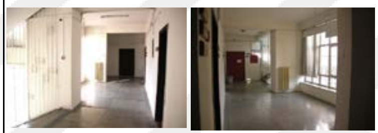
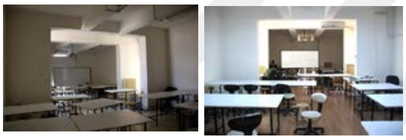
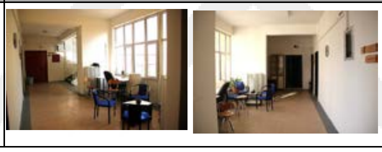
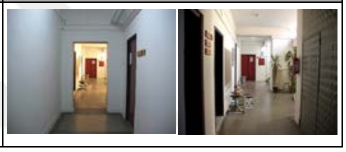
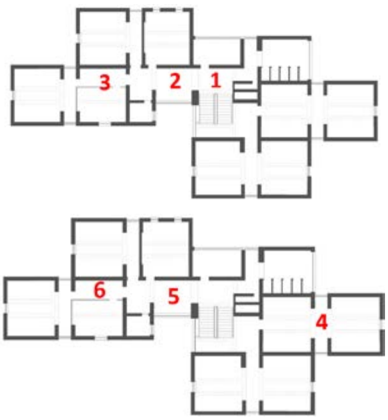
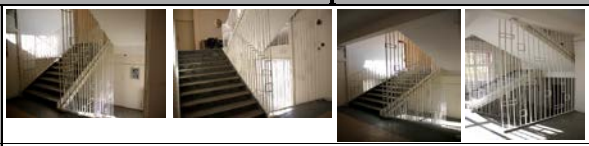
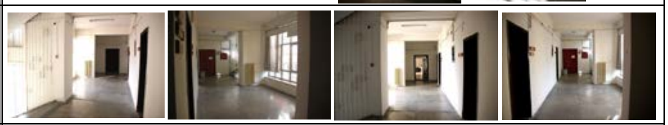
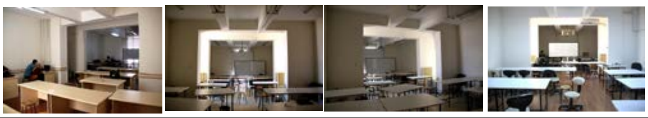
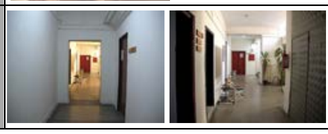
<table>
<tr><th>First and Second Floor of New Building</th><th colspan="2">Abstract of Findings</th></tr>
<tr><td></td><td colspan="2">These parts of the building do not have qualified elements such as dimension, various materials, plant, lighting, sitting areas, and do not provide pleasant places to approach or stay.
These places are not evaluated as pleasant and are not more preferred because of the lack of suitable access, defined architectural and spatial elements, view, lighting, architectural materials, sitting areas.</td></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><th>4</th><th>5</th><th>6</th></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Table 5-6: Assessing the users' environmental preferences and pleasantness (Author)

<table>
<tr><th>Historical Building</th><th colspan="2">Interior Spaces</th></tr>
<tr><td rowspan="5"></td><td>1</td><td></td></tr>
<tr><td>2
5</td><td></td></tr>
<tr><td>3</td><td></td></tr>
<tr><td>4</td><td></td></tr>
<tr><td>6</td><td></td></tr>
</table>

➢ Findings of observation in interior spaces of the sports hall building

The third area to be observed is the interior spaces of the sport hall building which is shown in the figure 5-2 with number 3., including two large studios. The following figure shows the rate of users' approaches and preferences to the spaces mentioned above. Field observations were conducted in three different periods such as morning, noon, and evening. The densities of black dots represent the volume of referrals and approaches to the respective areas.

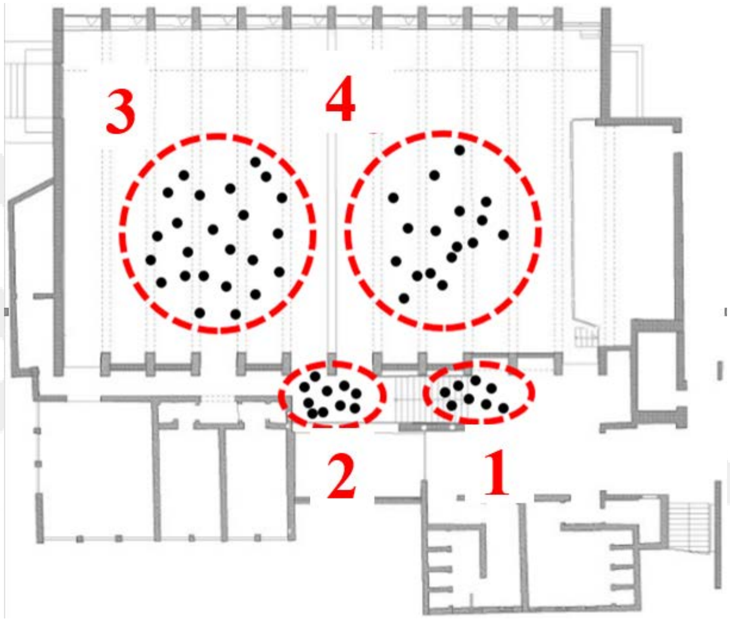
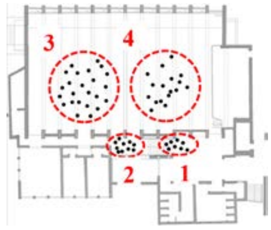


Figure 5-7: Interior spaces of the sport hall building preferred by students (Author)

As shown in the figure above, the place numbered 1 and 2 are the staircase and corridors which provide access between ground and mezzanine floors. Using concrete and stone as material, massive forms and walls, unsuitable lighting, narrow and dark corridors make this place unpleasant and scary. Users have to cross this path to go to the two very large studios numbered 3 and 4 which was used as sport hall in the past. The extreme largeness and proportions of these studios, using massive concrete columns and beams, unsuitable lighting, uncolored walls, sound echoes, and visibility make these places weird and somehow scary. Hence, relevant spaces were chosen to more investigate in terms of users' preferences, experiences and satisfaction.

Table 5-7: Assessing the users' environmental preferences and pleasantness (Author)

Sport Hall Building	Abstract of Findings	
	Using concrete and stone as material, massive forms and walls, unsuitable lighting, narrow and dark corridors make this place unpleasant and scary. The extreme largeness and proportions of these studios, using massive concrete columns and beams, unsuitable lighting, uncolored walls, sound echoes, and visibility make these places weird and somehow scary.	
1	**2**	**3 4**
 	 	 

The following table shows places which were selected for further study in related to the users' emotional evaluation of place based on more reviews and numerous references and observations in the relevant building.

Table 5-8: Assessing the users' environmental preferences and pleasantness (Author)

Sport Hall Building	Interior Spaces	
	**1**	 
	2	 
	3 **4**	   

In general, the results of observation showed that:

Due to its historical background, using local materials, providing diverse perspectives, access network, public spaces, and using trees and shrubs in defining spaces, the historical building (Konya Preceptress School) of the faculty has been effective in enhancing the quality of the environment and user satisfaction. Paying attention to criteria of sociability, legibility, view, landscape, accessibility, and permeability enables the discovery of environments, making meaningful interaction with the environment, enjoyable and exciting activities, also it provides mental restoration and has a significant impact on users' spatial preferences and satisfaction. Furthermore, using suitable geometry, spatial qualities (landscape, sitting areas, material, etc.), and definition of appropriate physical structures result in a sense of desirability, pleasantness as well as a simple and correct understanding of the environment and make the place sociable. Therefore, by recognizing the environmental qualities, one can encourage the collaborative and interactive behaviors of the users together and with the environment. Hence, environmental design patterns can be reinforced to satisfy individuals' preferences.

5.2. Findings of Interview and Open Questionnaire

After identifying spatial preferences and indicator elements of the case study, to extract the mechanism of perceiving place meaning from the perspective of users, the "thinking content" as well as "thinking method" concerning the environment was evaluated. In this regard, to ensure the reliability of the estimates made in the observation step and to know how users perceive the meaning of place, firstly, exposing places' pictures obtained from the observation step, the users' mental image was assessed with interviews. Indeed, the interview was a way to evaluate the users' method of thinking from their answers to questions asked in Table 4-2. Subsequently, to investigate the influence and contribution of each qualitative component of the place obtained from the interview results on the emotional experience of the users, the Pleasure-Arousal model was used as an open questionnaire. Indeed, filling such a questionnaire was a way to evaluate the users'-mind.

The results of the questionnaire from the interview represent criteria that are very important to users and have a significant impact on their perception, emotional experience, and understanding of the architectural place. In addition to exploring factors affecting perception and experience of place, the interview also sought to examine the characteristics of a pleasant place from the users' point of view. In the interviews with users on "Whether the building reminds you of an old/new memory or experience?", keywords most users mentioned in related to the three building of faculty are: *memory*, *historical identity*, *security*, *beauty*, *order*, *diversity*, *compatibility with mental schema*, and *durability*. Answers to this question "Does the design of the hall appeal to you?" has keywords such as *lighting*, *vitality*, *color*, *security*, *material*, *scary*. Answers to these questions “Is the design of this building suitable for a scientific environment?” and “Are the plan and geometry of this building well designed for an educational space?”, have keywords such as *color*, *variety*, *lighting*, *geometry*, *proportion*, *façade*, and *rhythm*. Answers to these questions “Do you feel secure in this place?” and “Are the dimensions of spaces and the height of the ceiling appropriate?”, have keywords such as *lighting*, *height*, *proportion*, and *material*. Answers to this question “Are you satisfied with the furniture and the symbols used?”, has keywords such as *satisfaction*, *security*, *material*, *texture*, and *color*.

According to the results and based on keywords, users’ points of view about the factors of place meaning can be categorized into four groups of sensory, morphological (perceptual), and individual factors (cognitive and behavioral). The content of the following table represents the dimensions and indicators that are effective in shaping the meaning of place from the users’ point of view.

Table 5-9: Dimensions and attributes that shape the meaning of place from users’ point of view.

Historical Building	New Building	Sports Hall Building
		

Analysis Basis		Interview Quotes and Keywords	Analysis Criteria
Sensory Factor		* The historical building spaces are felt warm, intimate, and secure in terms of providing light, color, materials, and vitality. Whereas, other buildings are scary, boring and dark because of using glassy and inanimate colors, materials, and furniture.	* Color * Light * Texture * Material * Vitality
Morphological Factor (Perceptual)		* In the historical building dimensions, geometry, and aspect ratio is appropriate, but sports hall building is uniform and in terms of largeness, width, and height is so huge and makes the senses of fear, heaviness. I desire to leave such a place.	* Volume & facade * Geometry * Proportion * Scale * Rhythm
Individual Factor	Cognitive Factor	* I like the historical building because it reminds me of the architecture of the Early years of the Republic of Turkey. * Since the historical building was used as a school in the past, for us as students of architecture, it is very meaningful in terms of architectural and functional features, but other buildings are only functional and do not involve architectural qualities in terms of color, variety, brightness, etc.	* Memory * Identity * Compatibility with mental schema
	Behavioral Factor	* The new building and sports hall buildings are unpleasant due to the lack of spatial qualities and largeness. I am not satisfied and I do not feel secure. I would like to avoid these buildings.	* Security * Satisfaction

In general, it can be concluded that the historical identity, paying attention to the using of architectural qualities in design process (proportion, geometry, color, material, etc.), providing landscape, good views with greenery, security, lighting as well as appropriate access, holding ceremonies in the front and side yard of the school building and spatial diversity of the old building have played a very important role in the vitality, attraction, interaction, preferences, pleasant assessment, and satisfaction of users. In contrast, in relate to the new buildings (teachers' rooms and sports hall building), it should be mentioned that the lack of spatial organization, using architectural and physical qualities in design, and landscape make them be unpleasant places, hence users are not satisfied with them even they desire to avoid and do not prefer to use the spaces.

The interviews indicated that users generally expressed their feelings about the faculty spaces in three ways. The first group was more concerned with expressing their personal feelings, which came from individuals' intellectual and psychological backgrounds. These feelings were sometimes positive (secure, calm, vitality, exciting, etc.) and sometimes negative (fear, stress, hatred, etc.). An abundance survey showed that the majority of users engage their personal emotions in their way of thinking about space. "I like this building. Its spaces are intimate, secure, calm, colorful, and I feel happy to stay in it as well as I would like to spend time in this building to study, to chat and to work". In explaining how the faculty spaces were, the second group compared their faculty with other faculties and similar places. In this comparison, the behaviors, functions, and meanings of space were compared with similar examples of the space they had in mind or experienced before, and the meaning they presented from the place was based on the degree of similarity or dissimilarity of their mental schema. Other users had a comparative view of their way of thinking about space. "Many of the schools of architecture I have visited so far have no space for leisure time, chatting, social interaction, and respond to just functional-physical needs which make them feel tired. However, my faculty historical building was used as a school in the past, and for me as a student of architecture, it is very meaningful in terms of providing architectural and functional features, landscape, views, materials used and spatial qualities, etc.". The third group was those who expertly critiqued the physical and perceptual aspects of the buildings and were most influenced by the spatial quality, spatial preferences, and spatial behaviors. "In the historical building dimensions, geometry, and aspect ratio is appropriate, but sports hall building is uniform and in terms of largeness, width, and height is huge and cause feelings like fear or depressing. I desire to leave such a place.".

After summarizing the data, some items were formulated and each of these items was given under the relevant dimension. Relevant literature was also consulted to add to the dependability and increase the richness of the sub-dimensions contributing to the formation of meaning. To accomplish this, different studies were reviewed. In a similar vein, the studies carried out by Sixmith (1986) and Gustafson (2001) which they tried to work out some of the effective sub-dimensions in the formation of the meaning of place were significant. Specifically, all the factors studied in those studies were added to the ones determined through the interview, as seen in the following table. In this table, the dimensions and sub-dimensions contributing to the formation of place meaning are given. These will be used later as the theoretical framework of the study when it comes to constructing the questionnaire and in the analysis of the data. After collecting the data, statistical analysis was used in both descriptive and inferential levels. To assess the contribution of each of the parameters obtained from the interviews to affective evaluation, we made use of the Chi-2 Test[18] in the inferential level. During this process, the cases which were not meaningfully related to the formation of feelings and different meanings were deleted. Following that, to prioritize the remaining factors, we utilized descriptive statistics. In order to prioritize the responses, the percentage of the frequency of responses was considered as the basis for classification.

Table 5-10. Dimensions forming the meaning of place derived from the interview (Author)

Dimension / Sub-Dimension		Historical Building	New Building	Sports Hall Building	Total
Sensory Factor	Color	4.20	4.11	4.00	4.10
	Light	3.11	3.22	2.66	3.00
	Texture	**4.66**	3.66	4.00	4.11
	Material	4.51	4.33	3.77	**4.20**
	Vitality	2.66	2.70	2.11	2.49
Morphological Factor (Perceptional)	Volume & facade	**4.62**	4.12	4.33	**4.36**
	Geometry	4.33	4.00	4.11	4.15
	Proportion & Scale	4.12	3.99	**4.62**	4.24
	Rhythm	4.55	3.66	3.99	4.20
Individual Factor: Cognitive Factor	Compatibility with mental schema	1.66	1.99	1.33	1.66
	Memorability	2.20	1.11	1.44	1.58
Individual Factor: Behavioral Factor	Satisfaction	1.15	1.44	1.77	1.45

[18] The Chi-square test is intended to test how likely it is that an observed distribution is due to chance. It is also called a “goodness of fit” statistic because it measures how well the observed distribution of data fits with the distribution that is expected if the variables are independent.

As shown in the Table 5-10, both in the historical building and in the new buildings, of the sensory factors, material (M=4.20), texture (M=4.11), and color (4.10) affected users' emotions the most, and of the morphological (perceptual) factors, volume and facade (M=4.36), proportion and scale (M=4.24), rhythm (4.20) and geometry (4.15) affected users' emotions the most. Further, of the individual factors, security (M=4.38) affected users' emotions the most. As can be seen in the following diagram, according to users, the factors of material, color, texture, and security are the most influential factors in the formation of the meaning of place and subsequently are the most effective factors of emotional evaluation (Pleasure-Arousal model) in determining the pleasant or unpleasant environment. Furthermore, texture (M=4.66) affected users' emotions the most in the historical building. It can be said that by using local materials, colors, and landscapes, etc. it helps to make the relevant building pleasant and intimate so that interviewers ask the most effective sub-dimensions which cause that building to be desirable. Volume & facade and proportion & scale (M=4.62) affected users' emotions the concerning both historical building and sports hall building. The results and keywords evoked from the interviews confirm such a claim. Security (M=4.91) affected users' emotion the most in the new building (teachers' rooms) so that users mentioned in the interview that the dark corridors and loins walls make the relevant building appears to be scary and not secure. It is possible to say that during their university days, or during their professional career, users acquire a set of principles and standards to provide a critique of different spaces using these principles. What is of significance in the current study is that it points out whether such standards exist or not for users.

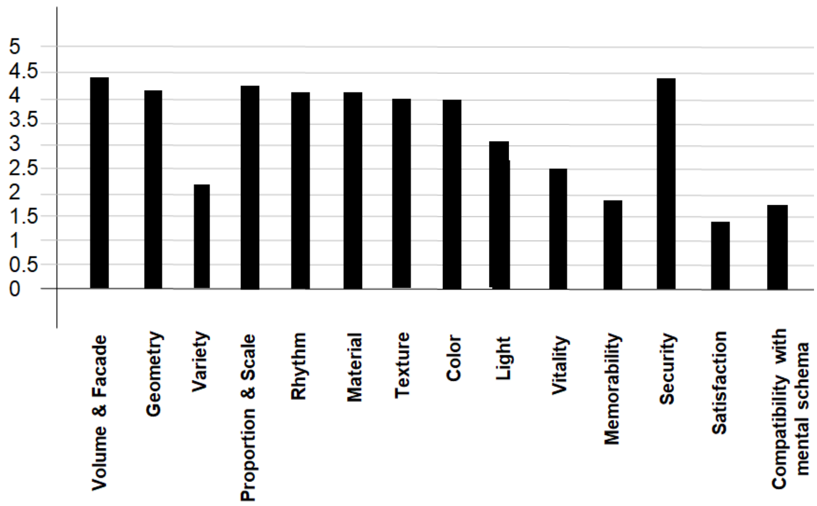


Diagram 5-2: Qualitative factors affecting emotional evaluation (Author)

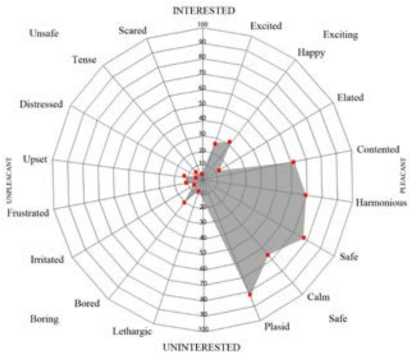
Consequently, answering the question “Which dimensions of the meaning of place are more significant for users?”, it was found that more significant factors forming the meaning of place from the users’ point of view can be categorized into three sensory, morphological, and individual (cognitive & behavioral) dimensions. Furthermore, in answer to this question “What is the mode of thinking of users during the interpretation of a place?” the interview results showed that users perceive place in three modes: The first category is emotional thinking. In this way, the meanings that people perceive from one place are derived from personal emotions that are influenced by their intellectual and psychological backgrounds. The second category is empirical thinking in which place meanings are derived from experiences and events that have already happened to them in that or similar places. The third category is relativistic thinking, in which the meanings of a place are evaluated and indicated by comparing with similar samples.

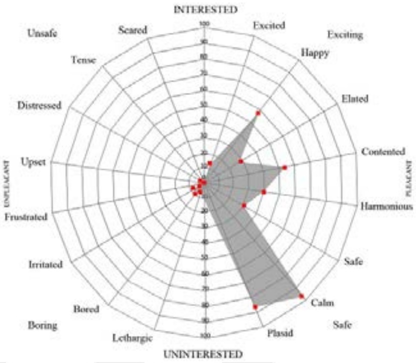
In terms of analyzing the content of thinking and evaluate the contribution of each qualitative components obtained from the first interview results (Table 5-10) in the emotional assessment of place as well as place meaning, Pleasant-Arousal model was distributed among users as a questionnaire and users were asked to indicate effective factors in environmental experience for each image based on Table 5-10. Tables 5-11 to 5-13 show differences in comparative results of the Pleasure-Arousal model in both historical and new buildings belong to the Faculty of Architecture at Selçuk University of Konya. Accordingly, historical building’s spaces have been assessed as *pleasant*, *exciting*, *placid*, *harmonic* and *safe*. In contrast, new buildings’ spaces have been assessed as *unpleasant*, *boring*, *irritating*, *frustrating*, *unsafe* and *upsetting*. It should be noted that along with the emotional assessment, the qualitative factors affecting this assessment, such as the factors listed in Table 5-10, and the importance of each, are mentioned by interviewees.

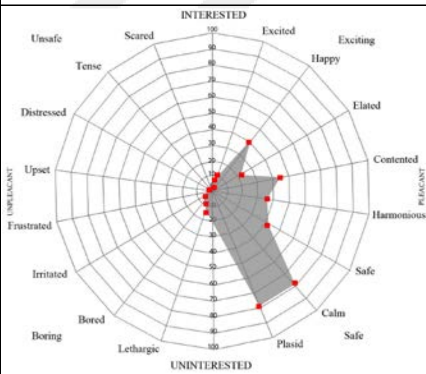
A comparative and interactive analysis between the three groups including morphological factor ($F(3, 246) = 3.82$, $p=0.01<0.05$), sensory factor ($F(3,246)=3.51$, $p=0.04<0.05$), individual factor ($F(3,246)= 2.27$, $p=0.030<0.05$) and the results of the Pleasure-Arousal model shows a meaningful relation. It means the affective attitude of students towards a different style of design and building is quite meaningful. Table 5-2 to 5-17 show differences and similarities in the comparative results of assessing the emotional-perceptional experience of place by the Pleasure-Arousal model for the exterior and interior places of the three buildings of the same faculty.

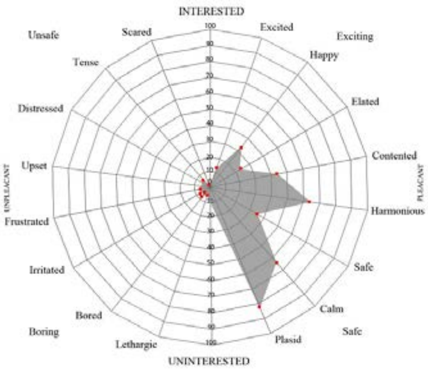
Table 5-11: The result of Pleasant-Arousal diagram of the exterior places of the Historical Building

<table>
<tr><th>Evaluated Place</th><th colspan="2">Average of The Places According to Pleasure-Arousal Diagram from The Users Point of View</th><th>Qualitative Factors Affecting the Emotional Evaluation</th></tr>
<tr><td>1

</td><td>
</td><td>Excited: 27.5
Happy: 31
Elated: 12.5
Contented: 62
Harmonious:70
Safe: 79
Calm: 66
Placid: 82.5
Lethargic: 8.6
Bored: 23
Irritated: 5.5
Frustrated: 11
Upset: 12
Distressed: 3.7
Tense: 8.4
Scared: 0.5</td><td>Volume
Proportion &
Scale
Rhythm
Geometry
Material
Color
Compatibility
with
mental schema
Memorability
Security</td></tr>
<tr><td>2

</td><td>
</td><td>Excited: 13
Happy: 58
Elated: 28
Contented: 55
Harmonious:40
Safe: 30
Calm: 99
Placid: 40
Lethargic: 5.9
Bored: 10
Irritated: 8
Frustrated: 2
Upset: 3.2
Distressed: 1
Tense: 1.5
Scared: 0</td><td>Material
Color
Texture
Variety
Memorability
Security</td></tr>
<tr><td>3

</td><td>
</td><td>Excited: 8.5
Happy: 41
Elated: 21.5
Contented: 45
Harmonious:37
Safe: 41
Calm: 79
Placid: 36
Lethargic: 6.25
Bored: 4.15
Irritated: 4.78
Frustrated: 3
Upset: 3
Distressed: 3
Tense: 7
Scared: 1</td><td>Volume
Proportion &
Scale
Rhythm
Material
Color
Texture
Variety
Memorability
Security</td></tr>
<tr><td>4

</td><td>
</td><td>Excited: 10.8
Happy: 15.3
Elated: 9.8
Contented:15
Harmonious:20
Safe: 20.7
Calm: 30.5
Placid: 26.1
Lethargic: 5.7
Bored: 3.2
Irritated: 5.6
Frustrated:3.43
Upset: 2.48
Distressed: 0.8
Tense: 5
Scared: 0.5</td><td>Material
Color
Compatibility
with
mental schema
Memorability
Security</td></tr>
</table>

According to the findings presented in Table 5-11, the all exterior spaces of the historical building (Preceptress School of Konya) numbered 1 to 4, were assessed as pleasant by users. By integrating the quantitative results of all four mentioned spaces, the mean data showed that the first quarter of the circle in the clockwise direction, which is associated with high arousal and represents the high activated exciting factor of pleasure, the relevant places were assessed as *contented* (M=44.5), and in the second quarter of the low activated safe factor of pleasure, they assessed as *calm* places (M=68.5). In general, the spaces of this building were assessed as **safe** (low arousal) with an average score of 49.80 compared to 28.5 rated for exciting (high arousal). Moreover, the data average of evaluating qualitative factors affecting the emotional experience of exterior places from the users' point of view showed that the color, texture, material, memorability, and security were most rated and made the historical building pleasant. This indicates that based on results obtained from interviews, the relevant building in terms of qualitative factors like material, color, texture, memorability, and security affects the emotional experience of users, and mostly represents adjectives such as placid, calm, safe, and harmonious compared to adjectives such as excited, happy, elated, and contented.

Table 5-12: The mean data of Pleasant-Arousal diagram of the pleasant exterior places of the Historical Building

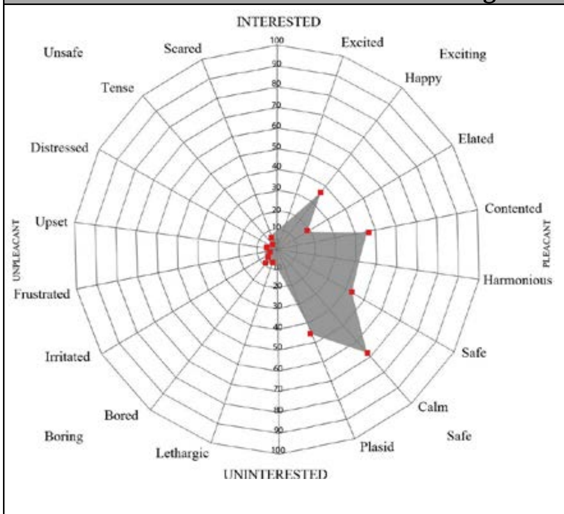
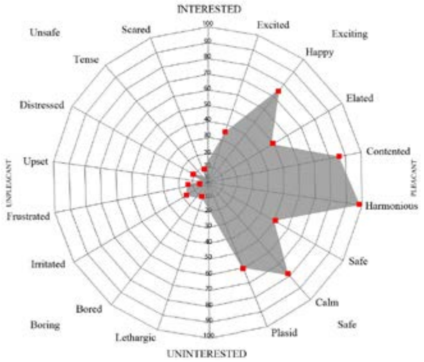
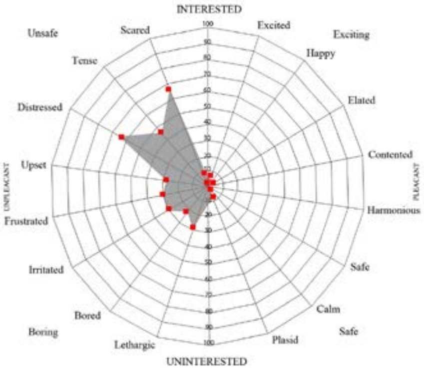
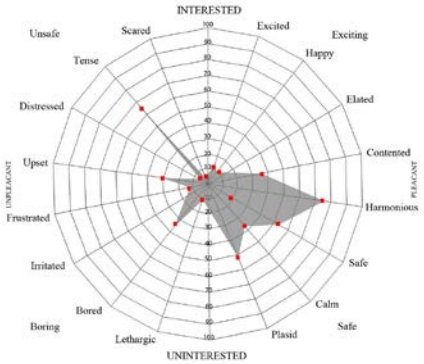
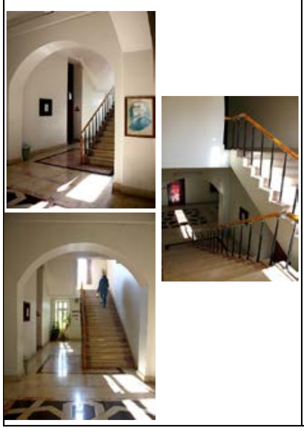
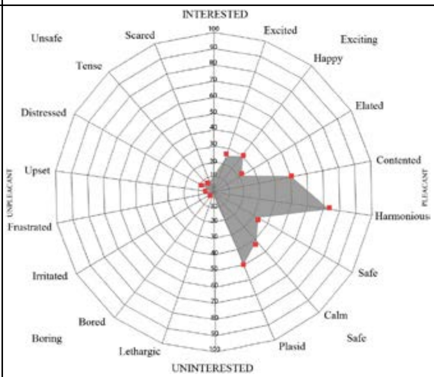
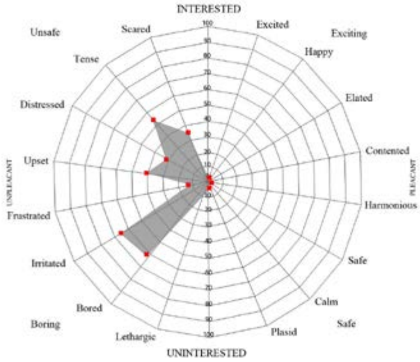
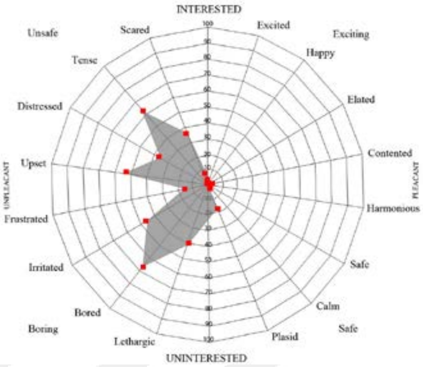
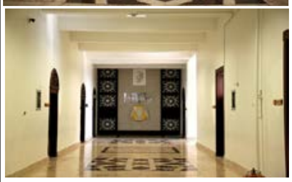
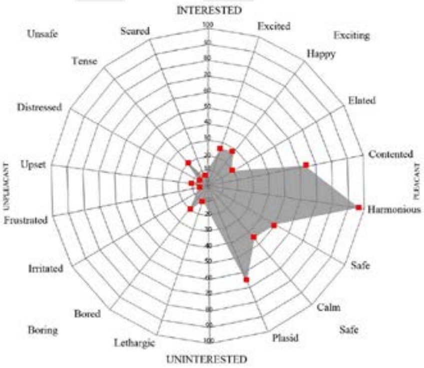
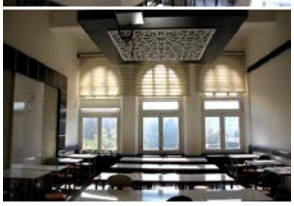
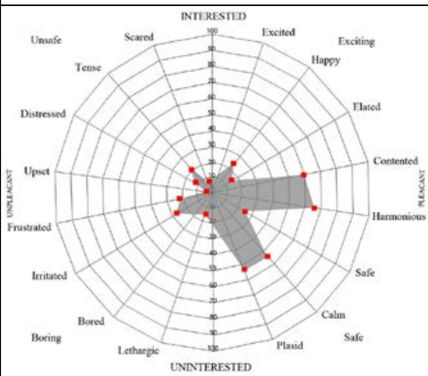
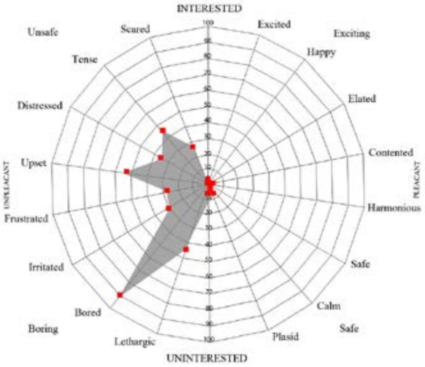
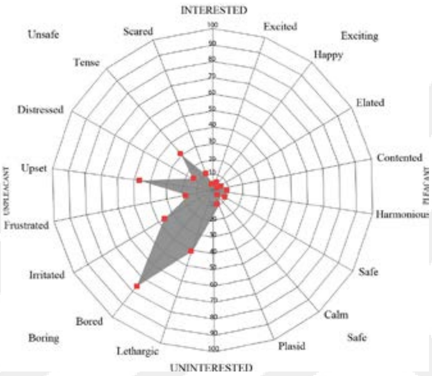
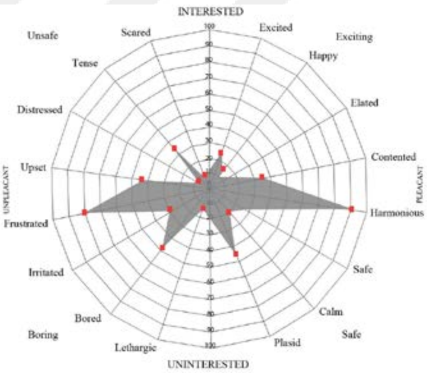
The Mean Data of Pleasure-Arousal Diagram	Criterion		Mood	
	**High Arousal**	**Exciting:** 28.5	**Excited**	15
			Happy	36.5
			Elated	18
			Contented	**44.5**
	Low Arousal	**Safe:** **49.80**	**Harmonious**	42
			Safe	43
			Calm	**68.5**
			Placid	46
	Low Arousal	**Boring:** 6.88	**Lethargic**	6.5
			Bored	10
			Irritated	6
			Frustrated	4.9
	High Arousal	**Unsafe:** 4.15	**Upset**	5
			Distressed	2
			Tense	8.85
			Scared	0.5

Table 5-13: The result of Pleasant-Arousal diagram of the interior places of the Historical Building

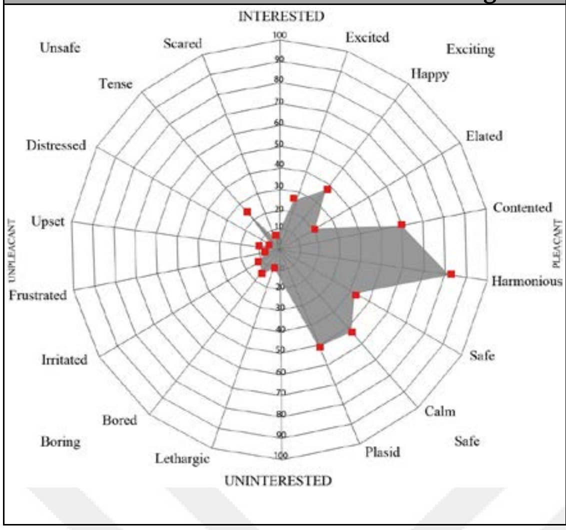
Evaluated Place	Average of The Places According to Pleasure-Arousal Diagram from The Users Point of View		Qualitative Factors Affecting the Emotional Evaluation
1 	 	**Excited:** 34 **Happy:** 77 **Elated:** 48 **Contented:** 86 **Harmonious:**99 **Safe:** 50 **Calm:** 79 **Placid:** 60 **Lethargic:** 12.5 **Bored:** 9 **Irritated:** 16.6 **Frustrated:** 5 **Upset:** 60.3 **Distressed:** 1.5 **Tense:** 0 **Scared:** 5	Proportion and Scale Rhythm Geometry Material Texture Color Light Sense of place Satisfaction Memorability Security
2 	 	**Excited:** 2.5 **Happy:** 3.3 **Elated:** 4 **Contented:** 9 **Harmonious:** 5 **Safe:** 5.65 **Calm:** 4.56 **Placid:** 10 **Lethargic:** 30 **Bored:** 22.30 **Irritated:** 68 **Frustrated:** 30 **Upset:** 28 **Distressed:** 65 **Tense:** 45 **Scared:** 66	Proportion and Scale Rhythm Geometry Material Texture Color Light Security
3 	 	**Excited:** 28 **Happy:** 23 **Elated:** 16.5 **Contented:** 37 **Harmonious:**76 **Safe:** 54 **Calm:** 36.6 **Placid:** 23.5 **Lethargic:** 11 **Bored:** 37 **Irritated:** 16 **Frustrated:** 11 **Upset:** 31 **Distressed:** 5.5 **Tense:** 65 **Scared:** 3.65	Proportion and Scale Rhythm Geometry Material Texture Color Light Memorability Security
4 	 	**Excited:** 25 **Happy:** 28.6 **Elated:** 11 **Contented:** 50.3 **Harmonious:**72 **Safe:** 31 **Calm:** 40 **Placid:** 47.45 **Lethargic:** 7.87 **Bored:** 2 **Irritated:** 3.5 **Frustrated:** 3.8 **Upset:** 8.4 **Distressed:** 2.25 **Tense:** 8.47 **Scared:** 2.9	Material Texture Color Light Memorability Security

Evaluated Place	Average of The Places According to Pleasure-Arousal Diagram from The Users Point of View		Qualitative Factors Affecting the Emotional Evaluation
5  		**Excited:** 3 **Happy:** 0 **Elated:** 0 **Contented:** 0 **Harmonious:**3 **Safe:** 0 **Calm:** 2 **Placid:** 6 **Lethargic:** 30 **Bored:** 65 **Irritated:** 66 **Frustrated:** 12 **Upset:** 40 **Distressed:** 31 **Tense:** 53 **Scared:** 34	Proportion and Scale Geometry Material Texture Color Light Security
6  		**Excited:** 0 **Happy:** 0 **Elated:** 0 **Contented:** 0 **Harmonious:**0 **Safe:** 0 **Calm:** 0 **Placid:** 17 **Lethargic:** 41 **Bored:** 69 **Irritated:** 44 **Frustrated:** 16 **Upset:** 53 **Distressed:** 35 **Tense:** 63 **Scared:** 35	Proportion and Scale Geometry Material Texture Color Light Security
7  		**Excited:** 26 **Happy:** 28 **Elated:** 18 **Contented:** 62 **Harmonious:**98 **Safe:** 50 **Calm:** 47 **Placid:** 67 **Lethargic:** 10 **Bored:** 22 **Irritated:** 9 **Frustrated:** 3.5 **Upset:** 13.5 **Distressed:** 5.5 **Tense:** 26 **Scared:** 5	Proportion and Scale Rhythm Geometry Material Texture Color Light Memorability Security
8  		**Excited:** 12.8 **Happy:** 25 **Elated:** 14 **Contented:** 60 **Harmonious:**67 **Safe:** 25 **Calm:** 52 **Placid:** 52 **Lethargic:** 17 **Bored:** 19 **Irritated:** 21 **Frustrated:** 20 **Upset:** 2 **Distressed:** 4.5 **Tense:** 22 **Scared:** 8	Proportion and Scale Rhythm Geometry Material Texture Color Light Security

Evaluated Place	Average of The Places According to Pleasure-Arousal Diagram from The Users Point of View		Qualitative Factors Affecting the Emotional Evaluation
9 		**Excited:** 6 **Happy:** 2 **Elated:** 2 **Contented:** 3 **Harmonious:**3 **Safe:** 5 **Calm:** 4.8 **Placid:** 10 **Lethargic:** 44 **Bored:** 91 **Irritated:** 30 **Frustrated:** 28 **Upset:** 55 **Distressed:** 34 **Tense:** 44 **Scared:** 27	Proportion and Scale Material Texture Color Light Security
10 		**Excited:** 4 **Happy:** 2 **Elated:** 3 **Contented:** 2.5 **Harmonious:**10 **Safe:** 7 **Calm:** 8 **Placid:** 10 **Lethargic:** 37 **Bored:** 75 **Irritated:** 35 **Frustrated:** 15 **Upset:** 45 **Distressed:** 15 **Tense:** 30 **Scared:** 10	Proportion and Scale Material Color Security
11 		**Excited:** 26 **Happy:** 15 **Elated:** 10 **Contented:** 35 **Harmonious:**92 **Safe:** 28 **Calm:** 20 **Placid:** 47 **Lethargic:** 15 **Bored:** 47 **Irritated:** 30 **Frustrated:** 80 **Upset:** 45 **Distressed:** 10 **Tense:** 35 **Scared:** 7	Proportion and Scale Rhythm Geometry Material Texture Color Light Security

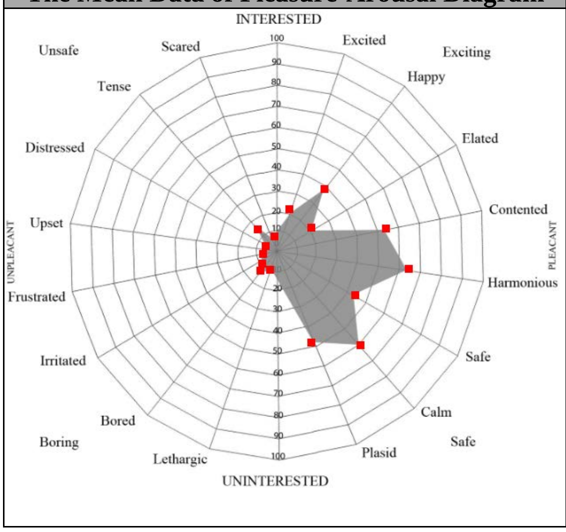
As shown in table 5-13 the interior spaces of the historical building were classified into two pleasant (numbered 1,3,4,7,8) and unpleasant (numbered 2,5,6,9,10) groups. The space numbered 11 was assessed as neutral, then it is not chosen for fMRI examination. According to data presented at table 5-14, for the interior spaces of the old building, the high activated pleasant factor (exciting), is assessed as a *contented* place (M=59), and of the low activated pleasant factor (safe), is assessed as a harmonic place (M=82.5). In this context, according to users' ideas, factors such as proportion and scale, rhythm, geometry, material, texture, color, light, satisfaction, memorability, and security have made the relevant spaces pleasant and **safe** (M=56.3).

Table 5-14: The mean data of Pleasant-Arousal diagram of the pleasant interior places of the Historical Building

The Mean Data of Pleasure-Arousal Diagram	Criterion		Mood	
	**High Arousal**	**Exciting:** 35.5	**Excited**	25.2
			Happy	36.3
			Elated	21.5
			Contented	**59**
	Low Arousal	**Safe:** **56.3**	**Harmonious**	**82.5**
			Safe	42
			Calm	51
			Placid	50
	Low Arousal	**Boring:** 12.8	**Lethargic**	11.7
			Bored	17.8
			Irritated	13.2
			Frustrated	8.7
	High Arousal	**Unsafe:** 11	**Upset**	10.5
			Distressed	3.9
			Tense	25
			Scared	4.9

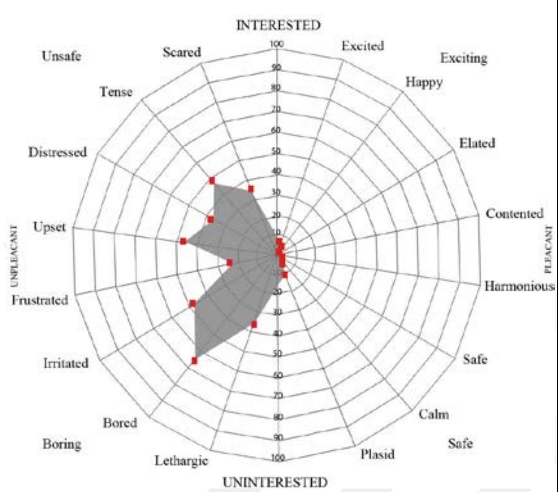
Accordingly, the average data of the all pleasant spaces (interior + exterior spaces) of the old building as shown in the following table, present that the adjectives of *harmonious* (M=62) with low arousal and *contented* (M=52) with high arousal play the significant role in inducing pleasant feeling, and high scored adjectives such as harmonious, safe, calm, and placid make it a **safe** place (M=53).

Table 5-15: The mean data of Pleasant-Arousal diagram of the all pleasant (interior+exterior) places of the Historical Building

The Mean Data of Pleasure-Arousal Diagram	Criterion		Mood	
	**High Arousal**	**Exciting:** 32	**Excited**	20
			Happy	36.5
			Elated	20
			Contented	**52**
	Low Arousal	**Safe:** **53**	**Harmonious**	**62**
			Safe	42.5
			Calm	60
			Placid	48
	Low Arousal	**Boring:** 9.85	**Lethargic**	9
			Bored	14
			Irritated	9.5
			Frustrated	6.5
	High Arousal	**Unsafe:** 7.75	**Upset**	8
			Distressed	3
			Tense	16.5
			Scared	2.7

As shown in table 5-16, related to the low activated unpleasant factor (boring), the relevant spaces were assessed as *bored* (M=64.5) as well as related to high activated unpleasant factor (unsafe), they were assessed as *tense* (M=47). Indeed, high scored adjectives such as lethargic, bored, irritated, and frustrated (M=42.3) with low arousal play a significant role in inducing unpleasant feelings and make them **boring** places.

Table 5-16: The mean data of Pleasant-Arousal diagram of the all unpleasant places of the Historical Building

The Mean Data of Pleasure-Arousal Diagram	Criterion		Mood	
	**High Arousal**	**Exciting:** 2.30	**Excited**	3.1
			Happy	1.5
			Elated	1.8
			Contented	2.9
	Low Arousal	**Safe:** 5.5	**Harmonious**	4.2
			Safe	3.5
			Calm	3.9
			Placid	10.6
	Low Arousal	**Boring:** **42.3**	**Lethargic**	36.5
			Bored	**64.5**
			Irritated	48
			Frustrated	20
	High Arousal	**Unsafe:** 40.4	**Upset**	44.2
			Distressed	36
			Tense	**47**
			Scared	34.5

As shown in the following tables (5-17 to 5-21), both the exterior and interior spaces of the new building including teachers' rooms and studios were assessed as unpleasant. In this regard, related to exterior spaces, of the low activated unpleasant factor (boring), they were assessed as *bored* (M=70), and of the high activated unpleasant factor (unsafe), they were assessed as *scared* (M=89.5). Indeed, high scored adjectives such as upset, distressed, tense, and scared (M=65) with high arousal play a significant role in inducing unpleasant feelings and make them **unsafe** places. Besides, according to data obtained from the interview, users filling the questionnaire (Pleasure-Arousal) mentioned the effects of factors such as volume and facade, geometry, proportion and scale, material, color, light, texture, vitality, and security on making the new building as unpleasant place. Related to interior spaces, of the low activated unpleasant factor (boring), they were assessed as *irritated* (M=69), and of the high activated unpleasant factor (unsafe), they were assessed as *tense* (M=73). Indeed, high scored adjectives such as upset, distressed, tense, and scared (M=62.5) with high arousal play a significant role in inducing unpleasant feelings and make them **unsafe** places. Besides, factors such as material, color, light, texture, and security make the new building unpleasant.

