

USING EYE TRACKING TO UNDERSTAND THE IMPACT OF VISUAL
COMPLEXITY AND PERCEPTUAL FLUENCY ON VIEWERS' AESTHETIC
PREFERENCES

A Ph.D. Dissertation

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Ankara
September 2024

To *Andaç Beder*



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PREFERENCES

The Graduate School of Economics and Social Sciences
of
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by

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İHSAN DOĞRAMACI BİLKENT UNIVERSITY
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PREFERENCES

By Dilara Beder

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Doctor of Philosophy in Interior Architecture and Environmental Design.

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ABSTRACT

USING EYE TRACKING TO UNDERSTAND THE IMPACT OF VISUAL COMPLEXITY AND PERCEPTUAL FLUENCY ON VIEWERS' AESTHETIC PREFERENCES

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This study investigates the interplay between cognitive styles, visual complexity, and aesthetic evaluations in environmental psychology and architectural design, utilizing Gestalt principles. Our research was divided into two studies. In Study I, we examined the aesthetic evaluations of 24 two-dimensional geometric stimuli, manipulated using the Gestalt principles of similarity based on color and shape differences, with 39 participants. In Study II, we focused on architectural façades and used 24 two-dimensional stimuli, manipulated through the Gestalt principles of similarity and proximity, to assess aesthetic evaluations with 79 participants. Participants were classified as Field Dependent or Field Independent using the Hidden Figures Test. Additionally, we collected their aesthetic evaluations through questionnaires, supported by eye-tracking data to assess visual attention.

Study I revealed a U-shaped relationship between visual complexity and aesthetic evaluations, with both low and high complexity stimuli rated higher than medium complexity ones. Study II found an inverse relationship between complexity and aesthetic ratings, with simpler façades generally preferred. Gestalt principles significantly influenced aesthetic judgments, with shape-based similarity rated higher than color-based similarity for geometric designs, and proximity-based façades rated higher than similarity-based façades in architectural contexts. Although cognitive styles did not significantly impact overall aesthetic evaluations, nuanced differences were identified in the responses of Field Dependent participants when comparing proximity-based to similarity-based designs. Gaze metrics data indicated that higher complexity levels led to more fixations and shorter fixation durations, reflecting more extensive visual exploration. These findings offer insights into how cognitive styles, complexity, and Gestalt principles shape aesthetic perceptions, informing design practices to enhance user experience.

Keywords: Eye tracking, Complexity, Gestalt, Aesthetic Preferences, Cognitive Styles

ÖZET

GÖRSEL KARMAŞIKLIĞIN VE ALGISAL AKICILIĞIN İZLEYİCİLERİN ESTETİK TERCİHLERİ ÜZERİNDEKİ ETKİSİNİ ANLAMAK İÇİN GÖZ TAKİP SİSTEMLERİNİ KULLANMAK

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Bu çalışma, çevre psikolojisi ve mimari tasarımda bilişsel stiller, görsel karmaşıklık ve estetik değerlendirmeler arasındaki etkileşimi, Gestalt ilkelerini kullanarak araştırmaktadır. Araştırmamız iki çalışmaya ayrılmıştır. Çalışma I'de, 39 katılımcı ile renk ve şekil farklılıklarına dayalı benzerlik Gestalt ilkeleri kullanılarak manipüle edilen 24 adet iki boyutlu geometrik uyarının estetik değerlendirmelerini inceledik. Çalışma II'de, 79 katılımcı ile mimari cephelere odaklandık ve estetik değerlendirmeleri incelemek amacıyla benzerlik ve yakınlık Gestalt ilkeleri kullanılarak manipüle edilen 24 adet iki boyutlu uyaran kullandık. Katılımcılar, Gizli Şekiller Testi kullanılarak Alan Bağımlı veya Alan Bağımsız olarak sınıflandırıldı. Ayrıca, estetik değerlendirmelerini toplamak için anketler kullandık ve görsel dikkati değerlendirmek amacıyla göz izleme verileri ile destekledik.

Çalışma I, görsel karmaşıklık ve estetik değerlendirmeler arasında U şeklinde bir ilişki ortaya koydu; hem düşük hem de yüksek karmaşıklıkta uyaranlar, orta derecede karmaşıklıkta olanlardan daha yüksek puan aldı. Çalışma II, karmaşıklık ve estetik değerlendirmeler arasında ters bir ilişki buldu; daha basit cepheler genel olarak tercih edildi. Gestalt ilkeleri estetik yargıları önemli ölçüde etkiledi; geometrik tasarımlar için şekil temelli benzerlik, renk temelli benzerlikten daha yüksek puan alırken, mimari bağlamda yakınlık temelli cepheler, benzerlik temelli cephelerden daha yüksek puan aldı. Bilişsel stiller, genel estetik değerlendirmeler üzerinde önemli bir etkiye sahip olmamakla birlikte, Alan Bağımlı katılımcıların yakınlık temelli tasarımlar ile benzerlik temelli tasarımlar karşılaştırıldığında verdikleri yanıtlar arasında ince farklar belirlendi. Göz hareketi verileri, daha yüksek karmaşıklık seviyelerinin daha fazla sabitlenmeye ve daha kısa sabitleme sürelerine yol açtığını, bunun da daha geniş bir görsel keşfi yansıttığını gösterdi. Bu bulgular, bilişsel stiller, karmaşıklık ve Gestalt ilkelerinin estetik algıları nasıl şekillendirdiğine dair içgörüler sunarak, kullanıcı deneyimini geliştirmek için tasarım uygulamalarını bilgilendirmektedir.

Anahtar Kelimeler: Göz izleme, Karmaşıklık, Gestalt, Estetik Tercihler, Bilişsel Stiller

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CHAPTER I

INTRODUCTION

Design as a word is subject to many discrepancies; it has numerous manifestations, but no clear and precise demarcation lines (Kandemir, 2019). Aesthetic assessment and visual complexity are essential elements of design, art and perception and it is formed by a mix of sensory experiences (Starr, 2023), emotional responses (Schindler et al., 2017) and intellectual reflection (Schellekens, 2022). Aesthetic assessment is the act of determining an object's visual appeal and beauty (Gatz, 1941; Isik & Vessel, 2021), whereas visual complexity is the degree of intricacy and detail in a visual stimulus (Snodgrass & Vanderwart, 1980). Gestalt principles have benefit controlling visual complexity. The core idea of Gestalt psychology is that individuals naturally organize disjointed elements into coherent parts when they notice relationships among visual components (Wagemans et al., 2012). These principles simplify complex visuals by arranging elements into coherent groups and patterns, making them simpler to comprehend and aesthetically pleasing (Donderi, 2006).

The feeling of beauty occurs when pleasure is obtained from sensation and prompts deliberate thought (Kant, 1790). When people engage with an item or piece of art, their visual perception undergoes a complicated interaction that includes the examination of several components such as forms, colors, textures and spatial connections (Friedenberg & Liby, 2016). Consequently, the cognitive ability to process complex visual stimuli influences aesthetic evaluation (Beck, 1945).

Nowadays, aesthetics is investigated in a multi-dimensional evaluation process by associating it with the cognitive process. For this reason, it has been shown that not only features of the stimulus, but also psychophysiological features of individuals are effective in aesthetic evaluations (Leder et al., 2004). Individual differences in cognitive style, conceptualized as field-dependent and field-independent, are the ways in which a person perceives, thinks, learns, solves problems and relates new information to existing knowledge (Angeli et al., 2009; E. Nisiforou & Laghos, 2016; G. Raptis et al., 2018; Rittschhof, 2010; Zhang, 2004). Moreover, aesthetic evaluation is a complex cognitive process and is associated with beauty (Jacobsen et al., 2006), pleasure (Graf & Landwehr, 2015), liking or appreciation (Corradi et al., 2019). Eye-tracking technology is commonly utilized in human-computer interaction studies to observe eye movement behavior during exposure to stimuli in aesthetic evaluation research. Eye-tracking systems are also used in studies examining how physical environments, designed with architectural elements, influence individuals' perception of space.

1.1. Aim of the Study

Environmental psychology consists of interactions between individuals and their physical environment. In this interaction, the physical environment changes the behavior and experiences of the individual. The built environments created by architects, interior architects and city planners are related to people's perceptual processes; that is, it is a cognitive process. How individuals perceive elements to achieve form is one of the main research topics of environmental psychology. In the field of architecture, aesthetics is related to the structure and geometric features of forms and forms, which are the core of perception studies. Although there has been a lot of academic study on the complexity and aesthetic evaluation of design, there is a gap in the literature regarding studies that analyze the relationship between compositions based on insights from Gestalt theory and aesthetics at the cognitive level. For this reason, our objective was to investigate the aesthetic evaluations of participants with different cognitive styles (Field Dependence and Field Independence) in response to geometrical organization stimuli at various levels of complexity (low, medium, high). These stimuli were created by manipulating Gestalt principles of similarity and proximity, and the study was supported by eye movement data.

1.2. Structure of the Thesis

This work comprises six chapters. The next chapter, following Chapter 1, is titled "Aesthetic Evaluation" and it introduces the literature's approach to aesthetic evaluation. It also theoretically explains how these evaluations relate to complexity and Gestalt principles over time, referencing the relevant studies. In this context, a

relational approach has been developed based on previous studies related to complexity, aesthetics, and their relationship with Gestalt principles.

The third chapter, titled “Cognitive Styles and Eye Tracking” discusses how cognitive differences among individuals affect their aesthetic evaluations of composition. Differences in the perception of complex stimuli between Field Dependent and Field Independent individuals are explored by analyzing their eye movements. Additionally, this chapter includes eye tracking studies conducted on architectural works, which form the basis for the present research.

The present study includes two investigations conducted based on the formulated hypotheses and research questions, providing detailed information about the participants, the steps involved in conducting the studies, the creation of stimuli for both investigations, and the adaptation of selected visual perception norms applied in the research. The study also presents subjective evaluations derived from participant responses through survey questionnaires for each stimulus and objective evaluations based on eye-tracking metrics during the rating process. The data were analyzed within the framework of the Gestalt principles applied in generating the visual objects, aiming to draw useful conclusions regarding respondents’ aesthetic perceptions. The analyses were conducted separately, depending on whether participants were categorized as field dependent or field independent, to clearly highlight their differences in aesthetic evaluations.

Chapter 4 is dedicated to the first study, while Chapter 5 addresses the second study. Detailed explanations for the first study are provided in Chapter 4 under the heading “Study I” including the method, participants, and experimental instruments, which

are discussed under the subheading 'Method'. The experimental results of Study I, supported by statistical data, are presented in Chapter 4 under the subheading 'Results' followed by an interpretation of these results and their connection with the literature under the subheading 'Discussion'.

Similarly, detailed explanations for the second study are provided in Chapter 5 under the heading "Study II": The method, participants, and experimental instruments for the second study are discussed under the subheading 'Method' and the experimental results of Study II, supported by statistical data, are presented under the subheading 'Results'. The interpretation of these results and their connection with the literature are discussed under the subheading 'Discussion'.

Chapter 6, titled "Conclusion" interprets the combined results of both studies, highlighting significant findings related to the impact of Gestalt principles on participants' aesthetic evaluations and gaze metric data. It also discusses the potential contributions of this study to future research and its implications for the design process.

1.3. Design of the Research

The purpose of this study was to assess participants' aesthetic judgments in relation to stimuli with varying complexity levels, created by manipulating certain Gestalt principles. For subjective evaluations, participants responded to questions in a questionnaire format, while 'top-down' and 'bottom-up' information processing was used for objective evaluations, as shown in Figure 1. However, there is ongoing

debate regarding how the definition of aesthetic experience should balance these two information processing methods (Massaro et al., 2012).

This method involved a top-down information processing approach, which examined eye movements based on memorized facts or knowledge. Conversely, the bottom-up information processing approach was directly influenced by the properties and compositions of objects, images, or physical environments (S. Lee et al., 2015; Nayak & Karmakar, 2019). Top-down information processing was assessed using the Hidden Figures Test, where participants identified simple shapes hidden within complex ones. Based on the test results, participants were divided into Field Dependent and Field Independent groups, and their differences became part of the study's scope (S. Lee et al., 2015). This approach seeks to achieve a holistic understanding through the integration of various theoretical approaches to aesthetic evaluation.

The present study consists of two experiments using stimuli designed by manipulating selected Gestalt principles (similarity and proximity). In Study I, two sets of stimuli were prepared: one consisting of black and white squares, and the other consisting of black circles and black squares. Set 1 aimed to manipulate the principle of similarity based on color differences, while Set 2 focused on shape differences to manipulate the Gestalt principle of similarity. As a preliminary to our main study, Study II (Beder et al., 2024), we analyzed the impact of similarity based on color and shape differences on cognitive styles in Study I. Based on the results, statistical differences between the two groups were observed with stimuli involving shape-based similarity. Therefore, shape-based similarity was used as a manipulation

in Study II. In Study II, we manipulated the principle of similarity based on shape difference and the principle of proximity in architectural façade drawings to create varying levels of complexity. While previous studies have mostly focused on differences within the Gestalt principles, there is a gap in the literature regarding differences between participant groups. To address this, both subjective and objective evaluation results of Field Dependent and Field Independent participants were included in this study.



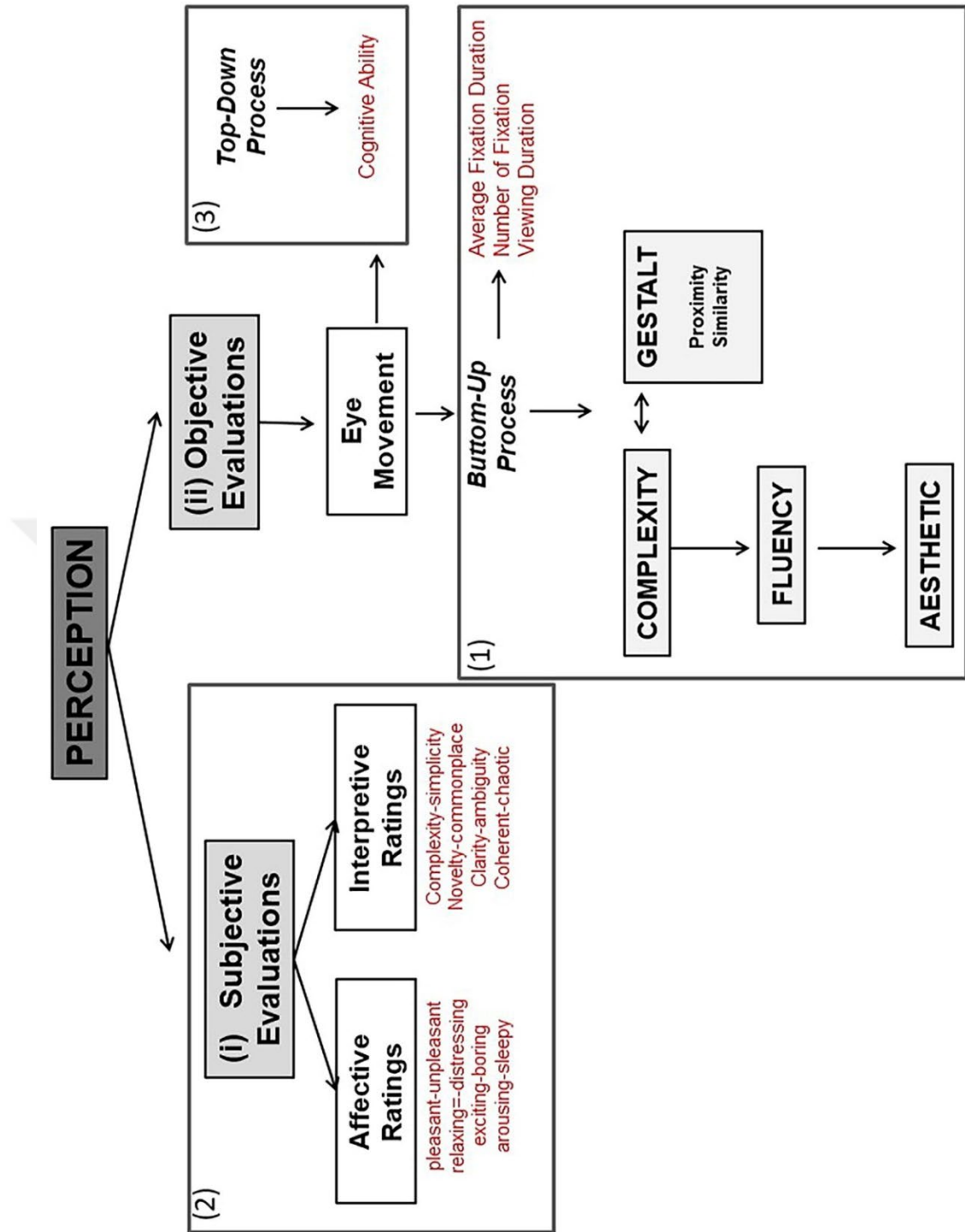


Figure 1. Theoretical framework of the study

CHAPTER II

AESTHETIC EVALUATIONS



Aesthetics is a philosophical and psychological construct that covers various ideas and concepts about how pleasure is received and interpreted (Graf & Landwehr, 2015), the nature and experience of beauty (Jacobsen et al., 2006), and mechanisms underlying appreciation (Corradi et al., 2019). As a result, aesthetics can unite emotional responses from subjectivity with various objective criteria across different cultures and sensory modalities. It is a sense that enables aesthetics to bridge the gap between subjective emotions and objective forms of evaluation. Aesthetics is a complex phenomenon connected to beauty, enjoyment, attraction, and value.

Aesthetics is derived from the Greek word “aesthetike,” which means perception.

The first research on aesthetic preferences was conducted by Gustav Theodor Fechner (1876), the founder of psychophysics, who made use of evaluative responses. In this respect, he started with one work of art to be evaluated aesthetically before moving on to several objects. Under these circumstances, empirical aesthetics came into being as Fechner sought to determine how people

grasp beautiful things through psychological processes that could be measured (Fechner, 1876). Fechner conducted his research in three steps using various geometric stimuli, such as lines or people, to establish the general laws governing aesthetics. In stage one, participants were asked to compare the stimuli according to their liking, thereby introducing a quantitative dimension into aesthetics for the first time. He used a structured approach that allowed for the objective measurement of subjective aesthetic experiences, which at that time had no precedents (Berlyne, 1971; Fechner, 1876). Next, participants had to produce new things based on their preferences by drawing them or manipulating them. This phase revealed creativity in selection preference plus factors arising from individual differences in making judgments about what looks good or bad on an object's surface (Fechner, 1876). In the final stage, Fechner aimed to establish which dimensions of simple objects influenced people's preferences. He assumed that certain proportions and structural elements were preferable in every situation, thereby shaping architectural design and ergonomic theory later on. According to Fechner's research, aesthetic preferences can be studied using empirical methods, and aesthetic judgment may reveal similar patterns across individuals from different cultures. The effect of Fechner's methodology and findings on aesthetics and psychology has been enduring. This work inspired a line of research that explored the connection between physical stimuli and aesthetic responses in different areas, such as visual arts, architecture, and design (Berlyne, 1971). The principles instituted by Fechner are still used in empirical aesthetic studies today which demonstrates the lasting impact he had on the field (Arnheim, 1954).

Contemporary psychological research into the neural and cognitive bases underlying aesthetic experiences combines classical ideas with modern scientific views. Leder et al. (2004) proposed an all-embracing, multi-stage model for aesthetic appreciation that has significantly contributed to our understanding of how people process art objects. The model suggests five stages: analysis of perception—initial sensory input processing; implicit memory integration—subconscious retrieval of past experiences related to the artwork; explicit classification—conscious recognition or categorization of artwork; cognitive mastering—an effort made by a viewer to understand or interpret a piece; evaluation—subjective judgment about artistic value based on general principles or individual preferences. Fundamentally, aesthetic experience is seen as part of psychology, involving individuals' attention towards objects, works of art, or their physical environment. Experimental research on aesthetic experiences focuses on the properties of objects and their perception by participants, arousal-pleasure relations of the stimulus, and individual differences among participants. This approach demonstrates that experimental aestheticians are not only concerned with the meaning of works of art but also with the reasons for including subjects in aesthetic activities and how this happens. The artist's work either facilitates or influences a person's aesthetic experience. In addition to the multi-stage model (Leder et al., 2004), Hekkert (2014) advanced understanding of aesthetic experience by developing the Unified Model of Aesthetics, which classifies aesthetic preferences into three major dimensions: perceptual, cognitive, and social. It combines both objective and subjective approaches to aesthetics evaluation, recognizing that individuals perceive art not only through individual cognitive processes but also due to the socio-cultural context. Perceptual aspects refer to sensory/formal qualities, including color, shape, and composition, which usually

evoke immediate aesthetic responses (S. E. Palmer et al., 2013). These cognitive elements involve interpretive processes like understanding its meaning within a specific context as well as symbolism used in an artwork (Silvia, 2012). Lastly social dimensions are critical in determining cultural norms societal values and interpersonal interactions which affect judgements about aesthetics emphasizing communal experiences can shape preferences along these lines and shared cultural backgrounds (Redies, 2015). The interplay between these dimensions underscores Hekkert's model, indicating that a holistic comprehension of an aesthetic experience must account for the fine and intricate interactions between perceptual immediacy, cognitive elaboration, and social context. This holistic approach provides a robust framework for examining how various factors contribute to the diversity of aesthetic preferences and evaluations observed across different individuals and cultures.

In aesthetic studies, understanding the complexities of aesthetic evaluations has become possible with the use of objective research methods along with empirical approaches. These often include developing items from hedonic values (both positive and negative) that target specific aesthetic evaluations. For instance, in architectural aesthetics, Devlin and Nasar (1989) introduced a method using adjective rankings on a seven-point bipolar scale. The researchers identified two major factor groups: Evaluative Scale and Interpretive Scale. The Evaluative Scale was ranked using the adjectives 'dissatisfying-satisfying,' 'boring-exciting,' 'disturbing-relaxing,' and 'meaningless-meaningful.' On the other hand, the Interpretive Scale consists of ratings with the adjectives 'complex-simple,' 'ordinary-innovative,' 'ambiguous-clear,' and 'compatible-incompatible.' Also, the aesthetic evaluations of the physical

environment can be defined by two types of visual qualities: “Form and Content – context.

Physical characteristics such as form, proportion and color are called formal attributes. These attributes are important determinants of the aesthetics of a place. However, contextual attributes go beyond just the physical features to involve hedonic responses which are pertinent indicators of emotional appraisal by users (R. Kaplan & Kaplan, 1989). Therefore, perception is not simply the identification of environmental stimuli but rather an intricate interplay between stimuli and individual responses that involve both emotions as well as cognition. Hence it is important for researchers in aesthetics to have multiple approaches given the complex nature involved in different stimuli that occur during perception process where no single theory or method can account for all experiences linked with various participants (Berlyne, 1974). For the nuances of aesthetic experiences to be captured, it is important to have comprehensive approaches that advance our understanding of environmental psychology.

In terms of physical environments, aesthetics is intricately bound to forms and geometric features, with orderliness, hierarchy, and ecological relationships playing key evaluative roles (Hekkert & Schifferstein, 2007). However, there is no set formula that can capture aesthetics completely, but design principles that underlie artistic taste are usually assessed by using the Gestalt theory, which argues that humans perceive objects as complete entities rather than as the sum of their parts (Wagemans et al., 2012). Complexity in aesthetics is more evident in the development of *Prägnanz* from Gestalt psychology’s notion of good form, where the

cognitive system recognizes organized complexity (Koffka, 1935). This means that aesthetic judgments are complex in nature as they involve multiple perceptual processes (S. E. Palmer et al., 2013). Survey methodologies are often used when trying to find out how people perceive and evaluate environments subjectively through different theories. Cognitive ease, which improves positive subjective evaluations, is closely related to operational fluency—ease of processing information (Reber et al., 2004). Hence operational fluency mediates between stimulus complexity and aesthetic evaluations which further highlights the relationship between perceptual fluency and aesthetic appraisal (Reber et al., 2004). By understanding these dynamics, researchers can better delve into the intricate interplay between complexity, cognitive processing, and aesthetic judgments within physical environments.

2.1. Complexity and Aesthetic Evaluations

Cognitive ease which plays a role in subjective evaluations has been tied closely to operational fluency forming the basis for Hedonic Fluency Model (Winkielman & Cacioppo, 2001). According to this model stimuli or objects that are perceived easily or effortlessly receive higher liking ratings from individuals. The basic underlying mechanism here is that positive experience occurs when processing becomes fluent hence one's response towards their surroundings tends to be affirmative (Forster et al., 2015). The aesthetic evaluation approach based on this theory is guided by three main assumptions (Graf & Landwehr, 2015): (1) the visual features of the objects or environments are able to influence an individual's cognitive processing experience; (2) positive emotions are evoked by cognitive ease; and (3) these positive emotions

are correlated with an aesthetic evaluation of the objects or environments. Processing fluency can be classified into conceptual and perceptual fluency. Conceptual fluency arises from how easily a stimulus can be interpreted in a meaningful way whereas perceptual fluency relates to the subjective ease of processing that depends on the properties of things being considered (Ball et al., 2018; Forster et al., 2015). Some factors that affect processing fluency include perceptual priming (Forster et al., 2013), false physiological feedback (Forster et al., 2015), presentation time (Forster et al., 2013) and objective manipulations such as contrast (Reber et al., 1998) and symmetry (Wurtz et al., 2008). Furthermore, complexity has been shown to determine processing fluency in aesthetic evaluations, where simple stimuli generally result in more fluent processing and are thus evaluated more favorably than their complex counterparts (Graf & Landwehr, 2015; Reber et al., 2004). Therefore, understanding various aspects related to processing fluency provides a comprehensive framework for analyzing aesthetic preferences and their cognitive bases.

In parallel with these evaluations, Berlyne (1971) suggested that the complexity of collative variables can be used as an important evaluation tool in aesthetic evaluation studies. There are many definitions of complexity according to different fields of study, but complexity is interpreted as the difficulty of understanding the whole with countless parts. From an architectural point of view, complexity is an element that needs to be controlled (Von Meiss, 1989), which means that the environment must be designed in an order, no matter how complex it is (Arnheim, 1977). The degree of complexity of visual stimulus is related to the combinations of line, direction, shape, size, color and texture elements to create harmony, contrast, dominance, rhythm and

balance (Osborne & Farley, 1970). The degree of complexity increases with the number of visible objects (Pieters et al., 2007), the irregularity, details, differences, asymmetry in arrangement, variety of color and contrast (Leder & Carbon, 2005). In his work on Berlyne's pleasure-arousal hypothesis (1963, 1971), he observed two different tones (positive and negative) as a function of arousal potential and revealed an inverted U-shaped relationship between stimulus complexity and individuals' preferences. Accordingly, stimuli with a medium level of complexity were preferred over those with low and high levels of complexity. Many studies support Berlyne's hypothesis, such as those on natural urban visual material (S. Kaplan et al., 1972) and façade drawings (Imamoglu, 2000). Contrary to these studies, there are also studies which shows that there is a positive linear and U-shaped relations between the complexity of stimuli and the preferences of individuals (Adkins & Norman, 2016; Friedenberg & Liby, 2016). There is a high correlation between measurement about eye movement and visual perception, especially in environments where it is more difficult to identify many important details and where the level of complexity is high (Wolfe, 2010).

Hypothetically, the evaluation of the people the processing fluency and complexity can be explained with the same logic as Berlyne's approach, which represents the evolution of the people to the complexity and aesthetics as an inverted U-shaped relation (Reber et al., 2004). It was noted that when the stimuli were manipulated to a medium level of complexity, the processing fluency of the people was at its highest level. In other words, a further increase in the complexity level of the stimuli may negatively affect people's processing fluency and cause a decrease in aesthetic evaluations. In this study, the aesthetic evaluations of people were examined under

two factors based on empirical research: Conceptual Fluency and Stimulus Complexity (Reber et al., 2004). Conceptual Fluency was defined as the ease with which a meaningful interpretation of the stimuli is achieved, and the Stimulus Complexity was manipulated to obtain low and high levels of complexity. According to the results, the complexity level of the stimuli and the conceptual fluency results impacted people's aesthetic evaluations. People only preferred complex stimuli that were conceptually easy to process (Ball et al., 2018). In addition to these results, the effect of processing fluency between the evaluation of the physical environments and the complexity level of stimuli was investigated (Orth & Wirtz, 2014). In the study, the photographs which were designed by manipulating the irregularity, similarity, and the number of objects, were used with low and high complexity levels. According to the research results, high processing fluency in low complex physical environment increases people's evaluations of satisfaction and attractiveness toward the physical environment. This is because cognitive overload involves more than just visual complexity. Complex material may increase cognitive load, but this in itself is not necessarily negative; challenging learners with complex material can lead them into deeper learning and improve their cognitive abilities (Kirschner et al., 2006). Nevertheless, a high degree of complexity could lead to cognitive overload where the learner's mental resources are insufficient for effective processing of the information. The management of cognitive load depends on how instructional materials and user interfaces are designed, such that logically organized content and scaffolding guide learners through difficult topics without overwhelming their cognition (Sweller, 2010).

Moreover, aesthetics or what is usually known as visual appeal and emotional response play an important role in cognitive processing too. Research conducted on human-computer interaction and instruction design indicates that pleasing designs have positive effects on users' engagement levels motivation and perceived usability (Thorlacius, 2007). Aesthetics influence how information is processed or recalled thereby affecting cognitive load. For instance visually appealing materials can draw attention to them for some time making it easier for learners to concentrate on contents hence lessening extraneous cognitive loads (Tversky et al., 2002). However aesthetic wisdom as pertaining to cognition overload is far from simple. Although well-designed materials may enhance learning processes intricate decorations may make it difficult for learners to understand the key message thus increasing extraneous loads (Norman, 2007). As such, designers face the challenge of creating materials that are both beautiful and cognitively efficient.

2.2. Gestalt and Aesthetic Evaluations

From broad perspectives, there are three basic theories of perception: The Transactional Theory, The Ecological Theory and the Gestalt Theory (Lang, 1987). The Transactional Theory consists of the relationship between people and their surroundings. According to this theory, perception is described as experimental or structural. People's moods and emotions are included in experimental descriptions and the physical or social structure of the environment is also included in structural descriptions (Lang, 1987). The ecological theory is defined by 'meaningless sense data' such as light, sound waves or other sources (Lang, 1987). The mind does not have an active role in this process; perception and sources interact together; that is,

people perceive the physical environment by moving their eyes, head and body. Gestalt theory, on the other hand, is associated with the human brain's self-determination of the organization which is created in the physical environment (Koffka, 1935). In short, the geometric structure of the physical environment, also known as shape, is an impressive tool of Gestalt Theory of perception. Gestalt psychology emerged in the early 20th century as a significant movement countering the reductionist perspectives prevalent in psychology at the time, which primarily sought to understand mental processes by breaking them down into their smallest elements (Koffka, 1935). On their part, Max Wertheimer, Wolfgang Köhler and Kurt Koffka amongst other Gestalt theorists argued against dissecting of psychological phenomena into parts; instead, they focused on how human mind perceives objects as whole forms rather than sums of their parts (Koffka, 1935; Wertheimer, 1922). This holistic approach is best captured by the well-known saying "The whole is greater than the sum of its parts," which implies that our perception is inherently structured and organized. Such Gestalt principles include proximity, similarity, continuity, closure and figure-ground organization explain how humans tend to naturally group visual elements together so that they are perceived like single wholes (Wagemans et al., 2012), as shown in Figure 2.

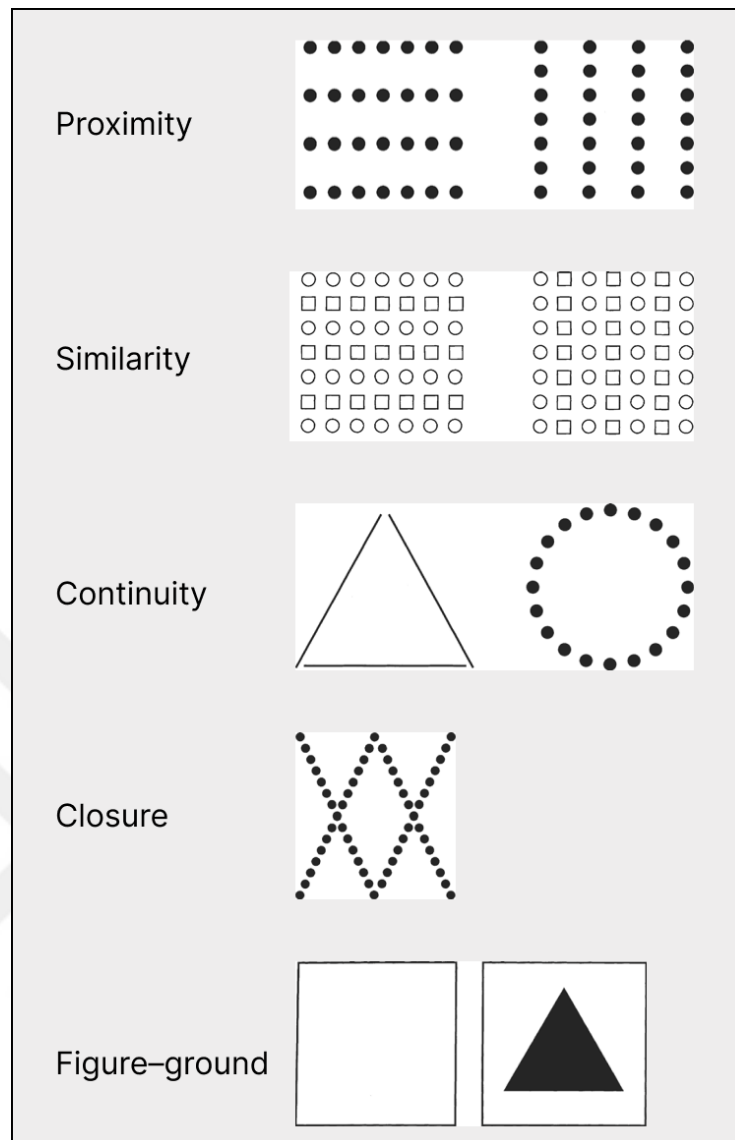


Figure 2. Examples of Gestalt principles ((adapted from Zakia, 2002)

For example, when faced with intricate or unfamiliar visual inputs, our brains intuitively use these rules to create meaningful patterns and structures within this environment to promote understanding (Chuang et al., 2023). This approach challenged existing theories and formed the basis for various applications, such as perception, learning, problem-solving, and even modern areas like design and artificial intelligence (S. Palmer & Rock, 1994; Wagemans et al., 2012). Therefore, theory's aim is to grasp how people order visual elements towards entire form and

apply principles of organization for grouping elements. Therefore, the purpose of the theory is to understand how people organize the visual elements to the whole form and use the principles of organizing in this arrangement.

Aesthetic evaluation is an important concept mostly used in areas like architectural design, interior architecture and visual design. This concept also explains whether there are other factors influencing perception, including attention, focus, motivation, etc. People instinctively perceive physical surroundings through the coordination of their eyes with their brain, thus translating it into aesthetic judgments (Uzunoglu & Uzunoglu, 2011). Design's underpinning is supposed to be composed of dots, which being combined into lines, textures and volumes constitute the basis (Lang, 1987). Therefore, this primary design theory stems from the Gestalt perception theory.

As underscored by the Bauhaus masters, aesthetics in architecture are characterized by the laws of formation of architectural forms and propositions of their elements (Lang, 1984). There are certain compositional occurrences that follow definite organizational principles, and these basic geometric elements form the foundation. Architectural experience is mainly formed by the physical form, shape, or structure of an environment (Weber et al., 2002). The aesthetic quality in architecture that developers or interior designers aim to achieve depends on the geometrical arrangement of elements as guided by Gestalt theory (Lang, 1994).

In essence, individual do not perceive their physical environments randomly; they apply Gestalt principles when organizing elements (Uzunoglu & Uzunoglu, 2011). Formal aesthetics are related to shape proportions rhythms scale complexity color

and lighting both in built and natural environments (Lang, 1987). When following Gestalt law/forms such good forms although it does not mean beautiful because Gestalt theory does not equate 'good' with 'beautiful' (Lang, 1994).

In addition, Arnheim (1954) further describes the Gestalt approach of architectural forms which reveals that these forms can be looked into through symmetry, size, quantity and spatial arrangement. Although perception is a cognitive process consisting of different complex parts, and Gestalt theory may not be the only basis for perception, it is still an influential element in organizing the elements together to create a physical environment (Lang, 1987). Furthermore Kim and Penn (2004) analyzed how people move through and interpret built environments depending on their spatial configuration of architectural elements. These studies emphasize the significance of this theory not only in aesthetics perception but also for practical purposes in architecture and design. However, perception is a mental activity with many different levels. Therefore, while Gestalt theory may not necessarily underpin our entire understanding of human perception, it is integrally related to the ways by which elements are arranged to create a given physical environment (Lang, 1987).

CHAPTER III

COGNITIVE STYLES AND EYE TRACKING

3.1. Cognitive Styles

The cognitive function of the human brain makes it skillful in handling visual information. Complexity is associated with vision thereby making it a significant aspect in cognitive processing (Q. Guo & Chen, 2023). The cognitive process is related to people's focus on things, works of art, or their physical surroundings (Solso, 1996). Experimental studies on aesthetic experiences focus on the properties of items and how participants perceive them, the stimulus's arousal-pleasure relationships, and the variations among individuals. This approach of thinking demonstrates that experimental aestheticians consider not just the content of works of art, but also why and how subjects are incorporated into aesthetic approaches. Human beings take in objects and their physical environment primarily through their senses, and then carry the situations that concern them to their brain and encode them consciously or unconsciously. Therefore, perception, cognition and emotion interact dynamically to form aesthetic experience (Arnheim, 1954). In early studies in the

field of aesthetics, the properties of stimuli were mainly defined. Nowadays, aesthetics is investigated through a multi-dimensional evaluation process by associating it with the cognitive process. For this reason, it has been revealed that not only features of the stimulus, but also psychophysiological features of individuals are effective in aesthetic evaluations (Leder et al., 2004). Cognition is defined as brain's ability to acquire, process, store, and retrieve information (Khera & Rangasamy, 2021), in other words, it is acquisition of knowledge. In a different way, cognition is essentially the acquisition of knowledge. Alternatively, cognition is essentially the acquisition of knowledge, but this acquired knowledge requires a process that employs more than one cognitive skill.