Table 5-17: The result of Pleasant-Arousal diagram of the exterior places of the New Building

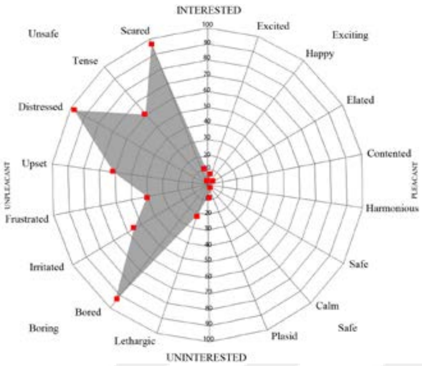
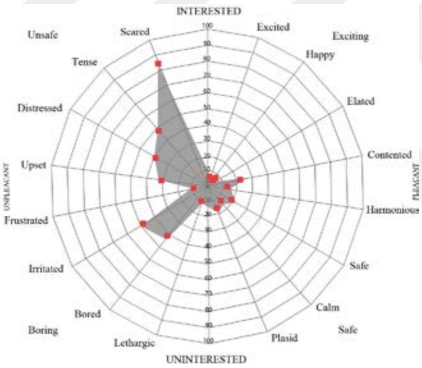
Evaluated Place	Average of The Places According to Pleasure-Arousal Diagram from The Users Point of View		Qualitative Factors Affecting the Emotional Evaluation
 		**Excited:** 0 **Happy:** 0 **Elated:** 0 **Contented:** 0 **Harmonious:** 0 **Safe:** 1.5 **Calm:** 1.5 **Placid:** 5 **Lethargic:** 23 **Bored:** 95 **Irritated:** 55 **Frustrated:** 40 **Upset:** 61 **Distressed:** 100 **Tense:** 60 **Scared:** 96.8	Volume and façade Geometry Proportion and Scale Rhythm Material Color Texture Security
 		**Excited:** 5.5 **Happy:** 7.5 **Elated:** 8.43 **Contented:** 26 **Harmonious:** 16 **Safe:** 20.85 **Calm:** 16.5 **Placid:** 20 **Lethargic:** 13.2 **Bored:** 44 **Irritated:** 50 **Frustrated:** 10 **Upset:** 32 **Distressed:** 40 **Tense:** 48 **Scared:** 82	Volume and facade Proportion and Scale Material Color Texture

Table 5-18: The mean data of Pleasant-Arousal diagram of the unpleasant exterior places of the New Building

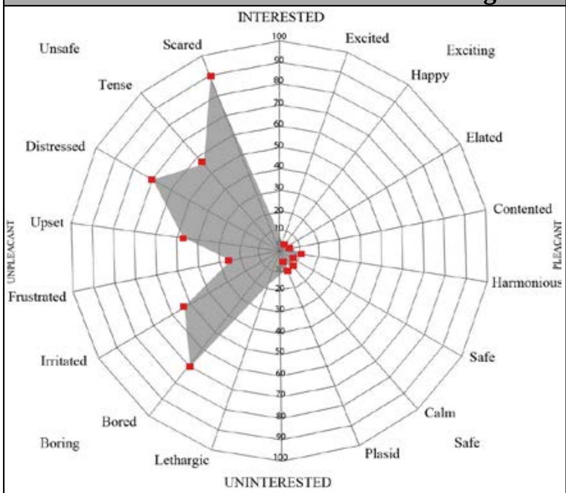
The Mean Data of Pleasure-Arousal Diagram	Criterion		Mood	
	**High Arousal**	**Exciting:** 5.8	**Excited**	2.25
			Happy	3.75
			Elated	4.20
			Contented	13
	Low Arousal	**Safe:** 10	**Harmonious**	8
			Safe	10.5
			Calm	9
			Placid	12.5
	Low Arousal	**Boring:** 41.25	**Lethargic**	17.5
			Bored	**70**
			Irritated	52.5
			Frustrated	25
	High Arousal	**Unsafe:** 65	**Upset**	46.5
			Distressed	70
			Tense	54
			Scared	**89.5**

Table 5-19: The result of Pleasant-Arousal diagram of the unpleasant interior places of the New Building

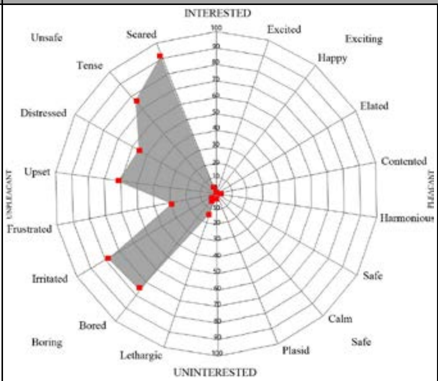
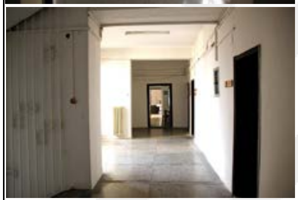
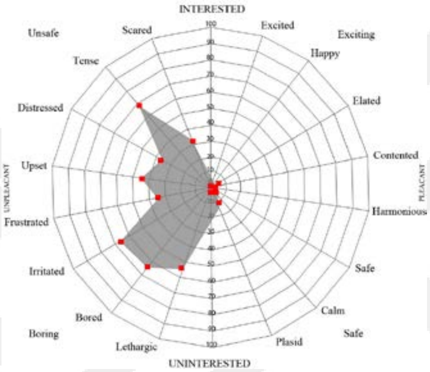
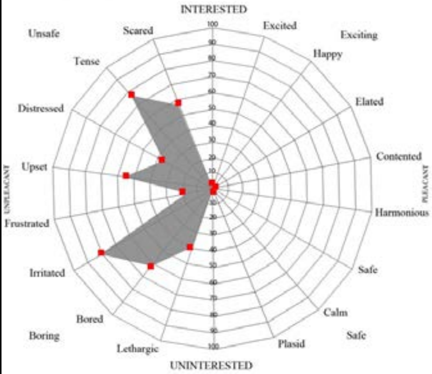
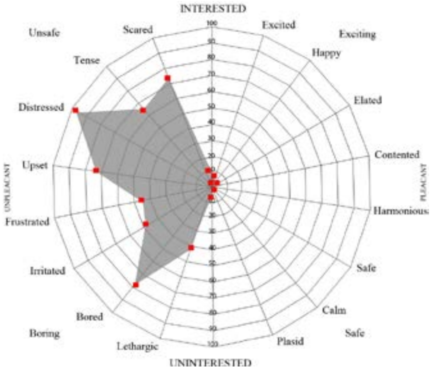
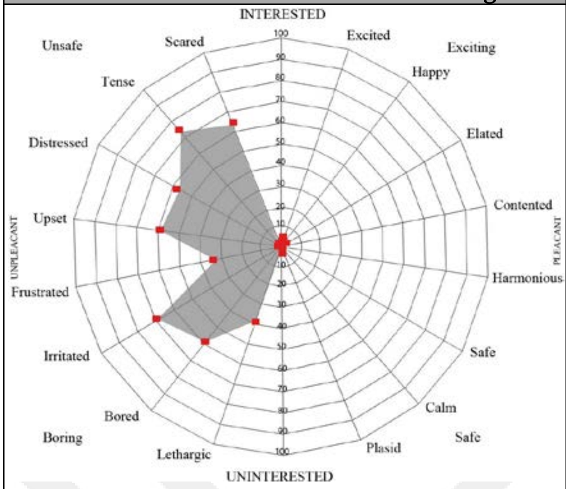
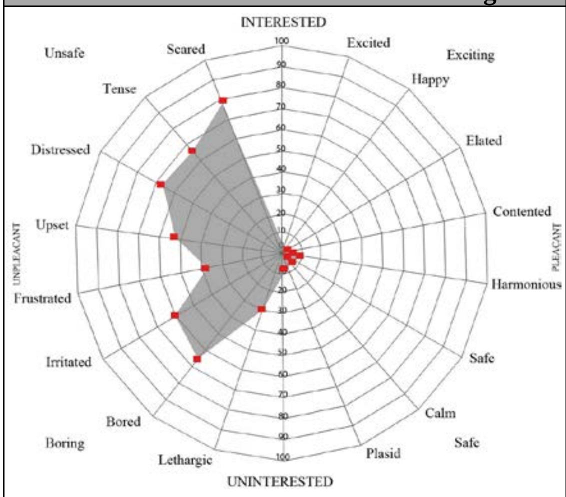
Evaluated Place	Average of The Places According to Pleasure-Arousal Diagram from The Users Point of View		Qualitative Factors Affecting the Emotional Evaluation
 		**Excited:** 0 **Happy:** 0 **Elated:** 0 **Contented:** 0 **Harmonious:**0 **Safe:** 2 **Calm:** 1 **Placid:** 2 **Lethargic:** 16 **Bored:** 76 **Irritated:** 79 **Frustrated:** 30 **Upset:** 61 **Distressed:** 55 **Tense:** 77 **Scared:** 91	Rhythm Material Texture Color Light Security
 		**Excited:** 2.2 **Happy:** 2 **Elated:** 1.5 **Contented:** 0 **Harmonious:** 2 **Safe:** 2.5 **Calm:** 1.5 **Placid:** 15 **Lethargic:** 55 **Bored:** 22.65 **Irritated:** 68 **Frustrated:** 35 **Upset:** 45 **Distressed:** 36 **Tense:** 70 **Scared:** 32	Material Texture Color Light Security
 		**Excited:** 0 **Happy:** 0 **Elated:** 0 **Contented:** 0 **Harmonious:**0 **Safe:** 0 **Calm:** 0 **Placid:** 3 **Lethargic:** 38 **Bored:** 62 **Irritated:** 81 **Frustrated:** 18 **Upset:** 53 **Distressed:** 33 **Tense:** 77 **Scared:** 56	Material Texture Color Light Security
 		**Excited:** 0 **Happy:** 0 **Elated: 0** **Contented:** 0 **Harmonious:**0 **Safe:** 0 **Calm:** 0 **Placid:** 0 **Lethargic:** 43 **Bored:** 79 **Irritated:** 47 **Frustrated:** 45 **Upset:** 72 **Distressed:** 100 **Tense:** 66 **Scared:** 73	Material Texture Color Light Security

Table 5-20: The mean data of Pleasant-Arousal diagram of the unpleasant interior places of the New Building

The Mean Data of Pleasure-Arousal Diagram	Criterion		Mood	
	**High Arousal**	**Exciting:** 0.3	**Excited**	0.5
			Happy	0.5
			Elated	0.4
			Contented	0
	Low Arousal	**Safe:** 1.8	**Harmonious**	0.5
			Safe	1.1
			Calm	0.6
			Placid	5
	Low Arousal	**Boring:** 50	**Lethargic**	38
			Bored	60
			Irritated	**69**
			Frustrated	32
	High Arousal	**Unsafe: 62.5**	**Upset**	58
			Distressed	56
			Tense	**73**
			Scared	63

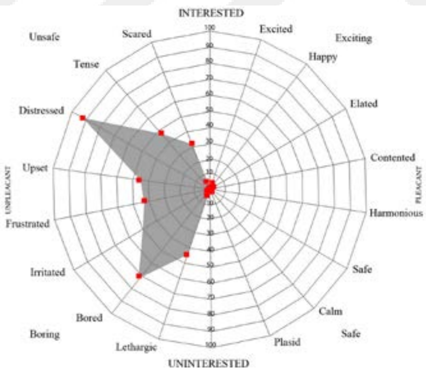
Accordingly, the average data of the all unpleasant spaces (interior + exterior spaces) of the new building as shown in the following table, present that the adjectives of *bored* (M=65) with low arousal and *scared* (M=76.5) with high arousal play the significant role in inducing unpleasant feeling, and high scored adjectives such as upset, distressed, tense, and scared make it **unsafe** place (M=53).

Table 5-21: The mean data of Pleasant-Arousal diagram of the all unpleasant (interior+exterior) places of the New Building

The Mean Data of Pleasure-Arousal Diagram	Criterion		Mood	
	**High Arousal**	**Exciting:** 3.05	**Excited**	1.38
			Happy	2.12
			Elated	2.3
			Contented	6.5
	Low Arousal	**Safe:** 5.9	**Harmonious**	9.25
			Safe	5.8
			Calm	4.8
			Placid	8.75
	Low Arousal	**Boring:** 45.6	**Lethargic**	27.8
			Bored	**65**
			Irritated	60.8
			Frustrated	28.5
	High Arousal	**Unsafe: 63.75**	**Upset**	52.3
			Distressed	63
			Tense	63.5
			Scared	**76.5**

As shown in the following tables (5-22 to 5-25), both the exterior and interior spaces of the sports hall building were assessed unpleasant. In this regard, related to exterior spaces, of the low activated unpleasant factor (boring), they were assessed as *bored* (M=72), and of the high activated unpleasant factor (unsafe), they were assessed as *distressed* (M=92). Indeed, high scored adjectives such as upset, distressed, tense, and scared (M=54) with high arousal play a significant role in inducing unpleasant feelings and make them **unsafe** places. Besides, according to data obtained from the interview, factors such as volume and facade, rhythm, proportion and scale, material, color, texture, and security make the sports hall building as an unpleasant place.

Table 5-22: The result of Pleasant-Arousal diagram of the unpleasant exterior places of the Sports Hall Building

Evaluated Place	Average of The Places According to Pleasure-Arousal Diagram from The Users Point of View		Qualitative Factors Affecting the Emotional Evaluation
 	 	**Exciting:** 2.8 **Excited:** 2.9 **Happy:** 0 **Elated:** 0 **Contented:** 2.7 **Safe:** 1 **Harmonious:** 0 **Safe:** 1 **Calm:** 1 **Placid:** 0 **Boring:** 52.5 **Lethargic:** 45 **Bored: 72** **Irritated:** 50 **Frustrated:** 43 **Unsafe: 54** **Upset:** 45 **Distressed: 92** **Tense:** 48 **Scared:** 31	Volume and facade Proportion and Scale Rhythm Material Color Texture Security

Related to interior spaces, of the low activated unpleasant factor (boring), they were assessed as *irritated* (M=61.5), and of the high activated unpleasant factor (unsafe), they were assessed as *tense* (M=57.5). Indeed, high scored adjectives such as upset, distressed, tense, and scared (M=48) with high arousal play a significant role in inducing unpleasant feelings and make make the places felt unsafe. Besides, factors such as proportion & scale, material, color, light, texture, and security make the new building unpleasant, and users are not satisfied.

Table 5-23: The result of Pleasant-Arousal diagram of the unpleasant interior places of the Sports Hall Building

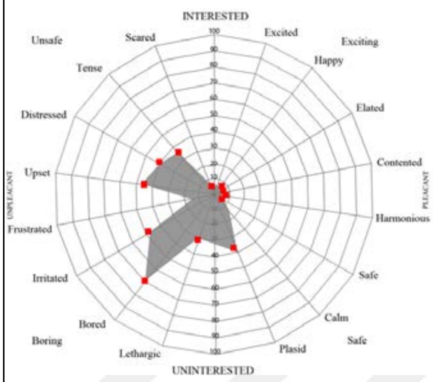
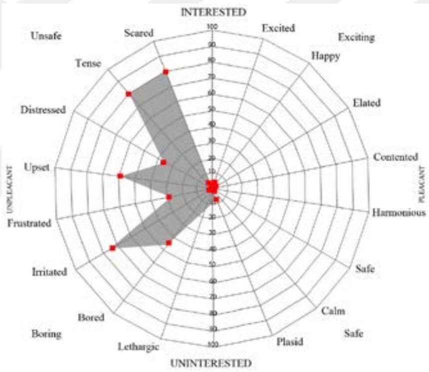
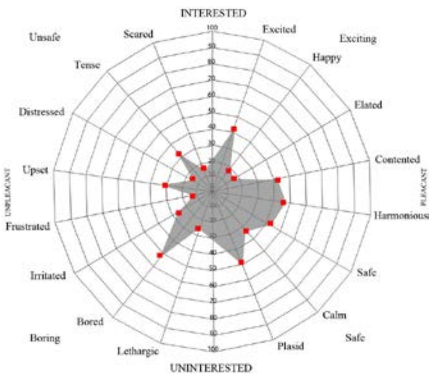
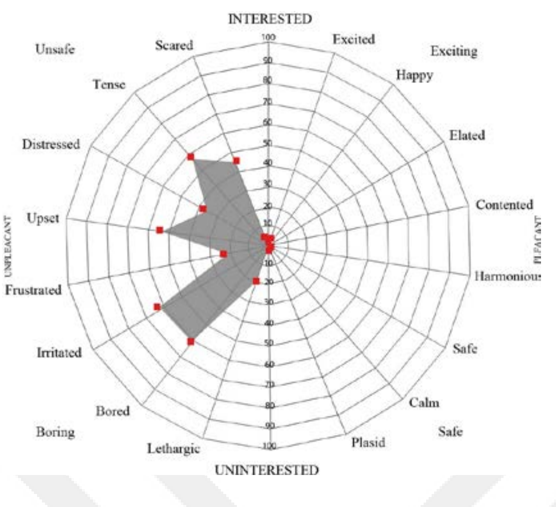
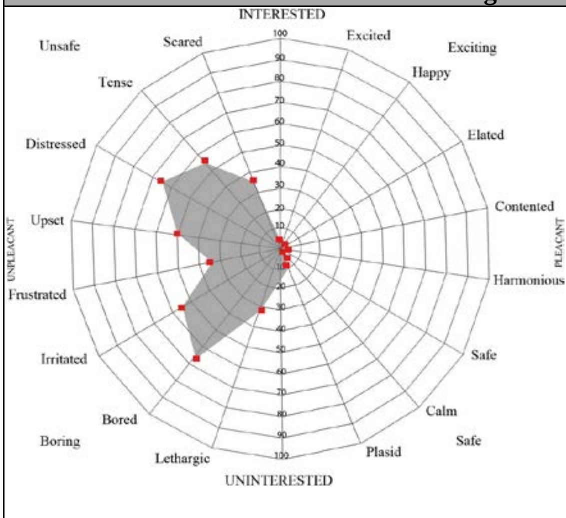
Evaluated Place	**Average of The Places According to Pleasure-Arousal Diagram from The Users Point of View**		**Qualitative Factors Affecting the Emotional Evaluation**
		**Excited:** 2 **Happy:** 0 **Elated:** 2 **Contented:** 2 **Harmonious:** 0 **Safe:** 1 **Calm:** 1 **Placid:** 42 **Lethargic:** 30 **Bored:** 70 **Irritated:** 47 **Frustrated:** 15 **Upset:** 45 **Distressed:** 40 **Tense:** 35 **Scared:** 7.5	Proportion and Scale Material Texture Color Light Security
		**Excited:** 0 **Happy:** 0 **Elated:** 0 **Contented:** 0 **Harmonious:** 0 **Safe:** 1 **Calm:** 1 **Placid:** 0 **Lethargic:** 8 **Bored:** 48 **Irritated:** 76 **Frustrated:** 30 **Upset:** 60 **Distressed:** 35 **Tense:** 80 **Scared:** 80	Material Texture Color Light Security
		**Excited:** 42 **Happy:** 18 **Elated:** 18 **Contented:** 42 **Harmonious:** 45 **Safe:** 42 **Calm:** 32 **Placid:** 50 **Lethargic:** 25 **Bored:** 52 **Irritated:** 25 **Frustrated:** 12 **Upset:** 32 **Distressed:** 12 **Tense:** 32 **Scared:** 12	Material Texture Color Light Security

Table 5-24: The mean data of Pleasant-Arousal diagram of the unpleasant interior places of the Sports Hall Building

The Mean Data of Pleasure-Arousal Diagram	Criterion		Mood	
	**High Arousal**	**Exciting:** 0.75	**Excited**	1
			Happy	0
			Elated	1
			Contented	1
	Low Arousal	**Safe:** 5.75	**Harmonious**	0
			Safe	1
			Calm	1
			Placid	21
	Low Arousal	**Boring:** 40.5	**Lethargic**	19
			Bored	59
			Irritated	**61.5**
			Frustrated	22.5
	High Arousal	**Unsafe: 48**	**Upset**	52.5
			Distressed	37.5
			Tense	**57.5**
			Scared	44

Accordingly, the average data of the all unpleasant spaces (interior + exterior spaces) of the sports hall building as shown in the following table, present that the adjectives of *bored* (M=65.5) with low arousal and *distressed* (M=65) with high arousal play a significant role in inducing unpleasant feeling, and high scored adjectives such as upset, distressed, tense, and scared make it **unsafe** place (M=51).

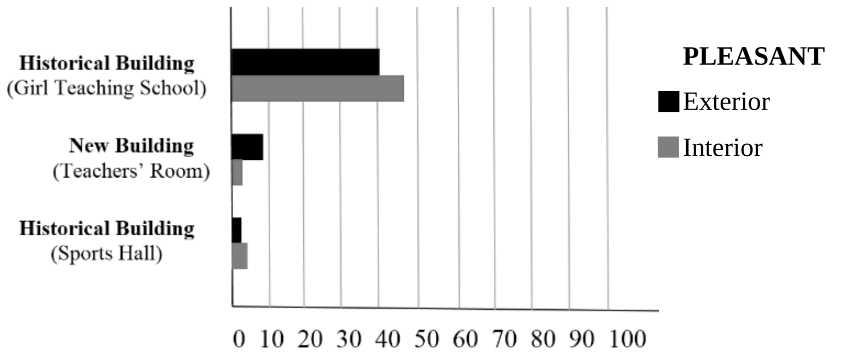
Table 5-25: The mean data of Pleasant-Arousal diagram of the all unpleasant (interior+exterior) places of the Sports Hall Building

The Mean Data of Pleasure-Arousal Diagram	Criterion		Mood	
	**High Arousal**	**Exciting:** 1.8	**Excited**	1.95
			Happy	0
			Elated	0.5
			Contented	1.85
	Low Arousal	**Safe:** 3.38	**Harmonious**	0
			Safe	1
			Calm	1
			Placid	10.5
	Low Arousal	**Boring:** 46.5	**Lethargic**	32
			Bored	**65.5**
			Irritated	56
			Frustrated	33
	High Arousal	**Unsafe: 51**	**Upset**	49
			Distressed	**65**
			Tense	53
			Scared	37.5

Tables 5-11 to 5-25 show differences and similarities in the comparative results of the Pleasure-Arousal model in three places of the same faculty. The average of statistical data related to interior and exterior spaces of faculty buildings is presented as follow:

Table 5-26: The average of statistical data related to interior and exterior spaces of faculty buildings

The Name of Place			**Old Building** (Girl High School)		**New Building** (Teachers' rooms)		**New Building** (Sports Hall)	
Criterion		**Mood**	**Int**	**Ext**	**Int**	**Ext**	**Int**	**Ext**
High Activated Pleasant	**Exciting**	**Excited**	25.2	15	0.5	2.25	1	2.9
		Happy	36.3	36.5	0.5	3.75	0	0
		Elated	21.5	18	0.4	4.20	1	0
		Contented	**59**	**44.5**	0	13	1	2.7
Low Activated Pleasant	**Safe**	**Harmony**	**82.5**	42	0.5	8	0	0
		Safe	42	43	1.1	10.5	1	1
		Calm	51	**68.5**	0.6	9	1	1
		Placid	50	46	5	12.5	21	0
High Activated Unpleasant	**Boring**	**Lethargic**	11.7	6.5	38	17.5	19	45
		Bored	17.8	10	60	**70**	59	**72**
		Irritated	13.2	6	**69**	52.5	**61.5**	50
		Frustrated	8.7	4.9	32	25	22.5	43
Low Activated Unpleasant	**Unsafe**	**Upset**	10.5	5	58	46.5	52.5	45
		Distressed	3.9	2	56	70	37.5	**92**
		Tense	25	8.85	**73**	54	**57.5**	48
		Scared	4.9	0.5	63	**89.5**	44	31



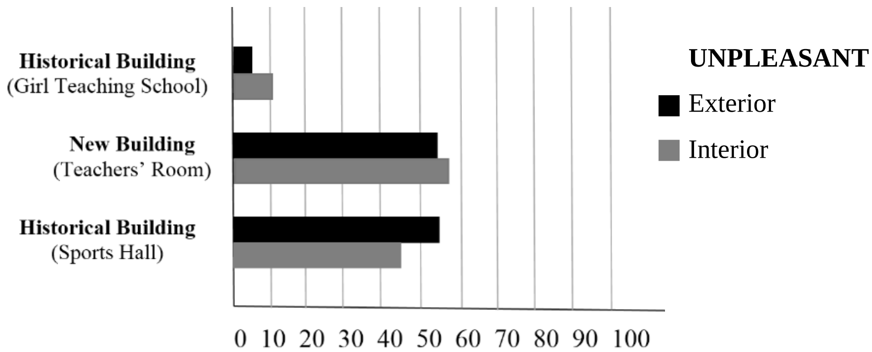


Diagram 5-2: The analysis of findings related to pleasant and unpleasant places

Consequently, in assessing the influence and contribution of qualitative components of place on the users' emotional experience of place, after integrating the quantitative results, all evaluated spaces of faculty were classified into pleasant and unpleasant groups. Accordingly, as shown in the following table, the mean data present what related to pleasant spaces, of the high activated pleasant factor (Exciting), were assessed as *contented* (M=52), and of the low activated pleasant factor (Safe), were assessed as *harmonic* (M=62). Accordingly, it can be said that rather than the adjectives of excited (M=20), elated (M=36.5), happy (M=20), and contented (M=52) with high arousal [**Exciting, M=32**], the adjectives of harmonious (M=62), safe (M=42.5), calm (M=60), and placid (M=48) with low arousal [**Safe, M=53**] play more significant role in inducing pleasant feeling, and make the relevant spaces **safe**. Further, related to unpleasant spaces, of the high activated unpleasant factors (Unsafe), were assessed as *distressed* (M=54.7), and of the low activated unpleasant factors (Boring), were assessed as *bored* (M=65). In this regard, it can be said that rather than the adjectives of lethargic (M=32.1), bored (M=65), irritated (M=55), frustrated (M=27.2) with low arousal [**Boring, M=44.8**], the adjectives of upset (M=48.5), distressed (M=54.7), tense (M=54.5), and scared (M=49.5) with high arousal [**Unsafe, M=51.7**] play a more significant role in inducing unpleasant feeling, and make the relevant spaces **unsafe**. In fact, the safety factor with low arousal in pleasant spaces (historical building) and with high arousal in unpleasant spaces (new building & sports hall building) contributed greatly to the users' emotional evaluation of place.

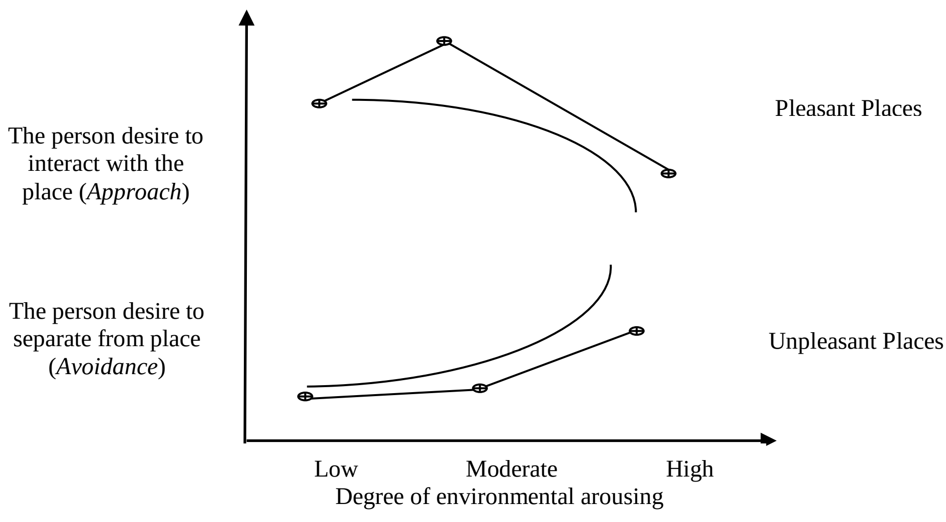
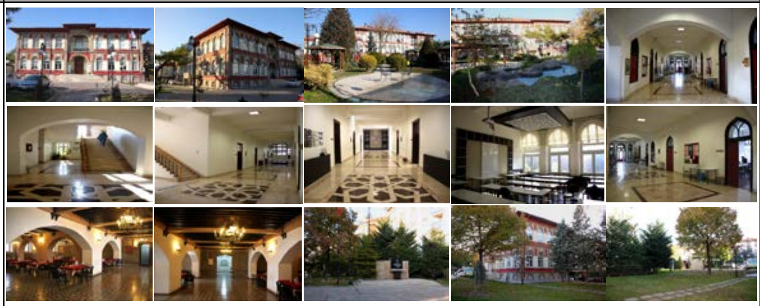
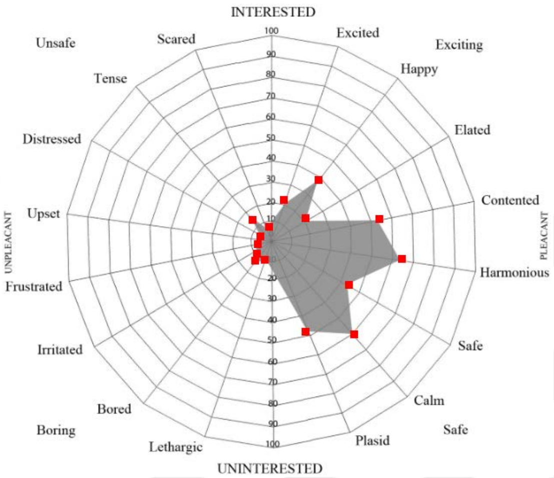


Diagram 5-3: The desire for interactivity in the pleasant and unpleasant places

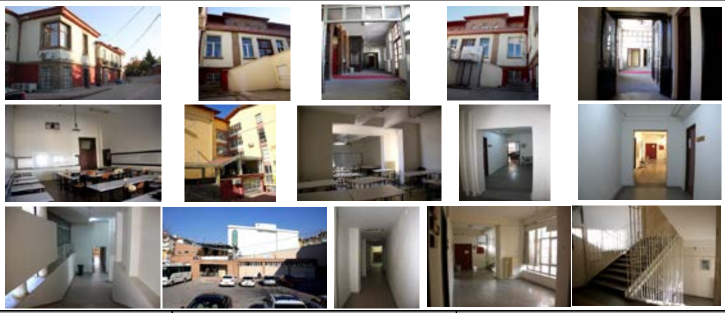
Table 5-27: The result of Pleasant-Arousal diagram of the exterior places of the Historical Building

Location	Selected Pleasant Places
	

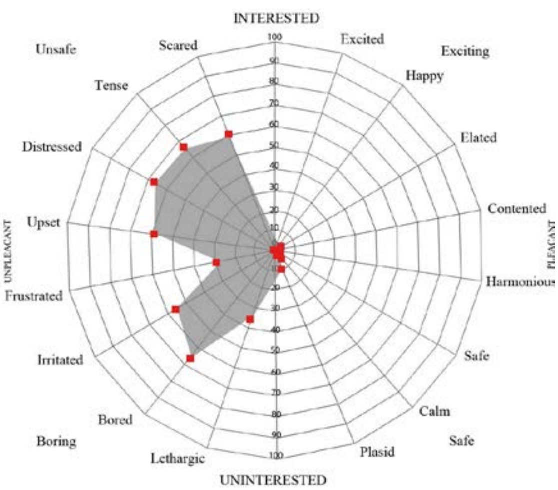
The Mean Data of Pleasure-Arousal Diagram



Criterion		Mood	
High Arousal	Exciting: 32	Excited	20
		Happy	36.5
		Elated	20
		Contented	**52**
Low Arousal	Safe: 53	Harmonious	**62**
		Safe	42.5
		Calm	60
		Placid	48
Low Arousal	Boring: 9.85	Lethargic	9
		Bored	14
		Irritated	9.5
		Frustrated	6.5
High Arousal	Unsafe: 7.75	Upset	8
		Distressed	3
		Tense	16.5
		Scared	2.7

Location	Selected Unpleasant Places
	

The Mean Data of Pleasure-Arousal Diagram



Criterion		Mood	
High Arousal	Exciting: 2.38	Excited	2.15
		Happy	1.23
		Elated	1.53
		Contented	3.75
Low Arousal	Safe: 4.93	Harmonious	4.57
		Safe	3.43
		Calm	3.23
		Placid	9.95
Low Arousal	Boring: 44.8	Lethargic	32.1
		Bored	**65**
		Irritated	55
		Frustrated	27.2
High Arousal	Unsafe: 51.7	Upset	48.5
		Distressed	**54.7**
		Tense	54.5
		Scared	49.5

Consequently, based on the results of the interview and open questionnaire, it should be noted that the quality of place and its components play an important role in an individual’s preferences and judgments. Physical features and environmental qualities such as color, light, texture, material, landscape, geometry, proportion, security, etc. can improve the emotional-perceptual quality of the environment, and this led to psychological pleasure and positive emotional assessment, satisfaction, and spatial preferences. Along with the emotional assessment of the place, qualitative factors such as morphological, sensory, and individual affect user assessment, and the results of the Pleasure-Arousal model shows a meaningful relation between the emotional evaluation of place and factors forming the meaning of place. According to interview results, material, color, texture, and security are the most influential factors in the formation of the meaning of place, and subsequently, are the most effective factors of emotional evaluation in determining the pleasant or unpleasant environment. There are specific relationships and harmony among physical dimensions and behavioral aspects of architectural spaces, users’ perception and affection. It seems that in the investigation of different dimensions of meanings that people perceive from one place, the emotional experience of a place is important and should be evaluated too. The physical environment is considered as stimuli in creating approach or avoidance decision and creates an emotional reaction in people, which, in turn, leads to desirable or undesirable behaviors. Physical features of an environmental setting affect the amount of pleasure and arousal. Emotions elicited by an environment affect individual’s behavior and experience. Environmental perceptions are directly related to the users’ behavioral tendencies, pleasure, and arousal.

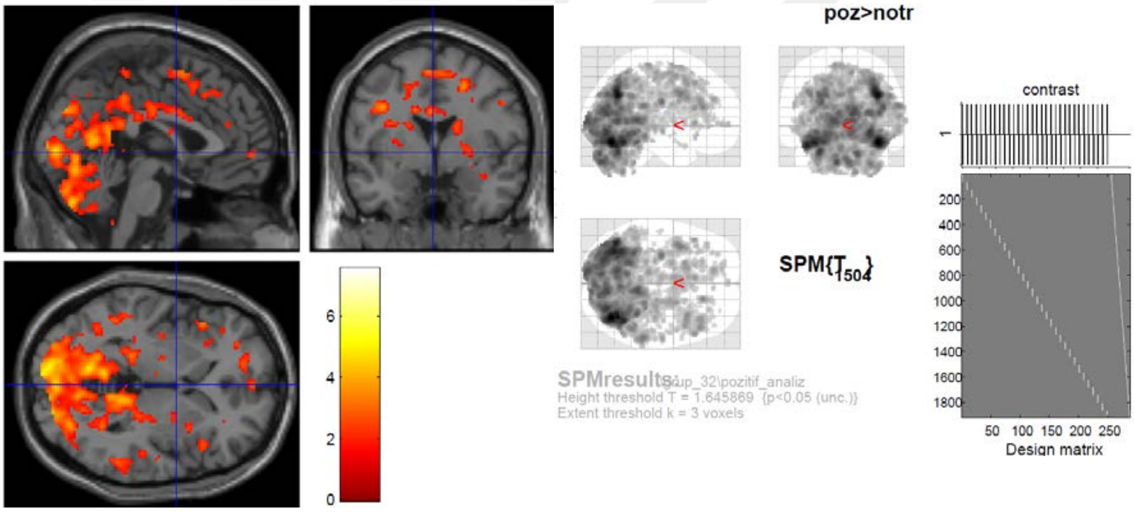
5.3. The Findings of the fMRI and Close Questionnaire

Because of the diversity of participants in terms of gender and field of study (discipline), the analyzes and findings were categorized into three kinds of study group consisted of (A) all users collectively (female architects + male architects + female urban designers + male urban designers), (B) a study group divided into female and male (female architects + female urban designers & male architects + male urban designers), and (C) a study group divided into architecture and urban design students (female architects + male architects & female urban designers + male urban designers).

5.3.1. The findings of the fMRI and closed questionnaire for all users

fMRI measurement data in related to pleasant places for all users

Figure 5-8 presents the parts of the brain that were activated when participants saw pleasant places. The top left image of the brain shows the midsagittal section, the right image shows the coronal section, and the bottom image shows a horizontal section. The left part of the midsagittal is the location of the occipital lobe and the right part is the location of the frontal lobe. The top part of the horizontal section is the right part of the midsagittal section and the bottom part is the left part of the midsagittal section. The bottom table of the following figure shows the coordinates of where the brain was activated. Using such coordinates makes it possible to indicate the sensory areas.



Statistics: *p-values adjusted for search volume*

set-level p	set-level c	cluster-level $p_{FWE-corr}$	cluster-level $q_{FDR-corr}$	cluster-level k_E	cluster-level p_{uncorr}	peak-level $p_{FWE-corr}$	peak-level $q_{FDR-corr}$	peak-level T	peak-level $(Z_\equiv)$	peak-level p_{uncorr}	mm	mm	mm
1.000	51	0.000	0.000	29505	0.000	0.000	0.000	7.54	7.47	0.000	38	-70	-18
						0.000	0.000	7.05	6.99	0.000	36	-62	30
						0.000	0.000	6.53	6.48	0.000	-40	-64	-22
		1.000	0.913	116	0.115	0.851	0.064	3.91	3.90	0.000	18	30	18
		0.018	0.003	1005	0.000	0.957	0.095	3.76	3.75	0.000	36	12	28
						0.983	0.116	3.68	3.67	0.000	48	26	24
						0.997	0.151	3.57	3.56	0.000	54	20	16
		1.000	0.913	196	0.046	0.999	0.176	3.48	3.47	0.000	-10	-28	60
						1.000	0.660	2.53	2.53	0.006	-2	-36	58
						1.000	0.915	2.04	2.04	0.021	-4	-18	60
		1.000	0.913	41	0.339	1.000	0.196	3.40	3.39	0.000	-44	22	2
		1.000	0.913	144	0.082	1.000	0.226	3.31	3.30	0.000	-12	42	26
						1.000	0.689	2.48	2.48	0.007	-2	38	20
						1.000	0.937	1.99	1.99	0.023	-6	38	10
		1.000	0.913	55	0.268	1.000	0.244	3.24	3.23	0.001	60	-14	-8
		1.000	0.913	27	0.441	1.000	0.360	3.01	3.00	0.001	-14	0	32
		1.000	0.913	74	0.201	1.000	0.403	2.94	2.93	0.002	-44	-42	28
						1.000	0.814	2.23	2.23	0.013	-38	-48	36
		1.000	0.913	172	0.060	1.000	0.404	2.93	2.93	0.002	-20	28	22
						1.000	0.439	2.87	2.87	0.002	-16	20	24
						1.000	0.593	2.64	2.64	0.004	-16	28	14

table shows 3 local maxima more than 8.0mm apart

Height threshold: T = 1.65, p = 0.049 (1.000)
Extent threshold: k = 3 voxels, p = 0.827 (1.000)
Expected voxels per cluster, <k> = 48.355
Expected number of clusters, <c> = 138.11
FWEp: 4.848, FDRp: 4.029, FWEc: 1005, FDRc: 1005

Degrees of freedom = [1.0, 1504.0]
FWHM = 7.3 7.4 7.3 mm mm mm; 3.7 3.7 3.7 {voxels}
Volume: 877024 = 109628 voxels = 1969.2 resels
Voxel size: 2.0 2.0 2.0 mm mm mm; (resel = 49.93 voxels)
Page 1

Figure 5-8: The fMRI analyses of pleasant places for all users (p-unc<0.05)

After observing the activated areas, in cluster 1, the most activated areas engaged in emotions were pointed at the cerebellum (left and right cerebellum), precuneus, frontal lobe, fusiform gyrus, medial frontal, middle frontal gyrus, left insula, right frontal, and anterior cingulate (T=7.54, p= 0.000<0.05, x=38, y=-70, z=-18, K=29505). The findings demonstrated that the activation of a distributed network including the cerebellum (left and right cerebellum), anterior cingulate, left insula, and right frontal are covaried in relation to **happiness** (according to Table 2-15). In addition, activation in the precuneus, anterior cingulate cortex, fusiform gyrus, middle frontal gyrus, frontal lobe, and medial frontal are covaried in relation to **pleasant emotions** ratings (according to Table 2-16).

Besides, according to the brain activated areas based on literature and previous case studies presented in Table 2-17, the *cerebellum* is engaged in affect and cognition, the *precuneus* area also is engaged in determining orientation in space, aesthetic and beauty assessments of artworks, and perception. The *frontal lobe* and *middle frontal lobe* are associated with beauty judgment and pleasantness; the *fusiform gyrus* is engaged in the neural representation of architectural styles and in identifying the locations. The *anterior cingulate cortex* is involved in the emotional processing of architecture, reward properties, the judgment of beauty, and the emotional salience of objects. In addition to activating the areas involved in the pleasantness and emotions, activities in other areas were also recorded which confirms the brain's response to spatial elements and architectural qualities. For instance, the *occipital lobe* which responds to perceptual information regarding architecture, and is involved in the perception of forms, colors, height, depth, geometry, spatial movement direction, visual processing, and recognizing objects; the *temporal lobe* which is engaged in visual perception (form, color, and recognition of objects) and spatial perception (height, depth, geometry); the *parietal temporal lobes* which is involved in understanding spatial orientation and perception (motion, depth, height, width, geometry), visual perception, cognition, identifying the position, location, and touch; the *cuneus* is responsive to the appreaciation of representational material; the *middle occipital gyrus* which is engaged in aesthetic assessments of artworks and beauty ratings; the *parahippocampal* which is involved in architectural experience and representation of large-scale places, landscape, and location; the *middle temporal* which is engaged in perceiving motion in an architectural space involved in the motion required for visuo-spatial exploration; the *superior temporal* is involved in visuo-spatial exploration of architectural space; the *right superior temporal gurus* which is engaged in visual processing and spatial perception the *left middle temporal* which engaged in semantic memory processing, visual perception, and aesthetic judgment; the *inferior occipital* is engaged in the processing of the configuration and shapes of objects; the *right parietal lobe* involved in spatial mapping; the *superior frontal gyrus* engaged in aesthetic assessments of artwork and beauty rating; the *left middle frontal gyrus* is involved in beauty judgement; the *inferior temporal gyrus* engaged in semantic memory processing and visual perception, and is involved in emotional processing of architecture, pleasantness; reward properties, judgment of beauty, and emotional salience of objects.

Table 5-28: fMRI measurement data in related to pleasant places for all users (p-unc<0.05).

<table>
<tr><th colspan="6">Number of Defined Clusters Found: 42 Number of All Voxels: 32077</th></tr>
<tr><th>Cluster</th><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td rowspan="3">1</td><td>All Students</td><td>29505</td><td>38 -70 -18</td><td>7.54</td><td>0.000</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Cerebellum: 4783 / Left Cerebellum: 3320 / Right Cerebellum: 3118 / Precuneus: 2104 / Frontal Lobe: 1799/ Fusiform Gyrus: 1056 / Medial Frontal: 368 / Middle Frontal: 205 / Left Insula: 51 / Right Frontal: 24 / Anterior Cingulate: 11</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Architecture:</u>
Occipital Lobe: 8937 / Limbic Lobe: 3437 / Temporal Lobe: 3340 / Parietal Lobe: 3134 / Lingual Gyrus: 2963 / Cuneus: 2316 / Posterior Cingulate: 1528 / Middle Occipital: 975 / Parahippocampal: 903 / Middle Temporal: 858 / Superior Temporal: 744 / Right Superior Temporal: 489 / Left Middle Temporal: 294 / Inferior Occipital: 258 / Right Parietal Lobe: 210 / Superior Frontal: 150 / Inferior Frontal Gyrus: 102 / Angular Gyrus: 100 / Left Middle Frontal: 71 / Superior Parietal Lobe: 89 / Inferior Temporal: 13/ Anterior Cingulate: 11</td></tr>
<tr><td colspan="6"><u>Total Voxels Number of More Effective Activated Regions:</u>
Cerebellum: 4783 / Frontal Lobe: 3674 / Left Cerebellum: 3320 / Right Cerebellum: 3113 / Precuneus: 2104 / Medial Frontal: 668 / Middle Frontal: 436 / Anterior Cingulate: 133 / Fusiform Gyrus: 133</td></tr>
</table>

As shown in the table above, the areas of the brain engaged in emotions that were expected to be activated in the face of pleasant spaces are marked by bold fonts. Neuroanatomically, the results demonstrated that assessing the pleasantness of pleasant/positive in the aspect of spatial elements and architectural qualities was associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=8937] and the least value in the **Anterior Cingulate** [Voxels=8937]; and related to emotional assessment it was associated exclusively with the highest increase in the **Cerebellum** [Voxels=4783] and the least value in the **Fusiform Gyrus** [Voxels=133].

The closed questionnaire was concluded to measure the contribution of each effective sensory sub-components of the emotional-perceptual experience of place and determining the pleasant or unpleasant desirability of each place. Descriptive statistical analysis, arithmetic mean, and standard deviation values of all users' sensation measurement data distributions were examined in relate to pleasantness. Accordingly, the color measurement data was found to be 25.00/3.57±5.76, light 25.27/3.61±4.50, texture 26.88/3.84±4.90, material 25.55/3.65±4.95, sound 21.63/3.06±5.89, odor 19.30/2.76±6.34. It was observed that the **texture (touch)** measurement has the highest score, and is considered as the most effective sensory factor in making the relevant places pleasant. In this regard, the **odor** measurement has the lowest score. Likewise, it was observed that the score of color, light, and material is close to each other.

Table 5-29: All users sensation measurement data in related to pleasant places

Sub-Components	Mean ($\bar{X}$)		Standard Deviation
Color	25.00	3.57	5.76
Light	25.27	3.61	4.50
Texture	**26.88**	**3.84**	4.90
Material	25.55	3.65	4.95
Sound	21.63	3.06	5.89
Odor	**19.30**	**2.76**	6.34

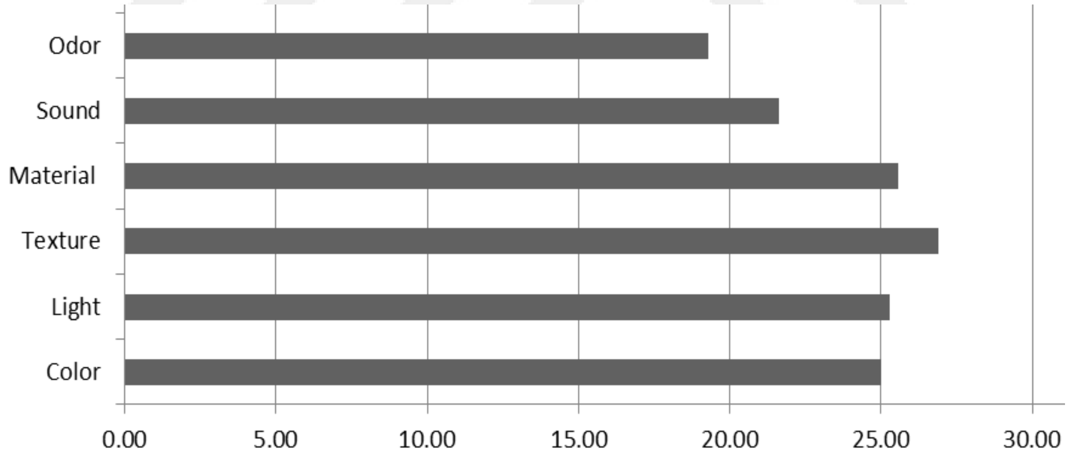


Diagram 5-4: All users sensation measurement data in related to pleasant places

All users' perceptual measurements data in conjunction with pleasant places revealed that the **geometry** (26.11/3.73±4.84) measurement has the highest score, and is considered as the most effective physical factor in making the relevant places pleasant. In this regard, the measurements of **largeness** (23.41/3.34±5.80) and **depth** (23.41/3.34±5.80) have the lowest score. Likewise, it was observed that the score of height, width, light, and material is near to each other.

Table 5-30: All users perception measurement data in related to pleasant places

Sub-Components	Mean ($\bar{X}$)		Standard Deviation
Largeness (Size)	**23.41**	**3.34**	5.34
Height	24.83	3.55	5.19
Depth	**23.41**	**3.34**	5.80
Width	23.92	3.42	5.29
Geometry	**26.11**	**3.73**	4.84
Proportion & Scale	25.44	3.63	5.01
Order	25.64	3.66	5.35
Rhythm	24.16	3.45	5.81

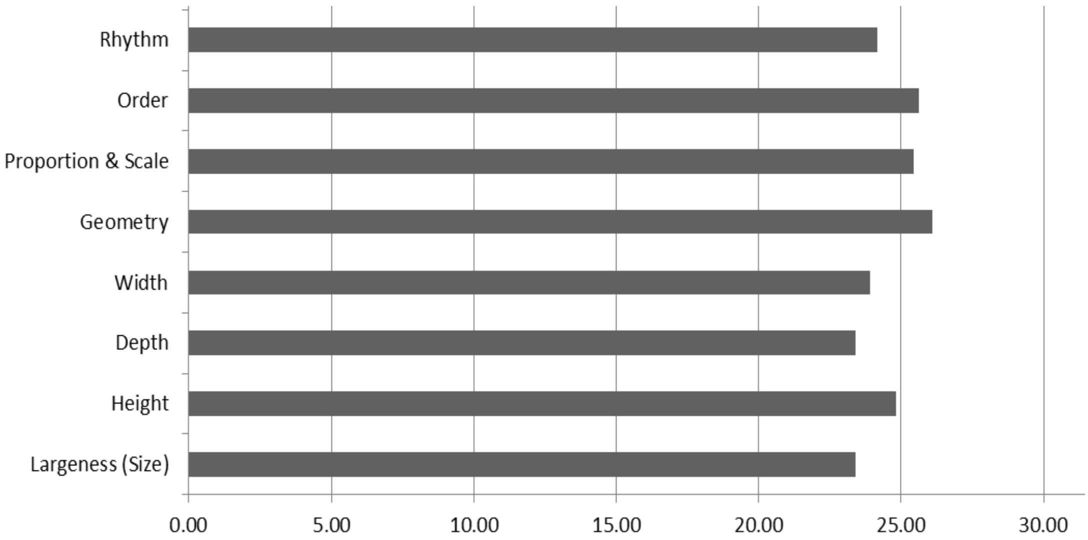


Diagram 5-5: All users perception measurement data in related to pleasant places

➢ fMRI measurement data in related to unpleasant places for all users

Figure 5-6 represents the parts of the brain that were activated when participants saw unpleasant places. Also, the following table shows the statistical analysis of the brain activated areas which makes it possible to indicate the most effective areas engaged in emotional and cognitive processes encountering negative scenes and places. Accordingly, in cluster 1, the most activated areas were pointed at the right cerebrum, left cerebrum, fusiform gyrus, left fusiform, middle temporal, frontal Lobe, thalamus, left hippocampus, cingulate gyrus, left-mid temporal, insula, hippocampus, and the left thalamus (T=5.53, p= 0.000<0.05, x=40, y=-66, z=-20, K=15641). The findings demonstrated that activation in a distributed network including the cerebrum, thalamus, left hippocampus, and left middle temporal is engaged in **fear**. Activation in the areas such as the middle temporal and cingulate is involved in **sadness** and **fear**. The frontal lobe and insula activations are engaged in **disgust**, **fear**, **anger**, and **sadness**. Also, activation in the hippocampus and left thalamus is covaried in relation to **anger** and **sadness**. Furthermore, according to Table 2-16, the fusiform gyrus is associated with **unpleasant emotions**, and the left fusiform is associated with **avoidance behavior**.

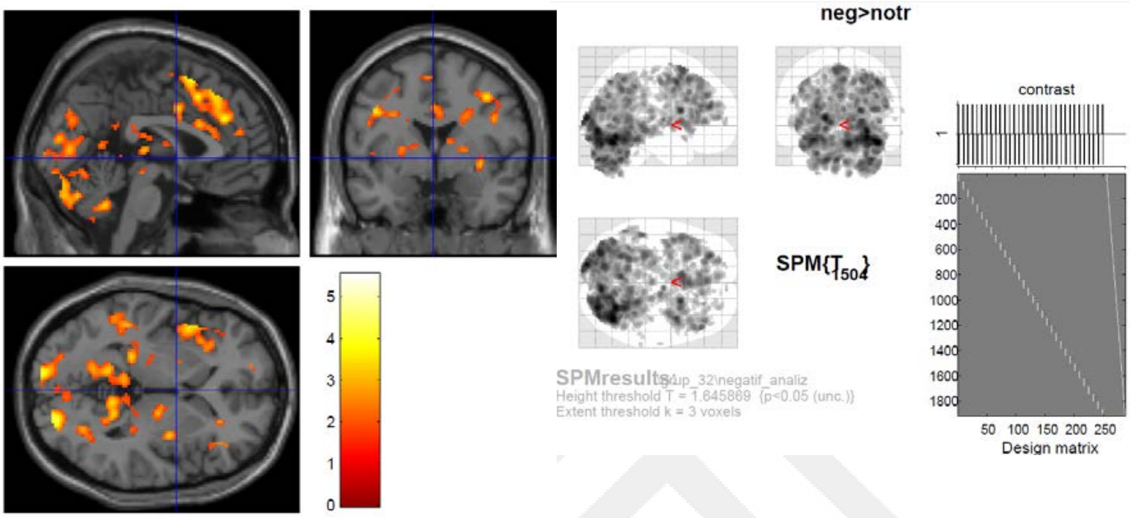


Figure 5-9: The fMRI analyses of unpleasant places for all users (p-unc<0.05)

In addition to activating the areas involved with the unpleasant emotions, activities in other areas were also recorded each of which confirms the brain's response to spatial elements and architectural qualities. According to the Table 2-17, the *fusiform gyrus* is engaged in neural representation of architectural styles and identifying locations; the *middle temporal* is engaged in perceiving motion in an architectural space; the *frontal lobe* is engaged in reward processing, beauty judgment, and planning; the *cingulate cortex* is involved in the emotional processing and the avoidance decisions of architectural spaces; the *left middle temporal* is involved in semantic memory processing, visual perception, and aesthetic judgment; the *insula* is engaged in avoidance behavior, the *hippocampus* is implicated in memories and perception.

Besides, the *occipital lobe* responds to perceptual information regarding architecture, and is involved in the perception of forms, colors, height, depth, geometry, spatial movement direction, visual processing, and recognizing objects; the *temporal lobe* is engaged in visual perception (form, color, and recognition of objects) and spatial perception (height, depth, geometry); the *parietal temporal* lobes is involved in understanding spatial orientation and perception (motion, depth, height, width, geometry), visual perception, cognition, identifying the position, location, and touch; the *posterior cingulate* is engaged in spatial memory and spatial orientation of objects; the *parahippocampal* is involved in architectural experience and representation of large-scale places, landscape, and location; the *middle occipital gyrus* is engaged in aesthetic assessments of artworks and beauty ratings; the *precuneus* is engaged in aesthetic assessments of artworks, pleasantness, and perception; the *superior temporal sulcus* is involved in visuo-spatial exploration of architectural space, processing of social cues and interpersonal touch.

Table 31: fMRI measurement data in related to unpleasant places (p-unc <0.05).

Number of Defined Clusters Found: 50 Number of All Voxels: 21784					
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	All Students	15641	40 -66 -20	5.53	0.000
	<u>Peak MNI Coordinate Region Engaged in Emotion:</u> **Right Cerebrum:** 6579 / **Left Cerebrum:** 3702 / **Fusiform:** 947 / **Left Fusiform:** 784 / **Middle Temporal:** 331 / **Frontal Lobe:** 220 / **Thalamus:** 211 / **Left Hippocampus:** 183 / **Cingulate:** 141 / **Left-Mid Temporal:** 110 / **Insula:** 52 / **Hippocampus:** 27 / **Left Thalamus:** 18				
	<u>Peak MNI Coordinate Region Engaged in Architecture:</u> Occipital Lobe: 4564 / Limbic Lobe: 1512 / Temporal Lobe: 1429 / Lingual Gyrus:1360 / Parietal Lobe: 1223 / Posterior Cingulate: 664 / Parahippocampal: 659 / Middle Occipital: 506 / Precuneus: 452 / Superior Temporal: 63 / Superior Parietal: 59				
<u>Total Voxels Number of More Effective Active Regions:</u> Right Cerebrum: 9019 / Left Cerebrum: 7139 / Frontal Lobe: 3123 / Fusiform Gyrus: 974 / Cingulate Gyrus: 808 / Left Fusiform: 784 / Middle Temporal: 340 / Insula: 303 / Thalamus: 219 / Left Hippocampus: 183 / Left-Mid-Temporal: 110 / Left Thalamus: 29 / Hippocampus: 27					

As shown in the table above, the areas of the brain that were expected to be activated in the face of unpleasant spaces are marked by bold fonts. Neuroanatomically, the results demonstrated that the emotional assessing of unpleasant/negative in aspect of spatial elements and architectural qualities was associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=4564] and the least value in the **Superior Parietal** [Voxels=59]; and related to emotional assessment it was associated exclusively with the highest increase in the **Right Cerebrum** [Voxels=9019] and the least value in the **Hippocampus** [Voxels=27].

Descriptive statistical analysis, arithmetic mean, and standard deviation values of all users' sensation measurement data distributions in relate to unpleasant showed that the **texture (touch)** measurement has the highest score (33.75/3.75±8.97), and is considered as the most effective sensory factor in making the relevant places unpleasant. In this regard, the **odor** measurement has the lowest score (29.44/3.27±9.77). Likewise, it is observed that the scores of color, light and material are close to each other.

Table 5-32: All users sensation measurement data in related to unpleasant places

Sub-Components	Mean ($\bar{X}$)		Standard Deviation
Color	32.96	3.66	9.26
Light	32.42	3.60	8.80
Texture	**33.75**	**3.75**	8.97
Material	33.49	3.72	9.26
Sound	30.31	3.37	8.79
Odor	**29.44**	**3.27**	9.77

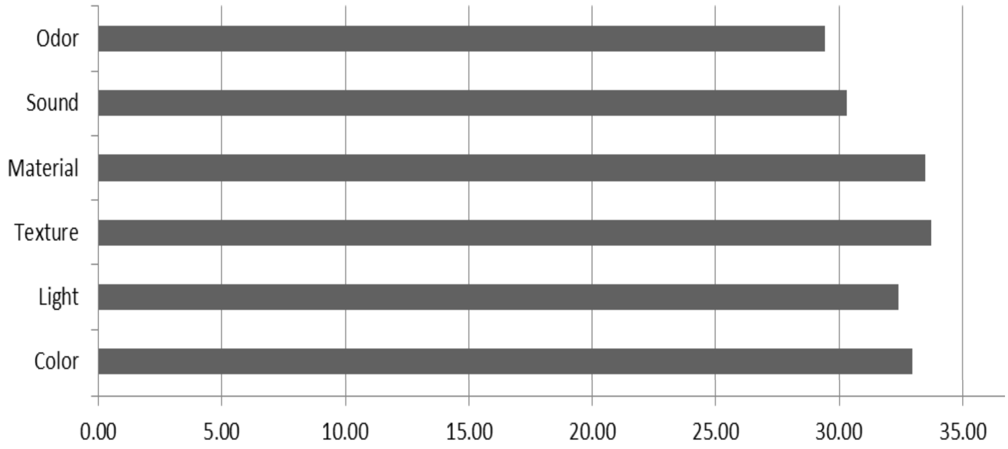


Diagram 5-6: All users sensation measurement data in related to unpleasant places

All users' perceptual measurements data in conjuction with unpleasant places revealed that the **geometry** (32.89/3.65±8.78), **proportion & scale** (32.84/3.65±8.62), and **order** (32.87/3.65±9.19) measurements have the highest score, and are considered as the most effective physical factors in making the relevant places unpleasant. In this regard, the **height** (29.87/3.32±8.50) measurement has the lowest score. Likewise, it is seen that the score of largeness, depth, width, and rhythm are close to each other.

Table 5-33: All users perception measurement data in related to unpleasant places

Sub-Components	Mean ($\bar{X}$)		Standard Deviation
Largeness (Size)	31.39	3.49	8.40
Height	**29.87**	**3.32**	8.50
Depth	31.42	3.49	8.26
Width	31.51	3.50	8.65
Geometry	**32.89**	**3.65**	8.78
Proportion & Scale	**32.84**	**3.65**	8.62
Order	**32.87**	**3.65**	9.19
Rhythm	32.67	3.63	9.72

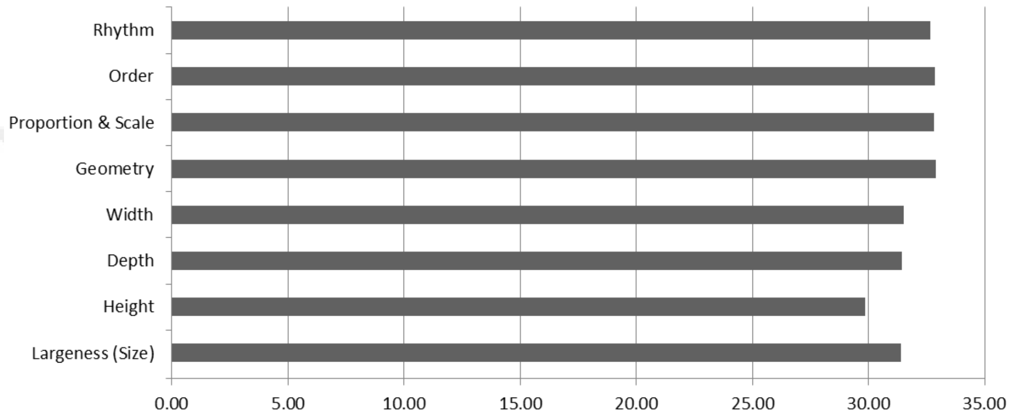


Diagram 5-7: All users perception measurement data in related to unpleasant places

- **The comparative fMRI and survey data of all users neurological ratings of pleasant and unpleasant places**

Neurological and quantitative experiments for assessing the emotional-perceptual experience of pleasant and unpleasant places were conducted and analyzed. Accordingly, the involvement of brain regions supported such a hypothesis that the perceptual and emotional evaluation of an architectural place rely on the specific neural areas that are active when people see or experience the pleasant (positive) or unpleasant (negative) scenes with a visual perceptual, cognitive, and rewarding emotional experience process. Also, the relevant findings supported the cognitive base of experiencing pleasantness to the neuroscience underlying users' perception and appreciation of architecture. Indeed, such detection suggests that the emotional-perceptual experience of architecture involved in the brain cortical, sensory, meaning, emotion, judgment, and valuation system. In this context, the current study findings had revealed significant differences between pleasant and unpleasant place ratings as the following frameworks.

Table 5-34: The comparative data of all users’ neurological ratings of pleasant and unpleasant places.

Place	Clusters Found	Voxels Found	The Brain’s More Effective Active Regions		Peak MNI Coordinate Region Engaged in Architecture:
Pleasant	42	32077	Cerebellum Frontal Lobe Left Cerebellum Right Cerebellum Precuneus Medial Frontal Fusiform Gyrus Anterior Cingulate	4783 3674 3320 3113 2104 436 133 133	Occipital: 8937 / Limbic: 3437 Temporal: 3340 / Parietal Lobe: 3134 Lingual: 2963 / Cuneus: 2316 / Posterior Cingulate: 1528 / Middle Occipital: 975 Parahippocampal: 903 / Middle Temporal: 858 / Superior Temporal: 744 Right Superior Temporal: 489 Left Middle Temporal: 294 Inferior Occipital: 258/Right Parietal: 210 Superior Frontal: 150/Inferior Frontal:102 Angular: 100 / Left Middle Frontal: 71 Superior Parietal: 89 / Inferior Temporal: 13/ Anterior Cingulate: 11
Unpleasant	50	21784	Right Cerebrum Left Cerebrum Frontal Lobe Temporal Lobe Fusiform Gyrus Cingulate Gyrus Left Fusiform Middle Temporal Insula Thalamus Left Hippocampus Left-Mid-Temporal Left Thalamus Hippocampus	9019 7139 3123 1486 974 808 784 340 303 219 183 110 29 27	Occipital Lobe: 4564 Limbic Lobe: 1512 Temporal Lobe: 1429 Lingual Gyrus:1360 Parietal Lobe: 1223 Posterior Cingulate: 664 Parahippocampal: 659 Middle Occipital: 506 Precuneus: 452 Superior Temporal: 63 Superior Parietal: 59 Angular: 19

As shown, it was found significant that there were activity changes and differences related to the emotional assessment of pleasant and unpleasant places. For pleasant places, the areas engaged in positive emotions were activated, and for unpleasant places, the areas engaged in negative emotions were activated. In this regard, the pleasant places were associated exclusively with strong activations and the highest score of found voxels (32077) compared to the unpleasant places (21784). Such a difference provides evidence that pleasant places in the aspect of using spatial and architectural qualities trigger emotions to a stronger degree than unpleasant places, and the brain areas engaged in emotions respond more effectively and more strongly to pleasant places than unpleasant places. These findings represent that the areas associated with pleasantness and reward processing are involved in preferences that include good (pleasant) or bad (unpleasant) designs.

Because of highly increased activities in visual areas of the **occipital lobe** (v=8937), beauty judgment areas of the **frontal lobe** (v=3674), visual-spatial perception (form, color, and recognition of objects) areas of the **temporal lobe** (v=3340), spatial orientation, tactile, and perception (motion, depth, height, width, geometry) areas of the **parietal lobe** (v=3134), spatial memory areas of the **posterior cingulate** (1528), the architectural experience of large-scale places and landscape areas of the **parahippocampal** (v=903), and visuo-spatial exploration of architectural space and the processing of social cues areas of the **superior temporal** (v=744) in relation to pleasant places rather than the same areas for unpleasant places [**occipital lobe** (v=4564), **frontal lobe** (v=3123), **temporal lobe** (v=1429), **parietal lobe** (v=1223), **posterior cingulate** (664), **parahippocampal** (v=659), **superior temporal** (v=63)], it is assumed that positive places in the aspect of providing architectural qualities are able to attract the more attention for design. Results suggest that the external appearance of an architectural design can influence the emotional, perceptual, cognitive, beauty judgment, and decision-making (behavioral) process of the user to a high degree. So, it can be possible that pleasant places due to attracting more attention and memory effects contribute to architectural design much better than unpleasant places. Findings suggest that unpleasant design will have a negative impact on the emotional-perceptual experience of place, and designers should pay more attention to the valence of good design.

Based on the data analysis of the "**sensation**" process in the close questionnaire evaluation, the following table provides comparative data related to rating the sub-components of sensation for pleasant and unpleasant places.

Table 5-35: The comparative data of all users' quantitative ratings of sensation sub-components in related to the pleasant and unpleasant places.

Relevant Place	Sub-Component	Mean ($\bar{X}$)
Pleasant	Texture	**3.84**
	Material	3.65
	Light	3.61
	Color	3.57
	Sound	3.06
	Odor	**2.76**
Unpleasant	Texture	**3.75**
	Material	3.72
	Color	3.66
	Light	3.60
	Sound	3.37
	Odor	**3.27**

Accordingly, it was concluded that the sub-component of “texture” had the highest score; and “odor” had the lowest score from users’ point of view. The results have been quite similar in two ways, both pleasant (texture; M=3.84; odor; M=2.76) and unpleasant (texture; M=3.75; odor; M=3.27). Therefore, the texture sub-component was the most effective item in making a pleasant and unpleasant sense of place, and the odor sub-component was the least effective item. The accurate investigation of numerical results of the sensation component in users’ emotional-perceptual experience in both pleasant and unpleasant states indicates that the “odor” and “sound” sub-components differ significantly from other items, and it can be said that the four sub-components of “texture”, “material”, “light”, and “color” are recognized as the main sub-components of the emotional experience of place and are distinguished from the other two “odor” and “sound” sub-components. In addition, it can be noted that there is very little difference in how the sub-components are graded in these two general emotional states. In other words, in the “sensation” component, every sub-component has the close or the same effect on both pleasant and unpleasant states. Another interpretation of this analysis that can be predicted is that by making appropriate changes to the “texture” of a place, it is likely to have significant positive effects on the users’ feelings. It can also be predicted that by making appropriate or inappropriate changes to the “odor” there may be no tangible changes in the pleasant or unpleasant feeling of users.

Given the direct relation of the four main sub-components of the sensation component of place emotional experience (texture, materials, light, and color) to the two senses of “vision” and “touch”, the main role of these two senses in making a pleasant and unpleasant sense of place is emphasized. In this regard, the results obtained are consistent with an important part of postmodern theorists and architects such as Johannes Pallasma (2012), Peter Zumthor (1998) and Steven Hall et al. (2007), who emphasize vision-oriented and multi-sensory architectural experience. These views emphasize that the architectural work is not experienced as a set of isolated visual images, and within a body-oriented approach considering the senses of body-physical and touch it provides a specific experience of the surrounding world. Thus, tactual components such as touch and material along with visual components of light and color make the users’ sense of the pleasant or unpleasant experience of place.

Based on the results obtained from previous parts representing the direct link between “pleasant or unpleasant experience of the architectural environment” and “the activation of areas engaged in happiness, pleasantness, beauty judgments (cerebellum, anterior cingulate, precuneus, fusiform, frontal), sadness, fear, and disgust (insula, cingulate, middle temporal, frontal lobe, thalamus)" in the brain, it is concluded that the sub-components of texture, materials, light, and color play the most role in activating the brain areas which involved in positive and negative feelings rather than sub-components of "odor" and "sound". The results show that the touch system, as well as the associated architectural features such as texture, and materials have a greater ability to create a pleasant and unpleasant sensation than other senses including vision and visual features. The skin and associated sense of touch constitute the closest human relation to the built environment, and in addition to its high capacity to provide comfort and protection, better perception of objects, ability to the understanding of temperature, hardness, softness, etc., have an undeniable role in the brain activity (activating the specific brain areas associated to positive and negative feelings) and thus affecting human emotional health.

Individuals are exposed to various tactual perceptions by being in an architectural place. Such a tactile experience can be described as: By walking into the architectural space and sensory-muscular experience, one's feet experiences the texture deeply and other properties of the floor. By sitting on different surfaces, lying down or leaning on surfaces, touching different elements such as stair railings, walls, floors, door handles, furniture, etc., different dual properties such as "roughness-smoothness", "softness-hardness", "cold-warm", "heaviness-lightness", etc. are transmitted to the brain processor. These stimuli activate the brain areas (anterior cingulate, occipital lobe, temporal lobe, superior temporal, parahippocampal, frontal lobe, fusiform) associated with "happiness, love, and satisfaction" or "fear, sadness, and disgust" through various tactile nerves (hair, cutaneous nerves, etc.) by transmitting to the main parts associated with touch in the brain (areas of the anterior, parietal and insular cortex) which cause in making pleasant or unpleasant feeling.

Applying appropriate or inappropriate materials, textures, color, and light to the interior and exterior of buildings can have a special ability to activate the parts of the brain engaged in happiness, sadness, satisfaction, fear, etc. Therefore, these components must be given serious consideration in contemporary architectural and urban design, and even restoration of historical monuments. The use of materials, textures, colors, and light in accordance with the users' preferences can create a pleasant feeling and increase the satisfaction of individuals. In contrast, though minor changes in materials, textures, colors, and light in a place that is experienced by users previously and provided their satisfaction can lead to unpleasant emotions and general dissatisfaction with that place.

Based on the data analysis of the "**perception**" process in the close questionnaire evaluation, the following table provides comparative data related to rating the sub-components of perception for pleasant and unpleasant places. Accordingly, results showed a trivial difference between the scores of other sub-components (the highest score of M=3.73 (geometry) and the lowest score of M=3.34 (largeness & depth) for pleasant places; the highest score of M=3.65 (geometry, order, proportion) and the lowest score of M=3.32 (height) for unpleasant places). This indicates that components of perception have a uniform and similar importance. Thus, the contribution of each sub-component to the pleasant and unpleasant perceptions of a place can be similar to other sub-components. For instance, related to pleasant places "largeness" and "depth" had exactly the same score and both of them made users feel pleasant.

Table 5-36: The comparative data of all users' quantitative ratings of perception sub-components in related to the pleasant and unpleasant places.

Relevant Place	Sub-Component	Mean ($\bar{X}$)
Pleasant	**Geometry**	**3.73**
	Order	3.66
	Proportion	3.63
	Height	3.55
	Rhythm	3.45
	Width	3.42
	Largeness (Size)	**3.34**
	Depth	**3.34**
Unpleasant	**Geometry**	**3.65**
	Order	**3.65**
	Proportion	**3.65**
	Rhythm	3.63
	Width	3.50
	Largeness (Size)	3.49
	Depth	3.49
	Height	**3.32**

In spite of trivial differences in sub-component scores, the three sub-components of "geometry", "order", and "proportion" had the most important and highest score. The degrees of other components in the pleasant and unpleasant conditions were different. This shows that unlike the "sensation" components that had similar degrees both in pleasant and unpleasant conditions, the "perception" component was different from each other in the aspect of degrees. This suggests that the perceptual sub-components have had vary significantly depending on the user characteristics.

Numerical analysis of perception data showed that in terms of pleasant feeling, the sub-components of “largeness” and “depth” had the least effect. In other words, the feeling of pleasantness to a place cannot depend significantly on the depth or largeness. Other data also suggest that the unpleasant feeling of a place cannot depend significantly on its size or height. The importance of three sub-components of geometry, order, and proportion in the pleasant perception of place emphasizes the main impact of “formal properties”, “mathematical ratios of physical elements”, and “visual disturbance rate” on the users’ satisfaction. Hence, the basic shapes used in the form, facade, and ornaments, how they are combined, the mathematical ratios of the sizes and shapes to each other and the human scale, as well as the amount of visual disturbance in the appearance of buildings and interior spaces, can influence how users perceive a place.

Given the direct relationship between the activation of brain areas engaged in the emotional process (happiness, sadness, etc.) and pleasant-unpleasant perception of place, one can conceive of a relationship between the brain activity and perceptual components. In this regard, given the similar and uniform evaluation of users from the perceptual sub-components, a balanced contribution can be defined to the ability of these sub-components to activate different parts of the brain engaged in emotional states (anterior cingulate, fusiform, inferior occipital, temporal, and cuneus). The higher score of the geometry, order, and proportion in making pleasant and unpleasant feelings emphasizes the less role of concepts such as “composition”, “spatial and formal relations”, and “visual aesthetics” in the brain activity. Given this fundamental issue, the effect of such properties on the activation of different parts of the brain can be described as follows: by being in places with various features, different ratios of height and width, and the extent of disturbance or order, cause in the different parts of brain to be activated.

In the investigation of the “**cognition**” process, the component of attention (M=3.88) had evaluated as the most effective factor. In this context, the “appearance facade” sub-component attracted the most attention of respondents (M=4.06). The sub-components of public spaces and functional spaces were classified in the next ranks. Experiencing architectural place, in addition to functional aspects, the visual characters of the place also trigger the attention. Thus, the overall face of a building and its mental images are recorded in the memory of users. Furthermore, the brain imaging analyses in the previous parts revealed activations in areas involved in attention such as the parietal lobe, frontal lobe, and temporal lobe which supported the relevant results.

Conceptualization is the second component evaluated in the process of cognition (M=3.32), and results showed that the “physical features” sub-component significantly contributed to conceptualizing and becoming meaningful in the users’ mind (M=3.91). The “social features” and “functional features” had the least contribution. This result is also in line with the results of the attention sub-component. Reminding appearance facade of a building, its physical features are also transformed into different meanings in the brain. Data analyses of “association” showed that symbolic and iconic signs (M=4.16) were more commemorative than other sub-components. The brain areas engaged in memory and association such as the temporal lobe, precuneus, and hippocampus were activated. Based on the data analysis of the “**cognition**” component in the closed questionnaire evaluation, the following table provides comparative data related to rating the sub-components of cognition.

Table 5-37: All users cognition measurement data in related to the case study places

Sub-Components		Mean ($\bar{X}$)		Standard Deviation
Attention	**Appearance Facade**	**4.06**	3.88	0.917
	Public Spaces	3.91		1.01
	Functional Spaces	3.67		1.28
Conceptualization	**Physical Features**	**3.91**	3.32	1.01
	Social Features	3.03		1.21
	Functional Features	3.02		1.38
Association	**Symbolic & Iconic Signs**	**4.16**	3.23	0.99
	Public Spaces	2.78		1.23
	Index Signs	2.74		1.30
Cognitive Map	**Landmark Knowledge**	**3.73**	2.28	2.00
	Route-road Knowledge	2.01		2.86
	Survey Knowledge	1.11		2.77

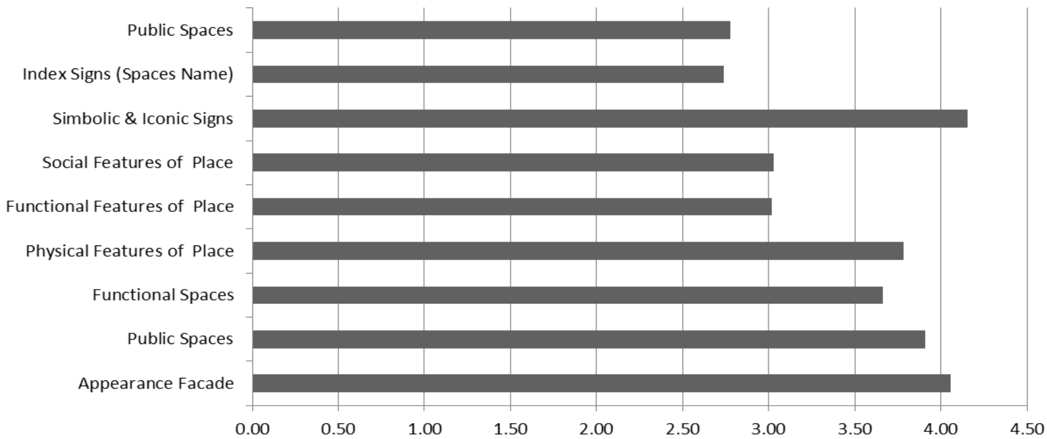


Diagram 5-8: All users cognition measurement data in related to case study places

In “cognitive map” the “landmark knowledge” was considered as the more effective criteria (M=3.73) in assessing users’ mental image. This suggests that locating symbolic buildings such as the Alaaddin Hill, Karatay Madrasah, and Alp Arslan forum play a significant role in users’ mental image and in identifying their school building. In this regard, the brain activations in areas such as the occipital lobe (engaged in the spatial movement, direction, and location); the parahippocampal (representation of large-scale places, landscape and location); the fusiform gyrus (recognizing and identifying locations); the left middle temporal (semantic memory processing), and the parietal (spatial orientation, cognition and location) support the importance of landmarks in the formation of users’ mental imaginary. Additionally, the “Route-road knowledge” sub-component was evaluated as the second factor (M=2.01) influencing users’ mental imaging. It suggests that passages and streets in the vicinity of the case study were considered by users that determine the motion paths. “Survey knowledge” was evaluated as the last factor (M=1.11). This knowledge develops over time and is promoted by increasing commuting to place. Since the current faculty had started working as an architecture school for one year, students needed a longer time to have an understanding of landmarks and distances. Tendencies to approach or avoid a place are considered as the main aspect of emotion which provides the possibility of responding to the various environmental stimuli. Based on the data analysis of the “**behavior**” process in the questionnaire evaluation, the following table provides comparative data of ratings on the sub-components of behavior for pleasant and unpleasant places.

Table 5-38: All users cognition measurement data in related to the case study places

Sub-Components		Mean ($\bar{X}$)	SD
The Old Bilding	**Approach**	4.69	2.00
	Avoidance	-0.31	
The New Bilding	**Approach**	0.82	2.86
	Avoidance	-3.84	
The Sports Hall Bilding	**Approach**	0.77	2.77
	Avoidance	-4.19	

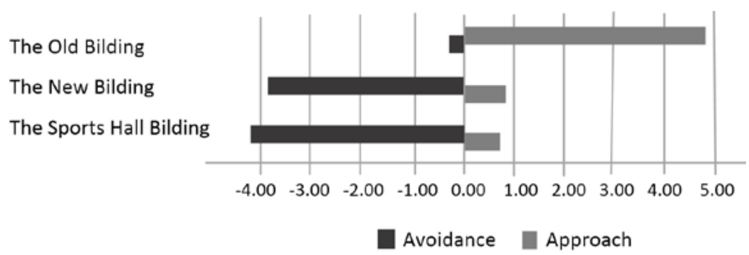


Diagram 5-9: All users behavior measurement data in related to case study place

As shown, the factor of the “approach” is assessed with positive numbers. The old building (M=4.69) assessed as a pleasant place scored highest and preferred to approach. In this regard, the findings of the observation and activation of brain areas engaged in approach (middle prefrontal cortex and middle frontal) for old buildnig supported this result. In “avoid”, the sports hall building (M=-4.19) and the new building (M=-3.84) which had evaluated as unpleasant buildings were scored the highest. In this regard, the findings of the observation and activation brain areas engaged in avoidance (insula, cingulate, left fusiform, and superior occipital) for these two buildings supported this result.

Consequently, in measuring the contribution of each component affecting the process of emotional-perceptual experience of place, it was found that the **behavior** is evaluated as the most effective factor (M=4.48). This suggests that the characteristics of pleasant and unpleasant places chiefly affect individual spatial judgments and behavior. Data presented in diagram 2-4 support this idea and considered behavior as a result of a sensory, perceptual, and cognitive process. Indeed, sensory factors like color, texture, light, etc., and perceptual factors (physical elements) such as size, height, geometry, proportion, etc. through a cognitive process (attention, conceptualization, etc.) affect the users’ behavior. So, from the results, it can be truly said that individuals match their five senses and perceptions obtained from the physical environment to base their behaviors in psychological representation formats. **Perception** is evaluated as the second effective factor (M=3.54), the **sensation** is the third effective factor (M=3.49), and **cognition** (M=3.18) is the last factor affecting the emotional-perceptual experience of place.

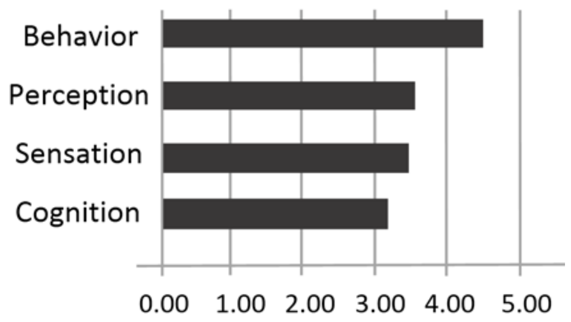
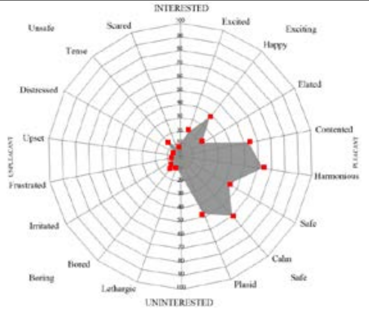


Diagram 5-10: Classifying the process factors of all users’ emotional-perceptual experience of place

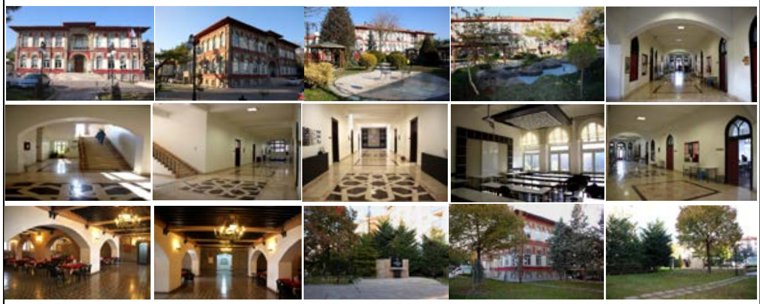
The first phase of findings which was related to all participants (female architects, male architects, female urban designers, and male urban designers) was conducted, and the summary of results is presented as the following table.

Table 5-39: The comparation of all users' emotional-neurological ratings of pleasantness (p-unc <0.05).

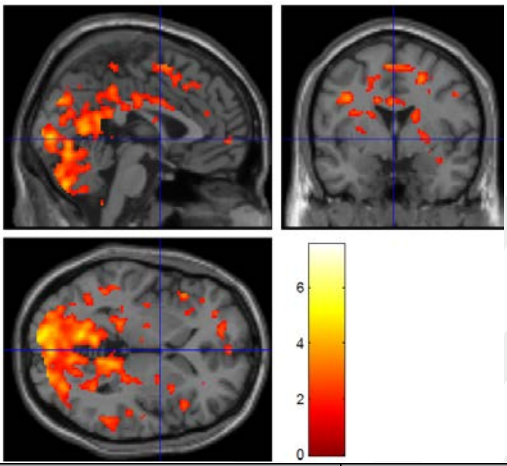
Pleasure-Arousal Model



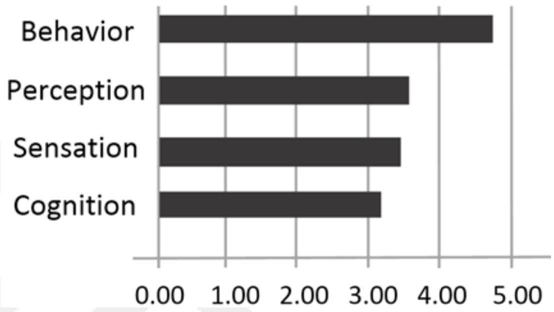
Selected Pleasant Places



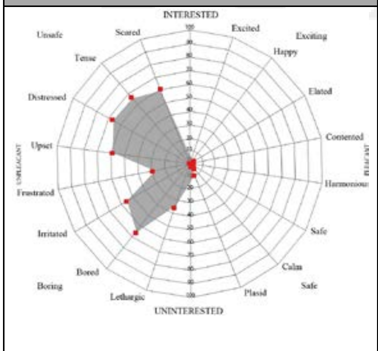
The Brain Activation of Pleasant Places



Quantitative Results of Pleasant Places

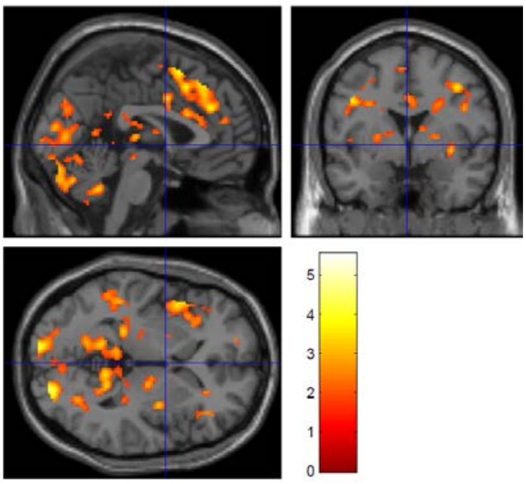


Pleasure-Arousal Model

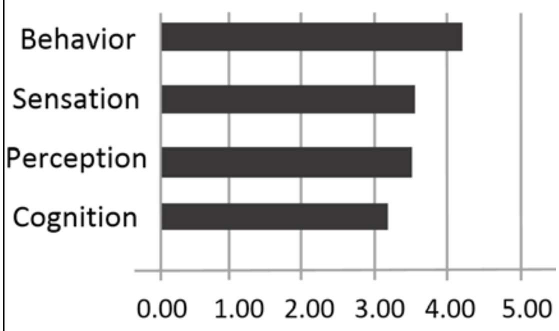


Selected Unpleasant Places

The Brain Activation of Pleasant Places



Quantitative Results of Pleasant Places



- **The comparative fMRI statistical analyzing methods of users ratings**

To increase the reliability and validity of the neurological investigation, and in addition to using p-unc<0.05 value in the statistical analysis of the brain activation, the p-unc<0.01 which is used as more sensitive with high statistical value and p-FWE<0.05 which is used for multiple comparisons were applied. The following figure and table present the results of statistical analysis with p<0.01 value for the **pleasant** places.

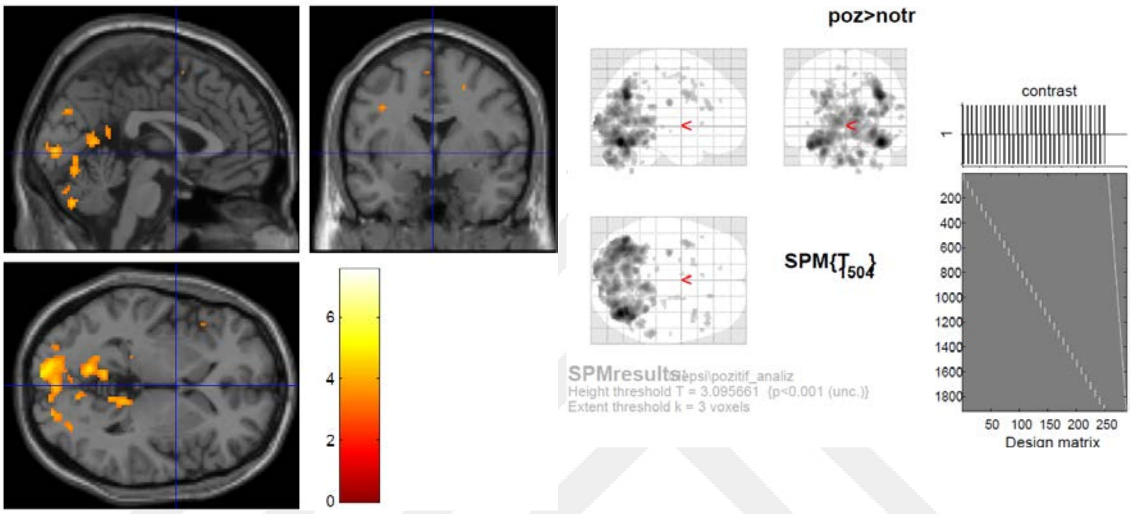


Figure 5-10: The fMRI analyses of pleasant places for all users (p-unc<0.01)

According to the figure above, the most activated areas engaged in emotions were shown in areas such as the cerebellum (right & left cerebellum), fusiform gyrus, precuneus, and frontal lobe (T=7.54, p= 0.000<0.01, x=38, y=-70, z=-18, K=7590). As observed, less but similar areas of the brain have activated than the p-unc<0.05 value.

Table 5-40: fMRI measurement data in related to pleasant places for all users (p-unc<0.01).

<table>
<tr><th colspan="6">Number of Defined Clusters Found: 24   Number of All Voxels: 8128</th></tr>
<tr><th>Cluster</th><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td rowspan="3">1</td><td>All Students</td><td>7590</td><td>38 -70 -18</td><td>7.54</td><td>0.000</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Left Cerebellum: 957 / Fusiform Gyrus: 819 / Right Cerebellum: 465 / Precuneus: 321/ Frontal Lobe: 61</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Architecture:</u>
Occipital Lobe: 3734 / Lingual Gyrus: 1357 / Cuneus: 823 / Parietal Lobe: 626 / Temporal Lobe: 597/ Middle Occipital Gyrus: 316 / Superior Parietal Lobe: 45 / Thalamus: 20</td></tr>
<tr><td colspan="6"><u>Total Voxels Number of More Effective Active Regions:</u>
Left Cerebellum: 957 / Fusiform: 819 / Right Cerebellum: 570 / Precuneus: 332 / Frontal Lobe: 196</td></tr>
</table>

The following figure and table present the results of statistical analysis with the method of p-FWE<0.05 value for the pleasant places.

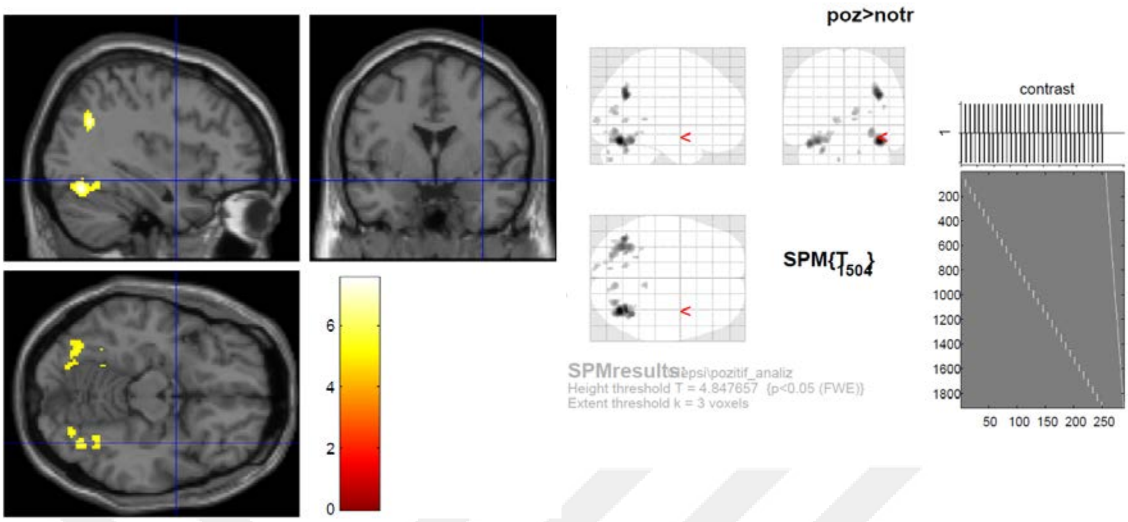


Figure 5-11: The fMRI analyses of pleasant places for all users (p-FWE<0.01)

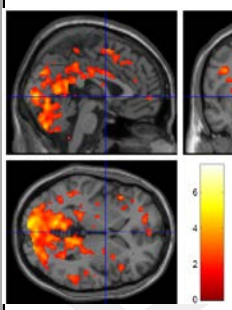
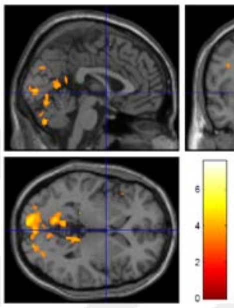
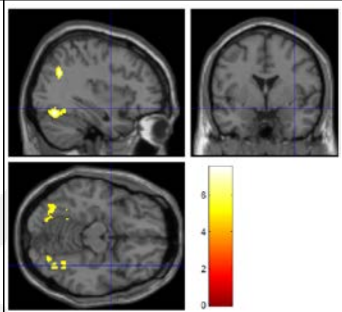
According to the figure above, the most activated areas engaged in emotions were found in areas such as the right cerebellum, fusiform gyrus, and precuneus (*T*=7.54, *p-FWE*= 0.000<0.05, *x*=38, *y*=-70, *z*=-18, *K*=244). As observed, in comparison the activated brain areas are less than areas found using the p-unc<0.05 value method.

Table 5-41: fMRI measurement data in related to pleasant places for all users (p-FWE<0.05).

Number of Defined Clusters Found: 12 Number of All Voxels: 786					
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	All Students	244	38 -70 -18	7.54	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Fusiform Gyrus:** 114 / **Right Cerebellum:** 56 / **Precuneus:** 10				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 119 / Temporal Lobe: 58 / Middle Occipital: 15				
Total Voxels Number of More Effective Active Regions: Fusiform Gyrus: 171 / Right Cerebellum: 56 / Precuneus: 10					

As shown in the tables presented above (5-40 and 5-41), in relate to pleasant places the brain activations found by using p-unc<0.05 value are more and stronger than the brain activations found by using both p-unc<0.01 and *p-FWE*<0.05 values for the same found cluster. The following comparative table shows that in p-unc<0.05 value, the number of found cluster voxels (*KE*=29505), the number of all clusters found (n=42), the number of all activated voxels (n=32077), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception are more and stronger than the p-unc<0.01 value (*KE*=7590; clusters found=24; all activated voxels=8128) and *p-FWE*<0.05 value (*KE*=244; clusters found=12; all activated voxels=786).

Table 5-42: All users fMRI data in related to pleasant places using different statistical p-values.

Peak MNI coordinate: *x*=38 *y*=-70 *z*=-18 **t-Peak Intensity:** 7.54 **p:** 0.000			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			
Clusters	42	24	12
Voxels	32077	8128	786
KE	29505	7590	244
Peak MNI Region Engaged in Emotion	**Cerebellum:** 4783; **Left Cerebellum:** 3320; **Right Cerebellum:** 3118; **Precuneus:** 2104; **Frontal Lobe:** 1799; **Fusiform Gyrus:** 1056; **Medial Frontal:** 368; **Middle Frontal:** 205; **Left Insula:** 51 **Right Frontal:** 24; **Anterior Cingulate:** 11	**Left Cerebellum:** 957; **Fusiform Gyrus:** 819; **Right Cerebellum:** 465; **Precuneus:** 321; **Frontal Lobe:** 61	**Fusiform Gyrus:** 114; **Right Cerebellum:** 56; **Precuneus:**10
Peak MNI Region Engaged in Architecture	Occipital Lobe: 8937; Limbic Lobe: 3437; Temporal Lobe: 3340; Parietal Lobe: 3134; Lingual Gyrus: 2963; Cuneus: 2316; Posterior Cingulate: 1528; Middle Occipital: 975; Parahippocampal: 903; Middle Temporal: 858; Superior Temporal: 744; Right Superior Temporal: 489; Left Middle Temporal: 294; Inferior Occipital: 258; Right Parietal Lobe: 210; Superior Frontal: 150; Inferior Frontal Gyrus: 102; Angular Gyrus: 100; Left Middle Frontal: 71; Superior Parietal: 89; Inferior Temporal: 13; Anterior Cingulate: 11	Occipital Lobe: 3734; Lingual Gyrus: 1357; Cuneus: 823; Parietal Lobe: 626; Temporal Lobe: 597; Middle Occipital Gyrus: 316; Superior Parietal Lobe: 45; Thalamus: 20	Occipital Lobe: 119; Temporal Lobe: 58; Middle Occipital: 15

Related to **unpleasant** places the following figure and table present the results of statistical analysis with a statistical p-unc<0.01 value.

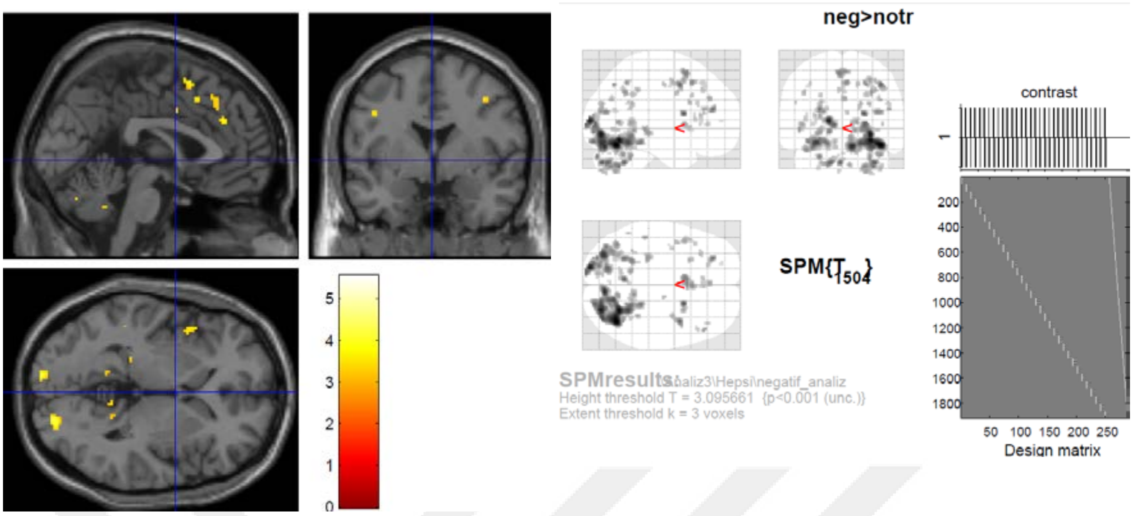


Figure 5-12: The fMRI analyses of unpleasant places for all users (p-unc<0.01)

According to the figure above, the most activated areas engaged in emotions were found in areas such as the right and left cerebrum, fusiform gyrus, temporal lobe, left hippocampus, insula, left insula, frontal lobe, and cingulate cortex (T=5.53, p= 0.000<0.01, x=40, y=-66, z=-20, K=1360). As shown, compared to data obtained by statistical p-unc<0.05 value, less and some different areas were activated such as temporal lobe and left insula.