Cognitive style in visual perception refers to the characteristic ways in which individuals conceptually organize the physical environment. Visual perception serves as a crucial discriminating factor between Field Dependent and Field Independent people. The most important difference between Field Dependent and Field Independent people is their visual perception (Witkin, 1950). The perceptual processing of visual stimuli significantly influences the pattern recognition abilities of these two types of learners (Farmaki et al., 2019). Field Dependent individuals tend to rely heavily on the overall visual structure of a stimulus, making it difficult for them to distinguish embedded elements from their contextual surroundings. In contrast, Field Independent people exhibit a high capacity to dissect complex visual figures and distinguish different parts more easily (Zhang, 2004). Field Dependent people need more time to identify the simple geometric figures within the embedded complex figure, and they have more difficulty distinguishing the relevant and irrelevant information than Field Independent people (Arthur & Day, 1991;

Goodenough et al., 1987). Moreover, it is more difficult for Field Dependent individuals to distinguish the received information from its contextual surroundings, and they are more influenced by external cues. In contrast to all things, Field Independent people prefer internal cues and are more selective in obtaining information (Guisande et al., 2007; Riding & Cheema, 1991; Zhang, 2004). Field Dependent people have difficulty perceiving a 'part' as separate from a complex 'whole' (Goodenough et al., 1987). Several assessment instruments have been developed to measure the construct of Field Dependence/Independence, such as the Hidden Figure Test, Embedded Figures Test and the Group Embedded Figures Test. These tools shed light on an individual's cognitive processing style and perceptual tendencies by assessing the individual's tendency toward Field Dependence or Independence (Kozhevnikov, 2007). Through tasks that require participants to identify embedded figures within complex visual stimuli, such assessments provide valuable information about individuals' cognitive functioning and their capacity to discriminate details amid contextual complexity.

3.2. Eye Tracking

Our nervous system has a set of special sensory system which is called sight, hearing, taste, smell and touch, to perceive the environment, but the most significant data for perceiving the environment are gathered from the eyes (Nayak & Karmakar, 2018). Cognitive style in visual perception also refers to the characteristic ways in which individuals conceptually organize the physical environment. The attractiveness of stimuli guides visual perception, influencing how people look at and react to visual content. The aesthetic appeal of objects, artworks or designs often

influences one's aesthetic experience (Nayak & Karmakar, 2019). For observing and analyzing human behavior, cognitive processes and their interactions with technology in a methodical and structured way, researchers often use eye-tracking devices integrated into Human-Computer Interaction systems in their cognitive research (Nayak & Karmakar, 2018; E. Nisiforou & Laghos, 2016; G. E. Raptis et al., 2016). In fact, eye-tracking research offers important insights into how people process and interact with visual information, which can help us better understand how the subconscious brain responds to visual stimuli (Nayak & Karmakar, 2019; E. A. Nisiforou et al., 2014). The cognitive and semantic components of a stimulus are crucial for the perception of images and scenes and eye tracking is used to examine the underlying cognitive processes of participants when they engage in visual interactions (S. H. Kim et al., 2012; E. Nisiforou & Laghos, 2016). Fixations are moments when the eyes remain relatively still, focusing on a specific area of interest within the field of view. The brain processes and perceives visual data during fixations (Mahanama et al., 2022). Through this process, humans are able to access extensive details about objects, textures and spatial relationships in their environment (Tatler, 2007). The fixation count refers to how often these intervals of relatively stable eyes occur over a period of time, while fixation duration reflects how long the eyes remain still in a given area (Chuang et al., 2023). A higher fixation count indicates that the person is focusing on multiple areas of interest or receiving more complex visual information from the scene (Forster et al., 2015; Noton & Stark, 1971). On the other hand, the amount of time the eyes remain still during each fixation is measured by fixation duration. Longer fixation durations indicate that the person is intently focused on the visual stimulus, possibly immersed in minute details or processing complex data (Privitera & Stark, 2000). Several studies have

investigated the association between eye tracking metrics and cognitive styles, particularly Field Dependent and Field Independent. Research findings suggest that as the complexity of the structure increased, Field Dependent people exhibited longer and more random eye movements compared to Field Independent people. The scan paths of Field Dependent people in medium and high complexity stimuli appeared disorientated and disorganized, in contrast to the more regular and directed scan paths of Field Independent people (Conklin et al., 1968; E. A. Nisiforou et al., 2014). Furthermore, the scan paths of Field Independent people revealed more focused eye movement behavior, characterized by fewer fixations, shorter total viewing time and longer fixation durations compared to Field Dependent people (E. Nisiforou & Laghos, 2016; G. Raptis et al., 2017, 2018).

Visual search experiments have consistently shown that eye movements are affected by the complexity of stimuli. Based on the findings from empirical aesthetics, higher number of fixations (Chassy et al., 2015; Y. Guo & Hall, 2009), higher trial duration (Brieber et al., 2018; Q. Wang et al., 2014) and lower fixation duration (Goldberg, 2012; Ishrat & Abrol, 2020; Marin & Leder, 2022) were reported in participants' eye movement data when exposed to a high complexity stimuli. Fixation duration, number of fixations and total viewing time are the three main eye metrics associated with aesthetic ratings (Y. Wang et al., 2023). More specifically, higher aesthetic ratings are consistently associated with longer fixation durations and fewer fixations (Marin & Leder, 2022). This means that people give longer attention spans and less focus to visually appealing stimuli, indicating a deeper level of engagement and appreciation for the aesthetic qualities of stimuli. Eye movements are influenced by mental processes as well as characteristics of the visual environment. People

perceive information about their physical environment spontaneously and use the co-operation of the eye and brain to transform it into a result based on aesthetic evaluation (Hasse & Weber, 2012; S. Lee et al., 2015).

Although, aesthetic evaluation is a complex cognitive process and it is associated with visual tendency (Arnheim, 1954). Therefore, eye movements are an integral and essential part of visual perception (E. Nisiforou & Laghos, 2016). For this reason, eye-tracking systems are used to explore the eye movement behaviors of people along with subconscious brain activity (Nayak & Karmakar, 2018). Berlyne (1971) classified visual research under two categories: Diverse Exploration and Specific Exploration. While individuals' random visual search behaviors are associated with Diverse Exploration, behaviors that focus on the images to obtain information are related to Specific Exploration. Moreover, it was concluded that in people's initial exploration of the visual, the first saccadic eye movements were long and fixation times were short. Diverse exploration followed specific exploration after a few seconds. Accordingly, longer fixation times with short saccadic eye movement occurred. In terms of the aesthetic experience study, eye tracking systems are used to analyze the liking/appreciation of the work of art (Kuchinke et al., 2009), the effect of stimuli complexity on aesthetic evaluations (Ball et al., 2018) and process of the bottom-up or top-down processing, which are the basis of art (Massaro et al., 2012). As a result of the studies, it was emphasized that higher processing fluency has a relationship with increased pupil dilation. The empirical data of aesthetic studies are based on behavioral (i.e., liking) and psychophysiological (i.e., pupil size) data of people and comprehensive aesthetic evaluation results have been reached by including the hedonic responses of people (Ho & Lu, 2014; Kuchinke et al., 2009).

In a study, in which three groups of cubist picture images were used, the identification time in the image by the participants was examined by using explicit classification, and people evaluated these pictures in terms of complexity, abstractness, and familiarity (Kuchinke et al., 2009). According to the results, less abstract pictures with higher processing fluency were more preferences by people and they had higher pupil size. However, no statistically significant conclusion could be drawn between the assessments of pupil dilatation, complexity, and similarity. This study was repeated using expressive images (Elschner et al., 2018). According to the results of the study, there was an inverse proportional relation between the pupil dilatation of people and the complexity level of the images, which led to an inference that as the pupil width increases, the abstraction decreases. However, there is no statistical relationship between the evaluation of preferred images and pupil dilatation. As a result of the repeated study, no results could be obtained to support that pupil dilatation of people is associated with processing fluency and aesthetic evaluation. The geometric shape of the physical environment is the main design subject of architects, interior and landscape architects.

Architectural works are intricate physical constructs that exist in both two and three dimensions. In recent years, eye-tracking systems have been utilized to analyze the perceptual evaluations of physical spaces (Colaço & Acartürk, 2018; De Cock et al., 2019; Evans et al., 2012; S. Lee et al., 2015; Liu et al., 2020; Tuszyńska-Bogucka et al., 2020; Viaene et al., 2016; Weber et al., 2002), the impact of three-dimensional environments on preference (S. Lee et al., 2015), the influence of environmental complexity on aesthetic evaluations (Rosas et al., 2023), and the effect of façade compositions on aesthetic judgment (Hasse & Weber, 2012). In the study, the

presence or absence of windows, the size of the windows, natural daylight intake and landscape variables as architectural design features were used to create positive and negative virtual environments (Zou, 2019). The study used objective evaluations to understand how architectural features impact users in the physical environment. In this context, heat maps, time spent, fixation time, and time to the first fixation was measured using eye-tracking systems. In the experimental phase, users were exposed to navigational and informative tasks. It was concluded that individuals exposed to studies in positive virtual environments focus more on spatial elements and remember more words. In another study, three-dimensional interior models and two-dimensional interior photographs were used to examine how differences in displaying the physical environment affected individuals' perception of areas (Weber et al., 2002). While non-architect participants focused more on spatial details in areas designed with the same composition and exhibited both in two and three dimensions. In contrast, the participants who were architects focused more on spatial arrangements. Another study (S. Lee et al., 2015), which was carried out by taking the research approach of the study of Weber et al. (2002), it was examined what kind of differences the formal features of architectural elements caused in the gaze pattern of the participants. According to the research results, while the architect participants mainly focused on the three-dimensional architectural elements, the non-architect participants mainly focused on the two-dimensional architectural elements. In addition, they found that the effect of participants' perceptions of architectural elements on aesthetic evaluation corresponded to Gestalt principles (S. Lee et al., 2015). Another study in which eye-tracking systems were used in architectural perception studies investigated how architectural drawings were perceived by participants with different educational backgrounds (Colaço & Acartürk, 2018).

According to the results, participants who did not receive architectural education had longer fixation and total gaze time than participants who received an architectural education. The next chapter contains the method, results, and discussion sections of Study I.



CHAPTER IV

STUDY I

4.1. Method

In the first study, we designed a set of stimuli consisting of the organization of geometric shapes to understand the participants' aesthetic evaluations and their relationship with the Gestalt principle of similarity, and to test the differences according to the participants' cognitive styles. This chapter presents research questions, hypotheses, and methods followed to seek answers and assess our assumptions.

4.1.1. Research Questions

The first study consists solely of research questions, laying the groundwork for the second study. Its goal is to identify and clarify important factors and connections that will be addressed in subsequent stages. This initial phase allows for a detailed examination of key ideas by focusing exclusively on the research topics. Previous

literature indicates that differences in Gestalt similarity principles, based on shape and color, influence participants' evaluations of stimuli. However, how these differences interact with complexity theory and participants' cognitive styles remains to be investigated.

In this context, the research questions of the first study involve manipulating Gestalt similarity principles through shape and color differences and examining the resulting changes in stimulus complexity. This approach aids in understanding the effects on participants' subjective and objective aesthetic evaluations, as well as whether these evaluations vary according to cognitive styles. By defining and focusing the research questions, the first study establishes a solid framework for the exploratory and empirical work in the second main study.

Research Question 1: How do participants' aesthetic evaluations of geometric compositions differ with respect to the Gestalt similarity principle based on color and shape differences?

Research Question 2: What are the differences in cognitive styles on participants' aesthetic evaluations of geometric compositions?

Research Question 3: How are the levels of complexity in geometric compositions related to participants' aesthetic evaluations?

Research Question 4: What are the differences in eye metrics among participants based on their cognitive styles in response to stimuli?

4.1.2. Participants

The study comprised a total of 39 individuals (22 female, 17 male; $M_{\text{age}} = 29.30$, $SD_{\text{age}} = 3.60$, range: 26–33 years). The participants hold various undergraduate degrees, such as engineering, business, and law. Out of the initial pool, ten participants were eliminated from the study owing to unstable eye movements. All individuals included in the analysis possessed normal or corrected-to-normal eyesight. The study adheres to the ethical guidelines outlined in the Declaration of Helsinki, as well as the ethical norms of both the University of Vienna and Bilkent University (see Appendix A).

4.1.3. Visual Stimuli

The instruments were prepared by two architects with advanced degrees in architecture. The study focused on a specific Gestalt principle, similarity, which was chosen for manipulation in a 2-dimensional geometric organization. Research has shown that color can impact our cognitive processes, emotions, and actions, as well as our preferences for aesthetic tastes (Elliot & Maier, 2014; Schloss & Palmer, 2011). Hence, to reduce the potential influence of color and individual preference (Acking & Kuller, 1972), the stimuli were generated in black and white.

Once the initial images for the study were generated, a group of 15 architects, acting as experts, evaluated the levels of complexity in 48 altered geometric organization drawings. The drawings were evenly divided: 24 manipulated based on the similarity principle using color difference for Set 1, and the remaining 24 manipulated based on the similarity principle using shape difference for Set 2. The architects assessed the

complexity of each drawing using a 7-point Likert scale featuring bipolar descriptors, ranging from ‘simple’ to ‘complex’.

After analyzing the ratings, the complexity rating distributions for each drawing were assessed. Twenty drawings that did not have a normal distribution were excluded from the main study. In the first study, as shown in Figures 3 and Figure 4, a total of 24 geometric organizational designs were utilized. Out of these, 12 drawings were modified based on the similarity principle using color difference for Set 1, while the other 12 were modified based on the similarity principle using shape difference for Set 2 (see Appendix B). The drawings in both sets were categorized into three subgroups based on the average complexity ratings: low complexity (images with average ratings of 1 to 4), medium complexity (images with average ratings of 5 to 8), and high complexity (images with average ratings of 9 to 12).

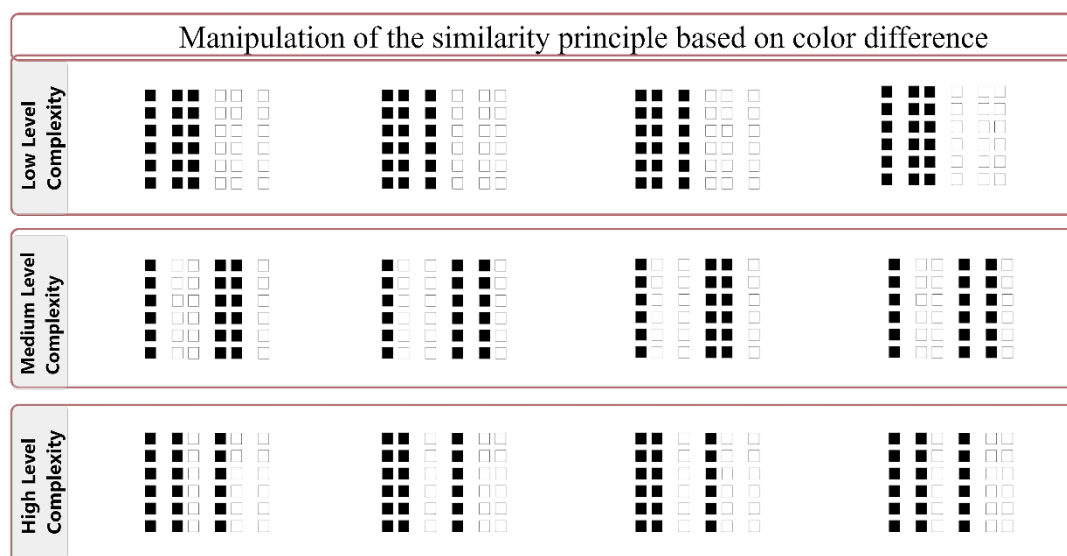


Figure 3. Drawings manipulated according to the similarity principle based on color differences in Study I

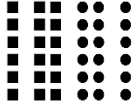
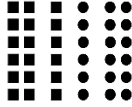
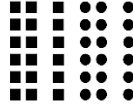
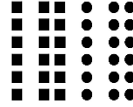
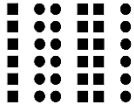
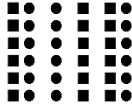
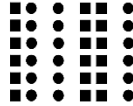
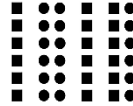
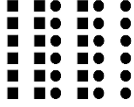
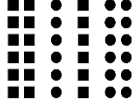
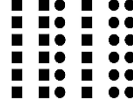
Manipulation of the similarity principle based on shape difference				
Low Level Complexity				
Medium Level Complexity				
High Level Complexity				

Figure 4. Drawings manipulated according to the similarity principle based on shape differences in Study I

Below are some concepts related to Gestalt theory that will be covered under Study 1, as shown in Figure 5.

(i) **Similarity Principle Based on Color Difference:** Items with the same or similar color are perceived as grouped together. This can be observed in how quickly we group items that share the same color in a given stimulus (Quinlan & Wilton, 1998). In the present study, this principle was modified according to differences in colors of squares, as shown in Figure 5. Consequently, greater differences in color, such as black and white, resulted in increased complexity levels of stimuli, as shown in Figure 3.

(ii) **Similarity Principle Based on Shape Difference:** Shapes that are similar in form are naturally grouped together in visual perception. This can be observed in patterns where objects of similar shapes are perceived as a collective unit (Quinlan &

Wilton, 1998). In this study, this principle has been changed according to the shape differences of geometric forms, as shown in Figure 4. Consequently, greater differences in shapes, such as square and circle, resulted in increased complexity levels of stimuli, as shown in Figure 5.