Table 5-43: fMRI measurement data in related to unpleasant places for all users (p-unc<0.01).

<table>
<tr><th colspan="6">Number of Defined Clusters Found: 51 Number of All Voxels: 3106</th></tr>
<tr><th>Cluster</th><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td rowspan="3">1</td><td>All Students</td><td>1360</td><td>40 -66 -20</td><td>5.53</td><td>0.000</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Right Cerebrum: 857 / Fusiform: 294 / Temporal Lobe: 36 / Left Hippocampus: 34 / Left Cerebrum: 32/ Insula: 22 / Left Insula: 15 / Frontal Lobe: 8 / Cingulate: 5</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Architecture:</u>
Occipital Lobe: 738 / Middle Occipital: 95 / Parahippocampal: 75</td></tr>
<tr><td colspan="6"><u>Total Voxels Number of More Effective Active Regions:</u>
Right Cerebrum: 1229 / Left Cerebrum: 817 / Fusiform Gyrus: 452 / Frontal Lobe: 286 / Temporal: 76 / Left Hippocampus: 34 / Left Insula: 31 / Insula: 22 / Cingulate: 11</td></tr>
</table>

Also, the following figure and table present the results of statistical analysis conducted by using the statistical method of p-FWE<0.05 value for the unpleasant places. Like the data shown with statistical method of p-unc<0.01, less and weak activations were revealed in this statistical method in comparison to p-unc<0.05.

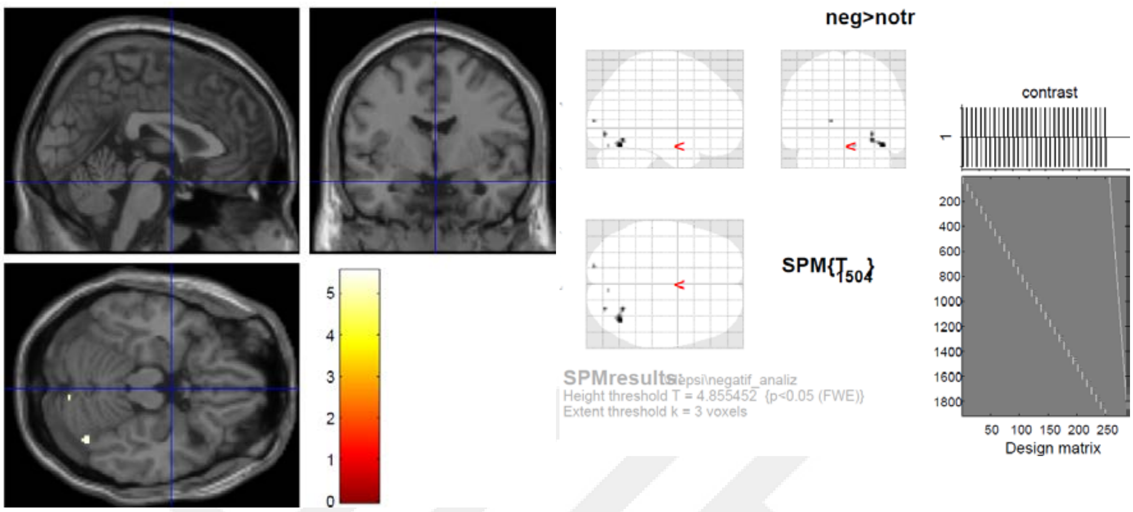


Figure 5-13: The fMRI analyses of unpleasant places for all users (p-FWE<0.05)

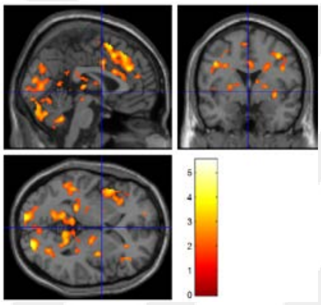
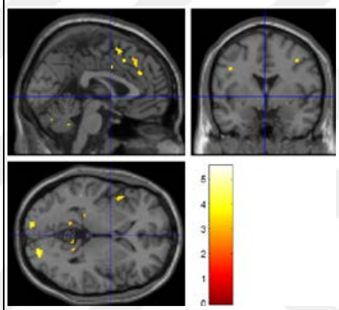
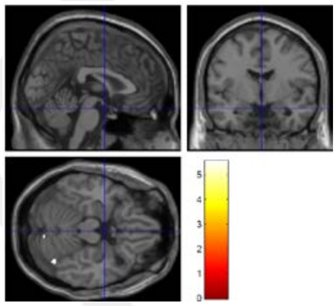
Accordingly, the most activated areas engaged in emotions were found in areas such as right cerebrum and fusiform (*T*=5.53, *p-FWE* = 0.000<0.05, *x*=40, *y*=-66, *z*=-20, *K*=33). As shown, in comparison to the statistical p-unc<0.05 value, fewer areas have activated.

Table 5-44: fMRI measurement data in related to unpleasant places for all users (p-FWE<0.05).

Number of Defined Clusters Found: 2 Number of All Voxels: 38					
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	All Students	33	40 -66 -20	5.53	0.000
	<u>Peak MNI Coordinate Region Engaged in Emotion:</u> **Right Cerebrum:** 27 / **Fusiform Gyrus:** 23				
	<u>Peak MNI Coordinate Region Engaged in Architecture:</u> Occipital Lobe: 23				
<u>Total Voxels Number of More Effective Active Regions:</u> Fusiform Gyrus: 23 / Right Cerebrum: 5 / Temporal Lobe: 4					

As shown in the tables presented above (5-43 and 5-44), in relation to unpleasant places the brain activations found using p-unc<0.05 value are more and stronger than the brain activations found using both p-unc<0.01 and *p-FWE*<0.05 values for the same found cluster. The following comparative table shows that in p-unc<0.05 value, the number of found cluster voxels (*KE*=15641), the number of all clusters found (n=50), the number of all activated voxels (n=21784), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception are more and stronger than the p-unc<0.01 value (*KE*=1360; clusters found=51; all activated voxels=3106) and *p-FWE*<0.05 value (*KE*=33; clusters found=2; all activated voxels=38).

Table 5-45: All users fMRI data in related to unpleasant places using different statistical p-values.

Peak MNI coordinate: *x*=38 *y*=-70 *z*=-18 **t-Peak Intensity:** 7.54 **p:** 0.000			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			
Clusters	50	51	2
Voxels	21784	3106	38
KE	15641	1360	33
Peak MNI Region Engaged in Emotion	**Right Cerebrum:** 6579; **Left Cerebrum:** 3702; **Fusiform Gyrus:** 947; **Left Fusiform:** 784; **Middle Temporal:** 331; **Frontal Lobe:** 220; **Thalamus:** 211; **Left Hippocampus:** 183; **Cingulate Gyrus:** 141; **Left-Mid Temporal:** 110; **Insula:** 52; **Hippocampus:** 27; **Left Thalamus:** 18	**Right Cerebrum:** 857; **Fusiform:** 294; **Temporal Lobe:** 36; **Left Hippocampus:** 34; **Left Cerebrum:** 32; **Insula:** 22; **Left Insula:** 15; **Frontal Lobe:** 8; **Cingulate:** 5	**Right Cerebrum:** 27; **Fusiform Gyrus:** 23
Peak MNI Region Engaged in Architecture	Occipital Lobe: 4564; Limbic Lobe: 1512; Temporal Lobe: 1429; Lingual Gyrus:1360; Parietal Lobe: 1223; Posterior Cingulate: 664; Parahippocampal: 659; Middle Occipital: 506; Precuneus: 452; Superior Temporal: 63; Superior Parietal: 59; Angular: 19	Occipital Lobe: 738; Middle Occipital: 95; Parahippocampal: 75	Occipital Lobe: 23

5.3.2. The findings of the fMRI and close questionnaire for women and men

- **fMRI measurement data in related to pleasant places for women**

Figure 5-14 presents the parts of the brain that were activated when female participants saw pleasant places. As shown, in cluster 1 the most activated areas were pointed at the cerebellum (left and right cerebellum), precuneus, fusiform gyrus, frontal lobe, and anterior cingulate (T=6.95, p= 0.000<0.05, x=36, y=-62, z=32, K=20068). The findings demonstrated that activation in a distributed network including the cerebellum and anterior cingulate covaried in relation to **happiness**. In addition, activation in the precuneus, anterior cingulate cortex and fusiform gyrus covaried in relation to **pleasant emotions** ratings.

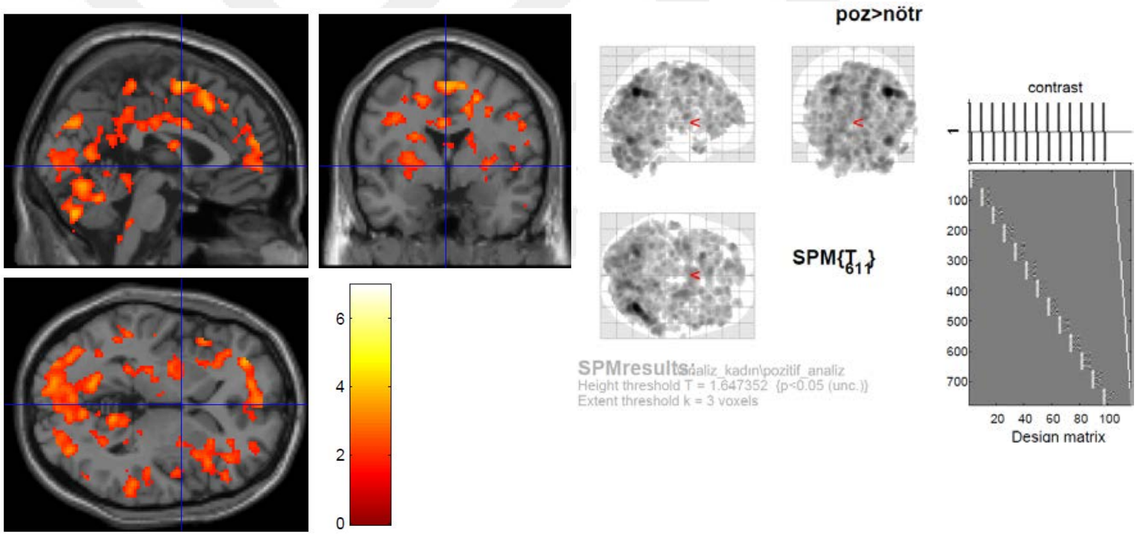


Figure 5-14: The fMRI analyses of pleasant places for all women (p-unc<0.05)

Besides, according to the brain activated areas based on literature and previous case studies presented in Table 2-17, the *precuneus* area also is engaged in determining orientation in space, aesthetic and beauty assessments of artworks, and perception. The *frontal lobe* is associated with beauty judgment and pleasantness; the *fusiform gyrus* is engaged in the neural representation of architectural styles and identifying locations, and the *anterior cingulate cortex* is involved in the emotional processing of architecture, reward properties, the judgment of beauty, and emotional salience of objects.

In addition to activating the areas involved in the pleasantness and emotions, activities in other areas were also recorded each of which confirms the brain’s response to spatial elements and architectural qualities. For instance, the *occipital lobe* which responses to perceptual information regarding architecture, is involved in the perception of forms, colors, height, depth, geometry, spatial movement direction, visual processing, and recognizing objects; the *temporal lobe* which is engaged in visual perception (form, color, and recognition of objects) and spatial perception (height, depth, geometry); the *parietal temporal lobes* which is involved in understanding spatial orientation and perception (motion, depth, height, width, geometry), visual perception, cognition, identifying the position, location, and touch; the *cuneus* which is responsive to the appreciation of representational material; and the *parahippocampal* which is involved in the architectural experience of large-scale places, landscape, and location.

Furthermore, As shown in cluster 2, the most activated areas were pointed to the medial frontal, middle frontal, left insula, and right frontal lobe (T=4.56, p= 0.000<0.05, x=-20, y=12, z=46, K=7908). The findings demonstrated that activation including the left insula and right frontal covaried in relation to **happiness**. In addition, activation in the medial frontal and middle frontal lobe covaried in relation to **pleasant emotions**. Besides, according to Table 2-17, the *medial frontal* area also is engaged in processing of the feeling of reward during architecture appraisal, and the *middle frontal* is involved in beauty judgment and approach behavior.

Table 5-46: fMRI measurement data in related to pleasant places for women (p-unc<0.05)

Number of Clusters Found: 44			Number of All Voxels: 29827		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Women	20068	36 -62 32	6.95	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Cerebellum:** 4014 / **Right Cerebellum:** 2983 / **Left Cerebellum:** 2424 / **Precuneus:** 1618 / **Fusiform Gyrus:** 1008 / **Frontal Lobe:** 64 / **Anterior Cingulate:** 9				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital: 5973 / Temporal: 2875 / Parietal Lobe: 2532 / Limbic Lobe: 2290 / Cuneus: 1825 / Lingual Gyrus:1803 / Parahippocampal: 415				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Women	7908	-20 12 46	4.56	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Frontal Lobe:** 4889 / **Medial Frontal:** 1302 / **Middle Frontal:** 500 / **Anterior Cingulate:** 395 / **Left Insula:** 280 / **Right Frontal:** 246				
Total Voxels Number of More Effective Active Regions: Frontal Lobe: 5543 / Cerebellum: 4014 / Right Cerebellum: 3002 / Left Cerebellum: 2461 / Precuneus: 1618 / Medial Frontal: 1432 / Fusiform Gyrus: 1014 / Middle Frontal: 542 / Anterior Cingulate: 412 / Left Insula: 287 / Right Frontal: 246					

As shown in Table 5-46, the areas of the brain engaged in emotions that were expected to be activated in the face of pleasant palces are marked by bold fonts. The results demonstrated that assessing the pleasantness of pleasant/positive in the aspect of spatial elements and architectural qualities was associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=5973], and the least value in the **Parahippocampal** [Voxels=415]; and in relation to emotionally assessing, it was associated exclusively with the highest increase in the **Frontal Lobe** [Voxels=5543] and at the least value in the **Right Frontal** [Voxels=246].

- **fMRI measurement data in related to unpleasant places for women**

The following figure presents the parts of the brain engaged in emotion that were activated when female participants saw unpleasant places. Also, the following table shows the statistical analysis of the activated brain areas which makes it possible to indicate the most effective areas engaged in the emotional and cognitive process encountering negative scenes and places. As shown in cluster 1, the most activated areas were pointed at the right and left cerebrum, fusiform gyrus, left fusiform, middle temporal, cingulate, superior occipital, frontal lobe, left hippocampus, thalamus, right middle temporal, insula, left thalamus, hippocampus, left middle temporal and left insula (*T*=5.14, *p*= 0.000<0.05, *x*=28, *y*=-54, *z*=-22, *K*=14556).

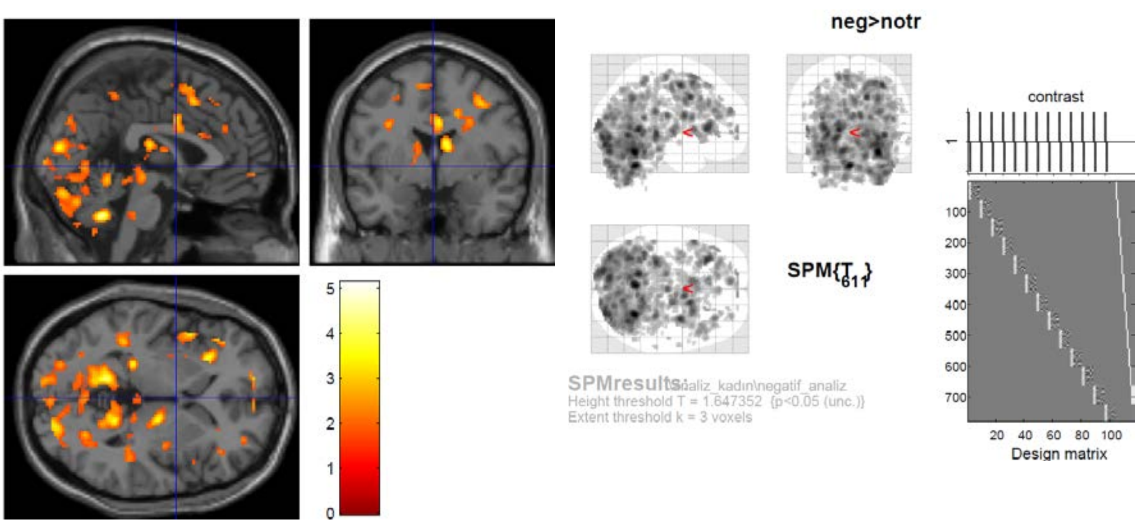


Figure 5-15: The fMRI analyses of unpleasant places for all women (p-unc<0.05)

The findings demonstrated that activation in a distributed network including the cerebrum, middle temporal, left hippocampus, thalamus, and left middle temporal are engaged in **fear**. Activation in the areas such as the cingulate, right middle temporal, and insula, is involved in **sadness** and **fear**. The frontal lobe and left insula are engaged in **anger**, **disgust**, and **fear**. The left thalamus and hippocampus are engaged in **sadness**. Also, the fusiform is engaged in **unpleasant emotion**, and left fusiform as well as superior occipital are involved in **avoidance behavior**.

In addition to activating the areas involved with the unpleasant emotions, activities in other areas were also recorded each of which confirms the brain's response to spatial elements and architectural qualities. According to the Table 2-17, the *fusiform gyrus* is engaged in the neural representation of architectural styles and identifying locations; the *middle temporal* which is engaged in perceiving motion in an architectural space; the *cingulate* is involved in the emotional processing and the avoidance decisions of architectural spaces, the *frontal lobe* is engaged in reward processing, beauty judgment, and planning; the *insula* is engaged in avoidance, *left middle temporal* is involved in semantic memory processing, visual perception, and aesthetic judgment. The *hippocampus* is implicated in memories and perception.

Besides, the *occipital lobe* responds to perceptual information regarding architecture, and is involved in the perception of forms, colors, height, depth, geometry, spatial movement direction, visual processing, and recognizing objects; the *temporal lobe* engaged in visual perception (form, color, and recognition of objects) and spatial perception (height, depth, geometry); the *parietal temporal* lobes involved in understanding spatial orientation and perception (motion, depth, height, width, geometry), visual perception, cognition, identifying the position, location, and touch; the *middle occipital gyrus* is involved in the aesthetic assessments of artworks and beauty ratings; the *posterior cingulate* is engaged in spatial memory and spatial orientation of objects; the *parahippocampus* is involved in aesthetic assessments of artworks, beauty ratings, and beauty ratings; the *precuneus* is engaged in aesthetic assessments of artworks, pleasantness, and perception; the *superior temporal sulcus* is involved in visuo-spatial exploration of architectural space, processing of social cues and interpersonal touch.

Furthermore, as shown in cluster 2, the most activated areas were pointed at the anterior cingulate, right insula, inferior frontal, and orbitofrontal lobe (T=3.55, p= 0.000<0.05, x=-48, y=10, z=2, K=107). The findings demonstrated that activation including the anterior cingulate is engaged in **fear** and **sadness**; the right insula and inferior frontal are involved in **disgust**; and orbitofrontal cortex is engaged in **fear**, **anger**, and **disgust**. Besides, according to Table 2-17, the *anterior cingulate cortex* is engaged in emotional processing of architecture, pleasantness; reward properties, judgment of beauty, and emotional salience of objects; also, the *orbitofrontal cortex* is engaged in evaluating the aesthetic value of architecture.

Table 5-47: fMRI measurement data in related to unpleasant places for women (p-unc<0.05)

<table>
<tr><th colspan="6">Number of Clusters Found: 60 Number of All Voxels: 20415</th></tr>
<tr><th>Cluster</th><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td rowspan="3">1</td><td>Women</td><td>14556</td><td>28 -54 -22</td><td>5.14</td><td>0.000</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Right Cerebrum: 5216 / Left Cerebrum: 3798 / Fusiform Gyrus: 925 / Left Fusiform: 785 / Middle Temporal: 260 / Cingulate Gyrus: 184 / Superior Occipital: 169 / Frontal Lobe: 157 / L- Hippocampus: 142 / Thalamus: 89 / R-Mid-Temporal: 74 / Insula: 56 / Left Thalamus: 32 / Hippocampus: 26 / L-Mid-Temporal: 9 / Left Insula: 4</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Architecture:</u>
Occipital Lobe: 4813 / Temporal Lobe: 1336 / Limbic Lobe: 1297 / Parietal Lobe: 676 / Middle Occipital: 603 / Parahippocampus: 554 / Posterior Cingulate: 533 / Precuneus: 404 / Superior Temporal: 57 / Angular Gyrus: 10</td></tr>
<tr><td rowspan="3">2</td><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td>Women</td><td>107</td><td>-48 10 2</td><td>3.55</td><td>0.000</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region:</u>
Anterior Cingulate: 123 / Right Insula: 69 / Inferior Frontal: 33 / L- Orbitofrontal: 18</td></tr>
<tr><td colspan="6"><u>Total Voxels Number of More Effective Active Regions:</u>
Right Cerebrum: 7865 / Left Cerebrum: 6031 / Frontal Lobe: 2748 / Temporal Lobe: 1348 / Fusiform Gyrus: 925 / Left Fusiform: 785 / Cingulate Gyrus: 771 / Middle Frontal: 439 / Superior Occipital: 316 / Middle Temporal: 285 / Thalamus: 226 / Inferior Frontal: 218 / Left Insula: 219 / Insula: 185 / Anterior Cingulate: 162 / Left Hippocampus: 142 / Right Middle Temporal: 86 / Right Insula: 81 / Hippocampus: 26 / Left Orbitofrontal: 18 / Left Middle Temporal: 18 / Left Thalamus: 8</td></tr>
</table>

As shown above, the areas of the brain that were expected to be activated in the face of unpleasant spaces are marked by bold fonts. The results demonstrated that emotional assessing of unpleasant/negative places in aspect of spatial elements and architectural qualities was associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=4813] and the least value in the **Superior Temporal** [Voxels=57]; and in relation to emotional assessment it was associated exclusively with a highest increase in the **Right Cerebrum** [Voxels=7865] and the least value in the **Left Thalamus** [Voxels=8].

Neurological experiments of assessing emotional-perceptual experience of pleasant and unpleasant places for women was conducted and analyzed. In this context, findings had revealed significant differences between pleasant and unpleasant place ratings. So, the following table represents a comparative framework of all women's neurological ratings. As shown, it was found there are significant activity differences in related to emotional assessment of pleasant and unpleasant places. For pleasant places the areas engaged in positive emotions were activated, and for unpleasant places the areas engaged in negative emotions were activated. In this regard, the pleasant places ware associated exclusively with strong activation and the highest score of found voxels (29827) in comparison to the unpleasant places (20415). Such a difference provides evidence that pleasant places in aspect of using architectural qualities trigger women's emotions to a stronger degree than unpleasant places, and the brain areas engaged in emotions respond more effectively and stronger to pleasant places than unpleasant places. These findings show that the women's brain areas associated with pleasantness and reward processing are involved in preferences which include pleasant or unpleasant designs.

Table 5-48: The comparison of statistical findings of pleasant and unpleasant place for women

Participant	Clusters Found	Voxels Found	The Brain's More Effective Active Regions		Peak MNI Coordinate Region Engaged in Architecture
Pleasant	44	29827	Frontal Lobe Cerebellum Right Cerebellum Left Cerebellum Precuneus Medial Frontal Fusiform Gyrus Middle Frontal Anterior Cingulate Left Insula Right Frontal	5543 4014 3002 2461 1618 1432 1014 542 412 287 246	Occipital: 5973 Temporal: 2875 Parietal Lobe: 2532 Limbic Lobe: 2290 Cuneus: 1825 Lingual Gyrus:1803 Parahippocampal: 415
Unpleasant	60	20415	Right Cerebrum Left Cerebrum Frontal Lobe Temporal Lobe Fusiform Gyrus Left Fusiform Cingulate Gyrus Middle Frontal Superior Occipital Middle Temporal Thalamus Inferior Frontal Left Insula Insula Anterior Cingulate Left Hippocampus Right Middle Right Insula Hippocampus Left Orbitofrontal	7865 6031 2748 1348 925 785 771 439 316 285 226 218 219 185 162 142 86 26 18 18	Occipital Lobe: 4813 Temporal Lobe: 1336 Limbic Lobe: 1297 Parietal Lobe: 676 Middle Occipital: 603 Parahippocampus: 554 Posterior Cingulate: 533 Precuneus: 404 Superior Temporal: 57 Angular Gyrus: 10

Because of highly increased activities in visual areas of the **occipital lobes** (v=5973), beauty judgement areas of the **frontal lobe** (v=5543), visual-spatial perception (form, color, and recognition of objects) areas of the **temporal lobe** (v=2875), spatial orientation, tactile, and perception (motion, depth, height, width, geometry) areas of the **parietal lobe** (v=2532), and architectural experience of large-scale places and landscape areas of the **parahippocampal** (v=415) in relation to pleasant places rather than the same brain areas for unpleasant places [**occipital lobes** (v=4813), **frontal lobe** (v=2748), **temporal lobe** (v=1336), **parietal lobe** (v=676)], it is assumed that positive places in aspect of providing architectural qualities are able to attract more attention of women to a design. Results suggest that the external appearance of an architectural design can influence the emotional, perceptual, cognitive, beauty judgement, and decision-making (behavioral) process for women to a higher degree. So, it suggests that attractive things to attention and memory do contribute to details for an architectural design that produce a pleasant place rather than an unpleasant one. Findings suggest that unpleasant design will have negative influence on women's emotional-perceptual experience of place, hence architects and urban designers should pay more attention to the valence of good design.

- **fMRI measurement data in related to pleasant places for men**

Figure 5-16 presents the parts of the brain engaged in emotions that were activated when men participants saw the pleasant places. As shown, in cluster 1, the most activated areas were pointed at the cerebellum (left and right cerebellum), precuneus, fusiform gyrus, and frontal lobe (T=6.21, p= 0.000<0.05, x=-40, y=-64, z=-22, K=21783). The findings demonstrated that activation in the cerebellum is involved in **happiness**. In addition, activation in the precuneus, fusiform gyrus, and frontal lobe covaried in relation to **pleasant emotions** ratings. Besides, according to Table 2-17, the *precuneus* area also is engaged in determining orientation in space, aesthetic and beauty assessments of artworks, and perception. The *frontal lobe* is associated with beauty judgement and pleasantness; the *fusiform gyrus* is engaged in neural representation of architectural styles and identifying locations.

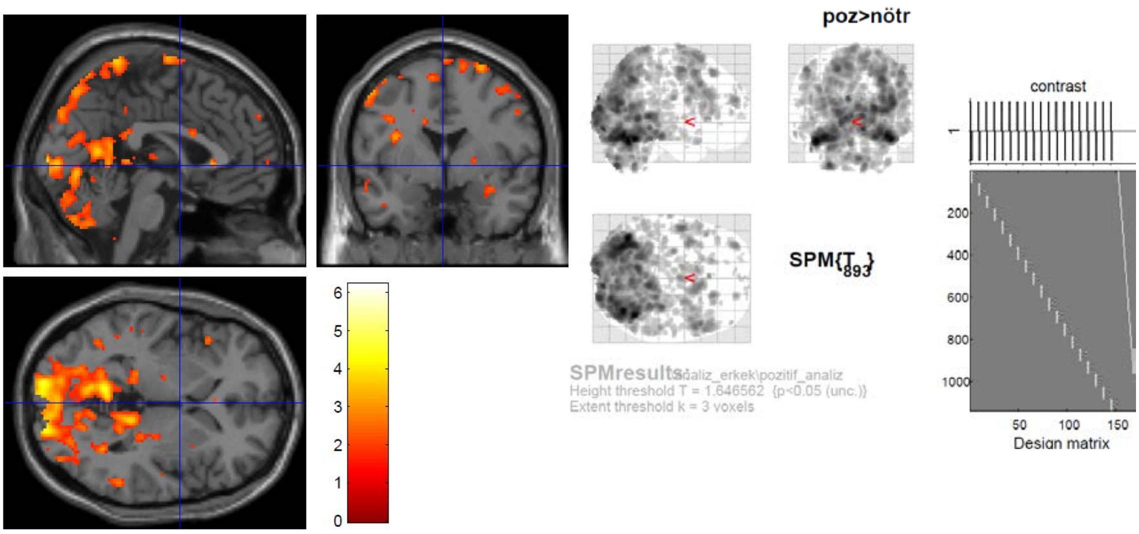


Figure 5-16: The fMRI analyses of pleasant places for all men (p-unc<0.05)

In addition to activating the areas involved in the pleasantness and emotions, activities in other areas were also recorded each of which confirms the brain's response to spatial elements and architectural qualities. For instance, the *occipital lobe* which responds to architectural perception, and is involved in the perception of forms, colors, height, depth, geometry, spatial direction, visual processing, and recognizing objects; the *parietal lobe* is involved in understanding spatial orientation and perception (motion, depth, height, width, geometry), visual perception, cognition, identifying the position, location, and touch; the *cuneus* is responsive to the appreaciation of representational material; the *parahippocampal* is involved in architectural experience of large-scale places, landscape, and location; and the *hippocampus* is implicated in memories and perception. As shown in the cluster 2, the most activated areas were pointed at the middle frontal, anterior cingulate, left insula, and right insula (T=4.05, p= 0.000<0.05, x=-52, y=-4, z=54, K=738). The findings demonstrated that activation includes the anterior cingulate and left insula covaried in relation to **happiness**. Also, activation in the middle frontal lobe is involved in **pleasant emotions**. According to Table 2-17, the *middle frontal* is involved in beauty judgment and approach behavior; and the *anterior cingulate* is involved in emotional processing of architecture.

As shown in the table 5.49, the areas of the brain engaged in emotions that were expected to be activated in the face of pleasant spaces are marked by bold fonts. The results demonstrated that assessing the pleasantness of pleasant/positive in aspect of spatial elements and architectural qualities was associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=8605] and the least value in the Hippocampus [Voxels=30], and in relation to emotional assessment it was associated exclusively with the highest increase in the **Frontal Lobe** [Voxels=3596] and the least value in the **Anterior Cingulate** [Voxels=26].

Table 5-49: fMRI measurement data in related to pleasant places for men (p-unc<0.05)

Number of Clusters Found: 84			Number of All Voxels: 27852		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Men	21783	-40 -64 -22	6.21	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Left Cerebellum:** 2307 / **Precuneus:** 2156 / **Right Cerebellum:** 1134 / **Fusiform:** 1069 / **Cerebellum:** 644 / **Medial Frontal:** 29 / **Frontal Lobe:** 19				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 8605 / Parietal Lobe: 4092 / Cuneus: 2190 / Limbic Lobe: 1994 / Parahippocampal: 898 / Angular: 131 / Hippocampus: 30				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Men	738	-52 -4 54	4.05	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Middle Frontal:** 852 / **Anterior Cingulate:** 16 / **Left Insula:** 12 / **Right Insula:** 3				
Total Voxels Number of More Effective Active Regions: Frontal Lobe: 3596 / Left Cerebellum: 2316 / Precuneus: 2179 / Right Cerebellum: 1378 / Middle Frontal: 1101 / Fusiform: 1069 / Medial Frontal: 130 / Left Insula: 28 / Anterior Cingulate: 26					

- **fMRI measurement data in related to unpleasant places for men**

The following figure presents the parts of the brain engaged in emotion that were activated when women participants saw the unpleasant places. Also, the following table shows the statistical analysis of the brain activated areas which makes it possible to indicate the most effective areas engaged in emotional and cognitive process encountering negative scenes and places. As shown, in cluster 1, the most activated areas were pointed at the right and left cerebrum, fusiform gyrus, left fusiform, cingulate, anterior cingulate, left hippocampus, superior occipital, left thalamus, thalamus, right amygdala, and amygdala (T=4.86, p= 0.000<0.05, x=42, y=-66, z=-20, K=5779).

The findings demonstrated that the cingulate and anterior cingulate are engaged in **fear** and **sadness.** Activation in the amygdala, left hippocampus, and thalamus areas is involved in **fear**. The left thalamus is engaged in **sadness**; and the right amygdala is involved in **sadness** and **disgust**. The fusiform is involved in **unpleasant emotions**; the left fusiform and superior occipital are engaged in **avoidance behavior**. In addition to that, according to the Table 2-17, the *fusiform gyrus* is engaged in neural representation of architectural styles; the *cingulate cortex* and *amygdala* is involved in the emotional processing and the avoidance of decisions in architectural spaces.

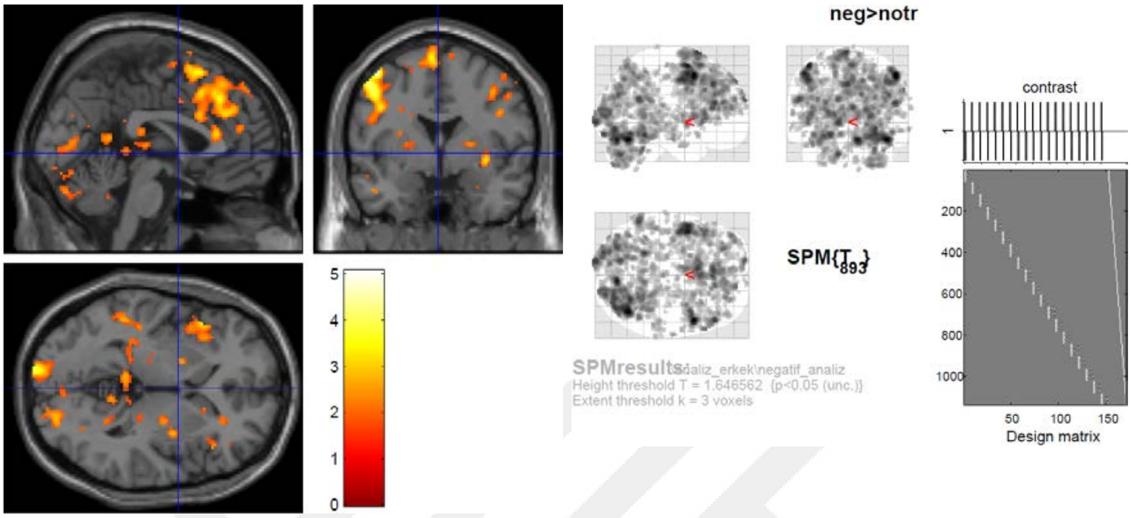


Figure 5-17: The fMRI analyses of unpleasant places for all men (p-unc<0.05)

Besides, the *occipital lobe* responds to perceptual information regarding architecture, and is involved in the perception of forms, colors, height, depth, geometry, spatial movement direction, visual processing, and recognizing objects; the *middle occipital gyrus* is involved in the aesthetic assessments of artworks and beauty ratings; the *precuneus* is engaged in aesthetic assessments of artworks, pleasantness, and perception; the *parahippocampal* is engaged in architectural experience and representation of large-scale places, landscape, and location.

Furthermore, as shown in cluster 2, the most activated areas were pointed the insula, left insula, frontal lobe, inferior frontal, right insula, left orbitofrontal, hippocampus, and left middle temporal (T=4.62, p= 0.000<0.05, x=-46, y=2, z=58, K=5054). The findings demonstrated that activation including the right insula and inferior frontal are engaged in **disgust**; insula is involved in **sadness** and **fear**; left insula and frontal lobe are involved in **anger**, **disgust**, and **fear**; the left orbitofrontal is engaged in **fear**, **anger**, and **disgust**; the hippocampus is engaged in **sadness** and **anger**, and the lift middle temporal is involved in **fear**. Besides, according to Table 2-17, the *left insula* is engaged in **avoidance behavior**.

Table 5-50: fMRI measurement data in related to unpleasant places for men (p-unc<0.05)

Number of Clusters Found: 109			**Number of All Voxels: 17460**		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Men	5779	42 -66 -20	4.86	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Right Cerebrum:** 1959 **/ Left Cerebrum:** 1750 **/ Fusiform Gyrus:** 708 / **Left Fusiform:** 456 / **Cingulate:** 272 **/ Anterior Cingulate:** 182 **/ Left Hippocampus:** 92 **/ Superior Occipital:** 35 / **Left Thalamus:** 12 / **Thalamus:** 9 / **Right Amygdala:** 5 **/ Amygdala:** 3				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 2943 / Lingual Gyrus: 588 / Middle occipital: 554 / Limbic Lobe:352 / Parahippocampal: 325 / Precuneus: 11				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Men	5054	-46 2 58	4.62	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **L-Mid- Frontal:** 498 **/ Insula:** 184 **/ Left Insula:** 170 **/ Frontal Lobe:** 14 / **Inferior Frontal:** 14 **/ Right Insula:** 11 **/ L-Orbitofrontal:** 5 **/ Hippocampus: 4 / L-Mid-Temporal:** 3				
Total Voxels Number of More Effective Active Regions: Right Cerebrum: 7486 / Left Cerebrum: 6753 / Frontal Lobe: 4891 / Fusiform Gyrus: 808 / Inferior Frontal: 787 / Left Middle Frontal: 519 / Left Fusiform: 459 / Right Middle Frontal: 449 / Cingulate: 407 / Insula: 274 / Anterior Cingulate: 228 / Left Insula: 170 / Left Thalamus: 111 / Right Insula: 80 / Thalamus: 78 / Left Middle Temporal: 44 / Left Hippocampus: 35 / Superior Occipital: 35 / Amygdala: 11 / Right Amygdala: 5 / Left Orbitofrontal: 5					

As shown, the areas of the brain that were expected to be activated in the face of unpleasant spaces are marked by bold fonts. The results demonstrated that emotional assessing of unpleasant places in aspect of spatial and architectural qualities are associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=2943] and the least value in the **Precuneus** [Voxels=11]. In relation to emotional assessment it was associated exclusively with the highest increase in the **Right Cerebrum** [Voxels=7486] and the least value in the **Left Orbitofrontal** [Voxels=5].

Neurological experiments of assessing emotional-perceptual experience of pleasant and unpleasant places for men was conducted and analyzed. In this context, findings had revealed significant differences between pleasant and unpleasant place ratings. The following table represents the comparative framework of all men's neurological ratings. As shown, it is found there are significant activity differences in related to emotional assessment of pleasant and unpleasant places. The pleasant places were associated exclusively with strong activation and highest score of found voxels (27852) in comparison to unpleasant places (17460). Such a difference provides evidence that pleasant places in aspect of using spatial and architectural qualities trigger men's emotions to a stronger degree than unpleasant places, and the brain areas engaged in emotions respond more strongly to pleasant places than unpleasant places.

Table 5-51: The comparison of statistical findings of pleasant & unpleasant place for men

Participant	Clusters Found	Voxels Found	The Brain's More Effective Active Regions		Peak MNI Coordinate Region Engaged in Architecture
Pleasant	84	27852	Frontal Lobe	3596	Occipital Lobe: 8605
			Left Cerebellum	2316	Parietal Lobe: 4092
			Precuneus	2179	Cuneus: 2190
			Right Cerebellum	1378	Limbic Lobe: 1994
			Middle Frontal	1101	Parahippocampal: 898
			Fusiform	1069	Thalamus: 149
			Medial Frontal	130	Angular: 131
			Left Insula	28	Hippocampus: 30
			Anterior Cingulate	26	
Unpleasant	109	17460	Right Cerebrum	7486	Occipital Lobe: 2943
			Left Cerebrum	6753	Lingual Gyrus: 588
			Frontal Lobe	4891	Middle occipital: 554
			Fusiform Gyrus	808	Limbic Lobe:352
			Inferior Frontal	787	Parahippocampal: 325
			Left Middle Frontal	519	Precuneus: 11
			Left Fusiform	459	
			Right Middle Frontal	449	
			Cingulate	407	
			Insula	274	
			Anterior Cingulate	228	
			Lef Insula	170	
			Left Thalamus	111	
			Right Insula	80	
			Thalamus	78	
			Left Middle Temporal	44	
			Left Hippocampus	35	
			Superior Occipital	35	
			Amygdala	11	
			Right Amygdala	5	
			Left Orbitofrontal	5	

Because of highly increased activities in visual areas of the **occipital lobes** (v=8605), beauty judgement areas of the **frontal lobe** (v=3596), the **parietal lobe** (v=2532), and architectural experience of large-scale places and landscape areas of the **parahippocampal** (v=898) in relation to pleasant places rather than for the same areas of the brain for unpleasant places [**occipital lobes** (v=2943), **parahippocampal** (v=325)], hence it is assumed that, positive places in aspect of providing architectural qualities are able to attract the more of men's attention for a design. The frontal lobe value in relation to unpleasant places is more than pleasant places (v=4891). It shows that spatial qualities of unpleasant places significantly engaged the men brains than pleasant places. Generally, the results suggest that the external appearance of an architectural design can influence the emotional, perceptual, cognitive, beauty judgement, and decision-making (behavioral) process for men to a high degree. So, it suggests that attractive things to attention and memory do contribute to details for an architectural design that produce a pleasant place rather than an unpleasant one.

- **The comparative fMRI data of women and men neurological ratings of pleasant and unpleasant places for women**

Neurological and quantitative experiments of assessing emotional-perceptual experience of pleasant and unpleasant places was conducted and analyzed for two different groups of women and men. Accordingly, the involvement of brain regions supported a hypothesis that the perceptual and emotional evaluation of an architectural place relies on the specific neural areas that are active when people see or experience the pleasant (positive) or unpleasant (negative) scenes within a visual perceptual, cognitive, and rewarding emotional experience process. Also, the relevant findings supported the cognitive base of experiencing pleasantness to the neuroscience underlying users' perception and appreciation of architecture. Indeed, such a detection suggests that the emotional-perceptual experience of architecture involved in the brain cortical, sensory, meaning, emotion, judgement, and valuation system. In this context, the current study findings had revealed significant differences between women and men's pleasant and unpleasant place ratings. The following tables present a comparative framework of women and men's neurological and quantitative survey ratings related to pleasant and unpleasant architectural places.

As shown in the table 5-52, both in women's and men's ratings for pleasant and unpleasant places shows areas engaged in positive and negative emotions were activated respectively. In relation to pleasant places, same areas were activated for both women and men. However, for unpleasant places, women shown to have more and different areas activated as compared to men. Women and men showed significantly more activation for pleasant than unpleasant places [women (voxels=29827); men (voxels=27852) for pleasant places, and women (voxels=20415); men (voxels=17460) for unpleasant places]. In this regard, for **women** both pleasant and unpleasant places were associated exclusively with strong activations and highest score of found voxels compared to **men**. Such a difference provides evidence that pleasant and unpleasant places trigger women's emotions to a stronger degree than men's emotions.

Indeed, the women's brain areas engaged in emotions respond more effectively and strongly to pleasant places than men's brains. In this regard, highly increased activities in the areas engaged in emotions such as the **frontal lobe** (v=5543), **left cerebellum** (v=2461), **right cerebellum** (v=3002), **medial frontal** (v=1432), **anterior cingulate** (v=412), and **left insula** (v=287) for women rather than the same areas for men [**frontal lobe** (v=3596), **left cerebellum** (v=2316), **right cerebellum** (v=1378), **medial frontal** (v=130), **anterior cingulate** (v=26), and **left insula** (v=28)] suggests that positive places in aspect of providing architectural qualities affected women's emotions more than men's. Furthermore, related to rating regions engaged in architectural experience, the men's brain areas respond more strongly to pleasant places than women's brain. In this context, highly increased activities in the areas engaged in architectural experience such as the **occipital lobe** (v=8605), **parietal lobe** (v=4092), **cuneus** (v=2190), and **parahippocampal** (v=898) for men rather than the same areas for women [**occipital lobe** (5973), **parietal lobe** (v=2532), **cuneus** (v=1825), and **parahippocampal** (v=415)] suggest that pleasant places in aspect of spatial elements attract the more attention and perception for men for a design more than for women.

Related to unpleasant places, the women's brain areas engaged in emotions respond more effectively and strongly than men's brains. In this regard, highly increased activities in the areas engaged in emotions such as the **right cerebrum** (v=7865), **fusiform** (v=925), **left fusiform** (v=785), **cingulate** (v=771), **superior occipital** (v=316), **thalamus** (v=226), **left insula** (v=219), and the **left hippocampus** (v=142) for women rather than the same areas for men [**right cerebrum** (v=7486), **fusiform** (v=808), **left fusiform** (v=459), **cingulate** (v=407), **superior occipital** (v=35), **thalamus** (v=78), **left insula** (v=170), and the **left hippocampus** (v=35)] suggests that negative places in aspect of providing architectural qualities affected women's emotion more than men's.

Additionally, increased activations were found for women's brain related to areas engaged in architectural experience than men. The relevant areas were the **occipital lobe** (v=4813), **temporal lobe** (v=1336), and **middle occipital** (v=603) rather than the same areas for men [**occipital lobe** (2943), **temporal lobe** (v=290), **middle occipital** (v=554)]. Such a difference suggests that negative places in aspect of providing the perceptual features of architectural qualities affected women's brains and perception more than men's brains and perception.

Table 5-52: The comparative data of women & men neurological ratings of pleasant & unpleasant places

Place	Clusters Found	Voxels Found	The Brain's More Effective Active Regions		Peak MNI Coordinate Region Engaged in Architecture:
Pleasant **Women**	44	29827	Frontal Lobe Right Cerebellum Left Cerebellum Precuneus Medial Frontal Fusiform Gyrus Middle Frontal Anterior Cingulate Left Insula Right Frontal	5543 3002 2461 1618 1432 1014 542 412 287 246	Occipital: 5973 Temporal: 2875 Parietal Lobe: 2532 Limbic Lobe: 2290 Cuneus: 1825 Lingual Gyrus:1803 Parahippocampal: 415 Anterior Cingulate: 412
Pleasant **Men**	84	27852	Frontal Lobe Left Cerebellum Precuneus Right Cerebellum Middle Frontal Fusiform Gyrus Medial Frontal Left Insula Anterior Cingulate	3596 2316 2179 1378 1101 1069 130 28 26	Occipital Lobe: 8605 Parietal Lobe: 4092 Cuneus: 2190 Limbic Lobe: 1994 Parahippocampal: 898 Angular: 131 Hippocampus: 30 Anterior Cingulate: 26
Unpleasant **Women**	60	20415	Right Cerebrum Left Cerebrum Frontal Lobe Fusiform Gyrus Left Fusiform Cingulate Gyrus Middle Frontal Superior Occipital Middle Temporal Thalamus Inferior Frontal Left Insula Insula Anterior Cingulate Left Hippocampus Right Middle Temporal Right Insula Hippocampus Left Orbitofrontal Left Middle Temporal	7865 6031 2748 925 785 771 439 316 285 226 218 219 185 162 142 86 81 26 18 18	Occipital Lobe: 4813 Temporal Lobe: 1336 Limbic Lobe: 1297 Parietal Lobe: 676 Middle Occipital: 603 Parahippocampus: 554 Posterior Cingulate: 533 Precuneus: 404 Superior Temporal: 57 Angular Gyrus: 10
Unpleasant **Men**	109	17460	Right Cerebrum Left Cerebrum Frontal Lobe Fusiform Gyrus Inferior Frontal Left Middle Frontal Left Fusiform Right Middle Frontal Cingulate Gurus Insula Anterior Cingulate Lef Insula Left Thalamus Right Insula Thalamus Left Middle Temporal Left Hippocampus Superior Occipital Amygdala Right Amygdala Left Orbitofrontal	7486 6753 4891 808 787 519 459 449 407 274 228 170 111 80 78 44 35 35 11 5 5	Occipital Lobe: 2943 Lingual Gyrus: 588 Middle occipital: 554 Limbic Lobe:352 Parahippocampal: 325 Temporal lobe: 290 Precuneus: 11

The results of independent samples *t*-test analysis regarding the meaningful difference ($p<0.05$) among the averages of "**sensation**" sub-components measurement data based on the gender variable of students are presented in the following table.

Table 5-53: The comparative data of women & men sensation ratings of pleasant & unpleasant places

Place	Sub-Components	Gender	Mean ($\bar{X}$)		SD	t	p
Pleasant	**Color**	Woman	24.03	3.43	5.02	3.37	**0.001**
		Man	26.18	3.74	4.91		
	Light	Woman	24.56	3.51	4.38	2.81	**0.005**
		Man	26.15	3.74	4.51		
	Texture	Woman	**25.83**	3.69	4.99	3.81	**0.000**
		Man	**28.16**	4.02	4.47		
	Material	Woman	24.41	3.49	5.03	4.13	**0.000**
		Man	26.95	3.85	4.51		
	Sound	Woman	21.11	3.02	6.17	1.53	0.128
		Man	22.26	3.18	5.49		
	Odor	Woman	19.15	2.74	6.22	0.42	0.676
		Man	19.49	2.78	6.57		
Unpleasant	**Color**	Woman	31.15	3.46	9.94	3.56	**0.000**
		Man	35.18	3.91	7.82		
	Light	Woman	30.84	3.43	9.36	3.22	**0.001**
		Man	34.35	3.82	7.65		
	Texture	Woman	**31.79**	3.53	9.73	4.00	**0.000**
		Man	**36.15**	4.02	7.28		
	Material	Woman	31.55	3.51	9.88	3.83	**0.000**
		Man	35.88	3.97	7.85		
	Sound	Woman	29.44	3.27	8.88	1.72	0.088
		Man	31.37	3.46	8.60		
	Odor	Woman	28.61	3.18	9.96	1.47	0.14
		Man	30.45	3.38	9.47		

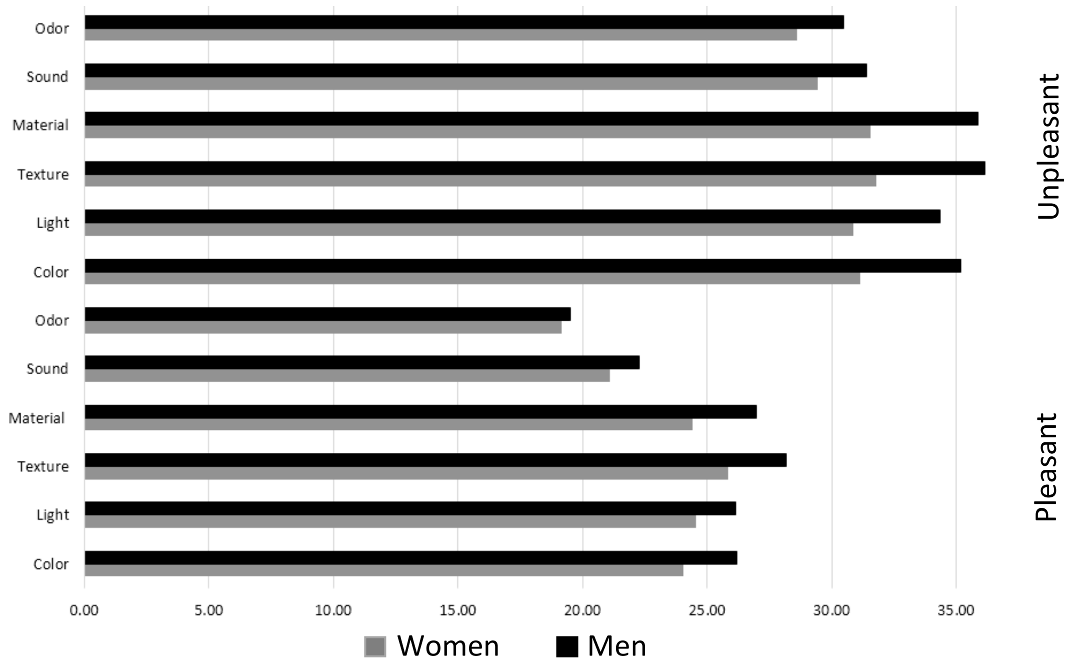


Diagram 5-11: Women & men sensation measurement data related to pleasant & unpleasant Places

Accordingly, in related to **pleasant** places factors such as sound [t= 1.53, p>0.05] and odor [t= 0.42, p>0.05] do not differ meaningfully. On the other hand, factors such as color [t= 3.37, p<0.05], light [t= 2.81, p<0.05], texture [t= 3.81, p<0.05], and material [t= 4.13, p<0.05] differ significantly according to gender. In this context, there is an increase in favor of male students [color=(26.18), light=(26.15), texture=(28.16), material=(26.95)] so that men have rated the relevant sub-components of sensation more than women. Like pleasant places, significant difference were shown in factors such as color [t= 3.56, p<0.05], light [t= 3.22, p<0.05], texture [t= 4.00, p<0.05], and material [t= 3.83, p<0.05] related to **unpleasant** places, and factors such as sound [t= 1.72, p>0.05] and odor [t= 1.47, p>0.05] do not differ meaningfully. Similarly, men rated unpleasant place sub-components more than women. Interestingly, the factor of "**texture**" is rated as the more effective sensory sub-component for both pleasant and unpleasant places in both women and men. The activation of the **parietal lobe** engaged in touch (tactile) in women and men supports this subscription.

The averages of "**perception**" sub-components measurement data based on the gender variable of students are presented as follows. Accordingly, related to **pleasant** places factors such as largeness (size) [t= 1.42, p>0.05] and width [t= 1.88, p>0.05] do not differ significantly. On the other hand, factors such as height [t= 3.21, p<0.05], depth [t= 3.28, p<0.05], geometry [t= 5.54, p<0.05], proportion [t= 4.45, p<0.05], order [t= 4.08, p<0.05], and rhythm [t= 3.58, p<0.05] differ significantly according to gender. In this context, there is an increase in favor of male students [height=(25.99), depth=(24.73), geometry=(27.90), proportion=(26.94), order=(27.14), rhythm=(25.60)] so that men have rated the relevant perceptual sub-components more than women. Related to **unpleasant** places significant difference were shown between women and men ratings of all perception sub-components (largeness [t=4.57, p<0.05]; height [t=4.81, p<0.05]; depth[t=3.97, p<0.05]; width [t=4.46, p<0.05]; geometry [t=3.36, p<0.05]; proportion [t=4.17, p<0.05]; order [t=3.88, p<0.05]; rhythm [t=4.60, p<0.05]). Similarly, men rated unpleasant place sub-components more than women [largeness=(34.00),height=(32.64),depth=(33.69),geometry=(34.94),proportion=(35.30), order=(35.32), rhythm=(35.67)]. Interestingly, both women and men rated the factor of "**geometry**" as the more effective perceptual component for both pleasant and unpleasant places. The activation of **the occipital** lobe and the **parietal lobe** engaged in geometry in women and men supports this subscription.

Table 5-54: The comparative data of women & men perception ratings of pleasant & unpleasant places

Place	Sub-Components	Gender	Mean ($\bar{X}$)		SD	t	p
Pleasant	**Largeness (Size)**	Woman	22.97	3.28	5.33	1.42	0.156
		Man	23.95	3.42	5.33		
	Height	Woman	23.89	3.41	5.17	3.21	**0.001**
		Man	25.99	3.71	5.00		
	Depth	Woman	22.33	3.19	5.77	3.28	**0.001**
		Man	24.73	3.53	5.58		
	Width	Woman	23.35	3.34	5.04	1.88	0.061
		Man	24.62	3.52	5.52		
	Geometry	Woman	**24.64**	3.52	4.69	5.54	**0.000**
		Man	**27.90**	3.99	4.43		
	Proportion	Woman	24.22	3.46	5.18	4.45	**0.000**
		Man	26.94	3.85	4.37		
	Order	Woman	24.41	3.49	5.50	4.08	**0.000**
		Man	27.14	3.88	4.78		
	Rhythm	Woman	22.99	3.28	5.96	3.58	**0.000**
		Man	25.60	3.66	5.30		
Unpleasant	**Largeness (Size)**	Woman	29.26	3.25	8.50	4.57	**0.000**
		Man	34.00	3.78	7.51		
	Height	Woman	27.61	3.07	8.01	4.81	**0.000**
		Man	32.64	3.63	8.29		
	Depth	Woman	29.58	3.27	8.33	3.97	**0.000**
		Man	33.69	3.74	7.61		
	Width	Woman	29.40	3.27	8.93	4.46	**0.000**
		Man	34.10	3.79	7.57		
	Geometry	Woman	**31.22**	3.47	9.02	3.36	**0.001**
		Man	**34.94**	3.88	8.04		
	Proportion	Woman	30.83	3.43	8.58	4.17	**0.000**
		Man	35.30	3.92	8.04		
	Order	Woman	30.87	3.43	9.21	3.88	**0.000**
		Man	35.32	3.92	8.59		
	Rhythm	Woman	30.22	3.36	9.85	4.60	**0.000**
		Man	35.67	3.96	8.70		

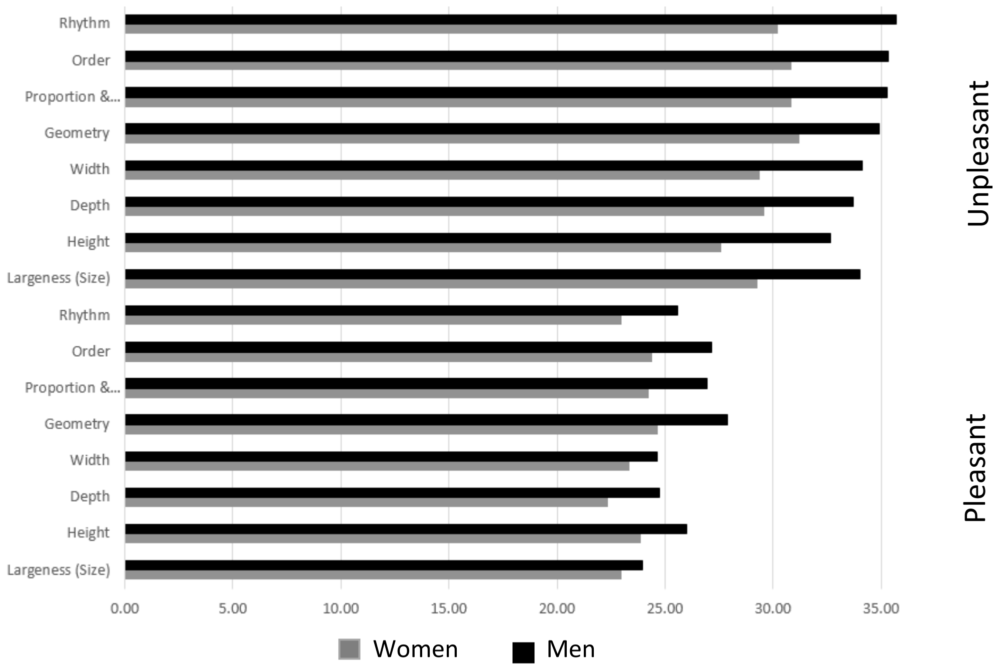


Diagram 5-12: Women & men perception measurement data related to pleasant & unpleasant Places

The difference in neurological evaluation of place experience between women and men supports the significant and meaningful differences between women and men emotional-perceptual rating obtained from the survey evaluation of place experience. As mentioned previously, both pleasant and unpleasant places in women's brains activated stronger than men's brains. In this regard, a comparative investigation of fMRI and survey results show that related to **pleasant** places, women rated emotionally than men that assessed perceptual. In this context, the **frontal lobe** of women's brains were activated larger than men (5543 to 3596 voxels). It indicates that assessing positive places, women were more interested in reward, aesthetic, beauty judgment, and emotional behavior aspect of place than men. Whereas, the brain areas such as the **occipital lobe**, **parietal lobe**, **parahippocampal**, **cuneus**, and **hippocampus** which are engaged in the perceptual and physical features of architecture like height, depth, width, scale, geometry, etc. showed large activation in the men's brains rather than women's. This implies that greater perceptual responses of men than women in assessing pleasantness of positive places. In contrast, for women the other areas involved in emotional experience of architecture (**anterior cingulate**), emotional memory (**temporal lobe**), modulating visual stimuli (**lingual gyrus**), affect and cognition (**cerebllum**), and aesthetic assessments of artworks **(precuneus)** were activated larger and stronger than men.

Interestingly, for unpleasant places, unlike pleasant places, women were more interested to consider the perceptual aspects of architecture. As for men, they were rated more emotionally than women. The areas which are involved in recognition of objects, forms, colors, height, depth, scale, and geometry such as the **temporal lobe**, **occipital lobe**, **parietal lobe** and the areas which are engaged in visual perception such as the **left middle temporal** and **precuneus** were activated in the women's brains stronger than men's. It indicates that unpleasant places attracted the more attention of women than men in aspect of perceptual-physical features and spatial perception. For men, strong activation in areas were seen in the **frontal lobe**, **left middle frontal**, and **lingual Gyrus** which are involved in reward processing, beauty judgment, deciding, and behavior indicates that men were more interested in the beauty and aesthetic assessing of unpleasant places rather than women. Furthermore, significant activation in areas such as **amygdala**, **insula**, and **anterior cingulate** which are involved in emotional experience of architecture and avoidance behavior implies that men show more emotional responses in assessing pleasantness of negative places compared to women.

The results of independent samples *t*-test analysis regarding the meaningful difference ($p<0.05$) among the averages of “**cognition**” sub-components measurement data based on the gender variable of students are presented in the following table.

Table 5-55: The comparative data of women & men cognition ratings of pleasant & unpleasant places

Sub-Components		Gender	Mean ($\bar{X}$)	SD	t	p
Attention	Appearance Facade	Woman	**3.89**	0.98	3.32	**0.001**
		Man	**4.26**	0.79		
	Public Spaces	Woman	3.85	1.03	1.00	0.317
		Man	3.98	0.98		
	Functional Spaces	Woman	3.52	1.25	1.99	**0.047**
		Man	3.85	1.31		
Conceptualization	Physical Features	Woman	**3.47**	1.28	4.86	**0.000**
		Man	**4.17**	0.99		
	Functional Features	Woman	2.91	1.25	1.52	0.131
		Man	3.15	1.15		
	Social Features	Woman	2.84	1.33	2.33	**0.021**
		Man	3.25	1.42		
Association	Simbolic & Iconic Signs	Woman	**3.76**	0.99	8.01	**0.000**
		Man	**4.65**	0.75		
	Index Signs (Spaces Name)	Woman	2.52	1.20	3.16	**0.002**
		Man	3.01	1.22		
	Public Spaces	Woman	2.77	1.34	0.12	0.903
		Man	2.79	1.26		
Cognitive Map	Landmark Knowledge	Woman	**3.11**	1.25	3.32	**0.001**
		Man	**3.36**	1.15		
	Route-road Knowledge	Woman	2.91	1.33	3.22	0.666
		Man	2.99	0.99		
	Survey Knowledge	Woman	2.77	1.42	1.10	0.324
		Man	2.97	1.33		

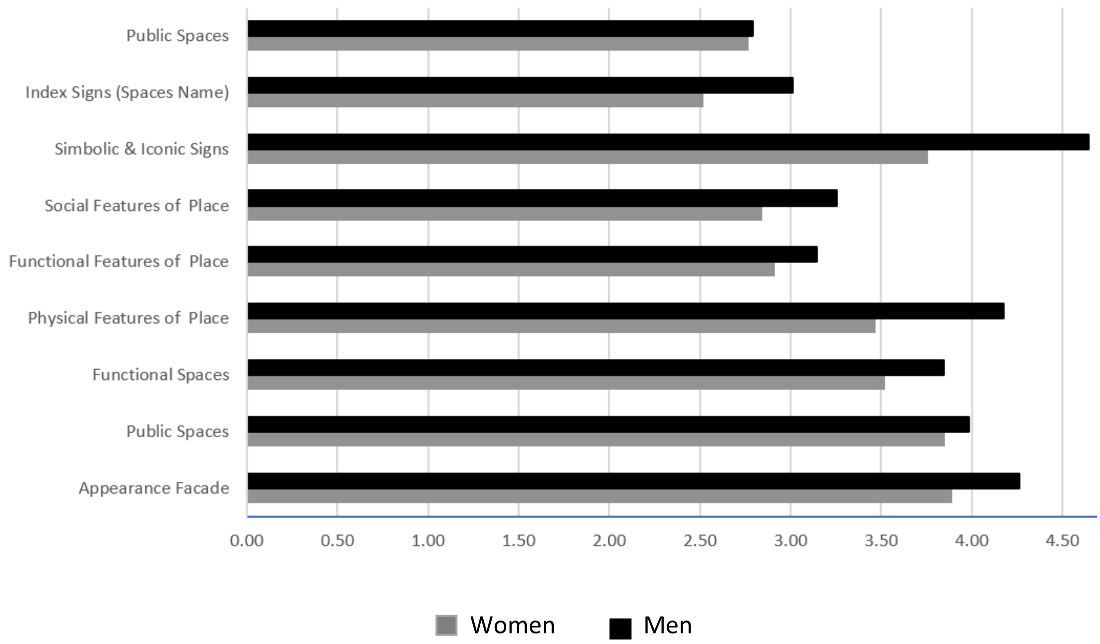


Diagram 5-13: Women & men cognition measurement data related to pleasant & unpleasant Places

Accordingly, it is shown that in relation to the component of “attention”, factors such as public spaces [t= 1.00, p>0.05] do not differ meaningfully, and the relevant spaces were rated the same extent for both women and men, but the sub-component of appearance facade [t= 3.32, p<0.05] and functional spaces [t= 1.99, p>0.05] were assessed differently between users so that men rated higher than women. In this regard, differences among activations in the areas involved in attention, form, and shape such as the **parietal lobe**, **occipital lobe**, **frontal lobe**, and **temporal lobe** for women and men emphasized on the difference between the evaluation according to gender variable. Related to the component of “conceptualization”, factors such as physical features [t= 4.86, p<0.05] and social features [t= 2.33, p<0.05] differ significantly according to gender. In this context, there is an increase in favor of male students [physical features=(4.17), functional features=(3.15), social features=(3.25)] so that men have rated the relevant sub-components more than women.

Data analyses of “association” showed that symbolic and iconic signs [t= 8.01, p<0.05] and index signs [t= 3.16, p<0.05] were assessed differently by women and men so that men have rated more than women. Differences between women and men’s brain areas activation engaged in memory and association such as the **temporal lobe**, **precuneus**, and **hippocampus** supported such a claim. Data analyses of “cognitive map” showed that there is a significant difference in assessing landmark knowledge [t=3.32, p<0.05] sub-component between women and men so that men have rated the relevant sub-components more than women. This suggests that men were more interested in symbolic buildings in the vicinity of the faculty, spatial direction, location, spatial orientation, and semantic memory than women. Moreover, for men the brain activations in areas such as the **occipital lobe** (engaged in spatial direction, and location); the **parahippocampal** (representation of large-scale landscape and location); the **fusiform gyrus** (identifying locations); the **left middle temporal** (semantic memory processing), and the **parietal** (cognition and location) are larger than women’s support the importance of landmarks in the formation of users’ mental imaginary.

Tendencies to approach or avoid a place are considered as the main aspect of emotion which provides the possibility of responding to the various environmental stimuli. Based on the data analysis of the “**behavior**” process in the closed questionnaire evaluation, the following table provides a comparative data related to women and men rating of behavior factor for pleasant and unpleasant places.

Table 5-56: The comparative data of women & men behavior ratings of pleasant & unpleasant places

Sub-Components		Behavior	Gender	Mean ($\bar{X}$)		SD	t	p
Approach - Avoidance	The Old Bilding	Approach	Woman	9.41	3.14	2.18	0.28	0.782
			Man	9.34	3.11	1.76		
	The New Bilding	Avoidance	Woman	7.73	2.58	2.87	0.34	0.736
			Man	7.61	2.54	2.86		
	The Sports Hall Bilding	Avoidance	Woman	8.59	2.86	2.66	1.34	0.182
			Man	8.12	2.71	2.89		

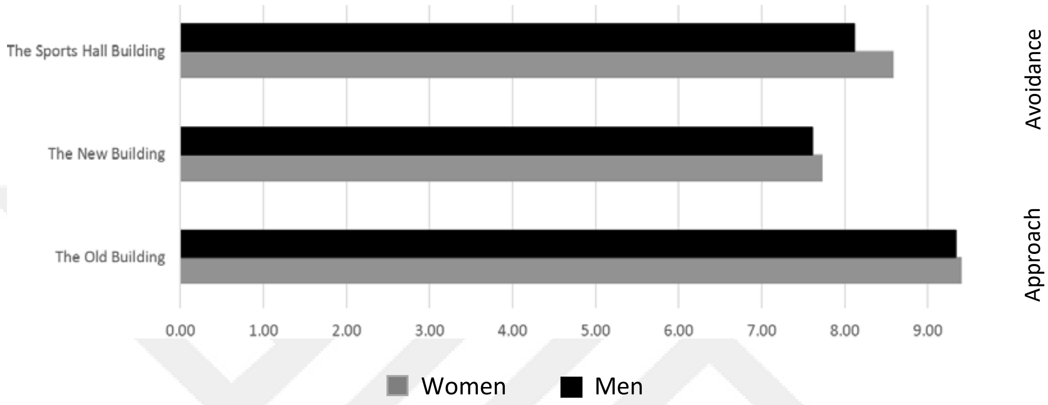
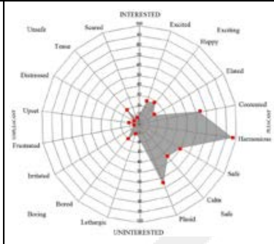


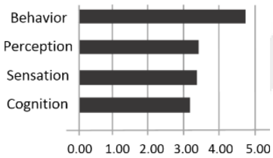
Diagram 5-14: Women and men behavior measurement data in related to case study places

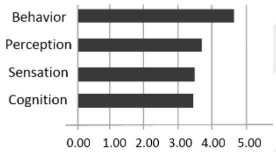
As shown, both women and men were interested to approach the old building. Also, they were seen to avoid the new building and the sports hall building, which shows there is no significant difference between their rating. Indeed, the investigation of observation, pleasure-arousal model, and fMRI showed the same results. Furthermore, the activation of brain areas engaged in approach (**middle frontal**) and avoidance behavior (**amygdala**, **insula**, **cingulate**) supports these results.

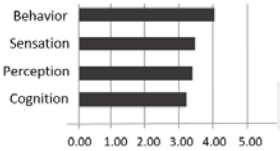
Consequently, in measuring the contribution of each component affecting the process of emotional-perceptional experience of place for women and men, it was found that the **behavior** is evaluated as the most effective factor (M=4.35). This suggests that the pleasant and unpleasant places characteristics chiefly affect individual spatial judgments and behavior. Indeed, sensory, perceptual, and cognition factors affect the users' behaviors. **Perception** is evaluated as the second effective factor (M=3.37), the **sensation** is the third effective factor (M=3.51), and the **cognition** (M=3.37) is the last factor effecting the emotional-perceptual experience of place. The second phase of findings which was related to women and men was conducted, and the summary of the results is presented as the following table.

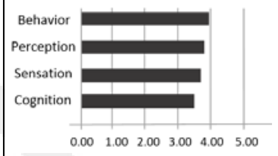
Table 5-57: The comparation of women & men emotional-neurological ratings of pleasantness (p <0.05).

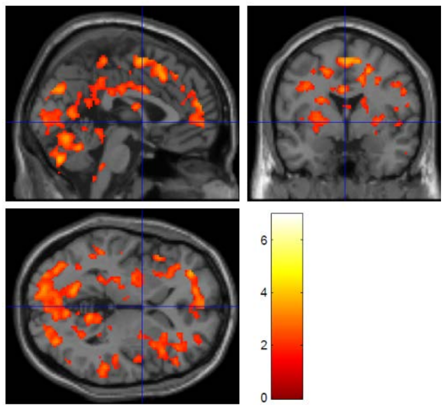
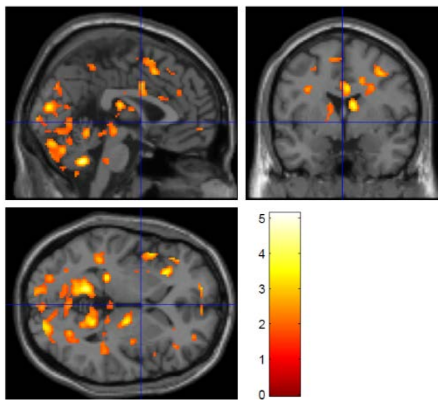
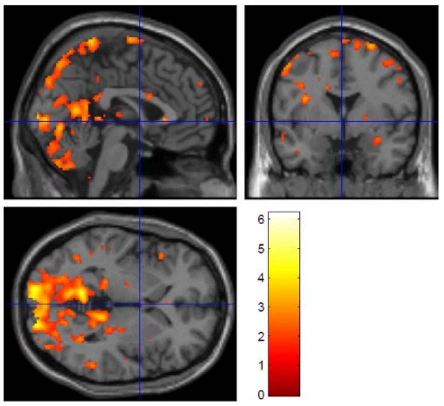
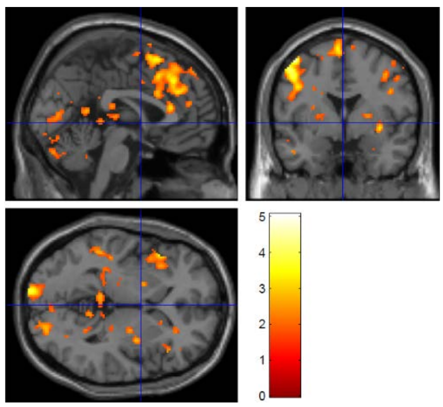
Selected Pleasant Places		Selected Unpleasant Places	
			
Pleasure-Arousal Model for Women	**Pleasure-Arousal Model for Men**	**Pleasure-Arousal Model for Women**	**Pleasure-Arousal Model for Men**
			
The Brain Activation of Women	**The Brain Activation of Men**	**The Brain Activation of Women**	**The Brain Activation of Men**









The Brain Activation of Pleasant Places		**Quantitative Results of Unleasant Places**	
Women		**Women**	
Men		**Men**	

- **The comparative fMRI statistical analyzing methods of women & men ratings**

To increase the reliability and validity of the neurological investigation, the p<0.01 and FWE<0.05 values were applied. The results of statistical analyzing with p-unc<0.01 value for women relate to **pleasant** places is presented as follows:

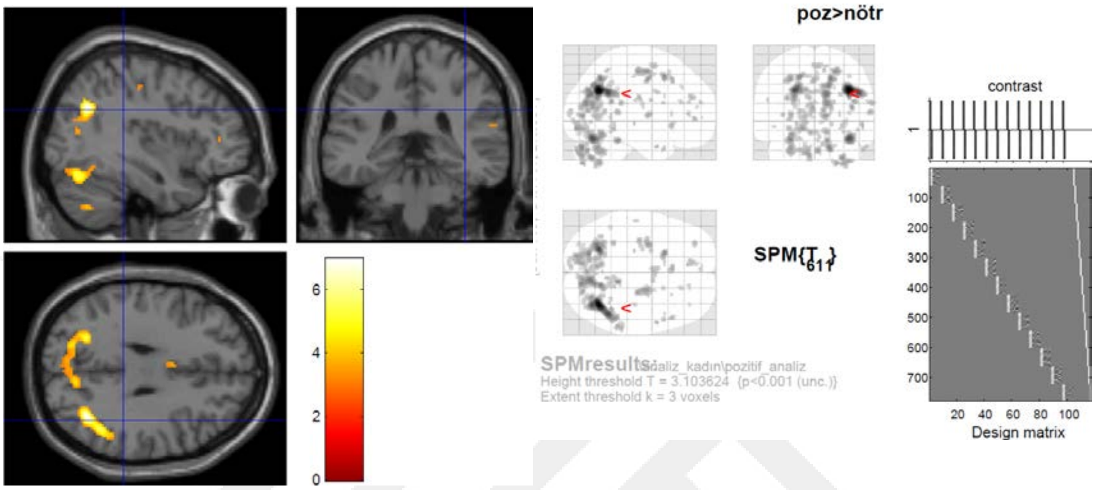


Figure 5-18: The fMRI analyses of pleasant places for women (p-unc<0.01)

The most activated areas engaged in emotions were shown in areas such as the precuneus (*T*=6.95, *p*=0.000<0.01, *x*=36, *y*=-62, *z*=32, *K*=47), and the frontal lobe, middle frontal, medial frontal, and anterior cingulate (*T*=4.56, *p*=0.000<0.01, *x*=-20, *y*=12, *z*=46, *K*=46). Less areas of the brain have activated than the p-unc<0.05 value.

Table 5-58: fMRI measurement data in related to pleasant places for women (p-unc<0.01).

Number of Clusters Found: 47 Number of All Voxels: 3003					
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Women	47	36 -62 32	6.95	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Precuneus:** 15				
	Peak MNI Coordinate Region Engaged in Architecture: Parietal Lobe: 295 / Temporal: 75 / Angular: 71				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Women	46	-20 12 46	4.56	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Frontal Lobe:** 41 / **Middle Frontal:** 18 / **Medial Frontal:** 17 / **Anterior Cingulate:** 5				
Total Voxels Number of More Effective Active Regions: Precuneus: 382 / Frontal Lobe: 316 / Medial Frontal: 98 / Middle Frontal: 28 / Anterior Cingulate: 8					

The following figure and table present the results of statistical analyzing with the method of p-FWE<0.05 value for the pleasant places.

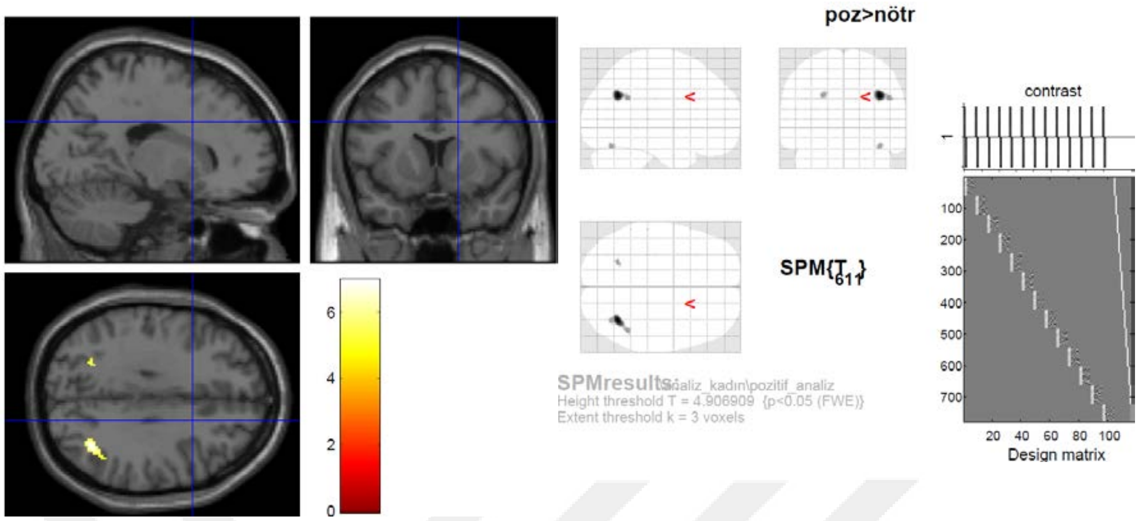


Figure 5-19: The fMRI analyses of pleasant places for women (p-FWE<0.05)

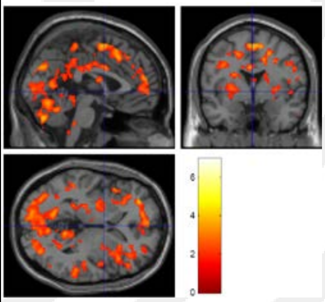
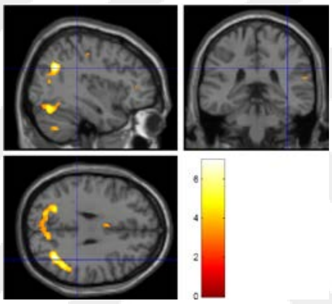
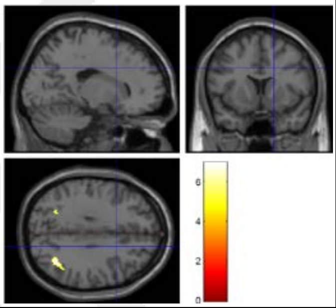
The most activated areas engaged in emotions were found in areas such as the right cerebellum and fusiform gyrus (*T*=6.95, *p-FWE*= 0.000<0.05, *x*=36, *y*=-62, *z*=32, *K*=84), and the precuneus (*T*=5.55, *p-FWE*= 0.000<0.05, *x*=-24, *y*=-62, *z*=32, *K*=12). As observed, the activated brain areas are less than areas found using the p-unc<0.05 value.

Table 5-59: fMRI measurement data in related to pleasant places for women (p-FWE<0.05).

Number of Clusters Found: 3 Number of All Voxels: 110					
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Women	14	36 -62 32	6.95	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Right Cerebellum:** 7 / **Fusiform Gyrus:** 5				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Women	12	-20 12 46	4.56	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Precuneus:** 7				
	Peak MNI Coordinate Region Engaged in Architecture: Parietal Lobe: 7				
Total Voxels Number of More Effective Active Regions: Right Cerebellum: 7 / Precuneus: 7 / Fusiform: 5					

As shown in tables presented above (5-58 and 5-59), related to pleasant places the women's brain activations found using p-unc<0.05 value are more and stronger than the brain activations found using both p-unc<0.01 and *p-FWE*<0.05 values. The following comparative table presents that in p-unc<0.05 value, the number of found cluster voxels (*KE*=20068 & 7908), the number of all clusters found (n=44), the number of all activated voxels (n=29827), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception are more and stronger than the p-unc<0.01 value (*KE*=47 & 46; clusters found=47; all activated voxels=3003) and *p-FWE*<0.05 value (*KE*=14 & 12; clusters found=3; all activated voxels=110).

Table 5-60: Women fMRI data in related to pleasant places using different statistical p-values.

Peak MNI coordinate: *x*=36 *y*=-62 *z*=32 **t-Peak Intensity:** 6.95 **p:** 0.000 **Peak MNI coordinate:** *x*=-20 *y*=12 *z*=46 **t-Peak Intensity:** 4.56 **p:** 0.000			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			
Clusters	44	47	3
Voxels	29827	3003	110
KE	20068 & 7908	47 & 46	14 & 12
Peak MNI Region Engaged in Emotion	**Frontal Lobe:** 5543 **Cerebellum:** 4014 **Right Cerebellum:** 3002 **Left Cerebellum:** 2461 **Precuneus:** 1618 **Medial Frontal:** 1432 **Fusiform Gyrus:** 1014 **Middle Frontal:** 542 **Anterior Cingulate:** 412 **Left Insula:** 287 **Right Frontal:** 246	**Precuneus:** 382 **Frontal Lobe:** 316 **Medial Frontal:** 98 **Middle Frontal:** 28 **Anterior Cingulate:** 8	Right Cerebellum: 7 Precuneus: 7 Fusiform: 5
Peak MNI Region Engaged in Architecture	Occipital: 5973 Temporal: 2875 Parietal Lobe: 2532 Limbic Lobe: 2290 Cuneus: 1825 Lingual Gyrus:1803 Parahippocampal: 415	Parietal Lobe: 295 Temporal: 75 Angular: 71	Parietal Lobe: 7

In related to **unpleasant** places the following figure and table present the results of the women's brain activity statistical analyzing with statistical p-unc<0.01 value.

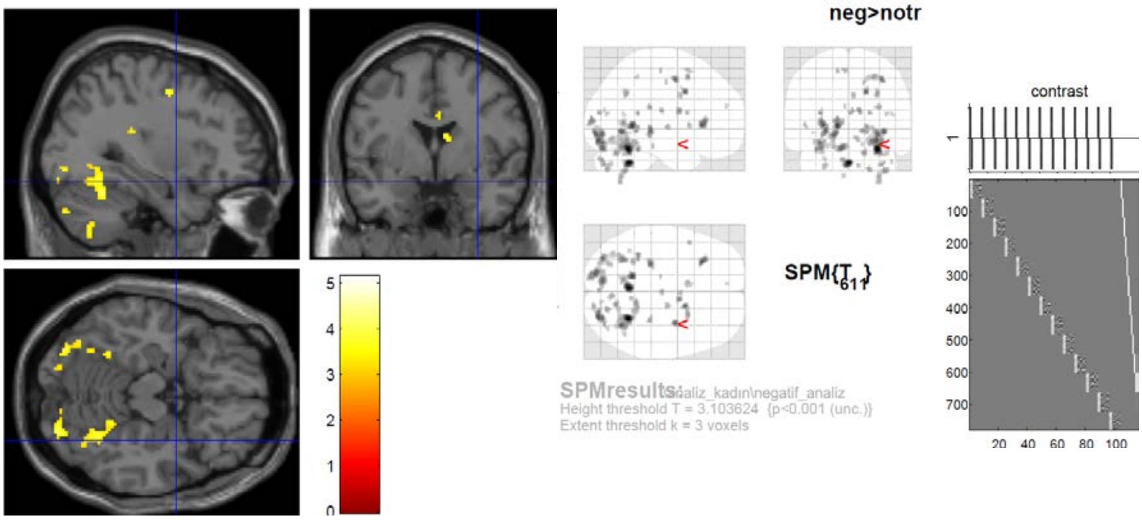


Figure 5-20: The fMRI analyses of unpleasant places for women (p-unc<0.01)

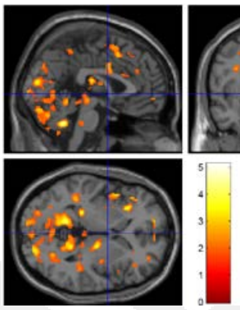
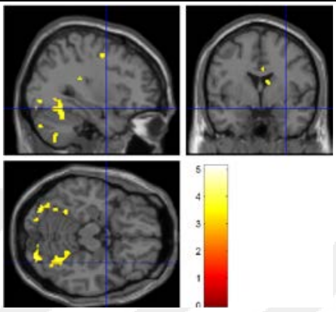
According to the figure above, the most activated areas engaged in emotions were found in areas such as the right cerebrum, fusiform gyrus, and insula (*T*=5.14, *p-unc*= 0.000<0.01, *x*=28, *y*=-54, *z*=-22, *K*=293), and the left cerebrum, left hippocampus, hippocampus, and thalamus (*T*=3.55, *p-FWE*= 0.000<0.05, *x*=-48, *y*=10, *z*=2, *K*=5) As observed, the activated brain areas are less than areas found using the p-unc<0.05 value.

Table 5-61: fMRI measurement data in related to unpleasant places for women(p-unc<0.01).

Number of Clusters Found: 37			Number of All Voxels: 1274		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Women	293	28 -54 -22	5.14	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Right Cerebrum:** 10 / **Fusiform Gyrus:** 46 / **Insula**: 3				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Women	5	-48 10 2	3.55	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Left Cerebrum:** 37 / **L- Hippocampus:** 28 / **Hippocampus:** 7 / **Thalamus:** 3				
Total Voxels Number of More Effective Active Regions: Left Cerebrum: 340 / Fusiform Gyrus: 88 / Right Cerebrum: 80 / Temporal Lobe: 53 / Left Hippocampus: 28 / Insula: 17 / Hippocampus: 7 / Thalamus: 3					

No activation was found for women’s brains in the p-FWE<0.05 value statistical method compared to p-unc<0.05. The following comparative table presents that in p-unc<0.05 value, the number of found cluster voxels (*KE*=14556 & 107), the number of all clusters found (n=60), the number of all activated voxels (n=20415), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception are more and stronger than the p-unc<0.01 value (*KE*=293 & 5; clusters found=37; all activated voxels=1274).

Table 5-62: Women fMRI data in related to unpleasant places using different statistical p values.

Peak MNI coordinate: *x*=28 *y*=-54 *z*=-2 **t-Peak Intensity:** 5.14 **p:** 0.000 **Peak MNI coordinate:** *x*=-48 *y*=10 *z*=2 **t-Peak Intensity:** 3.55 **p:** 0.000			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			**No Suprathreshold Clusters**
Clusters	60	37	0
Voxels	20415	1274	0
KE	14556 & 107	293 & 5	0
Peak MNI Region Engaged in Emotion	**Right Cerebrum:** 7865 **Left Cerebrum:** 6031 **Frontal Lobe:** 2748 **Temporal Lobe:** 1348 **Fusiform Gyrus:** 925 **Left Fusiform:** 785 **Cingulate Gyrus:** 771 **Middle Frontal:** 439 **Superior Occipital:** 316 **Middle Temporal:** 285 **Thalamus:** 226 **Inferior Frontal:** 218 **Left Insula:** 219 **Insula:** 185 **Anterior Cingulate:** 162 **Left Hippocampus:** 142 **Right Middle Temporal:** 86 **Right Insula:** 81 **Hippocampus:** 26 **Left Orbitofrontal:** 18 **Left Middle Temporal:** 18 **Left Thalamus:** 8	**Fusiform Gyrus:** 46 **Left Cerebrum:** 37 **Left Hippocampus:** 28 **Right Cerebrum:** 10 **Hippocampus:** 7 **Insula**: 3 **Thalamus:** 3	....
Peak MNI Region Engaged in Architecture	Occipital Lobe: 4813 Temporal Lobe: 1336 Limbic Lobe: 1297 Parietal Lobe: 676 Middle Occipital: 603 Parahippocampus: 554 Posterior Cingulate: 533 Precuneus: 404 Superior Temporal: 57 Angular Gyrus: 10	Left Cerebrum: 340 Fusiform Gyrus: 88 Right Cerebrum: 80 Temporal Lobe: 53 Left Hippocampus: 28 Insula: 17 Hippocampus: 7 Thalamus: 3	....

The results of statistical analyzing with p-unc<0.01 value for men relate to **pleasant** places is presented as follows:

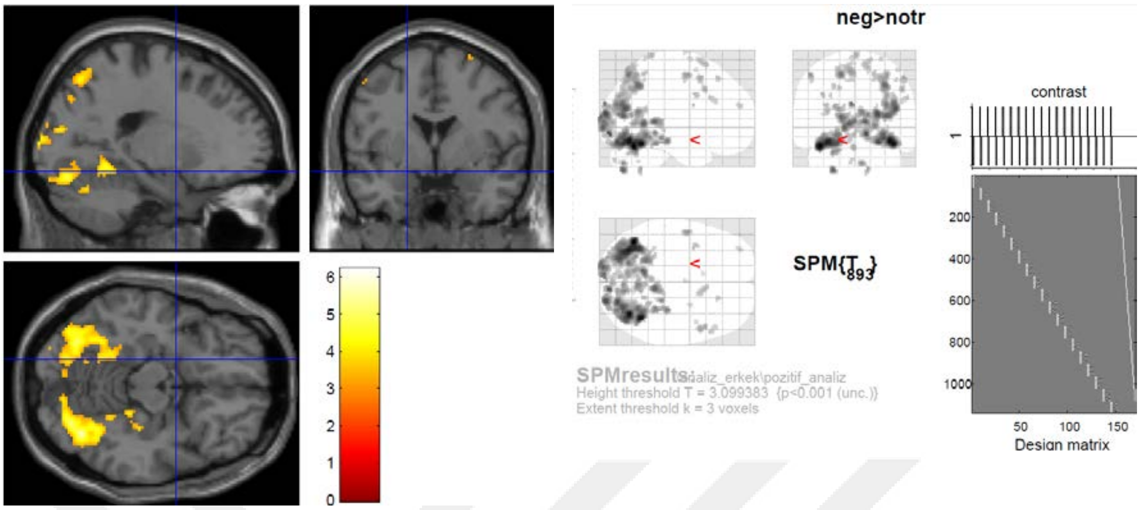


Figure 5-21: The fMRI analyses of pleasant places for men (p-unc<0.01)

The most activated areas engaged in emotions were shown in areas such as the fusiform, left cerebellum, frontal lobe (T=6.21, p=0.000<0.01, x=-40, y=-64, z=-22, K=1260), and the right cerebellum, precuneus, and middle frontal middle (T=4.05, p=0.000<0.01, x=-52, y=-4, z=54, K=28). Less areas of the brain have activated than the p-unc<0.05 value.

Table 5-63: fMRI measurement data in related to pleasant places for men (p-unc<0.01).

Number of Clusters Found: 34			**Number of All Voxels: 5242**		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Men	1260	-40 -64 -22	6.21	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Fusiform:** 330 / **Left Cerebellum:** 296 **/ Frontal Lobe:** 28				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 768 / Lingual Gyrus: 243 / Limbic Lobe: 84 / Parahippocampal: 83				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Men	28	-52 -4 54	4.05	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Right Cerebellum:** 138 / **Precuneus:** 135 / **Middle Frontal:** 25				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital: 895 **/** Parietal: 448 / Temporal: 242				
Total Voxels Number of More Effective Active Regions: Fusiform: 687 / Left Cerebellum: 420 / Precuneus: 246 / Frontal: 205 / Right Cerebellum: 183 / Middle Frontal: 81					

The following figure and table present the results of statistical analyzing with the method of p-FWE<0.05 value for the pleasant places.

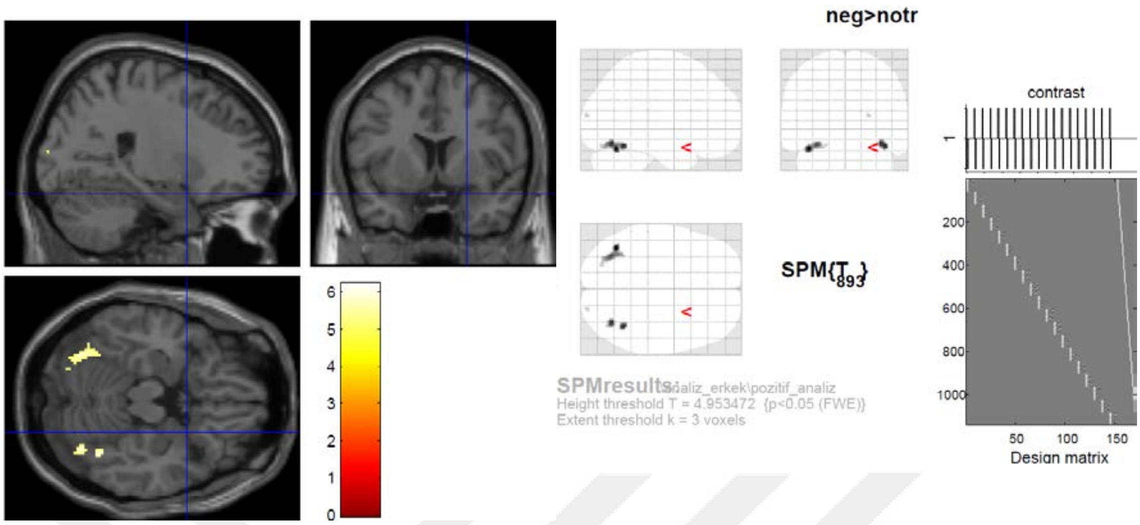


Figure 5-22: The fMRI analyses of pleasant places for men (p-FWE<0.05)

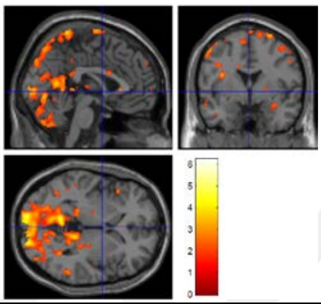
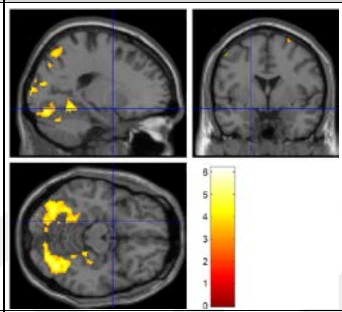
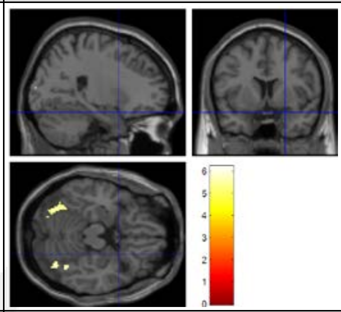
The most activated areas engaged in emotions were found in areas such as the left cerebellun, and the fusiform (*T*=6.21, *p-FWE*= 0.000<0.05, *x*=-40, *y*=-64, *z*=-22, *K*=5). As seen, the activated brain areas are less than areas found using the p-unc<0.05 value.

Table 5-64: fMRI measurement data in related to pleasant places for men (p-FWE<0.05).

Number of Clusters Found: 3			**Number of All Voxels: 167**		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Men	5	-40 -64 -22	6.21	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Left Cerebellum: 49 / Fusiform:** 39				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 44 / Temporal: 6 / Lingual: 5				
Total Voxels Number of More Effective Active Regions: Fusiform: 75 / Left Cerebellum: 49					

As shown in the tables presented above (5-63 and 5-64), related to pleasant places the men's brain activations found using p-unc<0.05 value are more and stronger than the brain activations found using both p-unc<0.01 and *p-FWE*<0.05 values. The following comparative table presents that in p-unc<0.05 value, the number of found cluster voxels (*KE*=21783 & 738), the number of all clusters found (n=84), the number of all activated voxels (n=27852), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception are more and stronger than the p-unc<0.01 value (*KE*=1260 & 28; clusters found=34; all activated voxels=5242) and *p-FWE*<0.05 value (*KE*=5; clusters found=3; all activated voxels=167).