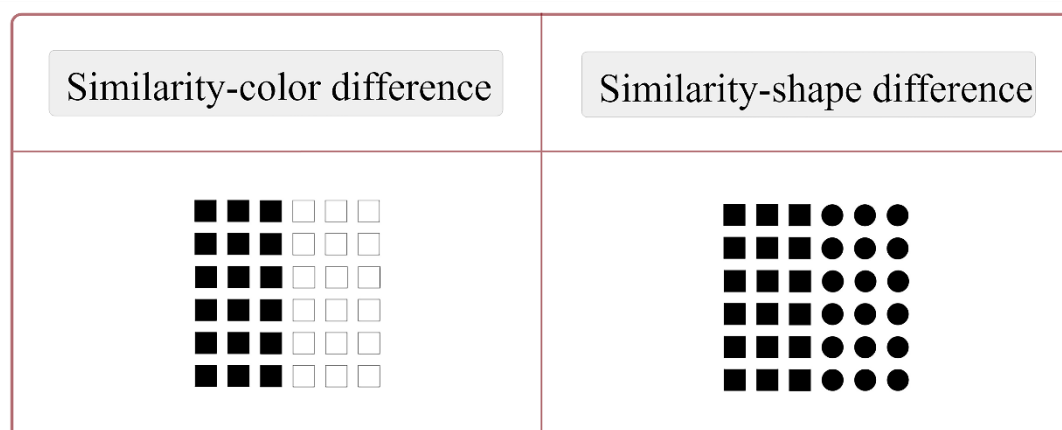


Figure 5. Illustrations of Gestalt principles of similarity based on color and shape differences in Study I

4.1.4. Hidden Figure Test

Participants' cognitive styles were measured using the Hidden Figures Test (Ekstrom et al., 1976), which classifies them as Field Dependent, Field Neutral and Field Independent (see Appendix C). The Hidden Figure Test is a psychometric instrument that measures an individual's degree of cognitive styles (E. Nisiforou & Laghos, 2016). In this test, participants are required to identify one of five basic figures that are embedded within a more intricate pattern. It consists of 32 questions divided equally into two parts, each of which has a length of 12 minutes, with scores ranging from 1 to 31 (max = 32 points). The Hidden Figure Test score was determined by minus the total number of correct answers from the total number of incorrect

responses, as per the instructions provided in the test manual. Participants scoring 10 or less were defined as Field Dependent, those scoring 11-17 as Field Neutral, and those scoring 18-31 as Field Independent.

4.1.5. Questionnaire

The survey data had two parts. The first part consisted of a 7-point Likert scale bipolar adjective question, ‘simple-complex,’ which was formulated to assess the participants’ perceived level of complexity for each item. The perceived complexity ratings were utilized to confirm that participants accurately recognized the altered level of complexity in these drawings (see Results sections). In the second part, the participants assessed each stimulus using 7-point Likert scales. They rated the stimuli based on the following pairs of contrasting adjectives: unpleasant-pleasant, distressing-relaxing, meaningless-meaningful, chaotic-coherent, commonplace-novel, and unclear-clear (see Figure 6). The survey questions were designed based on prior research conducted by Devlin and Nasar (1989) and Wagemans et al. (2012). The average of the participants’ responses was used as the aesthetic ratings in the study.

Please mark your judgement elicited by related space on scale.

How easy was the perception of the presented stimulus?

	-3	-2	-1	0	1	2	3	
Difficult								Easy

Please mark your aesthetic judgement elicited by related space on each scale.

Affective Ratings	-3	-2	-1	0	1	2	3	
Unpleasant								Pleasant
Distressing								Relaxing
Meaningless								Meaningful
Interpretive Ratings	-3	-2	-1	0	1	2	3	
Simple								Complex
Chaotic								Coherent
Commonplace								Novel
Ambiguous								Clear

Figure 6. The questionnaire of the studies

4.1.6. Measures and Procedure

The experiment took place at the Research Focus Empirical Visual Aesthetics Lab at the University of Vienna. Gaze data was gathered when individuals were exposed to the stimuli. The eye movements of each participant were recorded using an eye tracker (EyeLink 1000; SR-Research Ltd., Mississauga, Ontario, Canada) at a sampling rate of 250 samples per second for one eye. The stimuli were presented on a 22-inch screen with a resolution of 1028x1024. The participants were situated at a distance of 60 centimeters from the screen. To avoid head movement, a chin and

forehead rest were utilized to provide support for the head. There were no temporal constraints imposed during the course of the experiment. The study phases are outlined in the following manner (see Figure 7).

- (i) We gave the participants printed Hidden Figure Test questions as the first stage of the experiments. During this time, they were alone in the room and could keep track of their remaining time with a stopwatch. As mentioned above, participants who were Field Dependent and Field Independent continued with the rest of the study, while participants who were Field Neutral did not proceed to the next phases.
- (ii) The dominant eye of the participant was determined, and calibration of the eyes was conducted.
- (iii) The fixation point served as a central point to aid in eye calibration for each image. Participants focused their gaze on the fixation point before each modified stimulus and obtained visual perception of the visuals on the screen by fixating on this point.
- (iv) Participants performed four preliminary trials to become familiar with the task.
- (v) Upon completion of the trial tests, participants were automatically redirected to the main study. Participants had the freedom to independently examine the stimuli displayed on the screen, while their eye movements were monitored

and recorded. Once they felt prepared, they were instructed to press any key on the keyboard to access the questionnaire associated with the displayed stimulus. The participants responded to the questionnaire in the survey using verbal responses, and no data was collected on their eye movements during this task.

- (vi) Following their explicit responses to the questions on the modified stimuli, participants proceeded by pressing any key on the keyboard to view the subsequent stimulus, which had a fixation point on the screen. The stimuli were arranged in a random order using the EyeLink 1000 Experiment Builder (see Figure 8).

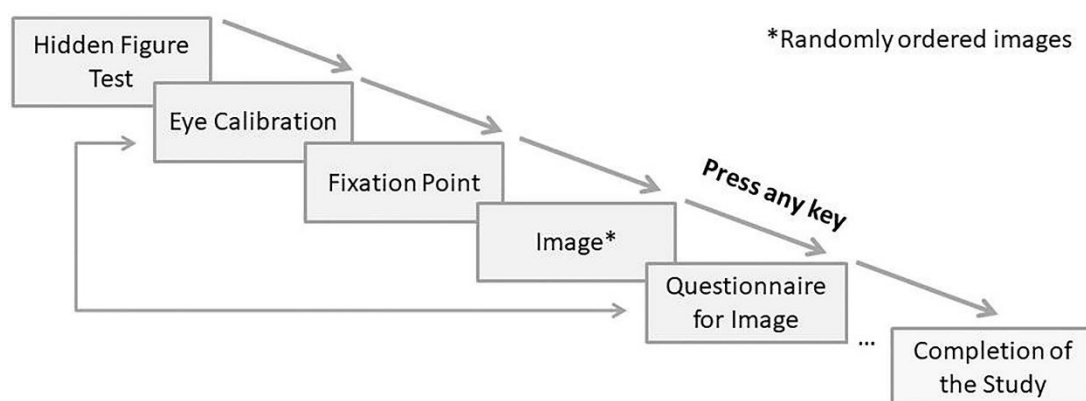


Figure 7. The procedure for collecting data

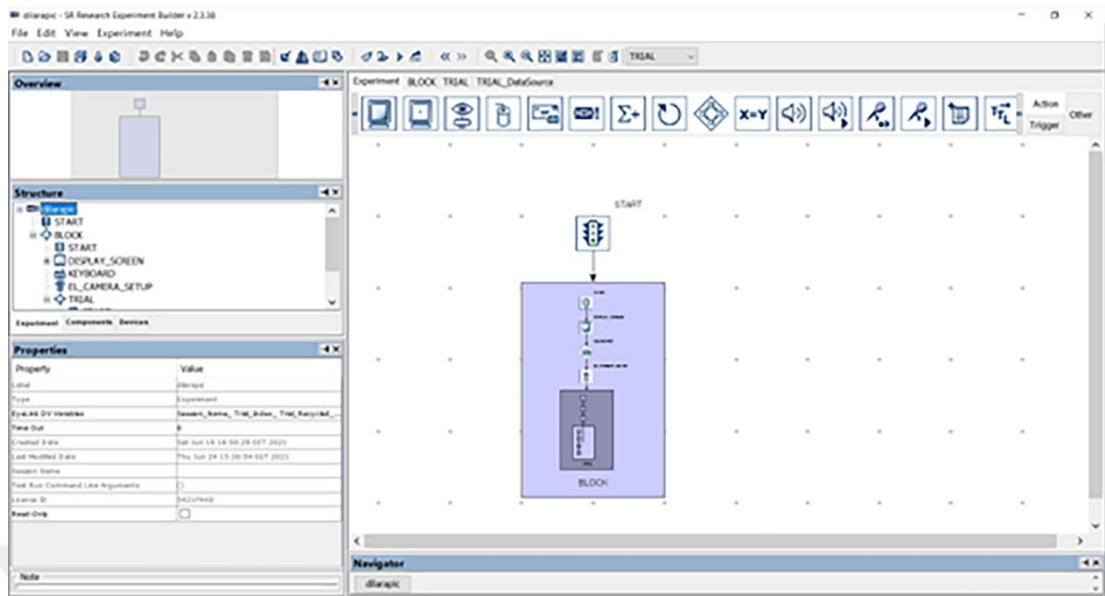


Figure 8. The experiment builder of EyeLink

4.2. Results

This chapter will describe the results of the analysis of the Study I in a systematic order.

4.2.1. Validation of Complexity Levels

As mentioned above, an analysis was carried out to explore whether the complexity manipulated by the experts was valid in relation to the perceived complexity of the participants. We found a positive correlation between manipulated complexity ratings and participants' perceived complexity ratings. There were highly significant correlations for both geometrical organizations manipulated with the similarity principle based on color difference and shape difference, $r = 0.90, p < .001$ and $r = 0.91, p < .001$, respectively. Thus, stimuli were generally perceived as manipulated

in terms of complexity. As we've already mentioned, the geometrical organizational stimuli were then sorted according to the average complexity ratings and grouped into three complexity levels: low complexity (consisting of images with average ratings of 1 to 4), medium complexity (consisting of images with average ratings of 5 to 8), and high complexity (consisting of images with average ratings of 9 to 12). The categorization process was carried out separately for the drawings manipulated according to the similarity principles based on color and shape differences. In the subsequent analyses of the study, the complexity was included in the study as low, medium and high.

4.2.2. Gestalt Principles and Cognitive Styles on Aesthetic Evaluation

As mentioned earlier, the questionnaire was used to examine participants' aesthetic evaluations of geometrical organization drawings. In line with our Research Question 1 (i.e., how do participants' aesthetic evaluations of geometric compositions differ with respect to the Gestalt similarity principle based on color and shape differences), we examined the effects of Gestalt principles on participants' aesthetic evaluation, and a paired samples t-test was conducted. There was a significant difference between participants' aesthetic evaluation ratings for the stimuli manipulated by Gestalt similarity principle based on color differences ($M = 4.30$, $SD = .44$) and the Gestalt similarity principle based on shape differences ($M = 4.54$, $SD = .37$); $t(38) = 2.73$, $p = .010$).

In line with our Research Question 2 (i.e., what are the differences in cognitive styles on participants' aesthetic evaluations of geometric compositions), we examined the effects of cognitive styles on participants' aesthetic evaluation ratings and an

independent samples t-test was conducted. There was no significant difference in the aesthetic evaluation ratings of Field Dependent participants ($M = 4.38$, $SD = .35$) and Field Independent participants ($M = 4.46$, $SD = .25$) for the stimuli conditions, $t(37) = -.82$, $p = .415$). In more detail, we conducted a one-way Repeated Measures ANOVA to compare the effects of Gestalt principles (2 levels) on aesthetic evaluations between Field Dependent and Field Independent participants. The results showed a significant difference between the groups ($F(1,37) = 5.28$, $p = .027$, $\eta p^2 = .13$). A post-hoc pairwise comparison with a Bonferroni adjustment indicated that Field Dependent participants' aesthetic evaluation ratings ($M = 4.40$, $SD = .37$) were lower than those of Field Independent participants ($M = 4.67$, $SD = .33$) for condition stimuli designed with the manipulation of the similarity principle based on shape differences. However, we did not observe a significant difference between the groups for stimuli designed with the manipulation of the similarity principle based on color differences ($p = .431$), as shown in Figure 9.

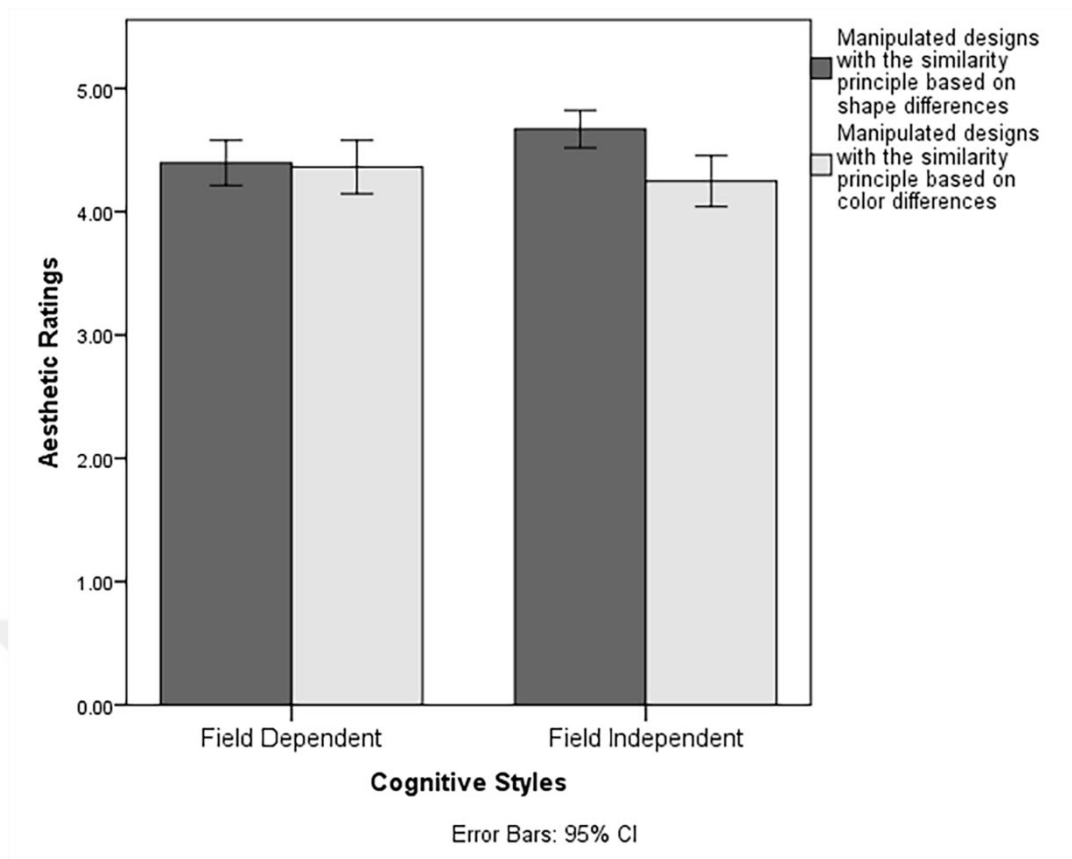


Figure 9. The interaction of Gestalt principles and cognitive styles on participants' aesthetic ratings

4.2.3. Complexity, Gestalt Principles and Cognitive Styles on Aesthetic Evaluation

In line with our Research Question 3 (i.e., how are the levels of complexity in geometric compositions related to participants' aesthetic evaluations), we conducted a one-way Repeated Measures ANOVA to examine the effects of the level of complexity (3 levels) on participants' aesthetic evaluation ratings. There was a significant main effect of level of complexity on participants' aesthetic ratings ($F(2, 76) = 14.88, p < .001, \eta p^2 = .281$). A post-hoc pairwise comparison with a Bonferroni adjustment indicated that the medium complexity stimuli ($M = 4.25.97, SD = .05$) received lower aesthetic ratings than the low ($M = 4.56, SD = .05$) and high complexity stimuli ($M = 4.46, SD = .07$). There was a U-shaped relationship between

participants' aesthetic ratings and complexity levels. In more detail, we conducted a two-way Repeated Measures ANOVA to compare the effects of Gestalt principles (2 levels) and levels of complexity (3 levels) on aesthetic evaluations across Field Dependent and Field Independent subject groups. The results showed a significant difference between the groups ($F(2,74) = 13.84, p = .000, \eta p^2 = .27$). A post-hoc pairwise comparison with a Bonferroni adjustment indicated that Field Dependent participants' aesthetic evaluation ratings ($M = 4.40, SD = .08$) were lower than those of Field Independent participants ($M = 4.46, SD = .136$) for condition stimuli designed with the manipulation of the similarity principle based on shape differences at low levels of complexity (see Figure 10).