Table 5-65: Men fMRI data in related to pleasant places using different statistical p-values.

Peak MNI coordinate: *x*=-40 *y*=-64 *z*=-22 **t-Peak Intensity:** 6.21 **p:** 0.000 **Peak MNI coordinate:** *x*=-52 *y*=-4 *z*=54 **t-Peak Intensity:** 4.05 **p:** 0.000			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			
Clusters	84	34	3
Voxels	27852	5242	167
KE	21783 & 738	1260 & 28	5
Peak MNI Region Engaged in Emotion	**Frontal Lobe:** 3596 **Left Cerebellum:** 2316 **Precuneus:** 2179 **Right Cerebellum:** 1378 **Middle Frontal:** 1101 **Fusiform:** 1069 **Medial Frontal:** 130 **Left Insula:** 28 **Anterior Cingulate:** 26	**Fusiform:** 687 **Left Cerebellum:** 420 **Precuneus:** 246 **Frontal:** 205 **Right Cerebellum:** 183 **Middle Frontal:** 81	**Fusiform:** 75 **Left Cerebellum:** 49
Peak MNI Region Engaged in Architecture	Occipital Lobe: 8605 Parietal Lobe: 4092 Cuneus: 2190 Limbic Lobe: 1994 Parahippocampal: 898 Angular: 131 Hippocampus: 30	Occipital Lobe: 768 Lingual Gyrus: 243 Limbic Lobe: 84 Parahippocampal: 83	Occipital Lobe: 44 Temporal: 6 Lingual: 5

In relation to **unpleasant** places, the following figure and table present the results of the men’s brain activity statistical analyzing with the statistical p-unc<0.01 value. Furthermore, no activation was found for men’s brain in the p-FWE<0.05 value statistical method compared to p-unc<0.05.

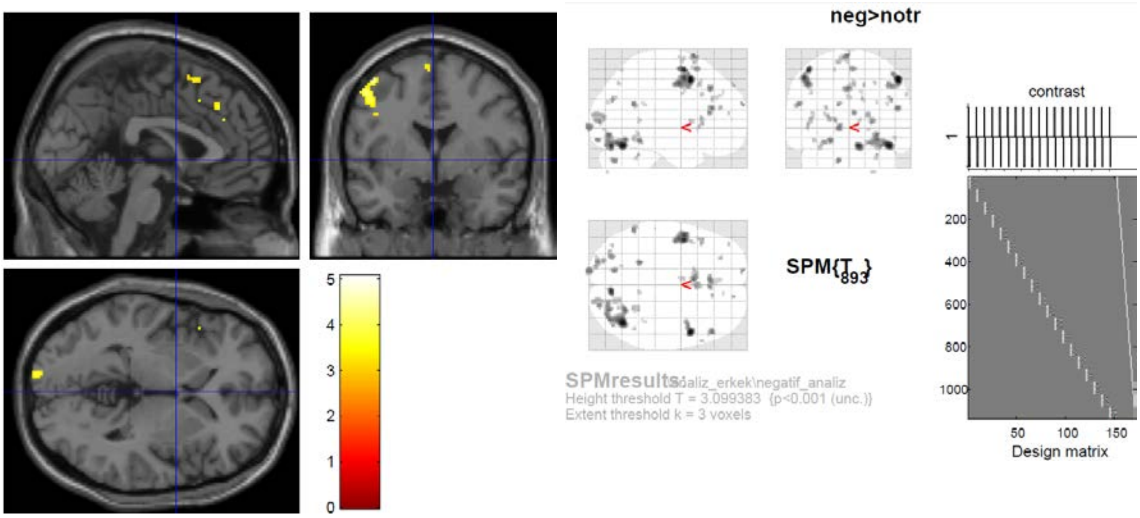


Figure 5-23: The fMRI analyses of unpleasant places for men (p-unc<0.01)

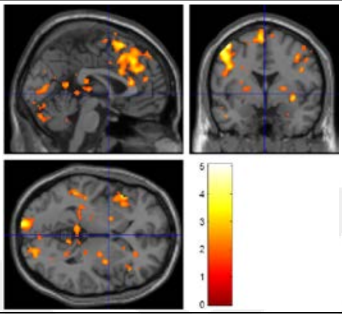
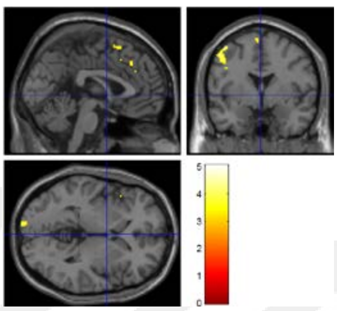
The most activated areas engaged in emotions were found in areas such as the right cerebrum, fusiform gyrus, and temporal lobe (*T*=4.86, *p-unc*= 0.000<0.01, *x*=42, *y*=-66, *z*=-20, *K*=343), and the frontal lobe, inferior frontal, and middle frontal (*T*=4.62, *p-unc*= 0.000<0.01, *x*=-46, *y*=2, *z*=58, *K*=21). As observed, the activated brain areas are less than areas found using the p-unc<0.05 value.

Table 5-66: fMRI measurement data in related to unpleasant places for men (p-unc<0.01).

Number of Clusters Found: 29			**Number of All Voxels: 1111**		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Men	343	42 -66 -20	4.86	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Right Cerebrum:** 252 **/ Fusiform Gyrus:** 144 **/ Temporal Lobe:** 21				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 231 / Lingual Gyrus: 56 / Middle occipital: 22				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Men	21	-46 2 58	4.62	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Frontal Lobe:** 21 **/ Inferior Frontal:** 11 **/ Middle Frontal:** 10				
Total Voxels Number of More Effective Active Regions: Right Cerebrum: 252 / Fusiform Gyrus: 144 / Temporal Lobe: 21 / Frontal Lobe: 21 / Inferior Frontal: 11 / Middle Frontal: 10					

The following comparative table presents that in p-unc<0.05 value, the number of found cluster voxels (*KE*=5779 & 5054), the number of all clusters found (n=109), the number of all activated voxels (n=17460), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception are more and stronger than the p-unc<0.01 value (*KE*=343 & 21; clusters found=29; all activated voxels=1111).

Table 5-67: Men fMRI data in related to unpleasant places using different statistical p values.

Peak MNI coordinate: *x*=42 *y*=-66 *z*=-20 **t-Peak Intensity:** 4.86 **p:** 0.000 **Peak MNI coordinate:** *x*=46 *y*=-2 *z*=58 **t-Peak Intensity:** 4.62 **p:** 0.000			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			**No Suprathreshold Clusters**
Clusters	109	29	0
Voxels	17460	1111	0
KE	5779 & 5054	343 & 21	0
Peak MNI Region Engaged in Emotion	**Right Cerebrum:** 7486 **Left Cerebrum:** 6753 **Frontal Lobe:** 4891 **Fusiform Gyrus:** 808 **Inferior Frontal:** 787 **Left Middle Frontal:** 519 **Left Fusiform:** 459 **Right Middle Frontal:** 449 **Cingulate:** 407 **Insula:** 274 **Anterior Cingulate:** 228 **Lef Insula:** 170 **Left Thalamus:** 111 **Right Insula:** 80 **Thalamus:** 78 **Left Middle Temporal:** 44 **Left Hippocampus:** 35 **Superior Occipital:** 35 **Amygdala:** 11 **Right Amygdala:** 5 **Left Orbitofrontal:** 5	**Right Cerebrum:** 252 **Fusiform Gyrus:** 144 **Temporal Lobe:** 21 **Frontal Lobe:** 21 **Inferior Frontal:** 11 **Middle Frontal:** 10	....
Peak MNI Region Engaged in Architecture	Occipital Lobe: 2943 Lingual Gyrus: 588 Middle occipital: 554 Limbic Lobe:352 Parahippocampal: 325 Precuneus: 11	Occipital Lobe: 231 Lingual Gyrus: 56 Middle occipital: 22	....

5.3.3. The findings of the fMRI and closed questionnaire for architects and urban designers

- **fMRI measurement data related to pleasant places for architects**

The following figure presents the architects' parts of the brain that were activated when were exposed to pleasant places. As shown, in cluster 1, the most activated areas were the left and right cerebellum, precuneus, fusiform gyrus, and frontal lobe (T=5.89, p=0.000<0.05, x=-40, y=-64, z=-22, K=18907). The findings demonstrated that the activation of the cerebellum covaried in relation to **happiness**. Also, activation in the precuneus and fusiform gyrus covaried in relation to **pleasant emotions** ratings. As observed in cluster 2, (T=3.28, p=0.001<0.05, x=48, y=50, z=8, K=36) the areas such as middle frontal, medial frontal, anterior cingulate, and left insula were activated. In this context, the anterior cingulate and the left insula are implicated in **happiness.** The middle frontal and medial frontal are engaged in **pleasant emotions**.

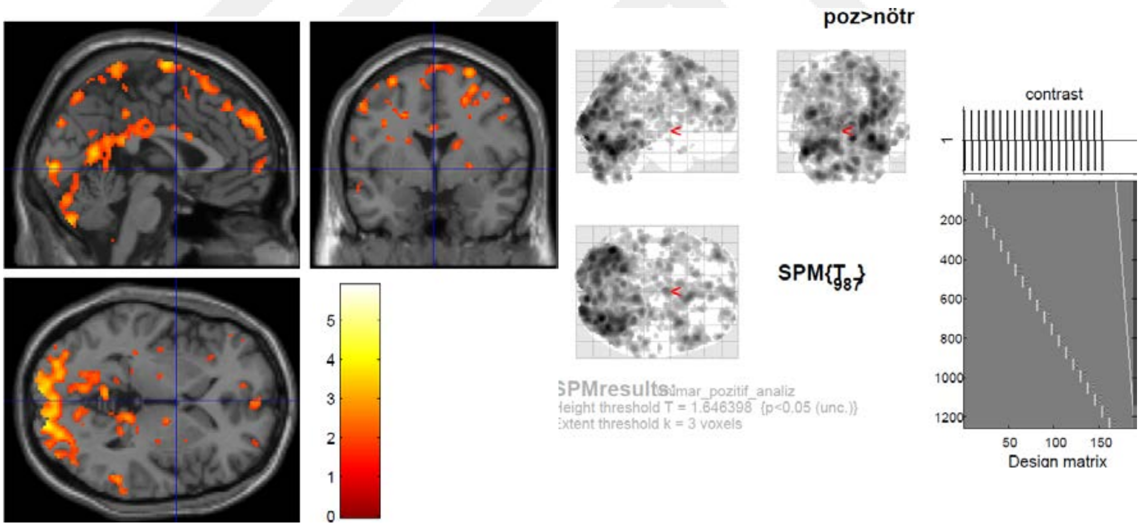


Figure 5-24: The fMRI analyses of unpleasant places for architecture students (p-unc<0.05)

Besides that, according to Table 2-17, the *precuneus* area also is engaged in determining orientation in space, aesthetic and beauty assessments of artworks, and perception. The *frontal lobe* is associated with beauty judgment; the *fusiform gyrus* is engaged in the neural representation of architectural styles and identifying locations, the *anterior cingulate cortex* is involved in the emotional processing of architecture, and the *middle frontal* is involved in pleasantness, beauty judgment, and approach behavior.

In addition, activities in other areas were also recorded each of which confirms the brain’s response to spatial elements and architectural qualities. For instance, the *occipital lobe* which is engaged in architectural perception of forms, colors, height, depth, and geometry; The *parietal lobe* which is engaged in understanding spatial orientation and perception (motion, depth, height, width, geometry); the *temporal lobe* which is engaged in visual perception (form, color, objects recognition) and spatial perception (height, depth, geometry); the *cuneus* is responsive to the appreciation of representational material; the *middle occipital* and *hippocampus* are involved in aesthetic assessments and beauty ratings; the *superior temporal* which is involved in visuo-spatial exploration of architectural space; *left middle temporal* and *inferior temporal* which are engaged in semantic memory processing, and visual perception.

Table 5-68: fMRI measurement data related to pleasant places for architecture students ($p<0.05$)

<table>
<tr><th colspan="6">Number of Defined Clusters Found: 82   Number of All Voxels Found: 26005</th></tr>
<tr><th>Cluster</th><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td rowspan="3">1</td><td>Architecture</td><td>18907</td><td>-40 -64-22</td><td>5.89</td><td>0.000</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Left Cerebellum: 2255 / Right Cerebellum: 1710 / Precuneus: 1469 / Fusiform: 1014 / Frontal Lobe: 331</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Architecture:</u>
Occipital Lobe: 7326 / Parietal Lobe: 2895 / Temporal Lobe: 2139 / Lingual gyrus: 2047 / Cuneus: 1488 / Limbic Lobe: 1707 / Middle Occipital: 1679 / Parahippocampus: 593 / Superior Parietal: 510 / Superior Temporal: 124 / Left Middle Temporal: 115 / Inferior Temporal: 23</td></tr>
<tr><td rowspan="3">2</td><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td>Architectue</td><td>36</td><td>48 50 8</td><td>3.28</td><td>0.001</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Middle Frontal Gyrus: 138 / Medial Frontal: 22 / Anterior Cingulate: 31 / Left Insula: 7</td></tr>
<tr><td colspan="6"><u>Total Voxels Number of More Effective Active Regions:</u>
Frontal Lobe: 4719 / Left Cerebellum: 2323 / Right Cerebellum: 1807 / Middle Frontal: 1634 / Precuneus: 1495 / Fusiform: 1014 / Medial Frontal: 360 / Anterior Cingulate: 52 / Left Insula: 12</td></tr>
</table>

As shown in the Table above, the areas of the brain engaged in emotions that were expected to be activated in the face of pleasant spaces are marked by bold fonts. The results demonstrated that architects’ assessing of pleasant places in the aspect of spatial elements and architectural qualities were associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=7326], and the least value in the **Inferior Temporal** [Voxels=23]; and related to emotionally assessing it was associated exclusively with the highest increase in the **Frontal Lobe** [Voxels=4719] and the least value in the **left insula** [Voxels=12].

- **fMRI measurement data related to unpleasant places for architects**

The following figure presents the parts of the architects' brains engaged in emotion that were activated when they were exposed to unpleasant places. Also, the following table shows the statistical analysis of the brain activated areas which makes it possible to indicate the most effective areas engaged in the emotional and cognitive process encountering negative scenes and places. As shown, in cluster 1, the most activated areas were the right and left cerebrum, fusiform gyrus, left fusiform, frontal lobe, right middle temporal, cingulate, thalamus, superior occipital, left hippocampus, right insula, hippocampus, insula, and anterior cingulate (T=5.86, p=0.000<0.05, x=-40, y=-64, z=22, K=21546). However, as observed in cluster 2, the most activated areas were activated in the left insula, left thalamus, inferior temporal, and orbitofrontal cortex (T=2.25, p=0.012<0.05, x=34, y=14, z=20, K=18).

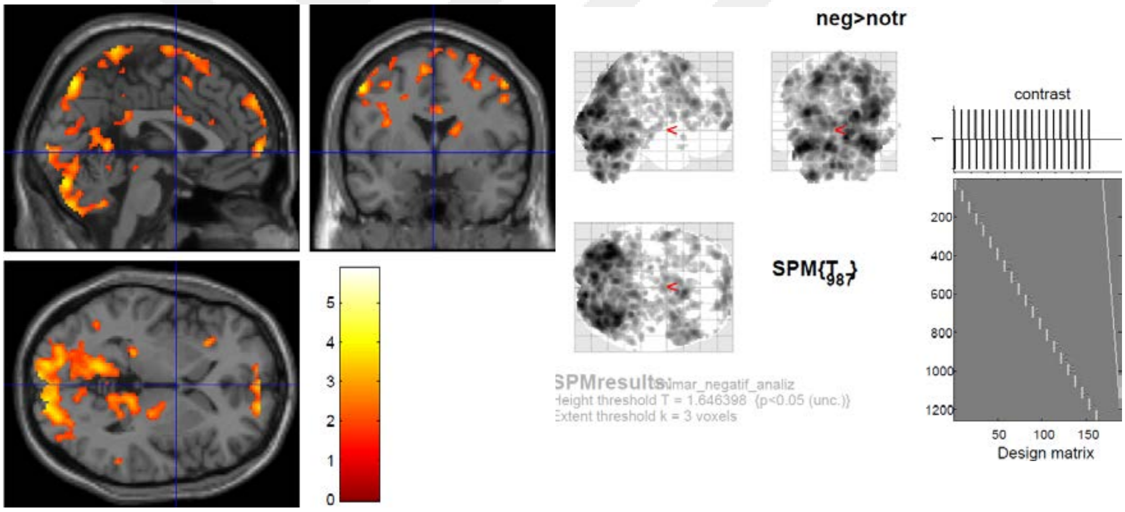


Figure 5-25: The fMRI analyses of unpleasant places for architecture students (p-unc<0.05)

The findings demonstrated that activation in the frontal lobe and orbitofrontal cortex are implicated in **fear**, **disgust**, and **anger**. The right middle temporal, cingulate, thalamus, insula, anterior cingulate, and left thalamus are engaged in **fear** and **sadness**. Furthermore, the cerebrum and left hippocampus are involved in **fear**, as well as the activation of hippocampus is engaged in **sadness** and **anger**; and right and left insula are engaged in **disgust** and **anger.** Also, the fusiform is engaged in **unpleasant emotions**, the insula is engaged in **negative affect**, and left fusiform, superior occipital, anterior cingulate, and left insula are engaged in **avoidance behavior**.

In addition to activating the areas associated with the unpleasant emotions, activations in other areas were also recorded each of which confirms the architects' brain response to spatial elements and architectural qualities. According to the Table 2-17, the *fusiform gyrus* is engaged in the neural representation of architectural styles and identifying locations; the *cingulate* is involved in the emotional processing and the avoidance decisions of architectural spaces, the *frontal lobe* and *orbitofrontal* cortex are engaged in reward processing and beauty judgment; the *insula* is engaged in avoidance, and aesthetic judgment; the *hippocampus* is implicated in memories and perception; the *anterior cingulate* is engaged in emotional processing of architecture and avoidance.

Table 5-69: fMRI measurement data related to unpleasant places for architecture students ($p<0.05$)

<table>
<tr><th colspan="6">Number of Defined Clusters Found: 71 Number of All Voxels Found: 28373</th></tr>
<tr><th>Cluster</th><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td rowspan="3">1</td><td>Architecture</td><td>21546</td><td>-40 -64 22</td><td>5.86</td><td>0.000</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Right Cerebrum: 8970 / Left Cerebrum: 6624 / Fusiform: 1061 / Left Fusiform: 990 / Frontal Lobe: 661 / Right Mid Temporal: 215 / Cingulate Gyrus: 121 / Thalamus: 93 / Superior Occipital Gyrus: 56 / Left Hippocampus: 23 / Right Insula: 12 / Hippocampus: 8 / Insula: 8 / Anterior Cingulate: 3</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Architecture:</u>
Occipital Lobe: 7646 / Parietal Lobe: 3476 / Middle Occipital: 1632 / Parahippocampal: 730 / Posterior cingulate: 717 / Superior Parietal: 565 / Superior temporal: 50 / Temporal Lobe: 13</td></tr>
<tr><td rowspan="3">2</td><td>Participant</td><td>Voxels Number (KE)</td><td>Peak MNI Coordinate
x y z</td><td>t
(Peak Intensity)</td><td>p</td></tr>
<tr><td>Architectue</td><td>18</td><td>34 14 20</td><td>2.25</td><td>0.012</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Left Insula: 41 / Left Thalamus: 8 / Orbitofrontal: 5</td></tr>
<tr><td colspan="6"><u>Total Voxels Number of More Effective Active Regions:</u>
Right Cerebrum: 12242 / Left Cerebrum: 9423 / Frontal Lobe: 5009 / Fusiform: 1061 / Left Fusiform: 990 / Cingulate Gyrus: 281 / R-Mid-Temporal: 215 / Thalamus: 149 / Superior Occipital: 56 / Left Insula: 44 / Left Hippocampus: 43 / Insula: 34 / Orbitofrontal: 8 / Hippocampus: 8 / Left Thalamus: 8</td></tr>
</table>

Besides that, the *occipital lobe* responds to perceptual information regarding architecture, and is involved in the perception of forms, colors, height, depth, geometry, spatial movement direction, visual processing, and recognizing objects; the *temporal lobe* which is engaged in visual perception (form, color, and recognition of objects) and spatial perception (height, depth, geometry); the *parietal temporal* lobes which is involved in understanding spatial orientation and perception (motion, depth, height, width, geometry), visual perception, cognition, identifying the position, location, and touch; the *middle occipital gyrus* is involved in the aesthetic assessments of artworks and beauty ratings; the *posterior cingulate* is engaged in spatial memory and spatial orientation of objects; the *parahippocampal* is engaged in architectural experience of large-scale places; the *superior temporal sulcus* is involved in visuo-spatial exploration of architectural space, processing of social cues and interpersonal touch.

As shown, the areas of the brain that were expected to be activated in the face of unpleasant spaces are marked by bold fonts. The results demonstrated that for architects, emotional assessment of unpleasant places in the aspect of spatial architectural qualities was associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=7646] and the least value in the **Temporal Lobe** [Voxels=13]; and in related to emotional assessment it was associated with the highest increase in the **Right Cerebrum** [Voxels=12242] and the least value in the **Left Thalamus** [Voxels=8].

Neurological experiments of assessing emotional-perceptual experience of pleasant and unpleasant places for architecture students was conducted and analyzed. In this context, findings had revealed significant differences between pleasant and unpleasant place ratings. So, the following table represents a comparative framework for all architects' neurological ratings. It was found that there are significant differences in activities in related to emotional assessment of pleasant and unpleasant places. The unpleasant places were associated exclusively with strong activation [voxels=28373] as compared to the pleasant places [26005]. Such a difference provides evidence that unpleasant places in aspect of using spatial and architectural qualities trigger architecture students' emotions to a stronger degree than pleasant places, and the brain areas engaged in emotions respond more effectively and more strongly to unpleasant places than pleasant places. These findings represent that the architects' brain areas associated with pleasantness and reward processing, are involved in preferences which include pleasant or unpleasant designs.

Because of the highly increased activities in visual-perceptual areas (perception of forms, colors, height, depth, geometry) of the **occipital lobes** (v=7646), beauty judgement areas of the **frontal lobe** (v=5009), spatial orientation, tactile, and perception (motion, depth, height, width, geometry) areas of the **parietal lobe** (v=3476), and architectural experience of large-scale places and landscape areas of the **parahippocampal** (v=730) in relation to unpleasant places rather than the same areas for pleasant places [**occipital lobes** (v=7326), **frontal lobe** (v=4719), **parietal lobe** (v=2895)], it is assumed that negative places due to the lack of appropriate architectural qualities, affect users emotional-perceptual experience, and it attracts more attention from architects to the valence of good design.

Table 5-70: The comparison of statistical findings of pleasant & unpleasant place for architects

Participant	Clusters Found	Voxels Found	The Brain's More Effective Active Regions		Peak MNI Coordinate Region Engaged in Architecture:
Pleasant	82	26005	Frontal Lobe	4719	Occipital Lobe: 7326
			Left Cerebellum	2323	Parietal Lobe: 2895
			Right Cerebellum	1807	Temporal Lobe: 2139
			Middle Frontal	1634	Lingual gyrus: 2047
			Precuneus	1495	Cuneus: 1488
			Fusiform	1014	Limbic Lobe: 1707
			Medial Frontal	360	Middle Occipital: 1679
			Anterior Cingulate	52	Parahippocampus: 593
			Left Insula	12	Superior Parietal: 510
					Superior Temporal: 124
					Left Middle Temporal: 115
					Inferior Temporal: 23
Unpleasant	71	28373	Right Cerebrum	12242	Occipital Lobe: 7646
			Left Cerebrum	9423	Parietal Lobe: 3476
			Frontal Lobe	5009	Middle Occipital: 1632
			Temporal Lobe	2101	Parahippocampal: 730
			Fusiform	1061	Posterior cingulate: 717
			Left Fusiform	990	Superior Parietal: 565
			Cingulate Gyrus	281	Superior temporal: 50
			R-Mid-Temporal	215	Temporal Lobe: 13
			Thalamus	149	
			Superior Occipital	56	
			Left Insula	44	
			Left Hippocampus	43	
			Inferior Temporal	35	
			Insula	34	
			Orbitofrontal	8	
			Hippocampus	8	
			Left Thalamus	8	

- **fMRI measurement data in related to pleasant places for urban designers**

The following figure presents the parts of the brain that were activated when urban design students were exposed to pleasant places. As shown in cluster 1, the most activated areas were pointed at the left and right cerebellum, precuneus, fusiform gyrus, and frontal lobe, medial prefrontal, anterior cingulate, left insula, and amygdala (T=5.89, p=0.000<0.05, x=36, y=-62, z=30, K=31520). The findings demonstrated that the activation of the cerebellum, anterior cingulate, and left insula covaried in relation to **happiness**. In addition, activation in the medial prefrontal, precuneus and fusiform gyrus covaried in relation to **pleasant emotions** ratings. Interestingly, the areas such as amygdala and frontal lobe which are implicated in **fear** and **disgust** were activated related to pleasant places. Besides, according Table 2-17, the *precuneus* area also is engaged in determining orientation in space, aesthetic and beauty assessments of artworks, and perception. The *frontal lobe* is associated with beauty judgment; the *fusiform gyrus* is engaged in the neural representation of architectural styles and identifying locations, the *anterior cingulate cortex* is involved in the emotional processing of architecture, and the amygdala is implicated in avoidance behavior.

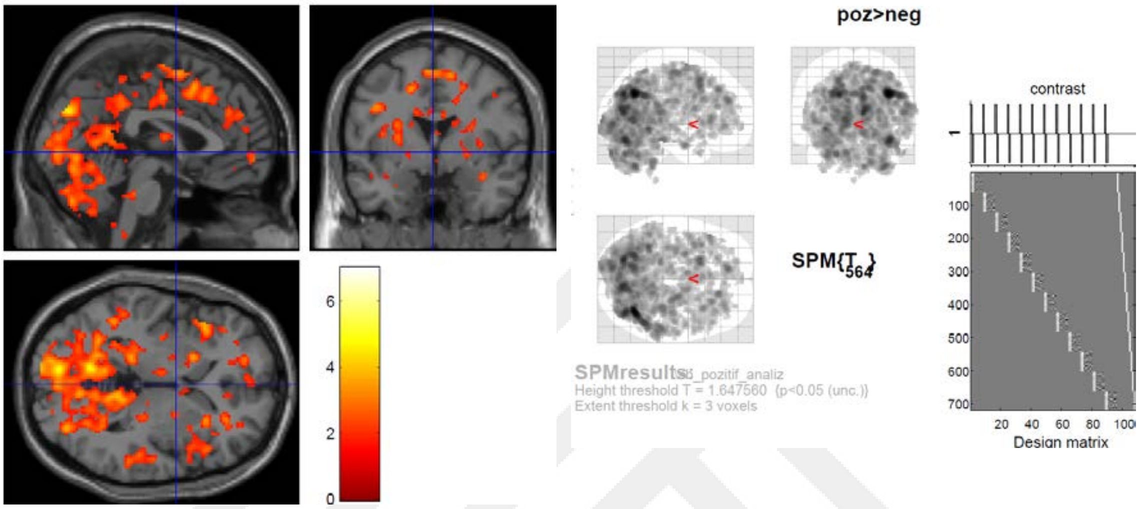


Figure 5-26: The fMRI analyses of pleasant places for urban design students (p-unc<0.05)

In addition, activities in other areas were also recorded each of which confirms the urban designers' brains' responses to spatial elements and architectural qualities. For instance, the *occipital lobe* which is engaged in architectural perception of forms, colors, height, depth, and geometry; together with the *parietal lobe* which is engaged in understanding spatial orientation and perception (motion, depth, height, width, and geometry); the *temporal lobe* which is engaged in visual perception (form, color, objects recognition) and spatial perception (height, depth, geometry); the *superior temporal* sulcus which implicated in visuo-spatial exploration of architectural space; the *parahippocampal* engaged in architectural experience and representation of large-scale places; the *cuneus* is responsive to the appreciation of representational material; the *middle occipital*, *superior frontal*, and *hippocampus* which are involved in aesthetic assessments and beauty ratings; *middle temporal* which is engaged in perceiving motion in an architectural space; and lastly, the *medial orbitofrontal* which engaged in processing of reward during architecture appraisal.

As shown in the following Table, the areas of the brain engaged in emotion in the face of pleasant spaces are marked by bold fonts. The results demonstrated that urban designers' assessing of pleasant places in the aspect of spatial elements and architectural qualities was associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=7153], and the least value in the **Medial frontal** [Voxels=23]; Related to emotionally assessing it was associated exclusively with the highest increase in the **Frontal Lobe** [Voxels=5151] and the least value in the **amygdala** [Voxels=25].

Table 5-71: fMRI measurement data related to pleasant places for urban design students ($p<0.05$)

<table>
<tr><th colspan="6">Number of Defined Clusters Found: 46 Number of All Voxels Found: 33057</th></tr>
<tr><th>Cluster</th><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td rowspan="3">1</td><td>Urban Design</td><td>31520</td><td>36 -62 30</td><td>6.98</td><td>0.000</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Frontal Lobe: 4801 / Right Cerebellum: 2887 / Precuneus: 2062 / Left Cerebellum: 2566 / Medial Prefrontal: 1256 / Fusiform Gyrus: 1047 / Anterior Cingulate: 372 / Left Insula: 357 / Amygdala: 25</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Architecture:</u>
Occipital: 7153 / Temporal Lobe: 3495 / Cuneus: 2089 / Superior Temporal: 1072 / Lingual gyrus: 2361 / Parietal Lobe: 3009 / Parahippocampal: 788 / Middle Temporal: 750 / Inferior Frontal Gyrus: 581 / Middle Occipital Gyrus: 544 / Superior Frontal Gyrus: 220 / Angular Gyrus: 94 / Hippocampus: 80 / Medial Orbitofrontal: 11 / Medial Frontal: 5</td></tr>
<tr><td colspan="6"><u>Total Voxels Number of More Effective Active Regions:</u>
Frontal Lobe: 5151 / Right Cerebellum: 2905 / Left Cerebellum: 2588 / Precuneus: 2072 / Medial Prefrontal: 1272 / Fusiform Gyrus: 1047 / Middle Frontal: 442 / Anterior Cingulate: 405 / Left Insula: 366 / Amygdala: 25</td></tr>
</table>

- **fMRI measurement related to unpleasant places for urban designers**

The following figure and table present the parts of the urban designers' brain engaged in emotion that were activated when they were exposed to unpleasant places. As shown, in the cluster 1, the most activated areas have pointed at the right and left cerebrum, frontal lobe, cingulate, fusiform gyrus, left fusiform, anterior cingulate, thalamus, right middle temporal, left thalamus, insula, left hippocampus, and right insula (T=6.85, p=0.000<0.05, x=-14, y=-86, z=-36, K=26788). Furthermore, in the cluster 2 the most activated areas were activated in the hippocampus and the left amygdala (T=3.87, p=0.000<0.05, x=-36, y=18, z=0, K=216). The findings demonstrated that activation in the frontal lobe and left insula are implicated in **fear**, **disgust**, and **anger**. The right middle temporal, cingulate, anterior cingulate, and insula are engaged in **fear** and **sadness**. Furthermore, the cerebrum, left hippocampus, and thalamus are involved in **fear**; the right insula is engaged in **disgust**; the left thalamus is engaged in **sadness**; the hippocampus is engaged in **sadness** and **anger**; and the left amygdala is engaged in **disgust, fear** and **sadness.** Also, the fusiform is engaged in **unpleasant emotions**. The insula is engaged in **negative affect**, and the left fusiform, anterior cingulate, and left insula are engaged in **avoidance behavior**.

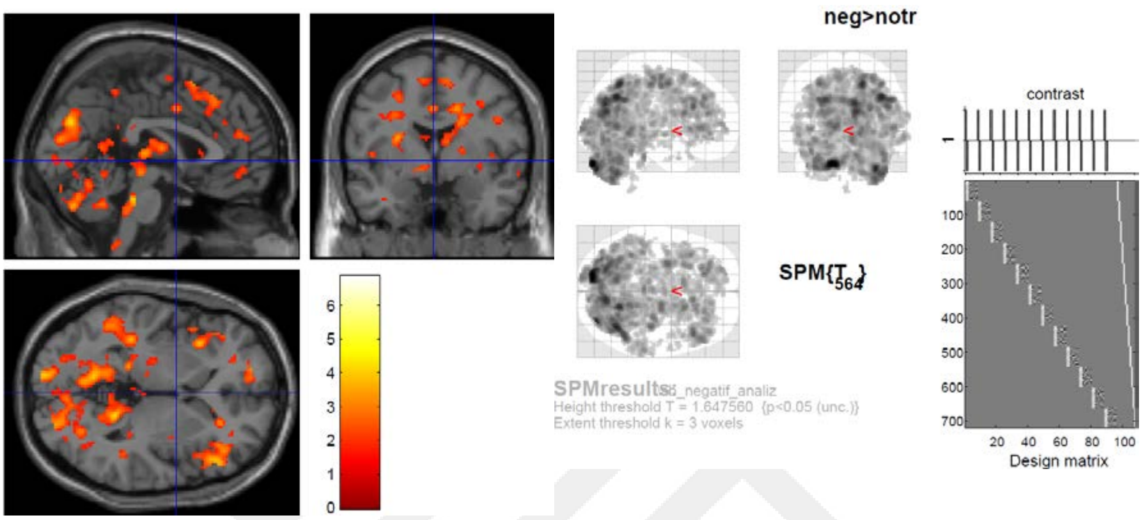


Figure 5-27: The fMRI analyses of unpleasant places for urban design students (p-unc<0.05)

In addition to activating the areas associated with the unpleasant emotions, activations in other areas were also recorded each of which confirms the urban designers' brain response to spatial elements and architectural qualities. According to Table 2-17, the *fusiform gyrus* is engaged in the neural representation of architectural styles and identifying locations; the *cingulate* is involved in the emotional processing and the avoidance decisions of architectural spaces, the *frontal lobe* is engaged in reward processing and beauty judgment; the *insula* is engaged in avoidance, and aesthetic judgment; the *hippocampus* is implicated in memories and perception; the *anterior cingulate* is engaged in emotional processing of architecture and avoidance.

Besides, the *occipital lobe* responds to perceptual information regarding architecture (forms, colors, height, depth, geometry, visual processing, and recognizing objects); the *temporal lobe* is engaged in visual perception (form, color, and recognition of objects) and spatial perception (height, depth, geometry); the *parietal temporal* is involved in understanding spatial orientation and perception (depth, height, width, geometry), the *middle occipital*, *superior frontal*, and *parahippocampus* are involved in the aesthetic assessments and beauty ratings; and the *superior occipital* is engaged in avoidance. As shown, in the following table, the areas of the brain that were expected to be activated in the face of unpleasant spaces are marked by bold fonts. The results demonstrated that urban designers' emotional assessment of unpleasant/negative places in aspect of spatial elements and architectural qualities was associated exclusively with the highest increase in the **Occipital Lobe** [Voxels=5243] and the least value in the **Superior Parietal** [Voxels=7]; and in related to emotionally assessing it was associated exclusively with the highest increase in the **Right Cerebrum** [Voxels=12591] and the least value in the **Right Insula** [Voxels=33].

Table 5-72: fMRI measurement data related to unpleasant places for urban design students ($p<0.05$)

Number of Defined Clusters Found: 50 Number of All Voxels Found: 28129					
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Urban Design	26788	-14-86 -36	6.85	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Right Cerebrum:** 12064 / **Left Cerebrum:** 8149 / **Frontal Lobe:** 5101 / **Cingulate:** 819 / **Fusiform gyrus:** 771 / **Left Fusiform:** 549 / **Anterior Cingulate:** 369 / **Thalamus:** 359 / **R - Middle Temporal:** 218 / **Left Thalamus:** 212 / **Insula:** 154 / **Left Insula:** 106 / **Left Hippocampus:** 82 / **Right Insula:** 33				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 5243 / Parietal Lobe: 2894 / Temporal Lobe: 2292 / Parahippocampus: 483 / Middle Occipital: 383 / superior occipital: 288 / Superior Frontal: 253 / Superior Parietal: 7				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Urban Design	216	-36 18 0	3.87	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Hippocampus:** 4 / **Left Amygdala:** 3				
Total Voxels Number of More Effective Active Regions: Right Cerebrum: 12591 / Left Cerebrum: 8851 / Frontal Lobe: 5405 / Cingulate: 953 / Fusiform gyrus: 774 / Middle Temporal: 736 / Left Fusiform: 562 / Right Middle Temporal: 404 / Anterior Cingulate: 393 / Thalamus: 367 / Insula: 243 / Left Thalamus: 212 / Left Insula: 118 / Left Hippocampus: 103 / Right Insula: 40 / Hippocampus: 6 / Left Amygdala: 3					

Neurological experiments of assessing emotional-perceptual experience of pleasant and unpleasant places for urban design students was conducted and analyzed. In this context, findings had revealed significant differences between pleasant and unpleasant place ratings. The following table represents a comparative framework of urban designers' neurological ratings. As shown, it was found that there is a significant difference in related to emotionally assessing of pleasant and unpleasant places. For pleasant places, the areas engaged in positive emotions was activated, and for unpleasant places the areas engaged in negative emotions was activated. In this regard, the pleasant places ware associated exclusively with strong activation and highest score of found voxels (33057) compared to the unpleasant places (28129). Such a difference provides evidence that pleasant places in aspect of using spatial and architectural qualities trigger urban designers’ emotions to a stronger degree than unpleasant places, while the brain areas engaged in emotions respond more effectively and more strongly to pleasant places than unpleasant places.

Table 5-73: The comparison of statistical findings of pleasant & unpleasant place for urban designers

Participant	Clusters Found	Voxels Found	The Brain’s More Effective Active Regions		Peak MNI Coordinate Region Engaged in Architecture
Pleasant	46	33057	Frontal Lobe Right Cerebellum Left Cerebellum Precuneus Medial Prefrontal Fusiform Gyrus Middle Frontal Anterior Cingulate Left Insula Amygdala	5151 2905 2588 2072 1272 1047 442 405 366 25	Occipital: 7153 Temporal: 3495 Cuneus: 2089 Superior Temporal: 1072 Lingual Gyrus:2361 Parietal Lobe: 3009 Parahippocampal: 788 Middle Temporal: 750 Inferior Frontal Gyrus: 581 Middle Occipital Gyrus: 544 Superior Frontal Gyrus: 220 Angular Gyrus: 94 Hippocampus: 80 Medial Orbitofrontal: 11 Medial Frontal: 5
Unpleasant	50	28129	Right Cerebrum Left Cerebrum Frontal Lobe Cingulate Gyrus Fusiform Gyrus Middle Temporal Left Fusiform Right Middle Temporal Anterior Cingulate Thalamus Insula Left Thalamus Left Insula Left Hippocampus Right Insula Hippocampus Left Amygdala	12591 8851 5405 953 774 736 562 404 393 367 243 212 118 103 40 6 3	Occipital Lobe: 5243 Parietal Lobe: 2894 Temporal Lobe: 2292 Parahippocampus: 483 Middle Occipital: 383 Superior Occipital: 288 Superior Frontal: 253 Superior Parietal: 7

Because of highly increased activities in the visual-perceptual areas of the **occipital lobes** (v=7153), visual-spatial perception (form, color, and recognition of objects) areas of the **temporal lobe** (v=3495), spatial orientation, tactile, and perception (motion, depth, height, width, geometry) areas of the **parietal lobe** (v=3009), and aesthetic assessments of architecture and beauty ratings areas of the **middle occipital** (v=544) in relation to pleasant places rather than the same areas for unpleasant places [**occipital lobes** (v=5243), **temporal lobe** (v=2292), **parietal lobe** (v=2894), **middle occipital** (v=383)], it is assumed that positive places in aspect of providing architectural qualities are able to attract the attention of urban designers for a design. Results suggest that the external physical features and spatial qualities of an architectural design can influence the emotional, perceptual, cognitive, beauty judgement, and decision-making (behavioral) process of urban designers to a high degree. So, it can be possible that pleasant places due to attracting more attention and memory, contribute to an architectural design much better than unpleasant places. Findings suggest that unpleasant design will have negative influence on the emotional-perceptual experience of place, hence, architects and urban designers should pay more attention to the valence of good design.

- **The comparative fMRI data for architects and urban designers in neurological ratings of pleasant and unpleasant places**

Neurological and quantitative experiments of assessing emotional-perceptual experience of pleasant and unpleasant places was conducted and analyzed for two different groups of architects and urban designers. The relevant findings supported the cognitive base of experiencing pleasantness of architecture, and suggests that the emotional-perceptual experience of architecture involved in the brain cortical, sensory, meaning, emotion, judgement, and valuation system. In this context, this part of current study findings had revealed significant differences between architects and urban designers' pleasant and unpleasant place ratings. The following tables presents a comparative framework of their neurological and quantitative survey ratings.

As shown in the table 5-74, related to pleasant places the same areas were activated both for architects and urban designers, but the urban designers' brain showed significantly more activation for pleasant places than architects [urban designers (voxels=33057); architects (voxels=26005)]. In this regard, highly increased activities in the areas engaged in emotions such as the **frontal lobe** (v=5151), **left cerebellum** (v=2588), **right cerebellum** (v=2905), **precuneus** (v=2072), **medial frontal** (v=1272), **anterior cingulate** (v=405), and **left insula** (v=366) for urban designers rather than the same areas for architects [**frontal lobe** (v=4719), **left cerebellum** (v=2323), **right cerebellum** (v=1807), **precuneus** (v=1495), **medial frontal** (v=360), **anterior cingulate** (v=52), and **left insula** (v=12)] suggests that positive places in aspect of providing architectural qualities affected urban designers' brain and emotion more than architects. Furthermore, highly increased activities in the areas engaged in architectural experience such as the **parietal lobe** (v=3009), **temporal lobe** (v=3495), **cuneus** (v=2089), and **middle temporal** (v=750) for urban designers rather than the same areas for architects [**parietal lobe** (v=2895), **temporal lobe** (v=2139), **cuneus** (v=1488), and **middle temporal** (v=115)] suggest that pleasant places in aspect of spatial elements attract the more attention and perception of urban designers for a design.

In related to unpleasant places, approximately the same areas were activated for two groups with similar number of found voxels [architects (voxels=28373); for urban designers (voxels=28129)]. In this regard, little increased of activities were found on architects' brain related to areas engaged in architectural experience than urban designers. The relevant areas were the **occipital lobe** (v=7646), **parietal lobe** (v=3476), **middle occipital** (v=1632), and **parahippocampal** (v=730) rather than the same areas for urban designers [**occipital lobe** (5243), **parietal lobe** (v=2894), **middle occipital** (v=383), **parahippocampal** (v=483)]. Such a difference suggests that negative places in aspect of providing the perceptual features of architectural qualities affected architects' brain more than urban designers. Furthermore, little increased activities in the areas engaged in emotions for urban designers' brain than architects [**cingulate** (v=953), **thalamus** (v=367), **insula** (v=243), **left hippocampus** (v=103), **left thalamus** (v=212), **left insula** (v=118) than **cingulate** (v=281), **thalamus** (v=149), **insula** (v=34), **left hippocampus** (v=43), **left thalamus** (v=8), **left insula** (v=44)] suggest that urban designers assessed the unpleasant places more emotionally than architects.

Generally, it is revealed that, in assessing pleasant and unpleasant places for both architects and urban designers, the same areas of brain were activated when they saw the relevant places, but based on the number of found voxels, there were some differences between the neurological ratings of two groups. Hence, in the face of pleasant places, urban design students respond more emotionally and perceptual than architecture students. Moreover, in the face of unpleasant places the results were similar and close between two groups, but based on number of found voxels architecture students reacted to perceptual aspects of places more than urban designers, whereas urban design students respond to emotionally aspects of place more than architects.

Table 5-74: The comparative data of women & men neurological ratings of pleasant & unpleasant places

Place	Clusters Found	Voxels Found	The Brain's More Effective Active Regions		Peak MNI Coordinate Region Engaged in Architecture:
Pleasant **Architects**	82	26005	Frontal Lobe Left Cerebellum Right Cerebellum Middle Frontal Precuneus Fusiform Medial Frontal Anterior Cingulate Left Insula	4719 2323 1807 1634 1495 1014 360 52 12	Occipital Lobe: 7326 Parietal Lobe: 2895 Temporal Lobe: 2139 Lingual gyrus: 2047 Cuneus: 1488 Limbic Lobe: 1707 Middle Occipital: 1679 Parahippocampus: 593 Superior Parietal: 510 Superior Temporal: 124 Left Middle Temporal: 115 Inferior Temporal: 23
Pleasant **Urban Designers**	46	33057	Frontal Lobe Right Cerebellum Left Cerebellum Precuneus Medial Prefrontal Fusiform Gyrus Middle Frontal Anterior Cingulate Left Insula Amygdala	5151 2905 2588 2072 1272 1047 442 405 366 25	Occipital: 7153 Temporal: 3495 Cuneus: 2089 Superior Temporal: 1072 Lingual Gyrus:2361 Parietal Lobe: 3009 Parahippocampal: 788 Middle Temporal: 750 Inferior Frontal Gyrus: 581 Middle Occipital Gyrus: 544 Superior Frontal Gyrus: 220 Angular Gyrus: 94 Hippocampus: 80 Medial Orbitofrontal: 11 Medial Frontal: 5
Unpleasant **Architects**	71	28373	Right Cerebrum Left Cerebrum Frontal Lobe Temporal Lobe Fusiform Left Fusiform Cingulate Gyrus R-Mid-Temporal Thalamus Superior Occipital Left Insula Left Hippocampus Inferior Temporal Insula Orbitofrontal Hippocampus Left Thalamus	12242 9423 5009 2101 1061 990 281 215 149 56 44 43 35 34 8 8 8	Occipital Lobe: 7646 Parietal Lobe: 3476 Middle Occipital: 1632 Parahippocampal: 730 Posterior cingulate: 717 Superior Parietal: 565 Superior temporal: 50 Temporal Lobe: 13
Unpleasant **Urban Designers**	50	28129	Right Cerebrum Left Cerebrum Frontal Lobe Cingulate Gyrus Fusiform Gyrus Middle Temporal Left Fusiform Right Middle Temporal Anterior Cingulate Thalamus Insula Left Thalamus Left Insula Left Hippocampus Right Insula Hippocampus Left Amygdala	12591 8851 5405 953 774 736 562 404 393 367 243 212 118 103 40 6 3	Occipital Lobe: 5243 Parietal Lobe: 2894 Temporal Lobe: 2292 Parahippocampus: 483 Middle Occipital: 383 Superior Occipital: 288 Superior Frontal: 253 Superior Parietal: 7

In related to pleasant and unpleasant places, the sub-components of "**sensation**", "**perception**", "**cognition**", and "**behavior**" rated similarly by architects and urban designers. Although the neurological and statistical ratings results numerically were different between these two groups, emotional assessment of pleasant and unpleasant places for these two groups were rated similarly in aspect of psychological arousal and the brain areas activation. The results of independent samples *t*-test analysis regarding the meaningful difference ($p<0.05$) among the averages of "sensation", "perception", "cognition", and "behavior" measurements data based on discipline variable showed that the field of study (discipline) of users did not influence their ratings. In most cases, the views of the two groups were similar. Consequently, both urban designers and architects have considered the sub-components of "texture", "materials", "color", and "light" as important sensory factors; and the sub-components of "geometry", "proportion", "order" as significant perceptual factors. In this regard, in aspect of emotional evaluating the brain areas involved in were activated. In the face of pleasant places, the brain areas implicated in positive emotions such as the **cerebellum**, **precuneus**, **fusiform**, **anterior cingulate**, **left insula**, **frontal lobe**, **middle frontal**, and **medial frontal** were activated in both architects and urban designers' brains.

Furthermore, in related to unpleasant places, the brain areas implicated in negative emotions such as the **cingulate**, **anterior cingulate**, **insula**, **amygdala**, **thalamus**, **hippocampus**, **middle temporal**, and **cerebrum** were activated. Additionally, in aspect of perceptual assessment, the brain areas such as the **parietal lobe** (touch), the **cuneus** (material), the **occipital lobe**, **temporal lobe**, and **parietal lobe** (color, height, geometry, width, etc.) were activated for both the architects and urban designers' brains in related to pleasant and unpleasant places. In relation to evaluating cognition component, the "appearance facade", "physical features", "symbolic & iconic signs", and "landmark knowledge" are considered as the main indicators of cognitive factors. In this context, the brain areas engaged in cognition such as the **occipital lobe, parahippcampal**, **fusiform**, **parietal lobe**, **posterior cingulate**, and the **left middle temporal** were activated. Also, in related to the ratings of the sub-components of behavior, both of the two groups were interested in approach to old and historical building (pleasant places), and avoid new and sport halls building (unpleasant places). In this regard, related to approach to pleasant places, the **left frontal** and the **middle frontal** engaged in approach behavior were activated. Furthermore, related to avoid unpleasant places the **cingulate**, **insula**, and **amygdala** were activated.

Table 5-75: The comparative data of architects & urban designers sensation ratings of pleasant & unpleasant places

Place	Sub-Components	Group	Mean ($\bar{X}$)		SD	t	p
Pleasant	**Color**	Architecture	25.10	3.59	4.81	0.314	0.754
		Urban Design	24.90	3.56	5.34		
	Light	Architecture	25.48	3.64	4.03	0.717	0.474
		Urban Design	25.07	3.58	4.92		
	Texture	Architecture	**27.09**	3.87	4.53	0.670	0.503
		Urban Design	**26.67**	3.81	5.23		
	Material	Architecture	25.73	3.68	4.34	0.563	0.574
		Urban Design	25.38	3.63	5.50		
	Sound	Architecture	21.45	3.06	5.72	0.464	0.643
		Urban Design	21.80	3.11	6.07		
	Odor	Architecture	19.18	2.83	6.35	0.305	0.760
		Urban Design	19.42	2.77	6.41		
Unpleasant	**Color**	Architecture	32.85	3.65	9.36	0.174	0.862
		Urban Design	33.06	3.67	9.19		
	Light	Architecture	31.74	3.53	9.09	1.18	0.240
		Urban Design	33.06	3.67	8.48		
	Texture	Architecture	**33.81**	3.76	9.18	0.105	0.917
		Urban Design	**33.69**	3.74	8.79		
	Material	Architecture	33.50	3.72	9.64	0.010	0.992
		Urban Design	33.49	3.72	8.93		
	Sound	Architecture	28.08	3.23	8.76	2.16	0.332
		Urban Design	27.09	3.50	8.69		
	Odor	Architecture	27.81	3.09	10.3	2.59	0.110
		Urban Design	29.01	3.45	9.02		

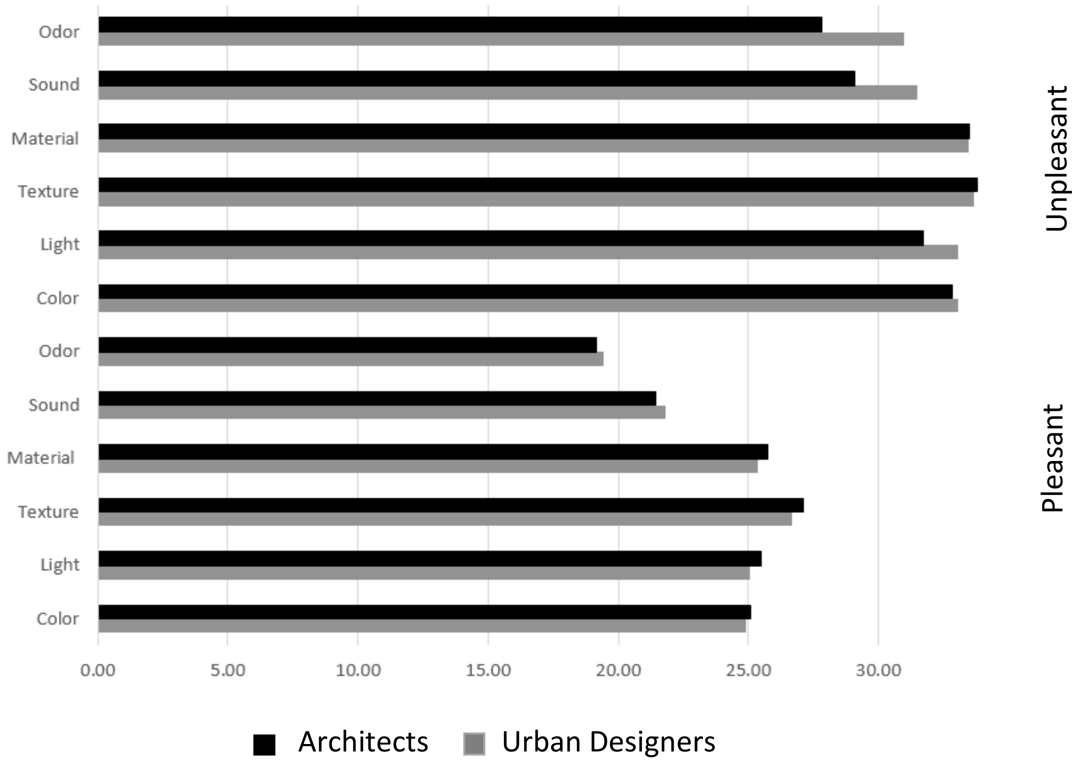


Diagram 5-15: Architects and urban designers sensation measurement data related to pleasant & unpleasant places.

Table 5-76: The comparative data of architects & urban designers perception ratings of pleasant & unpleasant places

Place	Sub-Components	Group	Mean ($\bar{X}$)		SD	t	p
Pleasant	Largeness (Size)	Architecture	23.14	3.31	5.18	0.765	0.445
		Urban Design	23.66	3.38	5.50		
	Height	Architecture	24.44	3.49	5.18	1.16	0.249
		Urban Design	25.21	3.60	5.20		
	Depth	Architecture	23.41	3.34	5.62	0.000	1.00
		Urban Design	23.41	3.34	5.98		
	Width	Architecture	23.76	3.39	5.35	0.463	0.643
		Urban Design	24.07	3.44	5.25		
	Geometry	Architecture	**26.33**	3.76	4.56	0.692	0.489
		Urban Design	**25.90**	3.70	5.11		
	Proportion	Architecture	**25.51**	3.64	4.87	0.206	0.837
		Urban Design	**25.38**	3.63	5.16		
	Order	Architecture	**25.90**	3.70	4.91	0.754	0.452
		Urban Design	**25.38**	3.63	5.76		
	Rhythm	Architecture	24.10	3.44	5.41	0.167	0.868
		Urban Design	24.22	3.46	6.19		
Unpleasant	Largeness (Size)	Architecture	31.09	3.45	8.20	0.540	0.590
		Urban Design	31.67	3.52	8.60		
	Height	Architecture	29.97	3.33	8.73	0.183	0.855
		Urban Design	29.77	3.31	8.30		
	Depth	Architecture	31.27	3.47	8.10	0.293	0.770
		Urban Design	31.58	3.51	8.43		
	Width	Architecture	31.17	3.46	8.55	0.608	0.544
		Urban Design	31.84	3.54	8.77		
	Geometry	Architecture	**33.21**	3.69	8.69	0.556	0.579
		Urban Design	**32.58**	3.62	8.88		
	Proportion	Architecture	**32.91**	3.66	8.47	0.127	0.899
		Urban Design	**32.77**	3.64	8.79		
	Order	Architecture	**32.77**	3.64	8.95	0.164	0.870
		Urban Design	**32.96**	3.66	9.44		
	Rhythm	Architecture	32.32	3.59	9.95	0.543	0.58
		Urban Design	33.00	3.66	9.52		

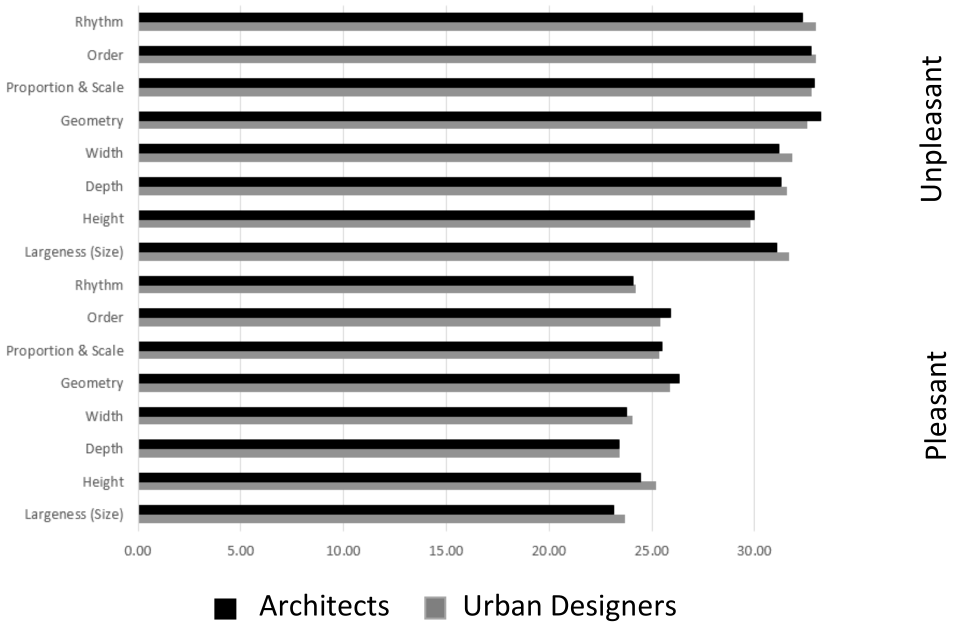


Diagram 5-16: Architects and urban designers perception measurement data related to pleasant & unpleasant places.

Table 5-77: The comparative data of architects & urban designers cognition ratings of pleasant & unpleasant places

	Sub-Components	Group	Mean ($\bar{X}$)	SD	t	p
Attention	Appearance Facade	Architecture	**4.05**	0.91	0.119	0.905
		Urban Design	**4.06**	0.93		
	Public Spaces	Architecture	3.98	0.97	0.986	0.325
		Urban Design	3.85	1.04		
	Functional Spaces	Architecture	3.74	1.25	0.911	0.363
		Urban Design	3.59	1.31		
Conceptualization	Physical Features	Architecture	**3.83**	1.23	0.628	0.530
		Urban Design	**3.74**	1.20		
	Functional Features	Architecture	2.95	1.15	0.842	0.401
		Urban Design	3.08	1.26		
	Social Features	Architecture	3.16	1.38	0.535	0.151
		Urban Design	2.90	1.38		
Association	Simbolic & Iconic Signs	Architecture	**4.24**	0.95	0.914	0.181
		Urban Design	**4.07**	1.03		
	Index Signs (Spaces Name)	Architecture	2.81	1.20	0.867	0.387
		Urban Design	2.67	1.26		
	Public Spaces	Architecture	2.76	1.31	0.250	0.803
		Urban Design	2.80	1.30		
Cognitive Map	Landmark Knowledge	Architecture	**3.08**	1.21	3.03	0.866
		Urban Design	**3.00**	1.17		
	Route-road Knowledge	Architecture	2.61	1.33	2.02	0.624
		Urban Design	2.10	0.95		
	Survey Knowledge	Architecture	2.14	1.24	1.16	0.276
		Urban Design	2.19	1.13		

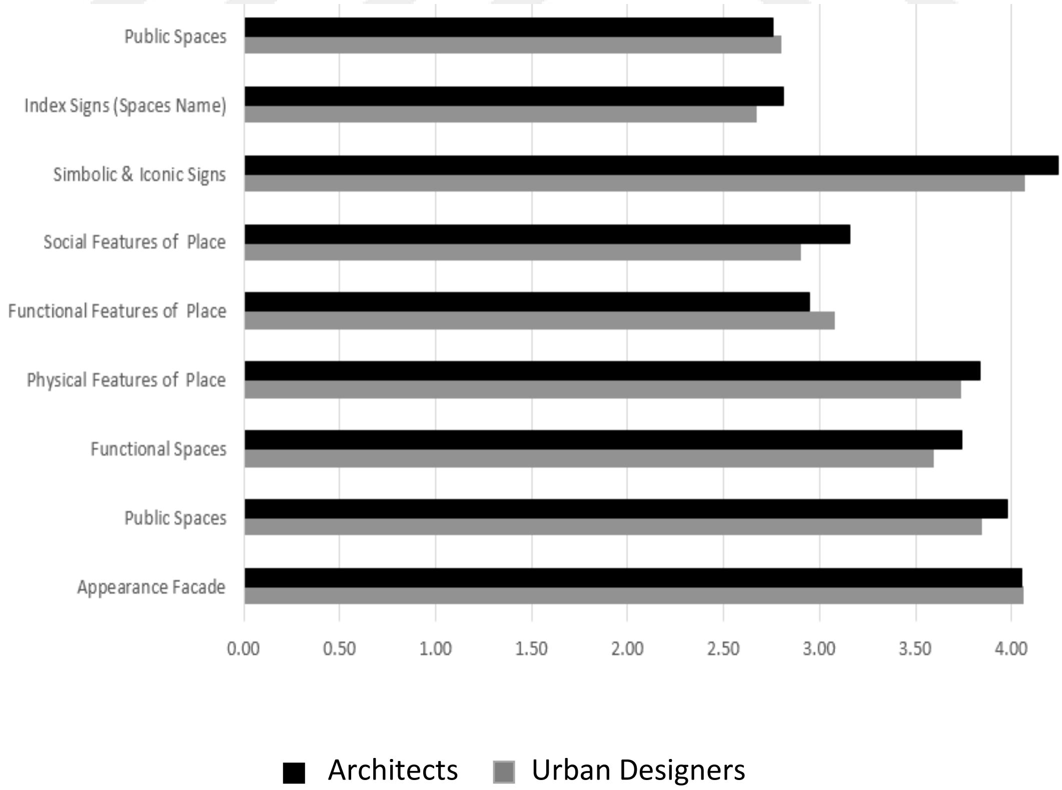


Diagram 5-17: Architects and urban designers cognition measurement data related to pleasant & unpleasant Places.

Table 5-78: The comparative data of architects & urban designers behavior ratings of pleasant & unpleasant places

Sub-Components		Gender	Mean ($\bar{X}$)		SD	t	p
Approach - Avoidance	The Old Bilding	Architecture	9.43	3.14	2.00	0.443	0.658
		Urban Design	9.32	3.11	2.00		
	The New Bilding	Architecture	7.92	2.64	2.76	1.33	0.185
		Urban Design	7.44	2.48	2.95		
	The Sports Hall Bilding	Architecture	8.48	2.83	2.73	0.528	0.598
		Urban Design	8.29	2.76	2.80		

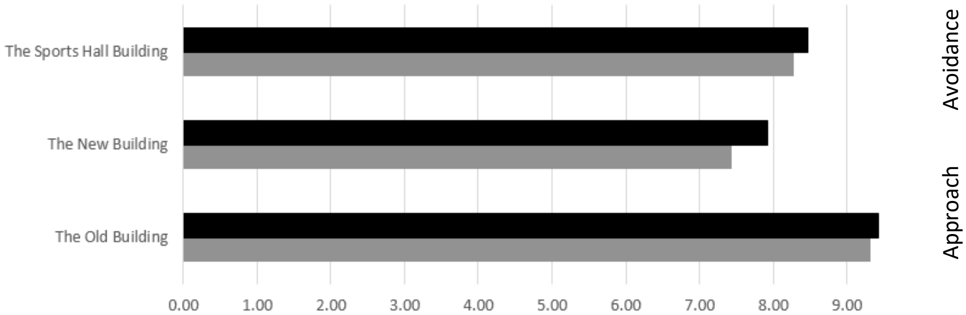
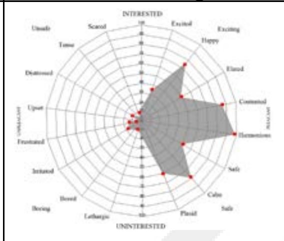
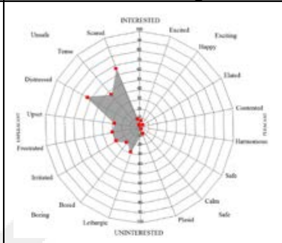
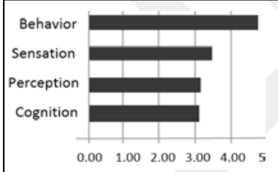
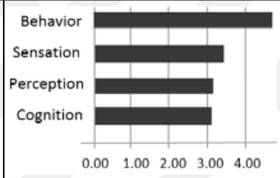
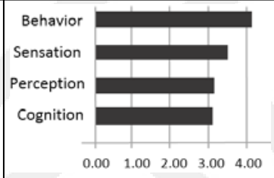
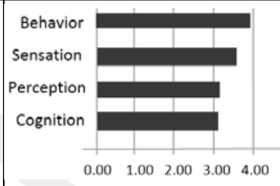
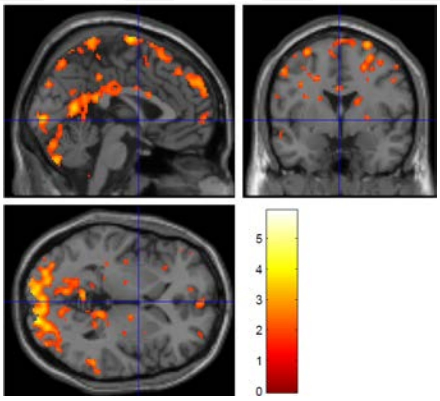
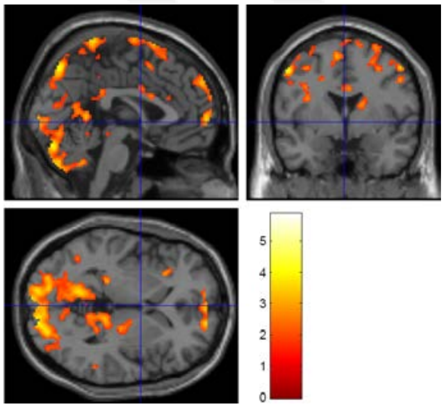
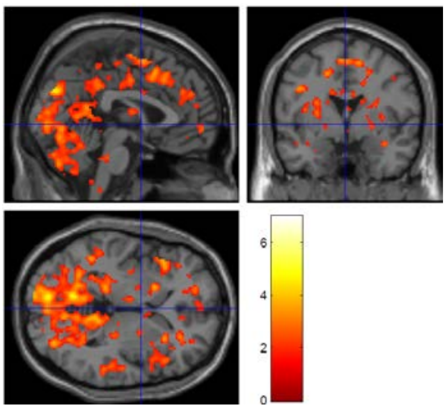
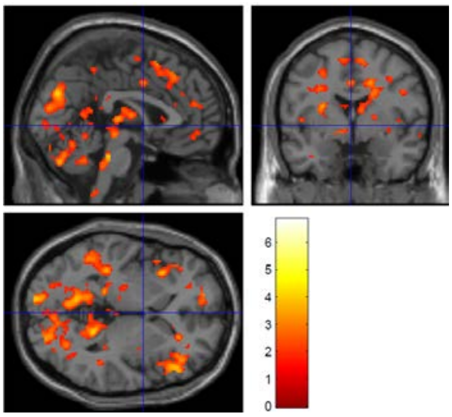


Diagram 5-18: Architects and urban designers behavior measurement data in related to case study places

Consequently, in measuring the contribution of each component affecting the process of emotional-perceptual experience of place for architects and urban designers, it was found that the **behavior** is evaluated as the most effective factor (M=4.35). This suggests that the pleasant and unpleasant places characteristics chiefly affect individual spatial judgments and behavior. Indeed, sensory, perceptual, and cognition factors affect the users' behavior. **Sensation** is evaluated as the second effective factor (M=3.50), the **Cognition** is the third effective factor (M=3.23), and **Perception** (M=3.14) is the last factor effecting the emotional-perceptual experience of place. The second phase of findings which was related to women and men was conducted, and the summary of the results is presented in the following table.

Table 5-79: The comparation of women & men emotional-neurological ratings of pleasantness (p <0.05).

<table>
<tr><th colspan="2">Selected Pleasant Places</th><th colspan="2">Selected Unpleasant Places</th></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><th>Pleasure-Arousal Model for Architects</th><th>Pleasure-Arousal Model for Urban Designers</th><th>Pleasure-Arousal Model for Architects</th><th>Pleasure-Arousal Model for Urban Designers</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><th>The Brain Activation of Architects</th><th>The Brain Activation of Urban Designers</th><th>The Brain Activation of Architects</th><th>The Brain Activation of Urban Designers</th></tr>
<tr><td>
</td><td>
</td><td>
</td><td>
</td></tr>
<tr><th colspan="2">The Brain Activation of Pleasant Places</th><th colspan="2">Quantitative Results of Unleasant Places</th></tr>
<tr><td>Architect</td><td></td><td>Architect</td><td></td></tr>
<tr><td>Urban Design</td><td></td><td>Urban Design</td><td></td></tr>
</table>

- **The comparative fMRI statistical analyzing methods of architects & urban designers ratings**

To increase the reliability of the neurological investigation, the results of analyzing with p-unc<0.01 value for architects related to **pleasant** places is presented as follows:

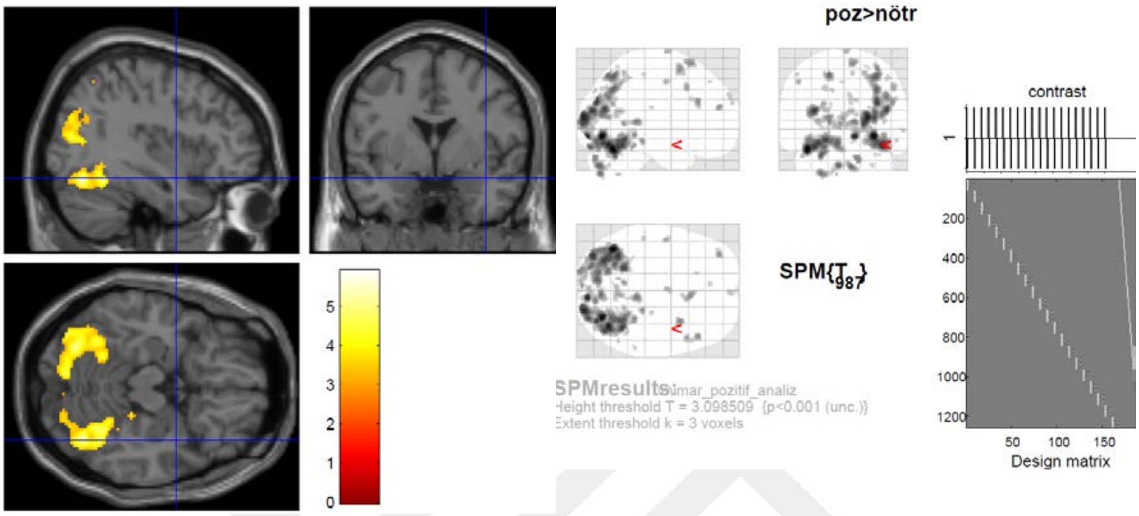


Figure 5-28: The fMRI analyses of pleasant places for architects (p-unc<0.01)

Less activations were shown in areas such as the left & right cerebellum, fusiform, and precuneus (*T*=5.89, *p*=0.000<0.01, *x*=-40, *y*=-64, *z*=-22, *K*=47), and the frontal lobe, left middle frontal, and middle frontal (*T*=3.28, *p*=0.000<0.01, *x*=48, *y*=50, *z*=8, *K*=31).

Table 5-80: fMRI measurement data in related to pleasant places for architects (p-unc<0.01)

Number of Defined Clusters Found: 30			**Number of All Voxels Found: 4359**		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Architecture	1221	-40 -64-22	5.89	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Left Cerebellum:** 444 / **Fusiform:** 280 / **Right Cerebellum:** 153 / **Precuneus:** 76				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 633 / Parietal Lobe: 2895 / Temporal Lobe: 60 / Lingual gyrus: 250 / Middle Occipital: 64 / Parahippocampus: 45				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Architectue	31	48 50 8	3.28	0.001
	Peak MNI Coordinate Region Engaged in Emotion: **Frontal Lobe:** 31 / **Left Middle Frontal:** 31 / **Middle Frontal:** 19				
Total Voxels Number of More Effective Active Regions: Left Cerebellum: 562 / Fusiform: 539 / Right Cerebellum: 239 / Frontal Lobe: 227 / Precuneus: 153 / Middle Frontal: 111 / Left Middle Frontal: 31					

The following figure and table present the results of statistical analyzing with the method of p-FWE<0.05 value for the pleasant places.

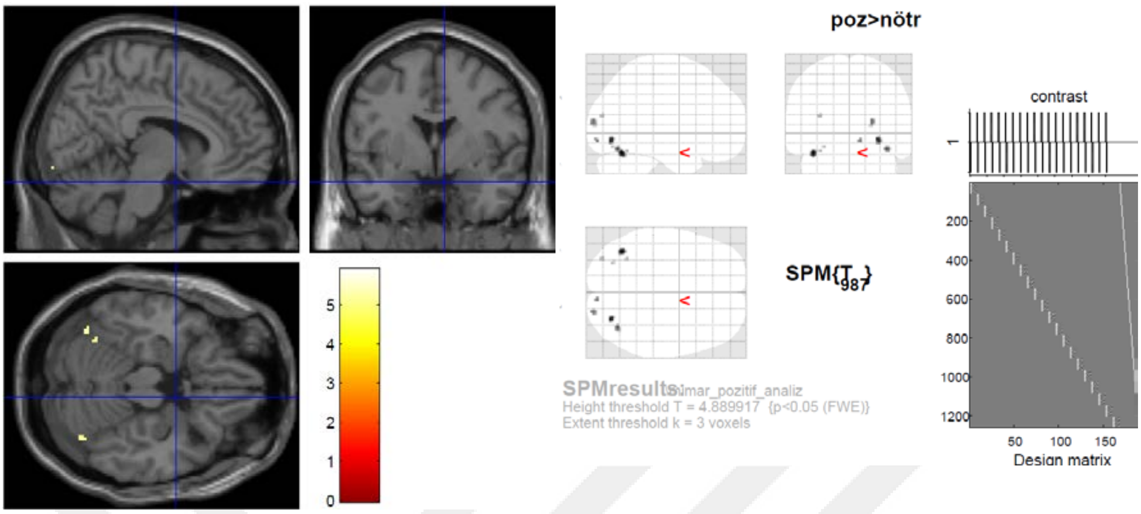


Figure 5-29: The fMRI analyses of pleasant places for Architects (p-FWE<0.05)

The most activated areas engaged in emotions were found in areas such as the left cerebellum, and fusiform (*T*=5.86, *p-FWE*= 0.000<0.05, *x*=-40, *y*=-64, *z*=22, *K*=25). The activated brain areas are less than areas found using the p-unc<0.05 value.

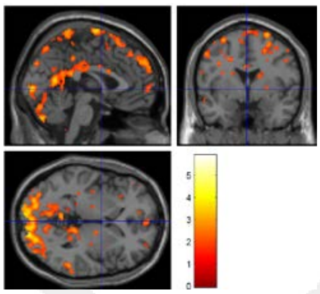
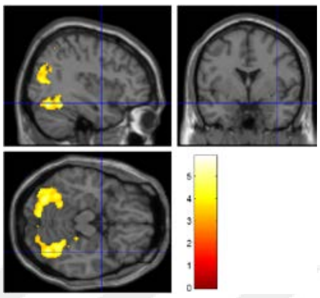
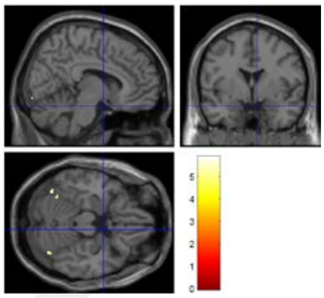
Table 5-81: fMRI measurement data related to pleasant places for architects (p- FWE<0.05)

Number of Defined Clusters Found: 5			**Number of All Voxels Found: 81**		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Architecture	25	-40 -64 22	5.89	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Left Cerebellum:** 19 / **Fusiform:** 4				
Total Voxels Number of More Effective Active Regions: Left Cerebellum: 19 / Fusiform: 16					

As shown in tables presented above, in related to pleasant places, the architects' brain activations found using p-unc<0.05 value are more and stronger than the brain activations found using both p-unc<0.01 and *p-FWE*<0.05 values. The following comparative table presents that in p-unc<0.05 value, the number of found cluster voxels (*KE*=18907 & 36), the number of all clusters found (n=82), the number of all activated voxels (n=26005), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception are more and stronger than the p-unc<0.01

value (*KE*=1221 & 31; clusters found=30; all activated voxels=4359) and *p*-FWE<0.05 value (*KE*=25; clusters found=5; all activated voxels=81).

Table 5-82: Architects fMRI data in related to pleasant places using different statistical p-values.

Peak MNI coordinate: *x*=-40 *y*=-64 *z*=-22 **t-Peak Intensity:** 5.89 **p:** 0.000 **Peak MNI coordinate:** *x*=-48 *y*=50 *z*=8 **t-Peak Intensity:** 4.56 **p:** 0.001			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			
Clusters	82	30	5
Voxels	26005	4359	81
KE	18907 & 36	1221 & 31	25
Peak MNI Region Engaged in Emotion	**Frontal Lobe:** 4719 **Left Cerebellum:** 2323 **Right Cerebellum:** 1807 **Middle Frontal:** 1634 **Precuneus:** 1495 **Fusiform:** 1014 **Medial Frontal:** 360 **Anterior Cingulate:** 52 **Left Insula:** 12	**Left Cerebellum:** 562 **Fusiform:** 539 **Right Cerebellum:** 239 **Frontal Lobe:** 227 **Precuneus:** 153 **Middle Frontal:** 111 **Left Middle Frontal:** 31	**Left Cerebellum:** 19 **Fusiform:** 16
Peak MNI Region Engaged in Architecture	Occipital Lobe: 7326 Parietal Lobe: 2895 Temporal Lobe: 2139 Lingual gyrus: 2047 Cuneus: 1488 Limbic Lobe: 1707 Middle Occipital: 1679 Parahippocampus: 593 Superior Parietal: 510 Superior Temporal: 124 Left Middle Temporal: 115 Inferior Temporal: 23	Occipital Lobe: 633 Parietal Lobe: 2895 Temporal Lobe: 60 Lingual gyrus: 250 Middle Occipital: 64 Parahippocampus: 45	....

In related to **unpleasant** places, the following figure and table presents the results of the architects' brain activity analyzed with statistical p-unc<0.01 value. According to the following figure, the most activated areas engaged in emotions were found in areas such as the left cerebrum, fusiform, left fusiform, temporal (*T*=5.86, *p*-FWE= 0.000<0.01, *x*=-40, *y*=-64, *z*=22, *K*=1404), the frontal lobe, left cerebrum, medial frontal, and right cerebrum (*T*=2.25, *p*-FWE= 0.012<0.05, *x*=34, *y*=14, *z*=20, *K*=42).

As shown, the activated brain areas are less than areas found using with the p-unc<0.05 value.

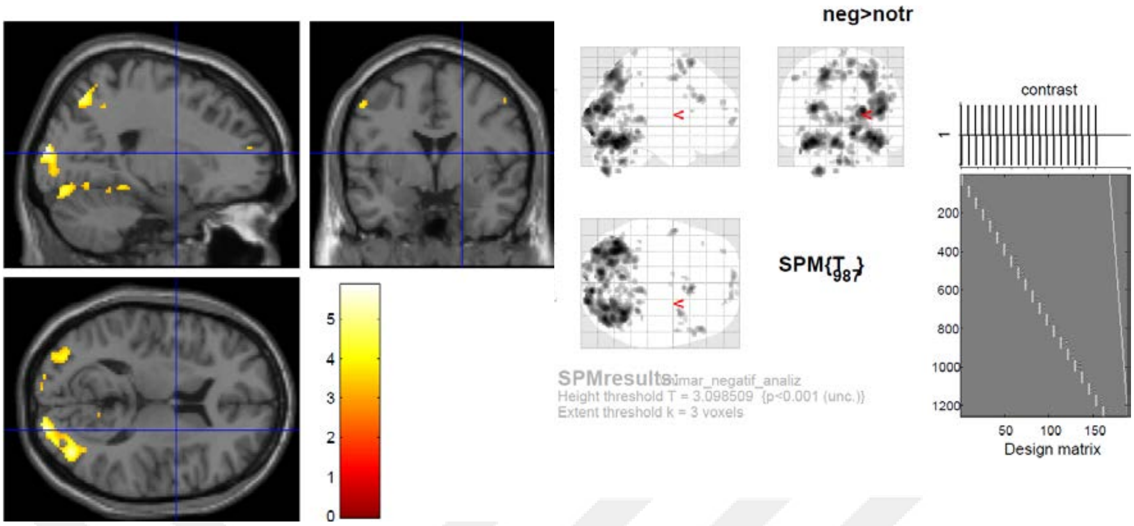


Figure 5-30: The fMRI analyses of unpleasant places for architects (p-unc<0.01)

Table 5-83: fMRI measurement data related to unpleasant places for architects (p<0.01)

Number of Defined Clusters Found: 43			**Number of All Voxels Found: 5797**		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Architecture	1404	-40 -64 22	5.86	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Left Cerebrum:** 720 / **Fusiform:** 335 / **Left Fusiform:** 541 / **Temporal:** 71				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 606 / Lingual Gyrus: 180 / Middle Occipital: 69 / Parahippocampal: 43				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Architectue	42	34 14 20	2.25	0.012
	Peak MNI Coordinate Region Engaged in Emotion: **Frontal Lobe:** 28 / **Left Cerebrum:** 21 / **Medial Frontal:** 19 / **Right Cerebrum:** 7				
Total Voxels Number of More Effective Active Regions: Right Cerebrum: 2855 / Left Cerebrum: 1811 / Fusiform: 703 / Temporal Lobe: 583 / Left Fusiform: 541 / Frontal: 278					

The following figure and table present the results of statistical analyzation with the method of p-FWE<0.05 value for the pleasant places. The most activated areas engaged in emotions were found in areas such as the left fusiform, left cerebrum, fusiform, and temporal (T=5.86, p-FWE= 0.000<0.05, x=-40, y=-64, z=22, K=125). Also, the right cerebrum, middle temporal, temporal lobe, right middle temporal (T=2.25, p-FWE= 0.000<0.05, x=34, y=14, z=20, K=5). The activated brain areas are less than areas found using the p-unc<0.05 value.

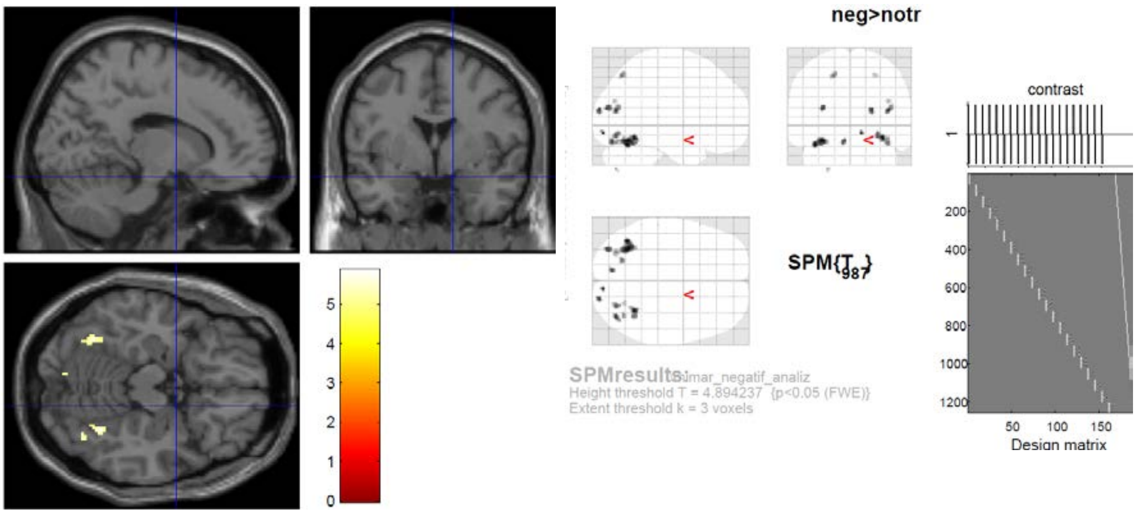


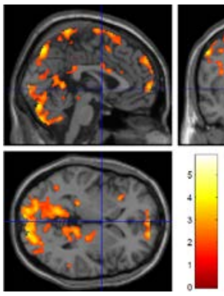
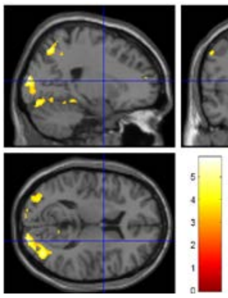
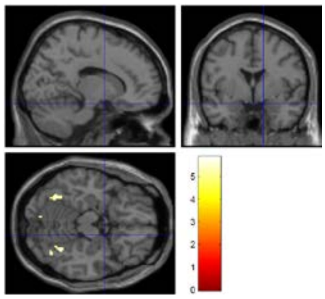
Figure 5-31: The fMRI analyses of unpleasant places for architects (p-FWE<0.05)

Table 5-84: fMRI measurement data related to unpleasant places for architects (p-FWE<0.05)

Number of Defined Clusters Found: 11			Number of All Voxels Found: 297		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Architecture	125	-40 -64 22	5.86	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Left Fusiform:** 66 / **Left Cerebrum:** 38 / **Fusiform:** 31 / **Temporal:** 12				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Architectue	5	34 14 20	2.25	0.012
	Peak MNI Coordinate Region Engaged in Emotion: **Right Cerebrum:** 5 / **Middle Temporal:** 3 / **Temporal Lobe:** 3 / **R-Mid/Temporal:** 3				
Total Voxels Number of More Effective Active Regions: Right Cerebrum: 98 / Occipital Lobe: 98 / Left Cerebrum: 67 / Left Fusiform: 66 / Fusiform: 64 / Temporal Lobe: 50 / Middle Temporal: 18					

As shown in the tables presented above, in related to pleasant places, the architects’ brain activations found using p-unc<0.05 value are more and stronger than the brain activations found using both p-unc<0.01 and *p*-FWE<0.05 values. The following comparative table shows that, in p-unc<0.05 value, the number of found cluster voxels (*KE*=21546 & 18), the number of all clusters found (n=71), the number of all activated voxels (n=28373), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception are more and stronger than the p-unc<0.01 value (*KE*=1404 & 42; clusters found=43; all activated voxels=5797) and *p*-FWE<0.05 value (*KE*=125 & 5; clusters found=11; all activated voxels=297).

Table 5-85: Architects fMRI data in related to unpleasant places using different statistical p-values.

Peak MNI coordinate: *x*=-40 *y*=-64 *z*=22 **t-Peak Intensity:** 5.86 **p:** 0.000 **Peak MNI coordinate:** *x*=34 *y*=14 *z*=20 **t-Peak Intensity:** 2.25 **p:** 0.012			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			
Clusters	71	43	11
Voxels	28373	5797	297
KE	21546 & 18	1404 & 42	125 & 5
Peak MNI Region Engaged in Emotion	**Right Cerebrum:** 12242 **Left Cerebrum:** 9423 **Frontal Lobe:** 5009 **Fusiform:** 1061 **Left Fusiform:** 990 **Cingulate Gyrus:** 281 **Right Middle Temporal:** 215 **Thalamus:** 149 **Superior Occipital:** 56 **Left Insula:** 44 **Left Hippocampus:** 43 **Insula:** 34 **Orbitofrontal:** 8 **Hippocampus:** 8 **Left Thalamus:** 8	**Right Cerebrum:** 2855 **Left Cerebrum:** 1811 **Fusiform:** 703 **Temporal Lobe:** 583 **Left Fusiform:** 541 **Frontal:** 278	**Right Cerebrum:** 98 **Occipital Lobe:** 98 **Left Cerebrum:** 67 **Left Fusiform:** 66 **Fusiform:** 64 **Temporal Lobe:** 50 **Middle Temporal:** 18
Peak MNI Region Engaged in Architecture	Occipital Lobe: 7646 Parietal Lobe: 3476 Middle Occipital: 1632 Parahippocampal: 730 Posterior cingulate: 717 Superior Parietal: 565 Superior temporal: 50 Temporal Lobe: 13	Occipital Lobe: 606 Lingual Gyrus: 180 Middle Occipital: 69 Parahippocampal: 43	....

The results of statistical analyzation with p-unc<0.01 value for urban designers in related to **pleasant** places, showed the most activated areas engaged in emotions in areas such as the precuneus, left cerebellum, frontal lobe, fusiform gyrus, insula, middle frontal, anterior cingulate, left insula, amygdala, and left amygdala (T=6.98, p=0.000<0.01, x=36, y=-62, z=30, K=2713). Less areas of the brain have activated than with the p-unc<0.05 value.

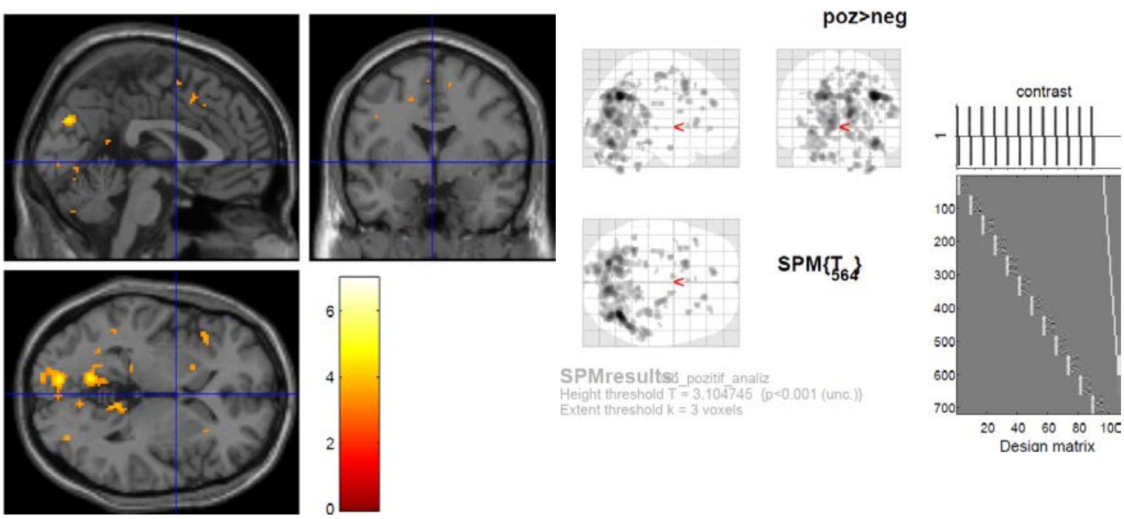


Figure 5-32: The fMRI analyses of pleasant places for urban designers (p-unc<0.01)

Table 5-86: fMRI measurement data in related to pleasant places for men (p-unc<0.01).

Number of Defined Clusters Found: 40			Number of All Voxels Found: 4914		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Urban Design	2713	36 -62 30	6.98	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Precuneus:** 515 / **Left Cerebellum:** 295 / **Fusiform Gyrus:** 45 / **Frontal Lobe:** 31 **/ Insula:** 17 / **Middle Frontal:** 16 **/ Cingulate Gyrus:** 13 / **Left Middle Frontal:** 10 / **Left Hippocampus:** 10 / **Amygdala:** 7 / **Left Insula:** 5 / **Left Amygdala:** 4				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 1311 / Limbic System: 480 / Parietal Lobe: 398 / Lingual Gyrus: 319 / Temporal Lobe: 110 / Middle Occipital Gyrus: 58 / Parahippocampal: 56				
Total Voxels Number of More Effective Active Regions: Precuneus: 515 / Left Cerebellum: 382 / Frontal Lobe: 379 / Fusiform Gyrus: 247 / Insula: 44 / Middle Frontal: 31 / Anterior Cingulate: 17 / Left Insula: 12 / Amygdala: 7 / Left Amygdala: 4					

The following figure and table present the results with the method of p-FWE<0.05 value for the pleasant places. As shown, the most activated areas engaged in emotions were shown in the fusiform gyrus and precuneus (*T*=6.98, *p*-FWE=0.000<0.05, *x*=36, *y*=-62, *z*=30, *K*=34); whereas, the areas activated with using p-unc<5 value were more and stronger than the p- FWE <0.05 value.

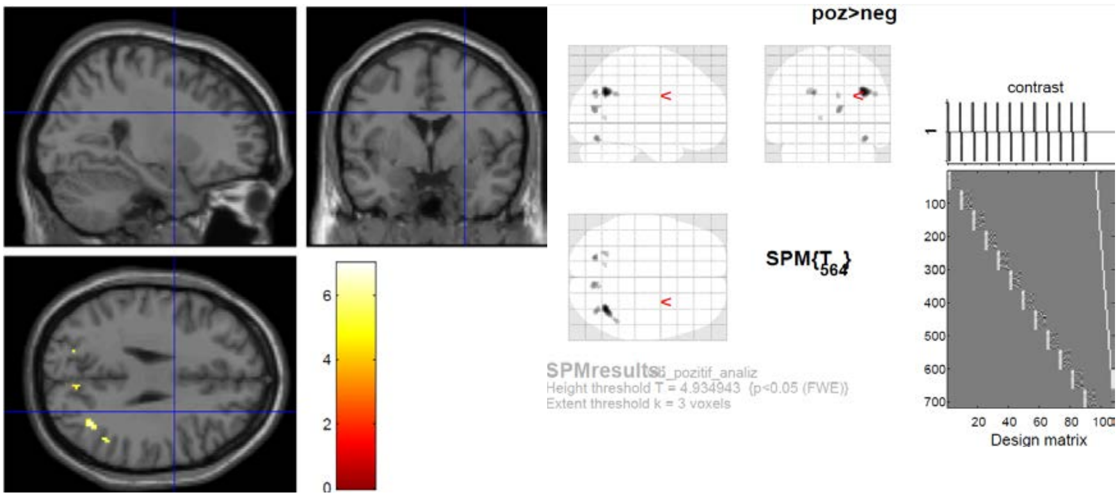


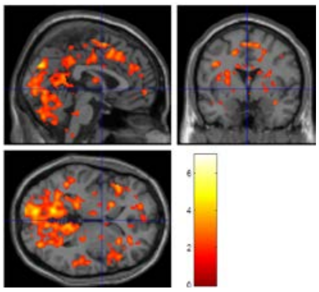
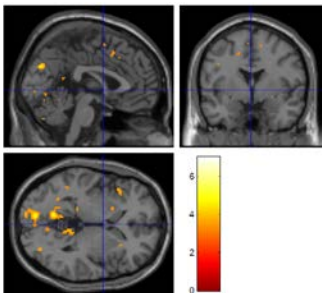
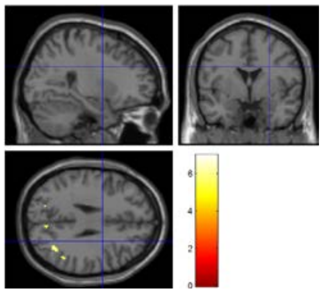
Figure 5-33: The fMRI analyses of pleasant places for urban designers (p-FWE<0.05)

Table 5-87: fMRI measurement data in related to pleasant places for urban designers (p-FWE<0.05)

<table>
<tr><th colspan="6">Number of Defined Clusters Found: 7 Number of All Voxels Found: 167</th></tr>
<tr><th>Cluster</th><th>Participant</th><th>Voxels Number (KE)</th><th>Peak MNI Coordinate
x y z</th><th>t
(Peak Intensity)</th><th>p</th></tr>
<tr><td rowspan="3">1</td><td>Urban Design</td><td>34</td><td>36 -62 30</td><td>6.98</td><td>0.000</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Emotion:</u>
Fusiform Gyrus: 14 / Precuneus: 8</td></tr>
<tr><td colspan="5"><u>Peak MNI Coordinate Region Engaged in Architecture:</u>
Occipital: 17 / Parietal Lobe: 11</td></tr>
<tr><td colspan="6"><u>Total Voxels Number of More Effective Active Regions:</u>
Precuneus: 23 / Fusiform Gyrus: 14</td></tr>
</table>

As shown in the tables presented above (5-86 and 5-87), related to pleasant places, the urban designers' brain activations found using with the p-unc<0.05 value are more and stronger than the brain activations found using both the p-unc<0.01 and *p-FWE*<0.05 values. The following comparative table presents that, in the p-unc<0.05 value, the number of found cluster voxels (*KE*=31520), the number of all clusters found (n=46), the number of all activated voxels (n=33057), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception, are more and stronger than by using the p-unc<0.01 value (*KE*=2713; clusters found=40; all activated voxels=4914) and *p-FWE*<0.05 value (*KE*=34; clusters found=7; all activated voxels=167).

Table 5-88: Urban designers fMRI data in related to pleasant places using different statistical p-values.