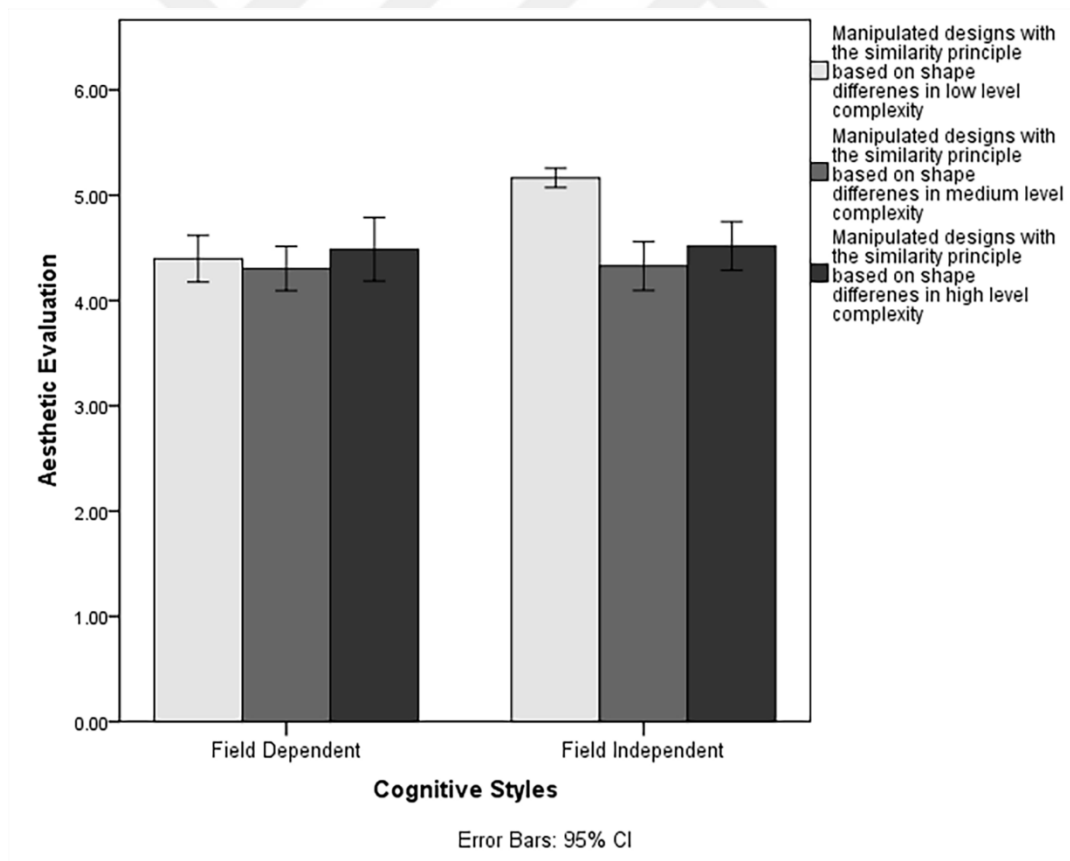


Figure 10. The interaction of Gestalt principles, cognitive styles and complexity levels on participants' aesthetic ratings

4.2.4. Gestalt Principles and Cognitive Styles on Eye Movements

In line with our Research Question 4 (i.e., what are the differences in eye metrics among participants based on their cognitive styles in response to stimuli), we examined the effects of cognitive styles on participants' eye metrics, independent samples t-tests were conducted. There was no significant difference in the fixation counts of Field Dependent participants ($M = 13.76$, $SD = 4.73$) and Field Independent participants ($M = 12.04$, $SD = 4.15$) for the stimuli conditions, $t(37) = 1.21$, $p = .234$. There was no significant difference in the fixation durations of Field Dependent participants ($M = 290.67$, $SD = 49.37$) and Field Independent participants ($M = 320.40$, $SD = 119.90$) for the stimuli; $t(37) = -.99$, $p = .331$. Moreover, there was no significant difference in the viewing duration of Field Dependent participants ($M = 4290.82$, $SD = 1643.65$) and Field Independent participants ($M = 3898.76$, $SD = 1519.56$) for the stimuli; $t(37) = .77$, $p = .444$. Furthermore, we conducted a one-way Repeated Measures ANOVA to compare the effects of Gestalt principles (2 levels) on eye metrics across Field Dependent and Field Independent participants. For stimuli designed with the manipulation of the similarity principles based on shape differences, the results showed a statistically significant difference in fixation count ($F(1,37) = 3.02$, $p = .003$, $\eta p^2 = .14$), average fixation duration ($F(1,37) = 3.60$, $p < .001$, $\eta p^2 = .13$) and viewing duration ($F(1,37) = 2.03$, $p = .042$, $\eta p^2 = .13$) between Field Dependent and Field Independent participants. A post-hoc pairwise comparison with a Bonferroni adjustment indicated a significant difference in the fixation counts between Field Dependent participants ($M = 13.76$, $SD = 7.01$) and Field Independent participants ($M = 12.04$, $SD = 9.89$) for stimuli designed with the manipulation of the similarity principles based on shape differences. The results also indicated a significant difference in the fixation duration between Field Dependent participants

($M = 263.48$, $SD = 153.26$) and Field Independent participants ($M = 306.24$, $SD = 209.33$) for stimuli designed with the manipulation of the similarity principles based on shape differences. Moreover, the results indicated a significant difference in the viewing duration of Field Dependent participants ($M = 4290.82$, $SD = 2390.12$) and Field Independent participants ($M = 3898.75$, $SD = 3339.88$) for stimuli designed with the manipulation of the similarity principles based on shape differences. However, there was no significant difference in fixation counts, average fixation duration, and viewing duration between Field Dependent and Field Independent participants for stimuli designed with the manipulation of the similarity principles based on color differences, $t(37) = -.82$, $p = .415$.

4.3. Discussion

The first study set out to explore the delicate relationships between manipulated complexity, perceived complexity, and aesthetic evaluations within the frameworks of Gestalt principles and cognitive styles. By presenting geometrical organization stimuli where similarity principles have been used based on color and shape manipulations; while also taking into account cognitive styles (Field Dependent vs Field Independent), this investigation presents a detailed analysis on how these variables interact with one another in terms of their influence on complexity perception, cognitive processing and aesthetic evaluation.

4.3.1. Complexity and Aesthetic Evaluations

Complexity can be defined in terms its components such as number of elements involved, their arrangement pattern or presence contrasting features among others (Osborne & Farley, 1970; Pieters et al., 2007). In our study, we varied geometric

organization through similarity principles with the manipulations of color and shape differences which are known to affect significantly how people perceive complexity visually (Wagemans et al., 2012). The significant positive relationship between manipulated and perceived complexity found in our study suggests that manipulations were perceived as expected. This suggests that these visual properties effectively elicited participants' perceptions, thereby implying the reliability of such controls in aesthetic research (Berlyne, 1971). This is because participants recognized the intended levels of intricacy consistently throughout different trials, showing the precision with which they were designed for this experiment to produce the desired effects. By categorizing stimuli into low, medium, and high levels, researchers were able to systematically examine the effects of different levels of complexity on aesthetic judgments. This step recognizes that complexity is not a homogeneous concept, but can take many forms and influence both cognitive processing and emotional responses (Berlyne, 1971). Thus, this categorization allowed the study to examine how different levels of complexity affect aesthetic evaluation, thereby providing a deeper understanding of the role complexity plays in shaping perceptions and evaluations. The findings are consistent with other literature suggesting that individuals tend to use their cognitive capacities along with sensory abilities when encountering complexities (Leder et al., 2004; Reber et al., 2004). The fact that people were able to perceive different levels of detail demonstrates the effectiveness of visual manipulation based on Gestalt principles.

The first study found a U-shaped relationship between complexity and aesthetic ratings; low as well high complexity objects were rated higher than those with medium levels. Berlyne's (1971) theory argues that moderate amounts are preferred because they provide an optimum level of arousal resulting from balancing novelty

against familiarity. However, this finding deviates from the predictions given by Berlyne who stated that most people would like things which have neither extreme too little nor too much intricacy since such items will be both interesting due their newness but at same time easy understand owing previous exposure. The current results indicate that very simple designs may also attract attention while more complicated ones can foster appreciation provided these are correctly organized or represented in mind (Kaplan et al., 1972; Imamoglu, 2000). One possible reason why subjects gave higher marks for low and high complex stimuli is fluency during processing. According to the Hedonic Fluency Model proposed by Reber et al. (2004), people tend to prefer objects that can be easily processed i.e., simple things or those which even though being intricate come with greater organization or structure. In other words, aesthetic liking depends largely on how easy it is for our minds to work with them. This ease of mental activity leads us to find such items more beautiful than we would if they required much cognitive effort to decipher (Reber et al., 1998, 2004; Winkielman et al., 2003). Due to their simplicity and the minimal demand placed on working memory resources at any given moment, information may need to be stored only temporarily until accessed later. This allows all relevant data to remain immediately accessible throughout task performance, even when unrelated pieces are stored separately to avoid interference with each other's retrieval process. This minimizes the chances of confusion about what was done earlier while still allowing for the management of new challenges encountered later in the same activity session (Reber et al., 2004). One possible reason for the lower ratings of medium complexity stimuli is that these stimuli may be seen as neither simple enough to be processed fluently nor complex enough to be interesting or rewarding. Thus, there appears to be a point in the spectrum of complexity at which

things can become too hard for us to handle without effort but still not engaging enough (Hekkert, 2006; Hekkert & Schifferstein, 2007). This implies that designers should strive for either very easy environments with lots of simplicity or quite challenging ones with lots of well-organized complicatedness; anything in between might fail to attract attention.

4.3.2. Gestalt Principles and Aesthetic Evaluations

The difference in aesthetic evaluations between stimuli altered by Gestalt similarity principles based on color and shape differences demonstrates how much impact these rules have on aesthetic perception. The idea that people organize visual elements into coherent wholes is a central concept of Gestalt psychology, which provides a strong framework for understanding how individuals see or respond to different visual stimuli (Wagemans et al., 2012). Study I adds to our knowledge that different Gestalt principles can lead to different aesthetic judgments because they represent different approaches to processing and evaluating visual information.

It is particularly significant that Gestalt similarity principles based on shape differences were found to be more aesthetically evaluated than those based on color alone. Shape is one of the fundamental building blocks for visual perception; it affects greatly how we organize and interpret what we see (Arnheim, 1954).

Sometimes shapes are closely related to structural organization among other visual elements, which can affect significantly perceived complexity (S. Palmer & Rock, 1994). Thus, under some circumstances where complex visual displays are involved, this given finding suggests that shape could differ in its impact compared to color

depending on contexts. The results of Study I are consistent with studies indicating that form perception plays a critical role not only in aesthetic preference, but also in perceptual organization itself (Arnheim, 1954; Lang, 1987). For instance, according to Arnheim (1954), an observer's ability to perceive harmony or unity within any work depends mainly upon their awareness of its formal structure while considering beauty standards.

Moreover, this study's emphasis upon shape over color fits within wider debates held by scholars who follow Gestalt psychology regarding which principles should take precedence over others during perceptual organization processes. Certainly, there is no doubt that color contributes greatly to our ability to see things, but it is possible that in situations where shape serves as the primary cue for structural organization and coherence within the perceived objects (S. Palmer & Rock, 1994). Such understanding has important implications for architects and designers since they deal with creating visually pleasing environments through manipulating shapes and forms.

4.3.3. Cognitive Styles and Aesthetic Evaluations

The investigation of cognitive styles conducted by this study highlights significant differences in aesthetic evaluations between Field Dependent and Field Independent participants thus revealing how cognitive style can affect visual perception as well as aesthetic evaluation. Cognitive style refers to a person's habitual or characteristic mode of processing information; it has been described in terms of field dependence and independence whereby field dependent people rely more on external cues

whereas their counterparts tend to be better at separating out details from background context (Goodenough et al., 1987; Witkin, 1950).

The results showing that Field Dependent participants gave lower aesthetic ratings than Field Independent participants when evaluating complexity represented by different shapes suggest that cognitive styles play an important role in determining aesthetic judgments of visual complexity. The inability to discriminate elements from their surroundings is typical of those classified as Field Dependent, so they are likely to have difficulty with the Gestalt similarity principle based on shape difference stimuli, leading to reduced levels of aesthetic appreciation. Previous studies have shown that Field Dependent participants tend towards perceiving overall structures rather than specific parts making it hard for them appreciate finer aspects contained within complex figures (Kozhevnikov, 2007).

On the other hand, people who are Field Independent have a tendency to detach elements from their context. Hence, for them stimuli based on shape may be more interesting and attractive visually. Therefore, it can be said that not only do cognitive styles affect the way people see things, but also how they feel about them emotionally and aesthetically too. Such discoveries add up to an ever-increasing number of readings concerning cognitive styles in terms of aesthetics which implies that the manner in which people think affects what is considered beautiful (Riding & Cheema, 1991; Zhang, 2004).

The lack of significant differences in aesthetic evaluations for Gestalt similarity principles based on color difference stimuli between the two cognitive styles again

highlights how different types of visual information are processed by the mind.

Because it is a direct and less structurally complex attribute, colors may be dealt with in much the same way by either cognitive style thus giving rise to more consistent judgments on beauty (Reber et al., 2004). This discovery corresponds with studies showing that people often perceive color holistically than shape i.e., they find it easier to process variations in its hue or intensity without much mental effort (Wagemans et al., 2012).

This study's distinction in processing different types of visual information demonstrates the complexity of our aesthetic evaluations, considering the cognitive and perceptual elements that interact during such experiences. It implies that there are numerous ways in which aesthetics can occur, depending on which specific visual attributes engage unique sets of brain mechanisms, ultimately leading to judgments about whether something is considered appealing or well-designed according to one's taste (Hekkert & Schifferstein, 2007).

4.3.4. Cognitive Styles and Eye Movements

Eye metrics from the present study have shed light on how cognitive styles influence visual processing. When individuals look at images or objects their gaze moves around different parts so as to take in relevant information – this can be measured using eye-tracking data. The scanning patterns recorded during such activities reflect the amount of mental work invested into them. In particular, Field Dependent participants tend to fixate longer on specific areas than do those who are Field Independent because they rely heavily upon contextual cues while interpreting what

they see. However, no significant differences emerged when total fixation count was compared across groups neither were any observed for average duration or total time spent looking at each stimulus type per group. However, further investigation revealed significant differences in these measures for stimuli designed using the Gestalt similarity principle based on shape differences alone; the numbers were much higher for those classified as Field Dependent than for others. This suggests that stimuli designed using the Gestalt similarity principle based on shape differences require more cognitive effort from Field Dependent participants, who may therefore find them less appealing compared to their counterparts.

These findings are consistent with earlier studies, which found that people with a Field Dependent cognitive style tend to make more random and disorganized eye movements when looking at complex objects (Conklin et al., 1968; E. Nisiforou & Laghos, 2016). Higher fixation counts and longer durations among such individuals suggest that they need additional time to process shape-based information in order for it to make sense; hence leading to lower aesthetic ratings of this type of stimulus. This supports the idea that processing fluency is an important determinant of aesthetic judgment. On the other hand, individuals who tended to separate elements from their immediate environment showed streamlined processing by recording fewer fixations in shorter time intervals. This suggests that they could assess shapes more quickly, thereby enhancing their attractiveness ratings based on visual appeal alone. This discovery aligns with general findings about cognitive styles, where individuals with Field Independent styles tend to give better aesthetic appraisals to complex visuals (Goodenough et al., 1987; Witkin, 1950; Witkin et al., 1975).

The nonexistence of substantial dissimilarities among eye measurements for stimuli designed using Gestalt similarity based on color differences suggests that, in terms of structure, color may not be as demanding cognitively as other visual attributes irrespective of the kind of mind one has. This adds to the suggestion that various kinds of visual information call for different cognitive processes which affect eye movement patterns as well as aesthetic acknowledgments (Leder et al., 2004). Additionally, the immediate and less contextually separable nature of color might lead to it being processed uniformly by individuals categorized as both Field Dependent and Field Independent, resulting in more consistent assessments of aesthetics. This discovery demonstrates the intricacy involved in seeing things visually hence each attribute may interact with cognitive styles differently. In comparison to shape/form which requires much thought processing alongside engaging varied ways through which we perceive things around us; it is possible that color could be perceived in a holistic manner thus leading towards less aesthetic evaluation diversity across diverse cognitive styles. Such an understanding could greatly impact how designers create visuals for different environments given they consider the interaction between various visual characteristics and personal cognitive dispositions in their designs to come up with designs that are not only effective but also pleasing from an aesthetic point of view. The next chapter contains the method, results, and discussion sections of Study II.

CHAPTER V

STUDY II

5.1. Method

In the second study, we designed a set of stimuli consisting of the organization of architectural façades to understand participants' aesthetic evaluations and their relationship with the Gestalt principles of similarity and proximity, and to test the differences according to participants' cognitive styles. This chapter presents the research questions, hypotheses, and methods used to seek answers to these questions and assess our assumptions.

5.1.1. Research Questions and Hypotheses

The influence of visual organization, as understood through Gestalt principles, on aesthetic assessment has not yet been explored from an architectural perspective, as observed from the research cited above. This gap in the literature is recognized. From an aesthetic perspective, complexity is a quality that needs to be controlled

(Von Meiss, 1989), which means that more complex structures need to be created in a more organized way (Arnheim, 1977). Architectural organizations and people's aesthetic assessments have, for the most part, been researched in connection with compositions that exhibit varying degrees of complexity (Devlin & Nasar, 1989; Ghomeshi & Jusan, 2013; Hasse & Weber, 2012; Imamoglu, 2000; S. Kaplan et al., 1972). The relationship between complexity levels and organizational Gestalt principles in architecture research and their impact on objective assessment remains unknown. In the early studies conducted in the field of aesthetics, stimulus properties were mainly defined (Fechner, 1876). However, today, aesthetic experience is investigated in a multidimensional evaluation process by associating it with the cognitive process. For this reason, it has been revealed that not only the characteristics of the stimulus but also the psychophysiological characteristics of individuals are effective in aesthetic evaluation (Leder et al., 2004). As seen in the studies mentioned above, the interaction of complexity levels and cognitive differences on subjective aesthetic evaluations has not yet been investigated from an organizational point of view of Gestalt insight. To address the goal of our study, we put four research questions and hypotheses, which are described in more detail below.

Research Question 1: What are the differences in cognitive styles on participants' aesthetic evaluations of façade compositions?

Hypothesis 1a: We hypothesized that façade compositions designed with the manipulation of the similarity principle would have lower aesthetic ratings than the ones designed with the manipulation of the proximity principle.

Hypothesis 1b: We hypothesized that Field Dependent participants would have lower aesthetic ratings than Field Independent participants.

Research Question 2: How are Gestalt principles and participants' aesthetic evaluations of façade compositions related at different levels of complexity?

Hypothesis 2: We hypothesized that the aesthetic rating of façade compositions would be negatively correlated with their complexity levels.

The research examines the significance of visual fixations in determining visual complexity and aesthetic evaluations (Brieber et al., 2018; Chassy et al., 2015; Goldberg, 2012; Y. Guo & Hall, 2009; Ishrat & Abrol, 2020; Q. Wang et al., 2014). The visual fixation data in those studies are defined by the fixation duration, fixation count and viewing time among other aspects.

Research Question 3: How do the effects of Gestalt principles and levels of complexity influence participants' eye metrics in response to façade compositions?

Hypothesis 3a: We hypothesized that participants would have the lowest fixation duration scores at high complexity levels.

Hypothesis 3b: We hypothesized that participants would have the highest number of fixations at high complexity levels.

Hypothesis 3c: We expected that participants would have the highest total viewing duration scores at high complexity levels.

Research Question 4: What are the differences in eye metrics among participants with different cognitive styles in response to façade compositions?

To address our aims and test our hypotheses, we investigated participants' aesthetic evaluations and gaze metrics in response to façade compositions designed with the manipulation of the selected Gestalt principles (similarity and proximity).

5.1.2 Participants

The study comprised a total of 79 individuals (49 female, 30 male; $M_{\text{age}} = 27.92$, $SD_{\text{age}} = 2.90$, range: 25–31 years). All the participants consist of undergraduate psychology students. Out of the initial pool, 11 participants were eliminated from the study owing to unstable eye movements. All individuals included in the analysis possessed normal or corrected-to-normal eyesight. The study adheres to the ethical guidelines outlined in the Declaration of Helsinki, as well as the ethical norms of both the University of Vienna and Bilkent University (see Appendix A).

5.1.3. Visual Stimuli

The instruments were designed by two architects who had advanced degrees in architecture. The study focused on two specific Gestalt principles, similarity and

proximity, which were chosen for manipulation in 2-dimensional façade design (Nan et al., 2011). Furthermore, the façade drawings did not incorporate other components, such as ornamentation, that would have given it a distinct identity, as indicated by previous research (Heath et al., 2000; J. H. Lee & Ostwald, 2023). Therefore, in our investigation, we employed an equal number of pieces across all levels of complexity. Color has been found to alter our cognition, affect, and behavior, and it can also influence our aesthetic tastes (Elliot & Maier, 2014; Schloss & Palmer, 2011). Therefore, in order to minimize the possible impact of color and personal preference (Acking & Kuller, 1972), the stimuli were created in black and white (see Appendix D).