Peak MNI coordinate: *x*= 36 *y*= -62 *z*= 30 **t-Peak Intensity:** 6.98 **p:** 0.000			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			
Clusters	46	40	7
Voxels	33057	4914	167
KE	31520	2713	34
Peak MNI Region Engaged in Emotion	**Frontal Lobe:** 5151 **Right Cerebellum:** 2905 **Left Cerebellum:** 2588 **Precuneus:** 2072 **Medial Prefrontal:** 1272 **Fusiform Gyrus:** 1047 **Middle Frontal:** 442 **Anterior Cingulate:** 405 **Left Insula:** 366 **Amygdala:** 25	**Precuneus:** 515 **Left Cerebellum:** 382 **Frontal Lobe:** 379 **Fusiform Gyrus:** 247 **Insula:** 44 **Middle Frontal:** 31 **Anterior Cingulate:** 17 **Left Insula:** 12 **Amygdala:** 7 **Left Amygdala:** 4	**Fusiform Gyrus:** 14 **Precuneus:** 8
Peak MNI Region Engaged in Architecture	Occipital: 7153 Temporal Lobe: 3495 Cuneus: 2089 Superior Temporal: 1072 Lingual gyrus: 2361 Parietal Lobe: 3009 Parahippocampal: 788 Middle Temporal: 750 Inferior Frontal Gyrus: 581 Middle Occipital Gyrus: 544 Superior Frontal Gyrus: 220 Angular Gyrus: 94 Hippocampus: 80 Medial Orbitofrontal: 11 Medial Frontal: 5	Occipital Lobe: 1311 Limbic System: 480 Parietal Lobe: 398 Lingual Gyrus: 319 Temporal Lobe: 110 Middle Occipital Gyrus: 58 Parahippocampal: 56	Occipital: 17 Parietal Lobe: 11

In related to **unpleasant** places, the following figure and table present the results of the urban designers' brain activity with the use of statistical p-unc<0.01 value. The most activated areas engaged in emotions were found in areas such as the left fusiform, left cerebrum, left temporal lobe, and fusiform gyrus (T=6.85, *p-unc*= 0.000<0.01, x=-14, y=-86, z=-36, K=36), also in the right cerebrum, frontal lobe, left insula, insula, cingulate, and left inferior frontal (T=3.87, *p-unc*= 0.000<0.01, x=-36, y=18, z=0, K=12). As observed, the activated brain areas are less than areas found using the p-unc<0.05 value.

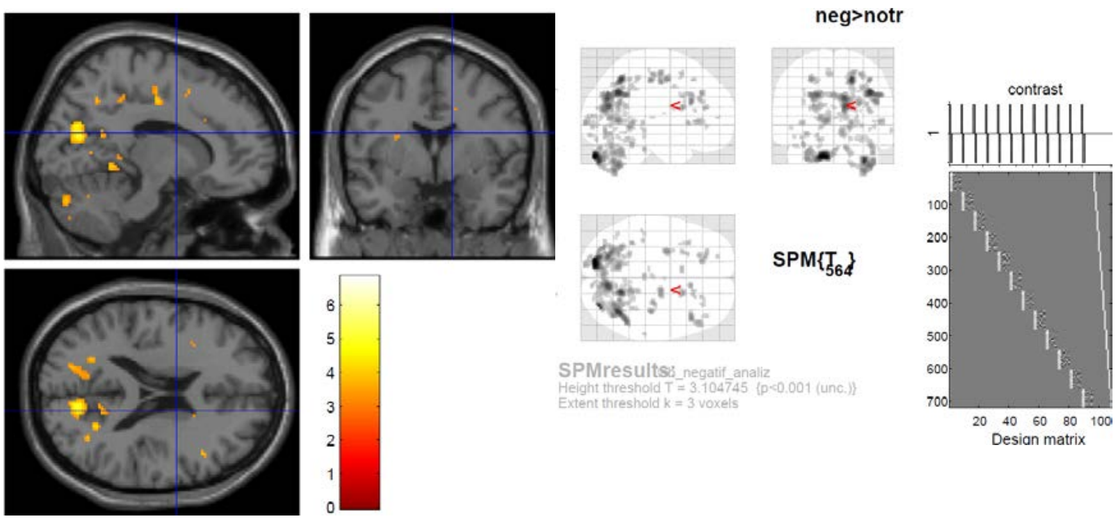


Figure 5-34: The fMRI analyses of unpleasant places for urban designers (p-unc<0.01)

Table 5-89: fMRI measurement data in related to unpleasant places for urban designers (p-unc<0.01)

Number of Defined Clusters Found: 65			**Number of All Voxels Found: 3167**		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Urban Design	36	-14-86 -36	6.85	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Left Fusiform:** 10 / **Left Cerebrum:** 9 / **Left Temporal Lobe:** 9 / **Fusiform gyrus:** 9				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 18				
2	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
	Urban Design	12	-36 18 0	3.87	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Right Cerebrum:** 36 / **Frontal Lobe:** 32 / **Left Insula:** 12 **/ Insula:** 7 / **Cingulate:** 4 / **Left Inferior Frontal:** 3				
Total Voxels Number of More Effective Active Regions: Right Cerebrum: 1231 / Left Cerebrum: 769 / Frontal Lobe: 424 / Left Inferior Frontal: 56 / Cingulate: 48 / Fusiform gyrus: 47 / Left Fusiform: 44 / Left Middle Temporal: 37 / Left Insula: 12 / Insula: 7					

The following figure and table present the results of the method of p-FWE<0.05 value for the unpleasant places. As shown, the most activated areas engaged in emotions were shown in the right cerebrum (*T*=3.87, *p-unc*= 0.000<0.01, *x*=-36, *y*=18, *z*=0, *K*=13); whereas, the areas activated using p-unc<0.05 value were more and stronger than using the p- FWE <0.05 value.

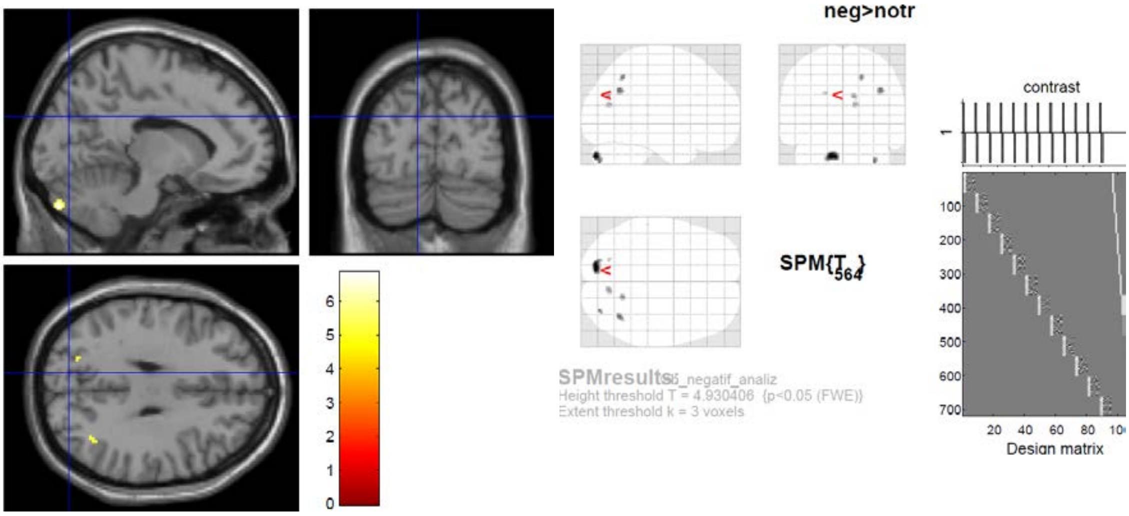


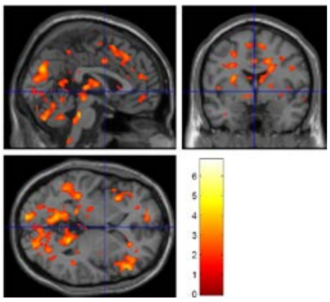
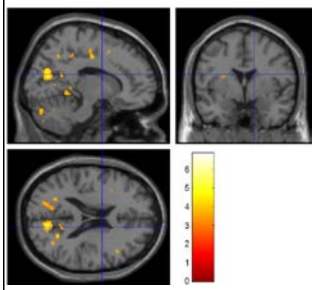
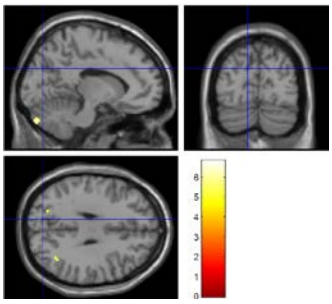
Figure 5-34: The fMRI analyses of unpleasant places for urban designers (p-FWE<0.01)

Table 5-90: fMRI measurement data in related to unpleasant places for urban designers (p-FWE<0.05)

Number of Defined Clusters Found: 6			**Number of All Voxels Found: 131**		
Cluster	**Participant**	**Voxels Number (*KE*)**	**Peak MNI Coordinate x y z**	**t (Peak Intensity)**	**p**
1	Urban Design	13	-36 18 0	3.87	0.000
	Peak MNI Coordinate Region Engaged in Emotion: **Right Cerebrum:** 13				
	Peak MNI Coordinate Region Engaged in Architecture: Occipital Lobe: 22				
Total Voxels Number of More Effective Active Regions: Right Cerebrum: 57					

The following comparative table shows that, in p-unc<0.05 value, the number of found cluster voxels (*KE*=26788 & 216), the number of all clusters found (n=50), the number of all activated voxels (n=28129), and the brain areas found considering peak MNI coordinate engaged in emotions and architectural perception, are more and stronger than using the p-unc<0.01 value (*KE*=36 & 12; clusters found=65; all activated voxels=3167), and the p-FWE<0.05 value (*KE*=13; clusters found=6; all activated voxels=131).

Table 5-91: Urban designers fMRI data in related to unpleasant places using different statistical p values.

Peak MNI coordinate: *x*=-14 *y*=-86 *z*=-36 **t-Peak Intensity:** 6.85 **p:** 0.000 **Peak MNI coordinate:** *x*=-36 *y*=18 *z*=0 **t-Peak Intensity:** 3.87 **p:** 0.000			
p-Value	**p-unc<0.05**	**p-unc<0.01**	***p-FWE*<0.05**
Brain fMRI			
Clusters	50	65	6
Voxels	28129	3167	131
KE	26788 & 216	36 & 12	13
Peak MNI Region Engaged in Emotion	**Right Cerebrum:** 12591 **Left Cerebrum:** 8851 **Frontal Lobe:** 5405 **Cingulate:** 953 **Fusiform gyrus:** 774 **Middle Temporal:** 736 **Left Fusiform:** 562 **Right Middle Temporal:** 404 **Anterior Cingulate:** 393 **Thalamus:** 367 **Insula:** 243 **Left Thalamus:** 212 **Left Insula:** 118 **Left Hippocampus:** 103 **Right Insula:** 40 **Hippocampus:** 6 **Left Amygdala:** 3	**Right Cerebrum:** 1231 **Left Cerebrum:** 769 **Frontal Lobe:** 424 **Left Inferior Frontal:** 56 **Cingulate:** 48 **Fusiform gyrus:** 47 **Left Fusiform:** 44 **Left Middle Temporal:** 37 **Left Insula:** 12 **Insula:** 7	**Right Cerebrum:** 57
Peak MNI Region Engaged in Architecture	Occipital Lobe: 5243 Parietal Lobe: 2894 Temporal Lobe: 2292 Parahippocampus: 483 Middle Occipital: 383 Superior Occipital: 288 Superior Frontal: 253 Superior Parietal: 7	Occipital Lobe: 18	Occipital Lobe: 22

6. RESULTS AND SUGGESTIONS

Following the quantitative and qualitative analysis of the research findings in the previous chapter, changing and modifying the research model is performed in the present chapter. In this regard, firstly, the practical model of the research is modified based on the results of quantitative analysis. Then, to adapt to the practical model of the research, the theoretical model is changed and completed. By scrutinizing the theoretical model of research, it is possible to answer research questions and reject or accept the hypotheses.

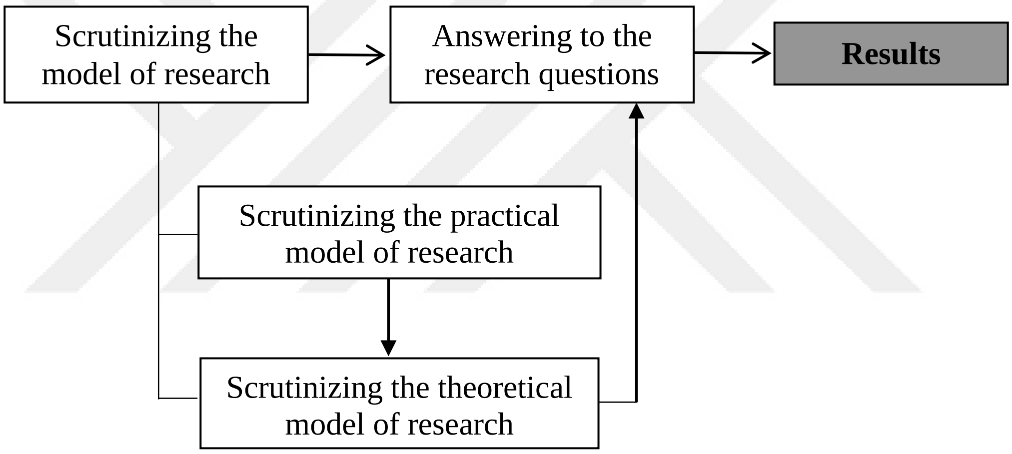


Diagram 6-1: The structure of chapter six (Author)

6.1. Scrutinizing the Model of Research

6.1.1. Scrutinizing the Practical Model of Research

After conducting the experimental measurement of research, the practical model was developed and modified for the experimental group of all participants. The following diagram presents a modified version of the practical model of research for all users participated in the study, and it can be generalized to the result of other experimented variables such as gender and discipline. In this model, based on data obtained from the observation, the criteria for evaluating place and place meaning for all three experimental groups in order of effectiveness are place preferences, pleasant place, and place suggestions. That is, users prefer a place by considering its spatial, physical, and functional characteristics, and by experiencing and living in a place, users evaluate its pleasantness and ultimately recommend that place. The process of assessing the emotional-perceptual experience of place is composed of four components such as sensation, perception, cognition, and behavior. For all three subject groups, behavior is evaluated as the most effective component. In investigating the component of behavior, the old building of faculty is assessed as a pleasant place and is preferred to approach. The sports hall building and the new building evaluated as unpleasant buildings are preferred to be avoided. For all users, in related to pleasant places, the component of perception and the factor of "**geometry**" and related to unpleasant places perception with "geometry", "order", and "proportion" are evaluated as the most effective criteria. The component of sensation with "**texture**" both for pleasant and unpleasant places are evaluated and the component of cognition with "**attention** (appearance facade)" are evaluated as the next criteria. Both for women and men in relate to pleasant place, the component of perception with "**geometry**" is evaluated as the most effective criteria, and sensation (**texture**) and cognition (**attention/appearance facade**) are classified as the other effective factors. In relate to unpleasant places for women, the sensation with "texture" is the most effective factor, and perception (**geometry**) with cognition (**attention/appearance facade**) are the next factors. For men, the perception with "**geometry**" is the most effective factor, and sensation and cognition are classified as the next factors. Both for architects and urban designers in relate to pleasant and unpleasant places, the component of sensation with "**texture**" is evaluated as the most effective criteria, while perception (**geometry, proportion, order**) and cognition (**attention/appearance facade**) are classified as the other factors.

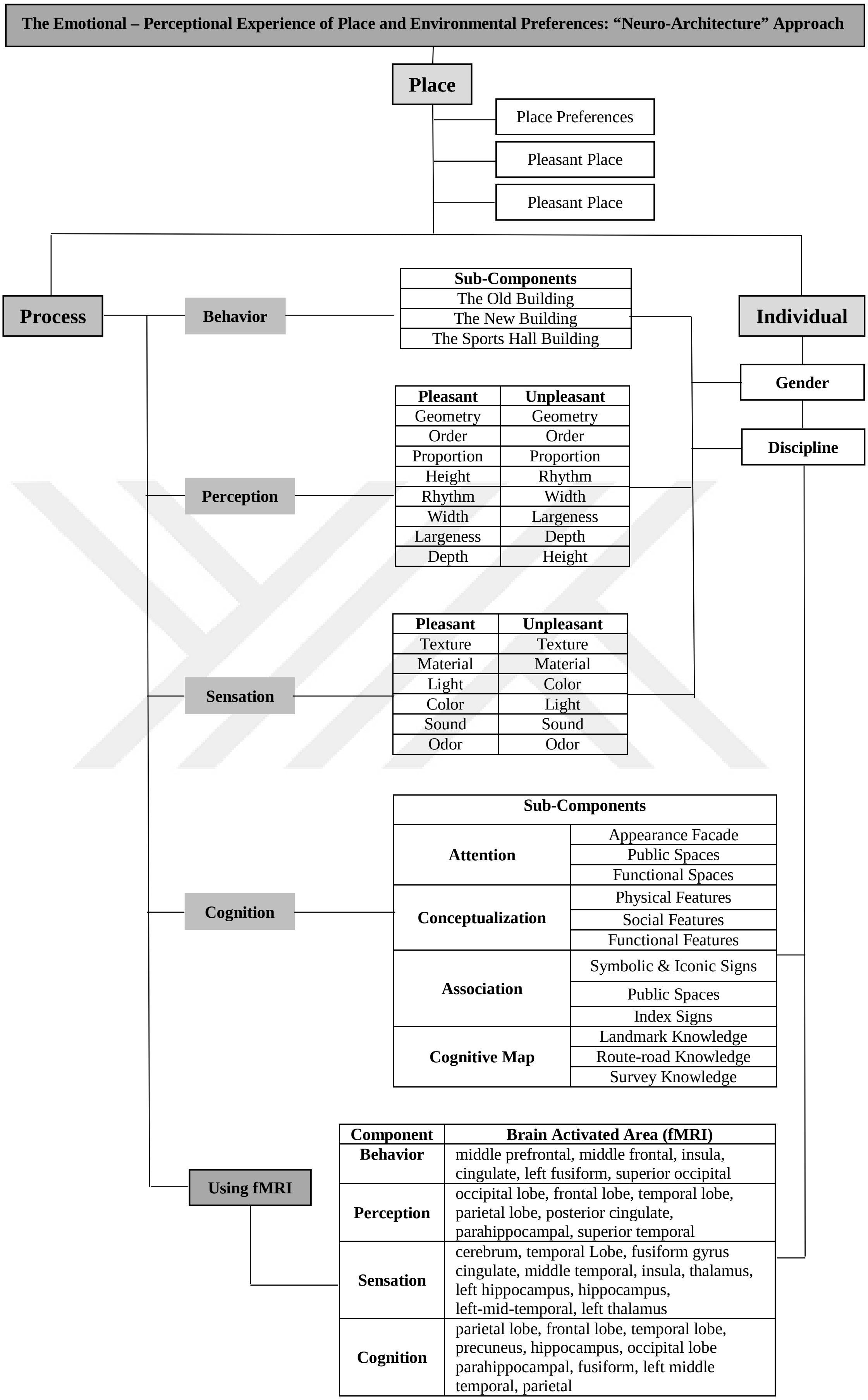
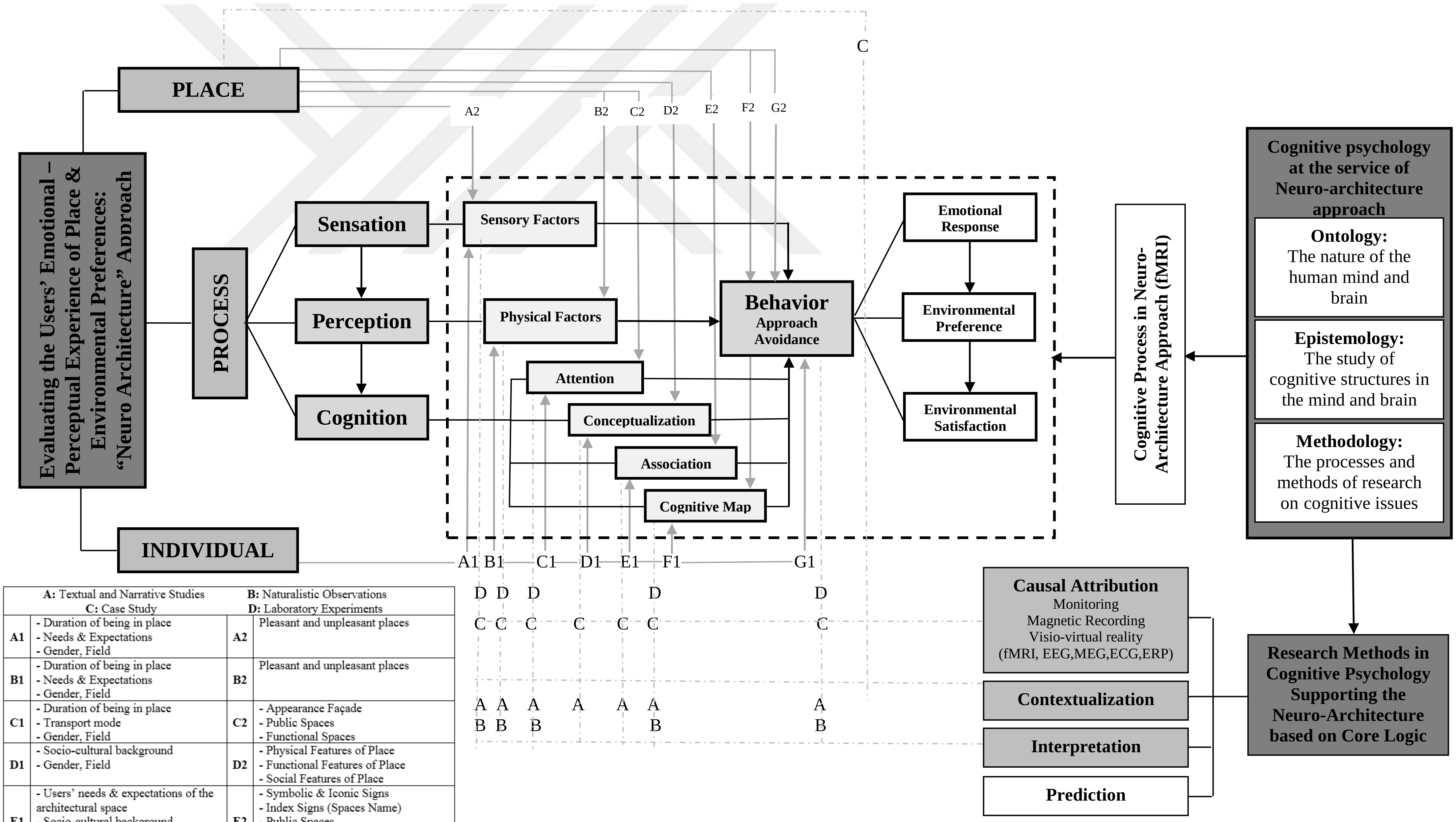


Diagram 6-2: The scrutinized version of practical model based on all users ratings (Author)

6.1.2. Scrutinizing the Theoretical Model of Research

After scrutinizing the practical model of research, the theoretical model of research was scrutinized. In this regard, the methods used during the research and the factors affecting the components of the process of the emotional-perceptual experience of the place which examined in the research were identified. As shown in the following diagram, the methods used in research are causal attribution logic, contextualization logic, and interpretation logic. The laboratory research method is based on causal attribution which was used for the brain functional imaging; The case studies research method is based on contextualization which was used in choosing and studying the case study, and the method of textual and narrative and naturalistic observations are based on the interpretation which was used as tools for collecting and analyzing data, considering the nature of research questions and goals.

The components of sensation, perception, cognition, and behavior using the textual-narrative, naturalistic observations, and laboratory methods such as interview and questionnaire (Pleasure-Arousal Model), as well as the laboratory functional magnetic resonance imaging (fMRI) were examined. In measuring the sub-components of sensation "texture" and "material" were rated as the most effective factors. Also, "sound" and "odor" were not assessed effectively as much as other sub-components. In measuring the sub-components of perception "geometry", "order", and "proportion" were rated as the most effective factors. Also, "depth" was not assessed effectively. Related to the sub-components of cognition, "appearance facade" and "public spaces" were assessed as effective factors affecting attention; "physical features" and "social feature" for conceptualization; "symbolic and iconic signs" for the association; and "landmark knowledge" were assessed as the most effective factor for the cognitive map. The variables of "gender" and "discipline" were considered as individual factors in evaluating the emotional-perceptual experience of place. Other variables such as age, occupation, education, housing status, length of residence, mode of transportation, and walking were not taken to account due to breadth of study and the high number of factors that are already to be studied.



	A: Textual and Narrative Studies C: Case Study		B: Naturalistic Observations D: Laboratory Experiments
A1	- Duration of being in place - Needs & Expectations - Gender, Field	A2	Pleasant and unpleasant places
B1	- Duration of being in place - Needs & Expectations - Gender, Field	B2	Pleasant and unpleasant places
C1	- Duration of being in place - Transport mode - Gender, Field	C2	- Appearance Façade - Public Spaces - Functional Spaces
D1	- Socio-cultural background - Gender, Field	D2	- Physical Features of Place - Functional Features of Place - Social Features of Place
E1	- Users' needs & expectations of the architectural space - Socio-cultural background Gender, Field	E2	- Symbolic & Iconic Signs - Index Signs (Spaces Name) - Public Spaces
F1	- Users' expectations of the architectural space - Duration of stay in place - Transport mode - Gender, Field	F2	- Landmark Knowledge - Route-road Knowledge - Survey Knowledge
G1	- Duration of stay in place - Needs & Expectations - Gender, Field	G2	Pleasant and unpleasant places

6.2. Answering to the Research Questions

The first question of research: How should we obtain an appropriate design pattern to ensure the user's emotional-perceptual experience appropriately? And which qualities of such a design can cause a feeling of being pleasant or unpleasant, positive or negative, and nice or ugly? And in such a situation what is the brain's response, and how can the brain activity be measured by an objective assessment?

- **Answer:** In our study the important effects of environmental psychology, cognitive psychology, also the mechanism of sensation, perception, cognition, and behavior in the brain on individuals' emotions, spatial preferences, and satisfaction were seen. Especially, it was determined that the physical features and spatial qualities evoke the brain's different areas engaged in emotions and perception. Such stimuli affect users' environmental behavior and cause a place to be preferred or judged as pleasant or unpleasant. Therefore, to create a pleasant environment, an appropriate design pattern should be involved in qualified spatial and physical elements in the aspect of providing material, texture, color, light, geometry, proportion, order, height, etc., also the relationship between 'user and environment', 'user's psychological, physiological, and functional needs', 'the effect of memory on behavior', and measuring of the individual preference according to the quality of environment should be considered. In this context, brain research has become a contemporary subject, and neurologists investigate the perception process based on the basics of physiology in an experimental approach. Advanced technologies such as fMRI have provided the possibility of investigating and measuring the brain responses when it is exposed to a pleasant or unpleasant place. Our research showed that using fMRI and relevant analysis tools such as MATLAB and SPM enable architects to observe, record, and measure brain functions. The functional imaging of the brain could objectively suggest that individuals' decisions or preferences about positive or negative designs are a result of their brain mental and cognitive process. Also, the results of the current study showed that the brain works differently depending on a good or a bad feeling so that when users were exposed to positive places (in the aspect of having good spatial qualities and physical features), their brain areas involved in positive emotions such as the cerebellum, prefrontal cortex, anterior cingulate, precuneus, and fusiform were activated. In contrast, when they saw negative architectural designs, the areas of the brain engaged in bad or negative emotions such as the amygdala, insula, hypothalamus, cingulate, etc. were activated.

The second question of research: Is there any meaningful relationship between the users' emotional-perceptual experience and the physiological activity of the brain?

- **Answer:** In our study the results of observation showed that using qualified materials and elements, providing landscape, public and open spaces in an architectural design have a significant impact on users' spatial preferences and satisfaction. Furthermore, the results of examining the emotional experience model of pleasure-arousal showed that considering suitable physical factors (geometry, proportion, order, height, width, etc.), sensory factors (color, material, light, historical identity, memories, aesthetic, etc.), social factors (open and public spaces, social interaction in space, variety, etc.), and functional factors (uses, functional activities, stability, etc.) in the process of architectural design result in a sense of harmonious, calm, placid, and safe for pleasant places and counter upset, distressed, tense, and scared senses for unpleasant places. In this regard, to objectify our subjective experiment and to find a meaningful relationship between place experience and brain activities, we incorporate users' architectural experiences into neural networks. Results showed that the appreciation of pleasant and unpleasant places relies on cortical areas, and it suggest that the areas such as the occipital lobe, frontal lobe, cerebellum, cerebrum, parietal lobe, anterior cingulate cortex, amygdala, insula, precuneus, fusiform gyrus, temporal lobe, hippocampus, hypothalamus, etc. are especially associated with positive or negative emotions, architectural experience, spatial approach-avoidance, and beauty judgments. For instance, in related to pleasant places the results demonstrated that activation in a distributed network including the cerebellum, anterior cingulate, left insula, and right frontal covaried are in correspond to the feelings of happiness and positive emotions. These findings support the results of the assessing pleasure-arousal model about the pleasant places that participants subjectively evaluated them as safe, calm, placid, harmonious, and happy places. In contrast, in related to unpleasant places, our findings demonstrated that activation in areas including the cerebrum, thalamus, left hippocampus, left middle temporal, insula, cingulate, and amygdala is engaged in unpleasant emotions such as fear, sadness, disgust, anger, and sadness. Findings support the results of assessing pleasure-arousal model on the unpleasant places that participants subjectively evaluated them as unsafe, distressed, tense, and scary.

In addition to activate the areas involved in the pleasantness and emotions, activities in areas such as the occipital lobe (involved in the perception of forms, colors, height, depth, geometry), the temporal lobe (engaged in visual perception of form, color, and recognition of objects, the spatial perception of height, depth, geometry), the parietal temporal lobe (involved in understanding depth, height, width, geometry), the cuneus (engaged in the appreciation of representational material); the parahippocampal (involved in architectural experience and representation of large-scale places, landscape, and location); the superior temporal (involved in the visuospatial exploration of architectural space), etc. suggest that there is a significant relationship between the emotional-perceptual experience of place and the brain areas activations engaged in positive or negative emotions and architectural experience. The findings of this study support such a claim that there is a significant and meaningful relationship between the place experience and brain activation. Accordingly, it is assumed that positive places in terms of providing architectural qualities are able to attract more attention for a design, and the spatial qualities and physical features of an architectural design can influence the emotional, perceptual, cognitive, beauty judgment, and decision-making (behavioral) process of the user to a high degree. Furthermore, it can be possible that pleasant places due to attracting more attention contribute to architectural design much better than unpleasant places. Findings suggest that unpleasant design will have a negative impact on the emotional-perceptual experience of place, and designers should pay attention to the valence of good design.

The third question of research: Can the "Neruo-Architecture" approach be used as a design approach in new architectural designs as a result of the brain behaviors regarding an architectural experience?

- **Answer:** Our study showed that in Neuro-Architecture, factors such as largeness, proportion, texture, material, color, sound, odor, geometry, order, etc. affect the emotional-perceptual experience of place, and determines the user’s spatial preferences and satisfaction. In addition, it is possible to determine brain reactions (beauty judgment and approach-avoidance decision) in related to different places. Relying on the scientific methods and principles of cognitive psychology, Neuro-

Architecture makes it possible to determine the effect of memory on behavior and measure the individual preference according to the quality of the environment. Indeed, Neuro-Architecture incorporating and including neuroscience findings into an architectural design, aims to investigates the physiological responses of users related to visual-emotional experience and environmental perception, and converts the findings into measurable and usable data. Therefore, this approach is implemented as a solution tool to specify the parameters of a more qualified and good value of design. Also, as one of the most important issues, it is a usability test to measure the individual and emotional satisfaction of a person.

The fourth question of research: What is the importance of Neuro-Architecture in the design process and evaluating the emotional-perceptual experience of place?

- **Answer:** The emotional-perceptual experience of the place indicates that based on their previous experiences of similar places people evaluate the environment according to their expectations, psychological, physiological, social and functional needs through a cognitive process. Meanwhile, the environmental behavior of users and their satisfaction with the environment depends on such a cognitive process. Cognition is a way to acquire, store, organize, and re-read perceived environmental information that actually takes place after the process of feeling and perceiving. Feeling and perceiving is part of man's innate reaction to the environment. Assessing the experience of the place and recognizing the human and spatial factors involved in it will not be possible without considering and evaluating the emotional, perceptual, cognitive and behavioral process. Therefore, the Neuro-Architecture approach by integrating cognitive and neurological sciences with environmental sciences, and considering its ability to objectify mental experiences, can lead to more accurate indicators in evaluating the emotional-perceptual experience of the place and providing design solutions to improve users' satisfaction.

  Relying on environmental and cognitive psychology, this approach uses psychological research to study the psychological and environmental processes of the human mind and strengthens the physical, semantic and social components affecting the experience of space. Neuro-Architecture can be used as a new approach in determining the relationship among brain areas and nervous systems and the emotional experience of place, environmental behavior and place perception. Therefore, this approach is implemented as a solution tool to specify the parameters of a more qualified design. Also, as one of the most important issues, it is a usability test to measure the individual and emotional satisfaction of a person. Advances in neuroscience are now able to explain how we perceive the world around us, and understanding of the principles of neuroscience, particularly in the area of the emotional experience of a place can inform designer how to build spaces to include environmental features that minimize negative physiological and emotional effects.

The fifth question of research: To what extent do the components of the emotional-perceptual experience of place process affect users' satisfaction and preferences?

- **Answer:** The process of assessing the emotional-perceptual experience of place is composed of four components such as sensation, perception, cognition, and behavior. Behavior is the most effective criteria in the approach-avoidance decision so that pleasant places are preferred to approach, and unpleasant places are avoided. Perception is the second effective component. In this regard, geometry, proportion, and order are the most important factors of perception in an architectural experience. Height, rhythm, width, largeness, and depth are considered as other effective factors. Sensation is the third significant factor affecting users' place experience, and the sub-component of texture and material is the most effective criteria of sensation, and color, light, sound, and odor are other criteria. Cognition is the forth effective criterion, and the sub-component of attention is the most effective criteria of cognition. In this context, factors such as appearance facade, public spaces, and functional spaces are classified as effective factors that result in users' attention in architectural experience. The sub-component of conceptualization is the second effective factor of cognition, and the physical features are considered as the most effective criteria in making the concept and memory of place for users. Social and functional features are the other effective factors of conceptualization. The sub-component of association is the third effective factor of cognition. Symbolic and iconic signs are considered as the most effective criteria in the association of memories for users in place experience. Public spaces and index signs are the other effective factors of association. The sub-component of the cognitive map is the forth effective factor of cognition. Landmark knowledge is considered as the most effective criteria in the mental image of users in place experience. Route-road knowledge and survey knowledge are the other effective factors of cognitive maps.

6.3. Results

The emotional-perceptual experience of place is one of the most important factors in evaluating the relationship between individuals and the environment in creating qualified environments. Such a definition of environmental meaning indicates a kind of deep connection between the individual and the environment, and if an environment can physically, semantically, functionally and socially satisfy the user, it is evaluated as pleasant. Hence, it promotes the quality of user's environmental behavior and preferences. As a psychological phenomenon, assessing the emotional-perceptual experience of a place can be analyzed with different approaches, each of which explains the individual's behavior differently and plays a certain role in the researchers' image of understanding the subject.

As a new approach, by focusing on the physiological, mental and psychological aspects of users and using the scientific and experimental methods, Neuro-Architecture is able to objectify the users' experiences and mental imagery that can measures the impact of the environment on users' psyche. Hence, this new scientific approach helps designers in architectural and urban design. Especially, as professions affecting the environment and human-environment relationship, the architectural and urban design to make a pleasant and suitable environment for users need to have a deep and correct psychological understanding of the physical environment, the cognitive process of the human mind, and interaction between these process. Accordingly, it seems that to create an environment that is responsive to users' physiological, psychological, behavioral, and functional needs [and also to reinforce the extent of satisfaction], it is necessary to interfere in the design process of spaces through the psychological investigation of the built environments.

The familiarity of designers with the knowledge which directly or indirectly contributes to the design profession, makes the presented designs to be more compatible with users' need. Therefore, to have a pleasant and safe life, the designed environments provide the appropriate situation. Due to the complex and intertwined nature of human issues for researchers interested in research in environmental studies, the need for familiarity with new and interdisciplinary sciences such as behavioral sciences, cognitive sciences, neuroscience, and Neuro-Architecture mentioned in this study is necessary. The major paradigms forming the basis of architectural and urban design are production-oriented. In other words, they are dealing with the production rather than the process. Designers should pay attention to two dimensions of process-oriented and production-oriented in creating quality in architectural environments, and in addition to designing a pleasant place (production), try to consider the aspects of the design process.

Architectural and urban space is a body that renews its vitality through the presence of human beings and is perceived by understanding and imagination that individual obtains from being in place, and if the visual perception conforms to the user's mental concepts and image, the extent of being in place and its readiness to meet the needs of users will be improved. By examining the process-oriented of the emotional-perceptual experience of place and using visual and three-dimensional methods of nervous system activity, Neuro-Architecture makes it possible to study the adaptation of space to the user's cognitive and psychological needs. Since the Neuro-Architecture approach relies on the principles of behavioral sciences, especially cognitive sciences, to study the relationship between human mental processes and environment, it provides designers with valuable information on the cognitive structures of the mind and brain activity in the face of architectural and urban spaces. This approach by studying the user's mental processes experiencing the place and by examining experimental processes in the user's mind, is able to provide an objective and scientific evaluation of place experience. To strengthen its results and to achieve a correct and measurable assessment of place experience, Neuro-Architecture examines the relationship between the activity of the measured brain areas with the contribution of each of sub-components (color, texture, light, geometry, proportions, order, attention, association, behavior, etc.) relying on environmental sciences and considering the process of sensation, perception, cognition, and behavior.

Therefore, considering the process of evaluating the experience of place by relying on behavioral, cognitive and neural sciences (Neuro-Architecture approach), leads to a more accurate and deeper understanding of the experience of the environment by users. Applying the Neuro-Architecture approach with the theoretical and practical model of the present research in conducting environmental research such as architecture, urban design, landscape design, restoration, etc. in addition to providing a complete and objective understanding of the case study, this project is considered as a new movement in the field of architectural design research based on which architectural and environmental researchers can consider the approaches, strategies, and tools used in environmental research. Also, they can provide design solutions to strengthen the user's mind, satisfaction, and environmental preferences. As the results of the present study showed that in the face of pleasant and unpleasant places, the brain areas engaged in positive or negative emotions were activated. Significant changes were recorded in the activity of the brain in between the emotional assessment of pleasant and unpleasant places. For pleasant places, the areas engaged in positive emotions were activated, and for unpleasant places, the areas engaged in negative emotions were activated.

Accordingly, the involvement of brain regions supports such a hypothesis that the perceptual and emotional evaluation of an architectural place rely on the specific neural areas that are active when people see or experience the pleasant (positive) or unpleasant (negative) scenes within a visual perceptual, cognitive, and rewarding emotional experience process. Also, the relevant findings supported the cognitive base of experiencing pleasantness to the neuroscience underlying users' perception and appreciation of architecture. Indeed, such detection suggests that the emotional-perceptual experience of architecture is involved in the brain cortical, sensory, meaning, emotion, judgment, and valuation system. Hence, the experience of place is objectively and measurable in connection with emotion, perception, mental processes, and user behavior. In this regard, for all participants, the brain areas activation related to the pleasant places were associated exclusively with strong activations and the highest score of found voxels compared to the unpleasant places.

Because of highly increased activities in *visual areas* of the occipital lobe, *beauty judgment areas* of the frontal lobe, *visual-spatial perception* (form, color, and recognition of objects) *areas* of the temporal lobe, *spatial orientation, tactile*, and *perception* (motion, depth, height, width, geometry) *areas* of the parietal lobe, *spatial memory areas* of the posterior cingulate, the *architectural experience of large-scale places and landscape areas* of the anterior cingulate and parahippocampal, and *visuospatial exploration of architectural space areas* of the superior temporal in relation to pleasant places rather than the same areas for unpleasant places, it is assumed that positive places in the aspect of providing architectural qualities can attract more attention for a design. Results suggest that the external appearance of an architectural design can influence the emotional, perceptual, cognitive, beauty judgment, and decision-making (behavioral) process of the user to a high degree. In this context, findings showed that the activation of the cerebellum (left and right cerebellum), anterior cingulate, left insula, and right frontal covaried in relation to happiness, and activation in the precuneus, anterior cingulate cortex, fusiform gyrus, middle frontal gyrus, frontal lobe, and medial frontal covaried in relation to pleasant emotions ratings. Also, activation in a distributed network including the cerebrum, thalamus, left hippocampus, and left middle temporal is engaged in fear. Activation in the areas such as the middle temporal and cingulate is involved in sadness and fear. The frontal lobe and insula activations are engaged in disgust, fear, anger, and sadness. Also, activation in the hippocampus and left thalamus is covaried in relation to anger and sadness. Furthermore, the fusiform gyrus is associated with unpleasant emotions, and the left fusiform is associated with avoidance behavior.

Women's and men's brain showed significantly more activation for pleasant than unpleasant places. In this regard, for women both pleasant and unpleasant places were associated exclusively with strong activations and the highest score of found voxels compared to men. Such a difference provides evidence that pleasant and unpleasant places trigger women's emotions to a stronger degree than men's emotion. The women's brain areas engaged in emotions respond more effectively and strongly to pleasant places than men's brain. In this regard, highly increased activities in the areas engaged in emotions such as the frontal lobe, left cerebellum, right cerebellum, medial frontal, anterior cingulate, and left insula for women rather than the same areas for men suggests that positive places in terms of providing architectural qualities affected women's emotion more than men. Furthermore, in related to rating regions engaged in the architectural experience, the men's brain respond more strongly to pleasant places than women's brain. In this context, highly increased activities in the areas engaged in an architectural experience such as the occipital lobe, parietal lobe, cuneus, and parahippocampal for men rather than the same areas for women suggest that pleasant places in terms of spatial elements attract the more attention and perception of men for the design than women.

In related to unpleasant places, the women's brain areas engaged in emotions respond more effectively and strongly than men's brain. In this regard, highly increased activities in the areas engaged in emotions such as the right cerebrum, fusiform, left fusiform, cingulate, superior occipital, thalamus, left insula, and the left hippocampus for women rather than the same areas for men suggests that negative places in terms of providing architectural qualities affected women's emotion more than men's. Additionally, increased activations were found for women's brain in related to areas engaged in architectural experience than men's. The relevant areas were the occipital lobe, temporal lobe, and middle occipital rather than the same areas for men. Such a difference suggests that negative places in the aspect of providing the perceptual features of architectural qualities affected women's brain and perception more than men's brain and perception.

The urban designers' brain showed significantly more activation for pleasant places than architects. In this regard, highly increased activities in the areas engaged in emotions such as the **frontal lobe**, **left cerebellum**, **right cerebellum**, **precuneus**, **medial frontal**, **anterior cingulate**, and **left insula** for urban designers rather than the same areas for architects suggest that positive places in terms of providing architectural qualities affected urban designers' brain and emotion more than architects. Furthermore, highly increased activities in the areas engaged in an architectural experience such as the **parietal lobe**, **temporal lobe**, **cuneus**, and **middle temporal** for urban designers rather than the same areas for architects suggest that pleasant places in the aspect of spatial elements attract the more attention and perception of urban designers for a design. In related to unpleasant places increased activities were found for architects' brain related to areas engaged in architectural experience than urban designers. The relevant areas were the **occipital lobe**, **parietal lobe**, **middle occipital**, and **parahippocampal** rather than the same areas for urban designers. Such a difference suggests that negative places in terms of providing the perceptual features of architectural qualities affected architects' brain more than urban designers. Furthermore, the increase of activities in the areas engaged in emotions for urban designers' brain than architects' suggests that urban designers assessed the unpleasant places more emotionally than architects. Generally, in the face of pleasant places, urban design students respond more emotionally and perceptually than architecture students. Moreover, in the face of unpleasant places, architecture students reacted to perceptual aspects of spaces more than urban designers, whereas, urban design students respond to emotional aspects of place more than architects.

Generally, it can be said that pleasant places due to attracting more attention and memory effects contribute to place perception and architectural design much better than unpleasant places. Findings suggest that unpleasant design will have a negative impact on the emotional-perceptual experience of place, and designers should pay more attention to the valence of good design. Such a difference provides evidence that pleasant places in the aspect of using spatial and architectural qualities trigger emotions to a stronger degree than unpleasant places, and the brain areas engaged in emotions respond more effectively and more strongly to pleasant places than unpleasant places.

These findings represent that the areas associated with pleasantness and reward processing are involved in preferences that include good (pleasant) or bad (unpleasant) designs. As a result, it is expected that in the research and design of future architecture, the Neuro-Architecture approach and the theoretical and practical model presented in this research could contribute to improving the pleasant experience of architecture and user's satisfaction.

6.4. Suggestions

The present study could provide an opportunity to have a neurophysiological basis study of architectural experience and could determine the more significant aspects of design with a good or bad value. It was a meta-analysis work of functional neuroimaging studies involving emotion. We examined whether specific brain areas were in association with emotional responses when an individual experiencing different architectural spaces. This study revealed that if users are exposed to positive places with high quality, they experience a pleasant feeling. In contrast, related to negative places, they get an unpleasant feeling. Participants were more likely to judge places as pleasant if they provide high spatial qualities (texture, materials, color, etc.), physical and functional features (proportion and geometry), and landscape. Places with higher ceilings and dark and narrow corridors were not likely to be entered than broad places with lower ceilings. Specifically, participants were more likely to approach and judge spaces as beautiful if they were open than enclosed, and more likely to avoid and opt to exit from them if they were enclosed rather than open. Moreover, pleasant and unpleasant places increase the activations in emotion processing and reward processing areas and have a significant effect on the activation of areas such as the middle occipital lobe, frontal lobe (orbitofrontal, prefrontal, middle and superior frontal, etc.), left middle temporal, parahippocampus, cingulate cortex, anterior cingulate, and precuneus. According to this fact, it is possible for designers to objectively know which aspect of architectural design makes users perceive a pleasant or unpleasant feeling.

Functional neuroimaging findings of experiencing pleasant and unpleasant architectural places investigated in this thesis has identified the following summary observations: (1) The anterior cingulate, cingulate gyrus, middle frontal, medial orbitofrontal cortex; cerebellum, precuneus, amygdala, insula, and hypothalamus play role in emotional processing of architecture; (2) The occipital lobe, cuneus, temporal lobe, parietal lobe, and parahippocampal play role in perceptual processing of architecture; (3) Unpleasant places evoke areas engaged in fear (amygdala, insula, cerebrum, hypothalamus, cingulate, hippocampus, frontal), sadness (insula, cingulate, hippocampus, left thalamus), disgust (amygdala, hypothalamus, amygdala, frontal); and pleasant places evoke areas involved in happiness (cerebellum, anterior cingulate, left insula, right frontal); (4) Approach decision is engaged in the middle frontal gyrus, avoidance decision is engaged in areas such as the amygdala, insula, cingulate, and superior occipital.

Our results suggest that a systematic appraisal of how the physical, functional, semantic, and social features of a place psychologically and physiologically affect the user's behavior, emotion, perception, and brain function. As an achievement, the findings of this study could reveal objectively why users prefer the places and which components of an architectural place make the user more satisfied. Our methodological Neuro-Architecture named approach could potentially improve the reliability and validity of determining certain brain areas engaged in positive and negative emotions experiencing an architectural place, and it is also able to make a more meaningful relationship between the users' emotional-perceptual experience and the physiological activity of the brain. Also, we believe that our findings could offer significant insights for architectural designing research, and the used approach can be used as a design method in new architectural designs as a result of the brain behaviors regarding an architectural experience. We believe that future neuroimaging studies will add to our current findings, but the patterns identified in this study are important constituents of the emotional-perceptual experience of place.

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YAYINLAR

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- “Spatial Analysis of Khaju Bridge As An Urban Element, In The Context of Space Perception Through Senses”, *IOSR Journal of Humanities And Social Science (IOSR-JHSS)*, Volume 21, Issue 4, Ver. 07 (Apr. 2016) PP: 66-75.
- “Typology of Residential Complexes, An Effective Step in the High-Quality Design of the Contemporary Residential Complexes: Case Study of Residential complexes in Tabriz city”, *Journal of Architecture and Urban Planning (Persian)*,2014, ISSN: 2008-2649 (put in print list)
- “Application of the Islamic Concepts in Designing and Localizing Functional Components of Universities”, *Journal of Ketab-e Mah Honar*, No: 174, ISSN: 1735-6784, (Feb. 2013) pp:40-47.

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- 2010, İran, "6. Uluslararası Fotoğraf ve Sanat Festivali", başarı ve katılım belgesi.

ÜYELİKLER

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- Program: Microsoft (Word, Powerpoint), Adobe Photoshop, P3, 3ds Max
- Sanat: Ressamlık, Fotoğrafçılık, Müzik Yapma, Şiir Yazma