In order to account for the participants' familiarity, a set of drawings was created based on images of real buildings in Vienna, as all of the participants were inhabitants of the city (Beder et al., 2024). Upon careful examination of the building façades, we selected windows that featured either orthogonal or circular designs. In light of the fact that the majority of buildings were between 3 and 5 stories in height, we made the decision to standardize the façade drawings to a 3-story structure in order to simplify the process. Once the initial images for the study were generated, a group of 15 architects, acting as experts, evaluated the levels of complexity in 36 manipulated façade drawings. The drawings were evenly divided, with 18 being manipulated based on the similarity principle and the remaining 18 manipulated based on the proximity principle. The architects assessed the complexity of each drawing by utilizing a 7-point Likert scale that featured bipolar descriptors, ranging from 'simple' to 'complex'. After analyzing the ratings, the complexity ratings distributions for each drawing were assessed. Twelve drawings that did not have a

normal distribution were excluded from the main study. As shown Figure 11 and Figure 12, a total number of twenty-four façade designs were used in the main study; twelve drawings were changed according to the similarity principle while twelve more followed proximity principle (see Appendix C). Façade drawings in each group were divided into three subgroups based on average complexity ratings: low complexity-images with average ratings ranging from 1 to 4; medium complexity-images with average ratings between five and eight; high complexity-images averaging nine through twelve.

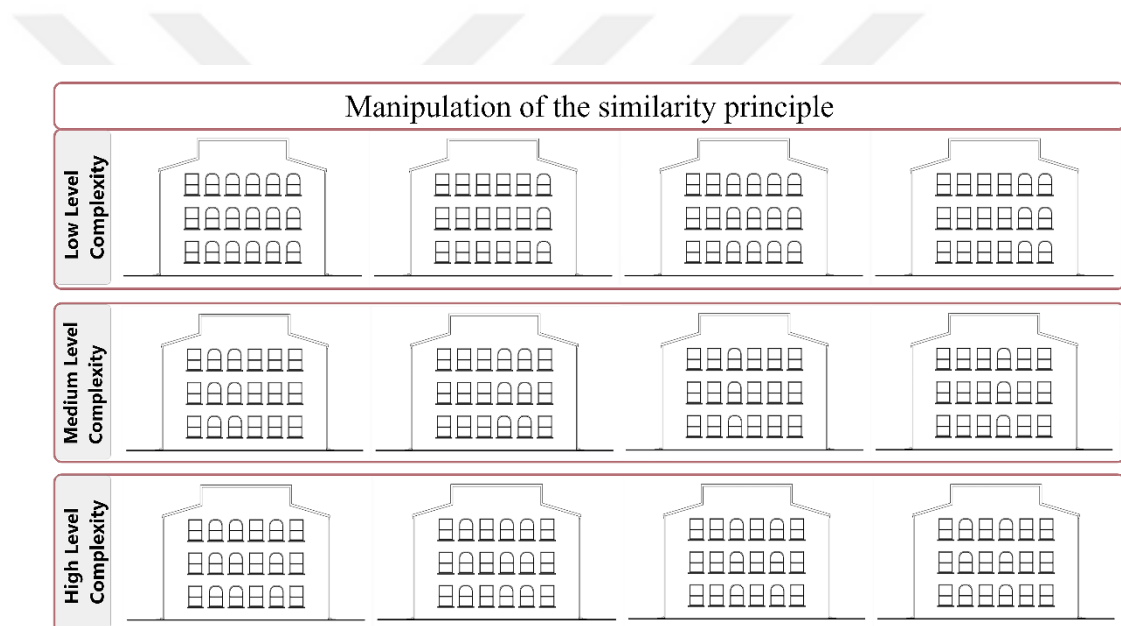


Figure 11. Building façade drawings manipulated according to the similarity principle in Study II

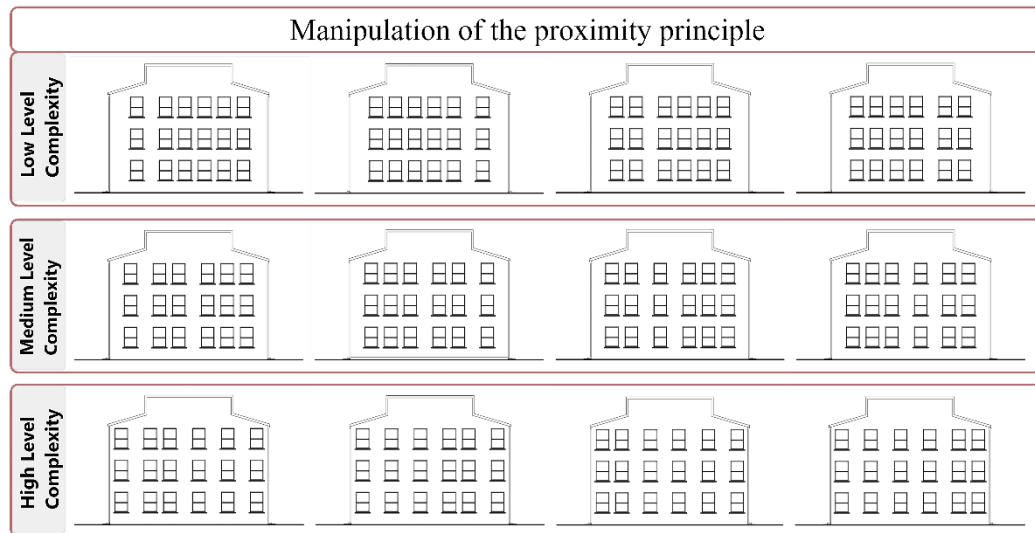


Figure 12. Building façade drawings manipulated according to the proximity principle in Study II

Below are some concepts related to Gestalt theory that will be covered under Study 2, as shown in Figure 13 and Figure 14.

(i) Similarity: Parts that have similar properties are perceived to be grouped together, in accordance with the similarity principle (see Figure 13; Palmer & Rock, 1994). In the present study, this principle was modified according to differences in shapes of windows, as shown in Figure 14. Consequently, more changes in geometrical distinctions for example orthogonal vs circular brought about by inclusion of window frame groups result in an increase in complexity levels of façades, as shown in Figure 11.

(ii) Proximity: According to the proximity principle individuals have a tendency to perceive things that are close to each other as being part of a single unit (see Figure 13; Wertheimer, 1922). We therefore manipulated spacing between windows in our present investigation while keeping them at different distances, as shown in Figure

14. The higher number of complications in terms of distance differences introduced within window frames groups led to increased complexity levels of the façade, as shown in Figure 12.

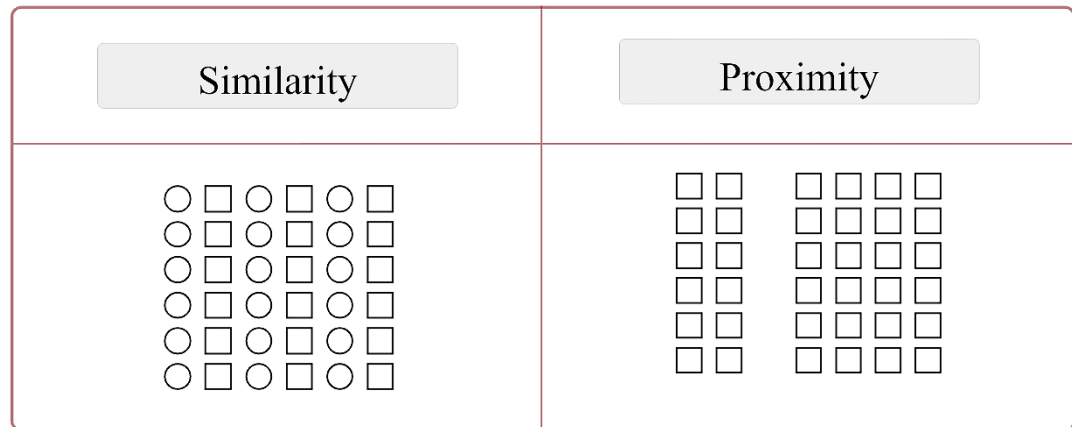


Figure 13. Illustrations of Gestalt principles of similarity and proximity in Study II (adapted from Zakia, 2002)

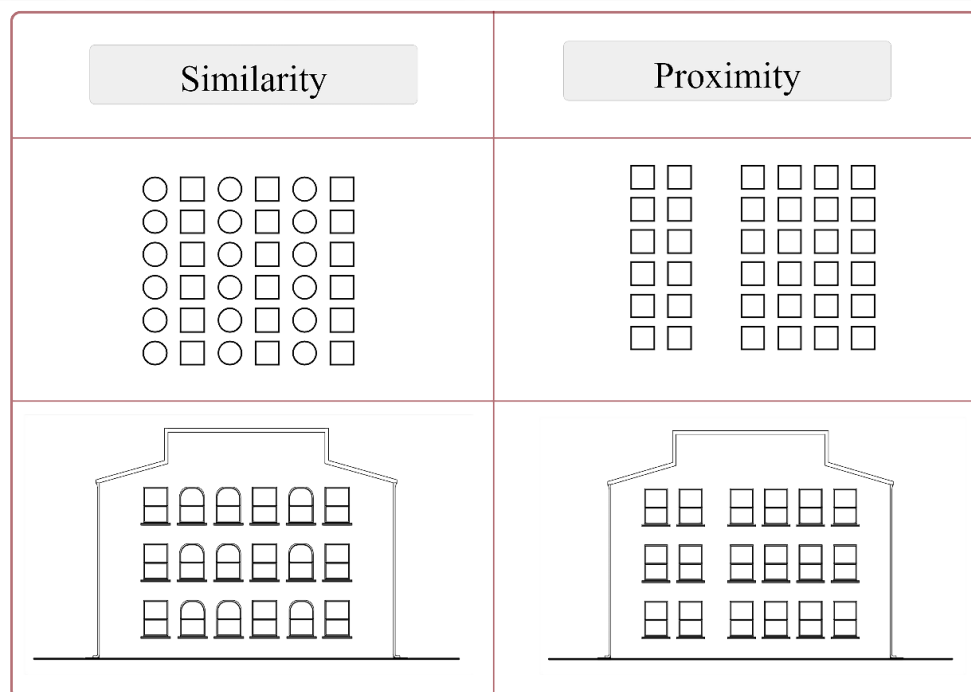


Figure 14. An example of illustrations from Study II demonstrating the manipulation of stimuli in accordance with Gestalt principles of similarity and proximity (adapted from Zakia, 2002).

5.1.4. Hidden Figure Test

Since the current study was built based on the data obtained from the first study; the materials used in the first experiment were also used in this study. As explained in detail in Section 4.1.4, participants who could be grouped as Field Dependent and Field Independent according to the Hidden Figure Test results were included in the second stage of the present study. The purpose of this was to obtain both subjective and objective evaluations of stimuli designed with selected Gestalt principles.

5.1.5. Questionnaire

Since Study I and Study II included the subjective and objective aesthetic evaluations of participants in response to stimuli of varying complexity levels using selected Gestalt principles, the same questionnaire was used for subjective evaluation in both studies. This was explained in detail in Chapter 4.1.5.

5.1.6. Measures and Procedure

Since the first and second studies are a continuation of each other, the methods and materials used are the same. For this reason, as explained in detail in Section 4.1.6., grouping participants' cognitive styles, monitoring and recording their eye movements, and gathering participants' subjective aesthetic evaluations for each stimulus were included within the scope of the survey study.

The stimuli in Study I consisted of the organization of geometric shapes designed by manipulating the Gestalt similarity principle based on color and shape differences. In contrast, the stimuli of Study II were 2-dimensional architectural façade drawings

designed by manipulating the Gestalt similarity principle based on shape differences and the proximity principle. Additionally, a larger number of participants were included in Study II.

5.2. Results

This chapter will describe the results of the analysis of the Study II in a systematic order. As explained in detail in the previous chapters, the stimuli for the main study, Study II, were designed based on the results obtained in Study II.

5.2.1. Validation of Complexity Level

As previously mentioned, an analysis was conducted to determine the validity of the complexity manipulated by the experts (architects) with the complexity perceived by the participants. We found a strong positive correlation between the perceived complexity ratings of participants and the manipulated complexity ratings, with $r = 0.95, p < .001$ for façades manipulated using the similarity principle, and $r = 0.92, p < .001$ for those manipulated using the proximity principle. Both correlations were highly significant. Consequently, drawings were generally perceived as being manipulated in terms of their complexity (Beder et al., 2024).

5.2.2. Gestalt Principles and Cognitive Styles on Aesthetic Evaluation

In line with our Hypothesis 1a (i.e., façade compositions designed with the manipulation of the similarity principle would have lower aesthetic ratings than those designed with the manipulation of the proximity principle), we examined the effects

of Gestalt principles on participants' aesthetic evaluation, and a paired samples t-test was conducted. The results indicated that façade compositions designed with the manipulation of the similarity principle ($M = 3.75$, $SD = .05$) were rated aesthetically lower than those designed with the manipulation of the proximity principle ($M = 3.91$, $SD = .05$); $t(78) = -3.55$, $p = .001$). Consequently, Hypothesis 1a could be confirmed. In line with our Hypothesis 1b (i.e., field Dependent participants would have lower aesthetic ratings than Field Independent participants), we examined the effects of cognitive styles on participants' aesthetic evaluation ratings and an independent samples t-test was conducted. There was no significant difference in the aesthetic evaluation ratings of Field Dependent participants ($M = 3.86$, $SD = .49$) and Field Independent participants ($M = 3.80$, $SD = .29$) for the stimuli; $t(77) = .72$, $p = .471$. In more detail, we conducted a one-way Repeated Measures ANOVA to compare the effects of Gestalt principles (2 levels) on aesthetic evaluations between Field Dependent and Field Independent participants. The results showed no significant difference between the groups ($F(1,77) = .61$, $p = .437$, $\eta p^2 = .008$). As shown in Figure 15, a more detailed pairwise comparison revealed a statistically significant difference between the aesthetic evaluations of the Field Dependent participants for the façade compositions designed with the manipulation of the similarity principle ($M = 3.77$, $SD = .56$) and those designed with the manipulation of the proximity principle ($M = 3.96$, $SD = .49$); $t(41) = -3.12$, $p = .003$. Pairwise comparison revealed that there was no significant difference between façade compositions designed using the similarity principle and those using the proximity principle for Field Independent participants, $t(36) = -1.84$, $p = .074$.

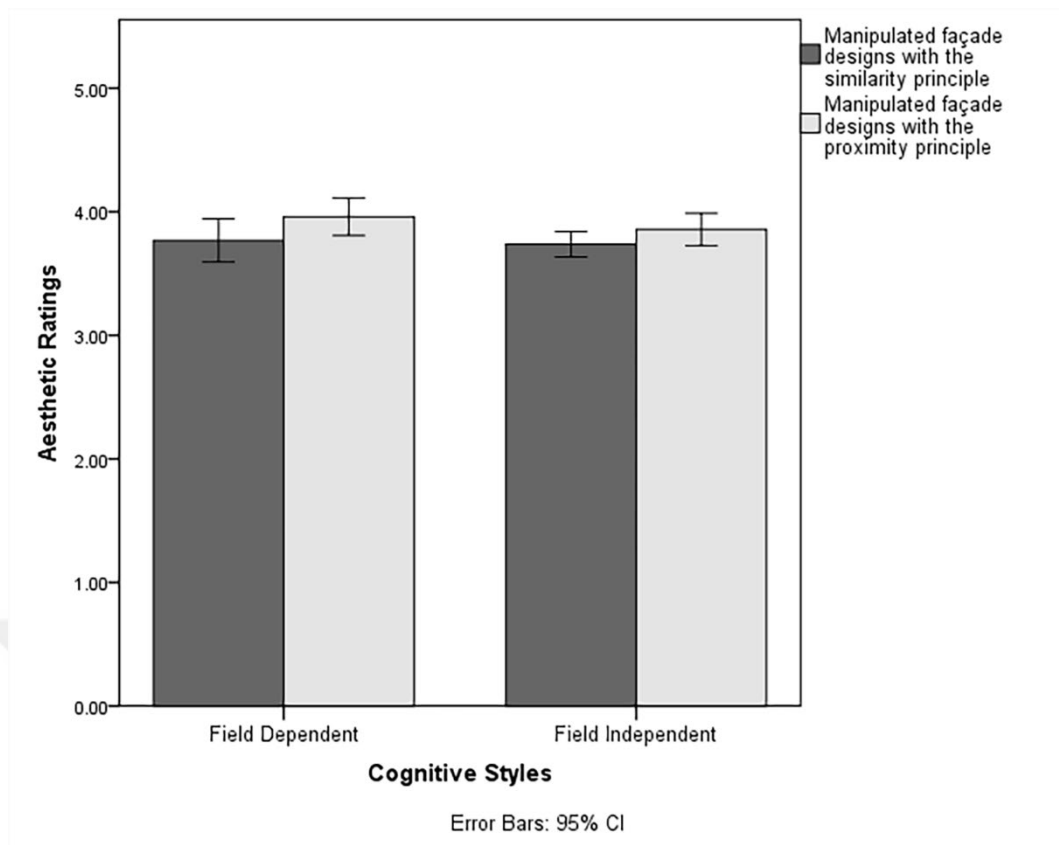


Figure 15. The interaction of Gestalt principles and cognitive styles on participants' aesthetic ratings

5.2.3. Gestalt Principles and Complexity on Aesthetic Evaluation

The questionnaire was used to evaluate the aesthetic evaluations of building façade drawings by participants, as previously mentioned. A two-way Repeated Measures ANOVA was performed to investigate the impact of Complexity Levels (3 levels) and Gestalt principles (2 levels) on the aesthetic evaluation of participants. The aesthetic ratings of participants were significantly influenced by the level of complexity ($F(2,156) = 37.98, p < .001, \eta p^2 = .33$). A post-hoc pairwise comparison with a Bonferroni adjustment revealed that the low complexity façade compositions ($M = 3.97, SD = .06$) received higher aesthetic ratings than the medium ($M = 3.89, SD = .05$) and high complexity ones ($M = 3.64, SD = .06$), in accordance with our

Hypothesis 2 (i.e., the aesthetic ratings of façade compositions would be negatively correlated with their complexity levels). As shown in Figure 16, the findings suggested a negative linear correlation between aesthetic ratings and complexity levels in selected Gestalt principles (Beder et al., 2024). Consequently, Hypothesis 2 could be confirmed.

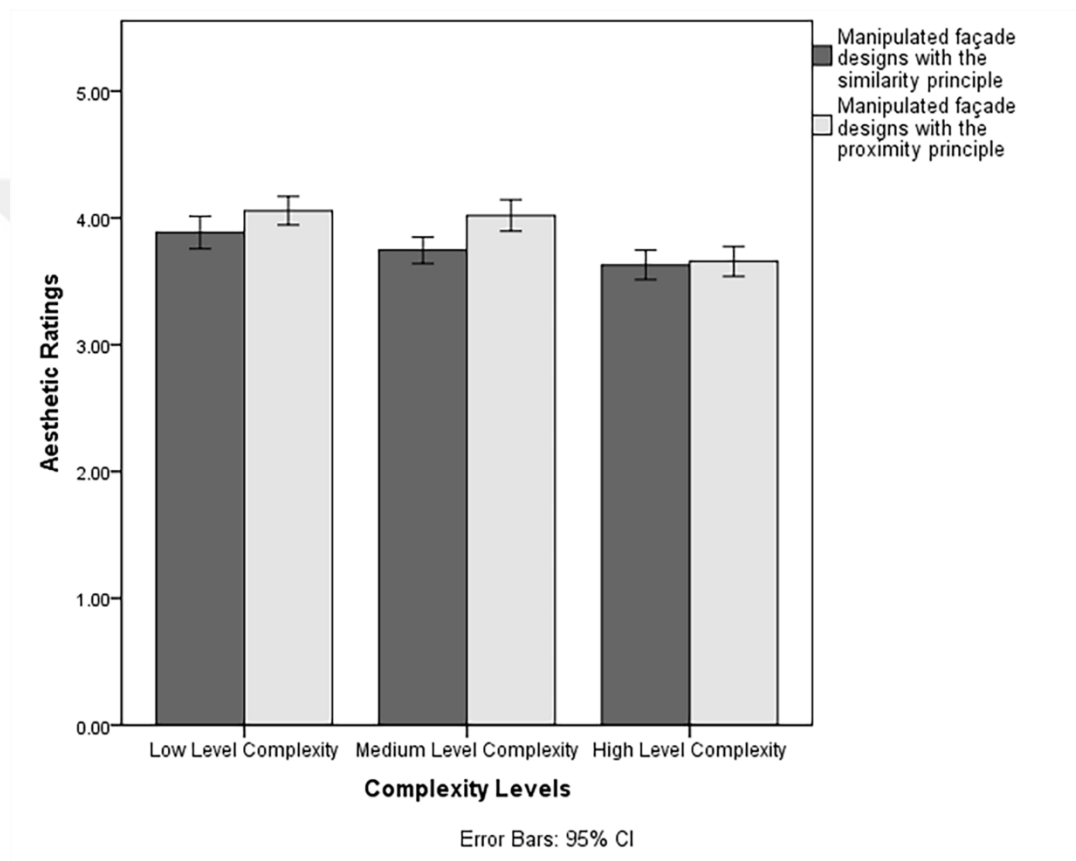


Figure 16. The interaction of Gestalt principles and complexity levels on participants' aesthetic ratings

5.2.4. Gestalt Principles and Complexity on Eye Movements

The average fixation duration, number of fixations, and viewing duration were incorporated as eye tracking metrics with respect to visual attention (Colaço &

Acartürk, 2018; S. Lee et al., 2015; Park et al., 2019; Weber et al., 2002). The second objective of the study was to investigate the impact of Complexity Levels (3 levels) and Gestalt principles (2 levels) on the objective evaluations of participants. For this purpose, a two-way Repeated Measures ANOVA was conducted. Our Hypothesis 3a (i.e., participants would exhibit the lowest fixation duration scores at high complexity levels) was confirmed by the significant main effect of complexity on the average fixation duration scores of participants ($F(2,156) = 7.40, p = .01, \eta p^2 = .09$). Participants' average fixation duration scores at the high complexity level ($M = 249.98, SD = 4.86$) were significantly lower than those at the medium ($M = 270.60, SD = 7.23$) and low complexity levels ($M = 262.41, SD = 6.67$) according to a post-hoc pairwise comparison with a Bonferroni adjustment. In accordance with Hypothesis 3b (i.e., participants would have the highest number of fixations at high complexity levels), there was a significant main effect of the level of complexity on the number of fixations ($F(2,156) = 17.63, p < .001, \eta p^2 = .18$). The post-hoc pairwise comparisons with a Bonferroni adjustment revealed that the number of fixations among participants at the high complexity level ($M = 36.64, SD = 2.25$) was significantly higher than that at the medium ($M = 33.91, SD = 2.20$) and low complexity levels ($M = 31.02, SD = 1.75$). In accordance with Hypothesis 3c (i.e., participants would achieve the highest total viewing duration scores at high complexity levels), there was a substantial main effect of complexity on participants' total viewing duration ($F(2,156) = 4.19, p = .02, \eta p^2 = .05$). Participants' total viewing duration scores at medium ($M = 41103.64, SD = 1350.48$) and high complexity levels ($M = 40796.18, SD = 1345.01$) were significantly higher than those at low complexity levels ($M = 39565.08, SD = 1345.16$) on the basis of post-hoc pairwise comparisons with a Bonferroni adjustment. Nevertheless, the total

viewing duration scores of participants at medium and high levels of complexity did not exhibit any significant difference. The results of the analyses suggested that hypotheses 3a and 3b could be confirmed, while hypotheses 3c had to be rejected.

The average fixation duration of participants was significantly influenced by the interaction between complexity levels and Gestalt principles ($F(2,156) = 3.45, p = .03, \eta p^2 = .04$). A substantial interaction between Gestalt principles and complexity levels was observed in the average fixation duration scores of participants at the high complexity level, where they exhibited the lowest aesthetic ratings. At high complexity levels, the average fixation duration scores of participants were lower for stimuli manipulated according to the principle of proximity ($M = 237.98, SD = 5.54$) than for those designed with the manipulation of the similarity principle ($M = 261.98, SD = 6.17$) according to a post-hoc pairwise comparison with a Bonferroni adjustment. As shown in Figure 17, inverted U-shaped relationship was observed between the level of complexity and the average fixation duration scores the manipulation of the principles of proximity and similarity (Beder et al., 2024).

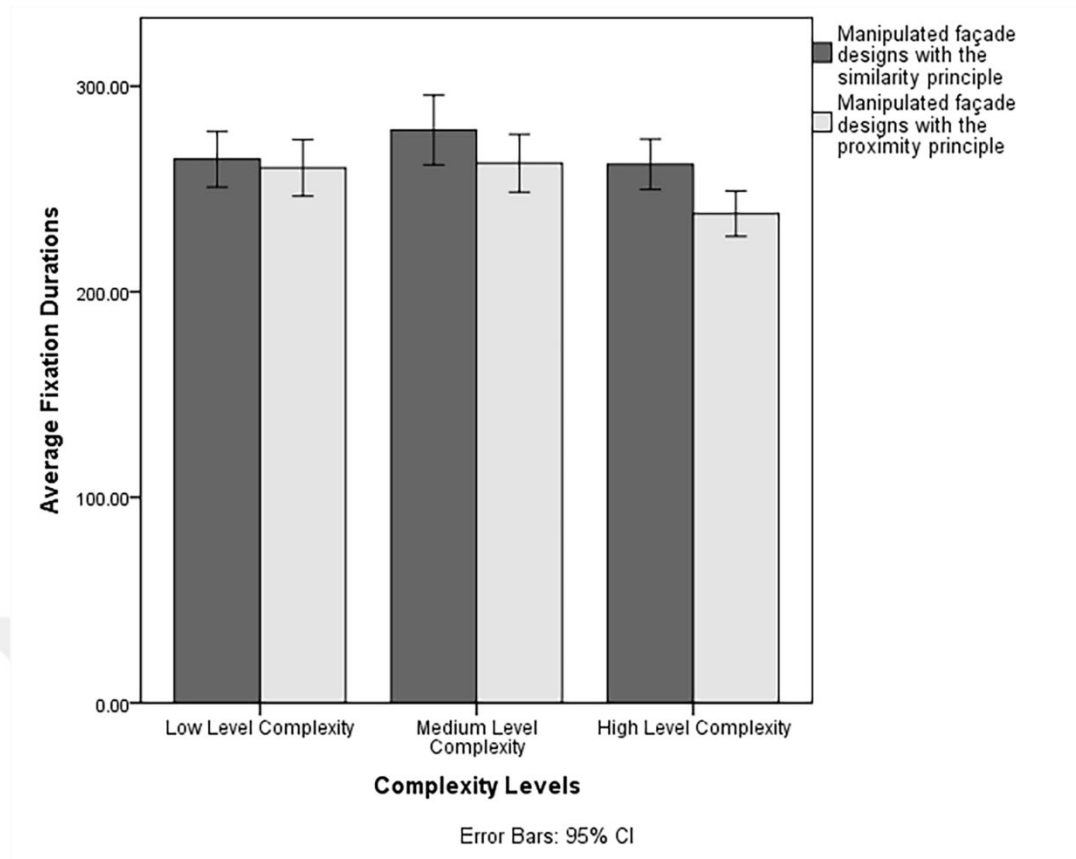


Figure 17. The interaction of Gestalt principles and complexity levels on participants' average fixation duration

Gestalt principles and complexity levels significantly influenced the number of fixations among participants ($F(2,156) = 3.86, p = .02, \eta p^2 = .05$). A substantial interaction between Gestalt principles and complexity levels was observed in the number of fixations at the low complexity level, where participants reported the highest aesthetic ratings. A post-hoc pairwise comparison using a Bonferroni adjustment revealed that the number of fixations in low complexity levels was higher for façades designed with the manipulation of the similarity principle ($M = 33.18, SD = 2.09$) than for those designed with the manipulation of the proximity principle ($M = 28.86, SD = 1.61$). As shown in Figure 18, for both the principles of proximity and

similarity, a positive linear relationship was observed between the number of fixations and the level of complexity (Beder et al., 2024).

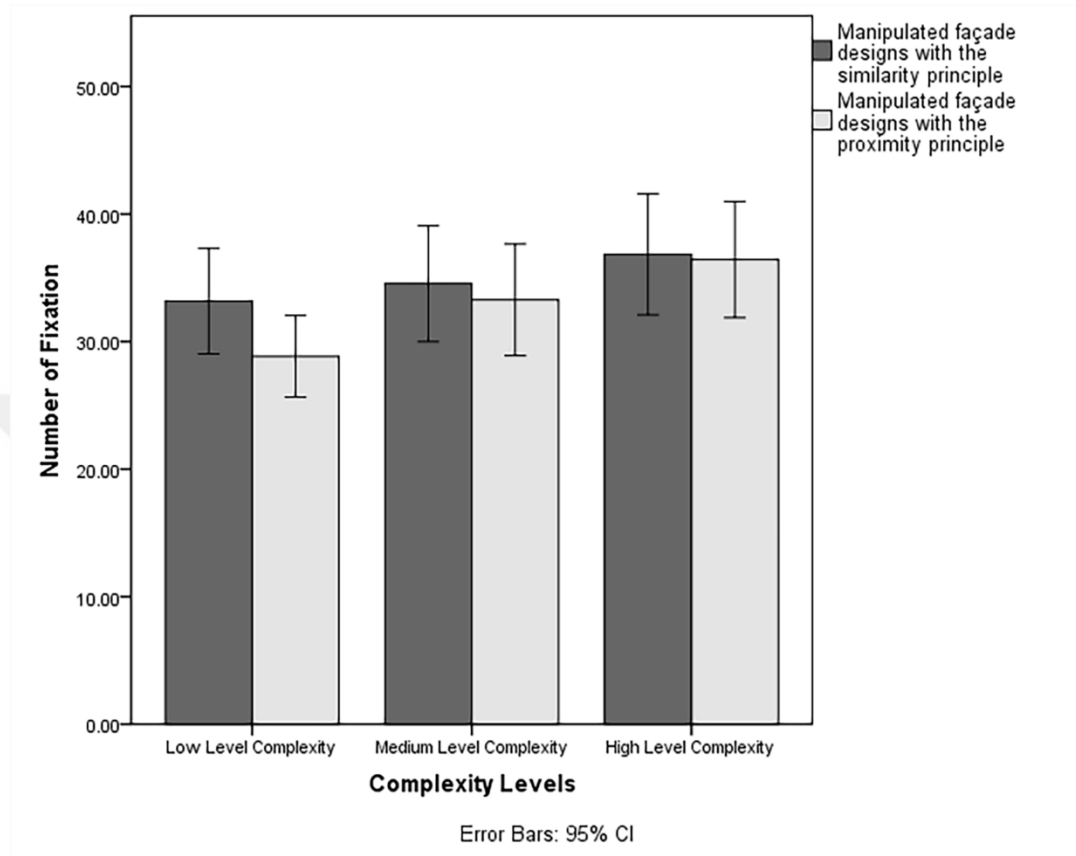


Figure 18. The interaction of Gestalt principles and complexity levels on participants' number of fixations

In the total viewing duration results of the participants, the interaction between complexity levels and Gestalt principles was not observed ($F(6,468) = .73, p = .50, \eta p^2 = .009$). As shown in Figure 19, an inverted U-shaped relationship was observed between the level of complexity and the total viewing duration for both the principles of proximity and similarity (Beder et al., 2024).

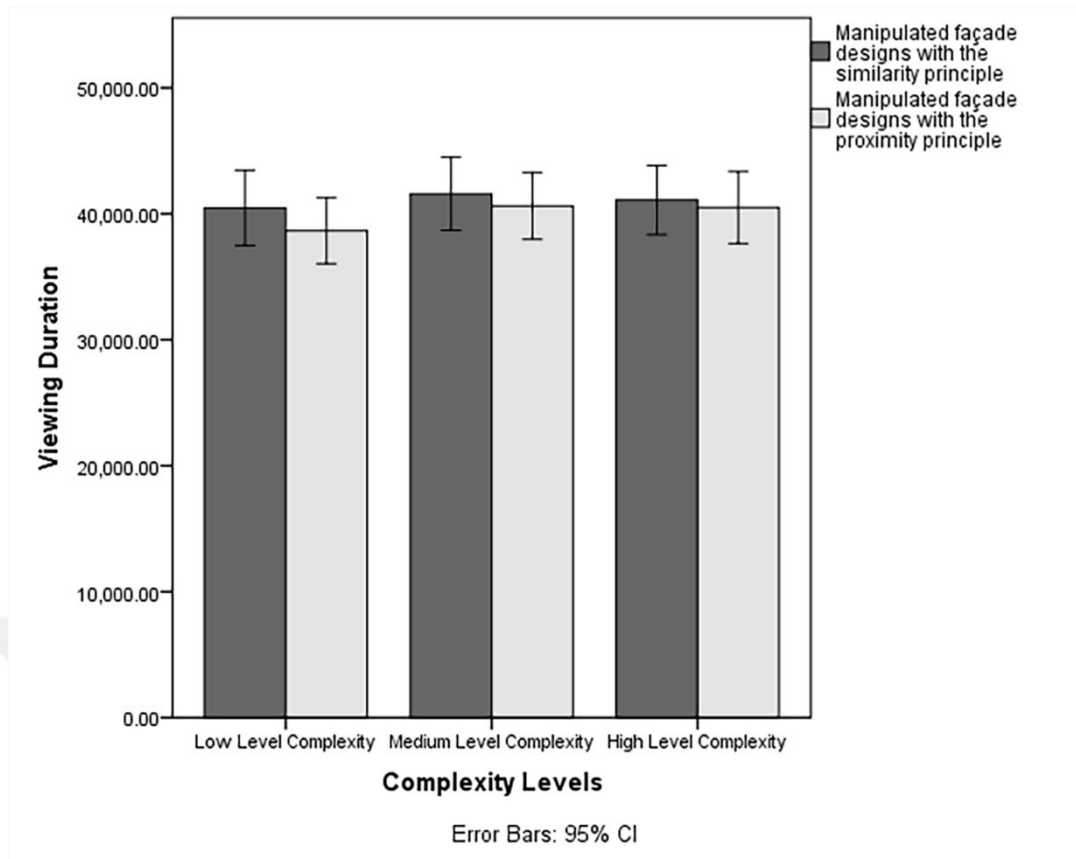


Figure 19. The interaction of Gestalt principles and complexity levels on participants' total viewing duration

5.2.5. Gestalt Principles and Cognitive Styles on Eye Movements

In line with our Research Question 4 (i.e., what are the differences in eye metrics among participants with different cognitive styles in response to façade compositions), we examined the effects of cognitive styles on participants' eye metrics, and independent samples t-tests were conducted. There was no significant difference in the fixation counts of Field Dependent participants ($M = 34.20$, $SD = 2.77$) and Field Independent participants ($M = 33.46$, $SD = 2.95$) for the stimuli conditions, $t(77) = 1.16$, $p = .856$. There was no significant difference in the fixation durations of Field Dependent participants ($M = 258.38$, $SD = 7.60$) and Field Independent participants ($M = 263.97$, $SD = 8.09$) for the stimuli; $t(77) = .632$, $p =$

.429. Moreover, there was no significant difference in the viewing duration of Field Dependent participants ($M = 39626.65$, $SD = 1798.61$) and Field Independent participants ($M = 41466.35$, $SD = 1916.29$) for the stimuli; $t(77) = 2.75$, $p = .101$. In more detail, we conducted a one-way Repeated Measures ANOVA to compare the effects of Gestalt principles (2 levels) on eye metrics across Field Dependent and Field Independent participants. The results showed no significant difference between the groups in terms of fixation counts, average fixation durations and viewing durations. However, a more detailed pairwise comparison revealed a statistically significant difference between the fixation counts of the Field Dependent participants for the façade compositions designed with the manipulation of the similarity principle ($M = 34.87$, $SD = 2.99$) and those designed with the manipulation of the proximity principle ($M = 33.53$, $SD = 2.62$); $t(41) = 3.24$, $p = .002$. A pairwise comparison revealed a statistically significant difference between the average fixation durations of the Field Dependent participants for the façade compositions designed with the manipulation of the similarity principle ($M = 266.08$, $SD = 8.68$) and those designed with the manipulation of the proximity principle ($M = 250.67$, $SD = 7.09$); $t(36) = -3.14$, $p = .003$. A pairwise comparison revealed a statistically significant difference between the average fixation durations of the Field Independent participants for the façade compositions designed with the manipulation of the similarity principle ($M = 270.99$, $SD = 9.25$) and those designed with the manipulation of the proximity principle ($M = 256.95$, $SD = 7.55$); $t(36) = 2.69$, $p = .011$.

5.2.6. Gestalt Principles and Complexity on Participants' Visual Attention

Participants' visual attention within design compositions is represented by heat maps generated from eye movement data (Bailey-ross et al., 2019). They present an alternative visualization for aggregate fixation data (Fairbairn & Hepburn, 2023), employing a color spectrum in which red indicates a higher attention area. Users' sites of interest in façade compositions were identified through the use of heat maps generated from vision fixations in the current study (see Figure 20). The participants' perusing trajectories became increasingly constrained as the complexity of building façade designs increased and aesthetic evaluation ratings decreased in tandem. As the complexity of the architectural façade increased, attention transferred to the area where the manipulated Gestalt principles were located, resulting in a restricted scanning area. During the low complexity phase, attention was observed over almost the entire façade. In façades where the similarity principle was manipulated, attention was focused on the differences in the geometry of window frames, whereas in façades where the proximity principle was manipulated, attention was focused on the distances between window frames (Beder et al., 2024).

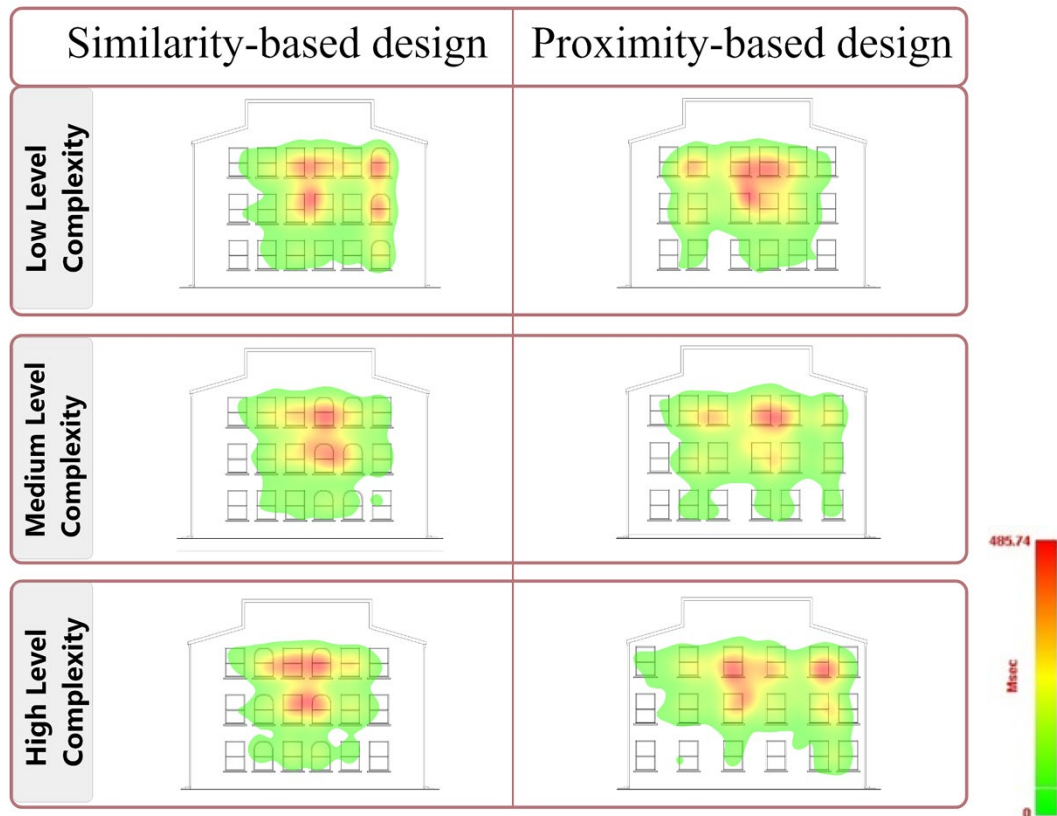


Figure 20. Heat maps illustrating visual attention patterns for building façade drawings

5.3. Discussion

The results of Study II provide significant insight into how architectural design interacts with and is perceived aesthetically, particularly with regard to the manipulation of Gestalt principles for façade complexity. The manipulations of complexity levels by experts (architects) closely matched the complexity levels reported by participants, indicating that the procedure was accurate and reliable. This shows us that proximity and similarity are vital principles if we want to make our designs look more or less complicated because they are very effective at modifying perceived complexity based on their manipulation while following Gestalt theory. The summary sections of Study I and Study II are provided in Table 1 and Table 2.

Research Questions of Study I	Results of Study I
RQ1: How do participants' aesthetic evaluations of geometric compositions differ with respect to the Gestalt similarity principle based on color and shape differences?	There was a significant difference between participants' aesthetic evaluation ratings for the stimuli manipulated by Gestalt similarity principle based on color differences and shape differences.
RQ2: What are the differences in cognitive styles on participants' aesthetic evaluations of geometric compositions?	Field Dependent participants' aesthetic evaluation ratings were lower than those of Field Independent participants for condition stimuli designed with the manipulation of the similarity principle based on shape differences. However, we did not observe a significant difference between the groups for stimuli designed based on color differences.
RO3: How are the levels of complexity in geometric compositions related to participants' aesthetic evaluations?	The medium complexity stimuli received lower aesthetic ratings than the low and high complexity stimuli. There was a U-shaped relationship between participants' aesthetic ratings and complexity levels.
RQ4: What are the differences in eye metrics among participants based on their cognitive styles in response to stimuli?	For stimuli designed with the manipulation of the similarity principles based on shape differences, the results showed a statistically significant difference in fixation count, average fixation duration and viewing duration between Field Dependent and Field Independent participants. However, there was no significant difference in fixation counts, average fixation duration, and viewing duration between Field Dependent and Field Independent participants for stimuli designed with the manipulation of the similarity principles based on color differences.

Table 1. The summary of Study I

Research Questions and Hypothesis of Study II	Results of Study II
H1a: We hypothesized that façade compositions designed with the manipulation of the similarity principle would have lower aesthetic ratings than the ones designed with the manipulation of the proximity principle.	Façade compositions designed with the manipulation of the similarity principle were rated aesthetically lower than those designed with the manipulation of the proximity principle.
H1b: We hypothesized that Field Dependent participants would have lower aesthetic ratings than Field Independent participants.	There was no significant difference in the aesthetic evaluation ratings of Field Dependent participants and Field Independent participants for the stimuli
H2: We hypothesized that the aesthetic rating of façade compositions would be negatively correlated with their complexity levels.	The medium complexity stimuli received lower aesthetic ratings than the low and high complexity stimuli. There was a U-shaped relationship between participants' aesthetic ratings and complexity levels.
H3a: We hypothesized that participants would have the lowest fixation duration scores at high complexity levels.	For stimuli designed with the manipulation of the similarity principles based on shape differences, the results showed a statistically significant difference in fixation count, average fixation duration and viewing duration between Field Dependent and Field Independent participants. However, there was no significant difference in fixation counts, average fixation duration, and viewing duration between Field Dependent and Field Independent participants for stimuli designed with the manipulation of the similarity principles based on color differences.
RQ4: What are the differences in eye metrics among participants with different cognitive styles in response to façade compositions?	A detailed pairwise comparison revealed significant differences in both fixation counts and average fixation durations between Field Dependent and Field Independent participants when viewing façade compositions designed with the similarity and proximity principles.

Table 2. The summary of Study II

5.3.1. Complexity, Gestalt Principles and Aesthetic Evaluation

The investigation examined how the intricacy of design relates to aesthetic judgments and discovers a linear inverse correlation between them. This outcome is in line with earlier studies that showed more intricate visual materials rated less beautiful (Chassy et al., 2017). Simpler designs are frequently regarded as more aesthetically pleasing due to their ease of cognitive processing (Berlyne, 1971; Leder et al., 2004). The present study further underscores the importance of simplicity in design, as evidenced by the negative linear correlation observed between complexity levels and aesthetic ratings across various Gestalt principles. Specifically, as the complexity of objects within a given principle increases, they were generally associated with lower aesthetic ratings. This might be due to the increased cognitive load required to process these more complex designs, which reduces the enjoyment derived from them (Chassy et al., 2017; Gartus & Leder, 2017). Therefore, in the present study, architectural complexity may be overwhelming for participants, leading to cognitive overload (Ghomeshi & Jusan, 2013) and reduced aesthetic evaluation. In light of these findings, it can be said that simpler façades are generally preferred, a finding that is consistent with many other studies in environmental psychology (S. Kaplan et al., 1972; Miniukovich & Marchese, 2020).

We found that participants rated façade stimuli that were designed using the manipulation of the Gestalt principle of proximity as more aesthetically pleasing than those that were designed using the manipulation of the Gestalt principle of similarity. The explanation for the lower attractiveness ratings given to such façades could be related to cognitive load theory, which states that when a design becomes more

complex or uniform, it demands more from one's mental faculties, thereby reducing its aesthetic appeal (S. Palmer & Rock, 1994; Sweller, 1994). This finding also suggests that the assumption that visual coherence invariably enhances aesthetic pleasure may not always hold true. Specifically, when a design becomes overly predictable or monotonous due to the excessive use of elements based on similarity, it may not necessarily result in increased aesthetic appeal (Chassy et al., 2017).

5.3.2. Gestalt Principles, Cognitive Styles and Aesthetic Evaluations

The results of this research indicate that cognitive styles, particularly Field Dependence and Field Independence, did not significantly affect the general aesthetic evaluations of associated stimuli by participants from an architectural perspective. There was no significant difference in aesthetic evaluation ratings between Field Dependent and Field Independent participants as indicated by the insignificant difference in mean scores for both groups, which means that other factors beyond cognitive style may contribute more to shaping of people's aesthetic evaluation.

In addition, Gestalt principles manipulations of proximity and similarity also revealed no significant differences in terms of aesthetic evaluations among the two groups characterized by different cognitive styles. This result refutes the assumption that context-sensitive individuals like Field Dependent would show a different response to Gestalt-based manipulations from their individualistic counterparts such as Field Independent who are more focused on elements within a composition. Some previous literature has suggested that external perceptual cues may influence the judgement of Field Dependent subjects while the focus for Field Independent

subjects could be specific details (Witkin et al., 1975; Witkin & Goodenough, 1981).

However, our finding suggests otherwise since these variations do not seem to manifest in perceptions about complex visual stimuli such as façade compositions.

Upon a more detailed analysis of the data, it becomes evident that a significant difference exists in how Field Dependent respondents evaluate aesthetics, particularly when comparing stimuli designed according to the manipulations of Gestalt principles, specifically similarity and proximity. In the case of field-dependent people, however, there were higher ratings for stimuli designed by manipulating the Gestalt principles of proximity than for those designed using the similarity principle. This can imply that within-group variations might occur regarding how visual elements are arranged leading to variation in artistic choice perhaps because they tend to use a holistic approach thereby being more sensitive towards spatial arrangement/relationship (E. Nisiforou & Laghos, 2016). On the other hand, where Field Independent participants were concerned there was no such significant difference among these participants implying that their aesthetic judgments may be less influenced by such principles of organization. While cognitive style does not appear to significantly influence overall aesthetic evaluations, the subtle effects observed within Field Dependent participants suggest that specific design principles may interact with cognitive styles in complex ways. These results highlight how different cognitive processes can affect visual and aesthetic experiences particularly when designing buildings and objects, which requires understanding user preferences (S. E. Palmer et al., 2013).

5.3.3. Gestalt Principles, Complexity and Eye Movements

The participants' eye movement data showed that when they were presented with architectural façades of high complexity levels, the number of fixations increased, and duration decreased. This finding was consistent with previous studies (Chassy et al., 2015; Goldberg, 2012; Y. Guo & Hall, 2009; Ishrat & Abrol, 2020) that found people tend to visually explore complex objects quickly and extensively.

Specifically, façades designed by manipulating the similarity principle received low aesthetic ratings. They also required more time to be processed by the visual system and attracted many fixations, resulting in longer fixation durations, whereas those built by altering the proximity principle received higher aesthetic ratings regardless of the level of complexity, as they required less processing time and attracted fewer fixations, resulting in shorter fixation durations.

Such differences in how individuals look at modified designs using similarity and proximity principles may indicate underlying mechanisms involved during perceptual processing. The use of similarity principle in design is meant to enhance visual coherence by grouping together things that share common features like color or shape to foster their collective analysis (Treisman & Gelade, 1980). But then these designs could increase cognitive load due to their uniformity or repetitive patterns thereby demanding greater mental effort for understanding different parts. In contrast, proximity principle which involves placing parts close to each other to create unity as well structure allows quick understanding of the arrangement, therefore reducing the need for thorough examination of individual elements.

Through making pieces appear as single units rather than separate items this method

should lead to faster aesthetic judgments while lowering cognitive demands among observers (S. Palmer & Rock, 1994).

Furthermore, the research showed that compared with highly complicated ones façades having moderate complexity levels led to much longer viewing times. In contrast to what we initially expected our records show that extremely intricate exteriors were looked at for a shorter period by subjects. This tendency can be explained by the idea that individuals tend to spend more time on stimuli of medium complexity which are perceived as interesting and easy to grasp (Hasse & Weber, 2012). This finding is consistent with cognitive load theory that proposes people allocate their mental resources mainly towards neither too simple nor very complex stimuli (Sweller, 1994). Therefore the observed viewing time pattern in this investigation may indicate greater involvement of participants with medium complex stimuli. This suggests an importance of considering complexity levels in architectural design for better engagement and aesthetic experience among viewers.

To sum up, in our study we used questionnaires together with eye-tracking measures so that we could understand aesthetic assessment more deeply and thoroughly.

Although the questionnaire data collected people's declared aesthetic preferences and emotional reactions deliberately, it still cannot represent visual processing accurately because of its limitations. Therefore eye-tracking devices were employed to examine visual attention directly as well as the processing pathways they follow. What was found by doing so is the way people process information visually which may be related or not connected with their subjective experiences reported by them. These results also contribute to a debate about Gestalt principles, complexity levels, and

eye tracking metrics in the architectural design field. Such findings offer an opportunity for cognitive psychology, aesthetics, and design interdisciplinary research in the future. This investigation will help us know better how human beings perceive and interact with the physical spaces they live in eventually. The next chapter includes a general conclusion that covers both studies.



CHAPTER VI

CONCLUSION

The present study is focuses on the relationship between aesthetic evaluations, complexity and cognitive styles within the framework of Gestalt principles by using geometric and architectural façade stimuli. The present two studies are complementary to each other in that they provide a more subtle understanding of people's perception and evaluation of visual objects with different degrees of complexity manipulated according to similarity and proximity among other Gestalt principles. These dynamics are analyzed in terms of geometric shapes (the first study) and architectural façades (the second study), thereby offering a holistic view of what factors come into play during aesthetic evaluations as well as visual processing. The findings can be summarized as follows:

- (i) In the context of the geometric stimuli (Study I), this U-shaped pattern suggests that both simplicity and complexity can enhance aesthetic appeal, albeit through different mechanisms. Simple designs are likely to be preferred because of their ease

of processing, whereas highly complex designs may attract attention and promote appreciation because of their intricate organization, which can be engaging and rewarding if successfully processed by the viewer. The U-shaped curve observed in this study underscores the importance of visual fluency and the role of cognitive resources in shaping aesthetic preferences. In architectural context (Study II) – this finding also indicates an important role played by visual organization processes while dealing with complicated structures like these buildings. However, the negative correlation observed between complexity and aesthetic ratings across design principles suggests that as the complexity of architectural façades increases, they tend to be perceived as less aesthetically valuable. The study found that façades designed using the Gestalt proximity principle manipulation were generally rated higher than those designed using the Gestalt similarity principle manipulation, suggesting that the way complexity is organized can either enhance or detract from the aesthetic appeal of a design. The results of both studies suggest that while simplicity is often associated with higher aesthetic value, well-organized complexity can also be aesthetically appealing, provided it does not exceed the viewer's cognitive capacity. The findings from both studies imply that although simplicity is often associated with higher aesthetic value, complex organization can also be pleasing if it does not exceed viewer's cognitive capacity.

(ii) These two studies shed light on how various Gestalt principles influence aesthetic evaluations. In terms of visual perception, Gestalt psychology claims that people tend to see things together rather than as separate elements assembled artificially by some external means. Hence this work was centered on two major principles namely similarity and proximity which were expected to have an effect on beauty perception.

For instance, in Study I the similarity principle was manipulated through differences in color and shape among other variables whereas in the case of Study II, architectural façades were designed based on the manipulation of proximity and similarity principles. The findings revealed that those objects modified using Gestalt similarity principles based on shape differences were rated as more aesthetic compared to those altered using color differences, thereby suggesting that shape plays a critical role during the organization as well as the interpretation of visual stimuli. Shapes are considered to be basic units for making sense of what is seen around us since they provide some form or structure within which other elements may fit better, so that a clearer picture can be obtained following Gestalt theory.

In Study II, we found that façades designed by manipulating the proximity principle were rated more aesthetically than those designed by manipulating the similarity principle. The manipulation of the similarity principle, which evaluates objects that are similar together, was therefore found to be less attractive than the manipulation of the proximity principle. While similarity can create visual coherence, it can also lead to monotony if overused, whereas proximity offers a more dynamic and engaging visual experience. These results show that different gestalt principles may have differing effects on aesthetic evaluations; hence designers should be aware of this when making their decisions.

(iii) Another dimension of complexity is added to the analysis of aesthetic evaluations by looking at cognitive styles, which in both studies are distinguished as Field Dependent and Field Independent. Cognitive style refers to an individual's

typical way of processing information; Field Dependent people rely on external cues, while Field Independent people are good at separating objects from the background.

In the first study, when evaluating various figures representing different levels of complexities Field Dependent participants tended to give lower ratings compared to Field Independent individuals. This suggesting that cognitive styles significantly affect aesthetic evaluations where people might find it difficult to appreciate complicated stimuli due to their holistic approach towards perceiving things rather than paying attention on details only observed by Field Independent participants who can easily single out parts from whole even in complex shapes.

On the other hand, in contrast to Study I where there was no significant difference between Field Dependent and Field Independent participants in terms of the architectural structures used as stimuli during aesthetic level ratings; this time the results indicated the opposite - some within-group variation in Field Dependent ratings revealed higher preference scores given to manipulations of stimuli designed according to the proximity principle over those designed according to similarity. This reflects their global perceptual orientation more than that of field-independent participants, who tend to have a local attentional bias toward such arrangements. Such findings suggest that knowledge about how people perceive things cannot be taken lightly, as cognitive styles can interact with different aspects of visual information and thus ultimately affect aesthetic evaluations.

(iv) Eye tracking measures employed in both investigations provide objective indices for visual processing which complement subjective questionnaire-based

assessments regarding attractiveness. Fixation counts, fixation durations and viewing durations for an image are some of the eye metrics used to understand participant's interaction with various stimuli types with diverse levels of intricacy.

In Study I, according to the similarity principle based on shape differences, the stimuli require more cognitive effort from Field Dependent participants, as evidenced by eye-tracking data in which higher fixation counts and longer fixation durations were observed. The reason behind this finding could be that Field Dependent participants may have difficulty processing shapes thereby decreasing their aesthetic ratings. Conversely, fewer fixations over shorter time intervals were recorded during processing of shapes by Field Independent participants who gave them higher aesthetic ratings.

In line with these findings from Study I, Study II extended these findings to the architectural context, where eye-tracking data showed that as the complexity of façades increased, the number of fixations also increased, while fixation duration decreased. This pattern suggests that participants tended to visually explore complex façades more extensively, but with shorter fixations, possibly due to the increased cognitive load associated with processing intricate designs. Façades designed using the similarity manipulation received lower aesthetic ratings and took longer to process, while those designed using the proximity manipulation were processed more quickly and received higher aesthetic ratings. This suggests that proximity-based designs are easier to process and more visually appealing, possibly because they create a stronger sense of unity and coherence.

Limitations and Future Studies

Although valuable in terms of information about architectural design, Gestalt principles, and aesthetic evaluation, there are certain things that this research does not address. The number of people used as samples for this study may not be large enough or diverse enough in terms of race, making the results not widely applicable. Future studies should consider increasing the number and diversity of their subjects by considering such things as age groups, among others, to better understand how different factors affect aesthetic perception in architecture.

Secondly, we used the Gestalt principles of proximity and similarity, leaving aside other principles such as continuity or closure that could have been considered. It is recommended that future research include a wider range of Gestalt principles, thus providing a holistic understanding of their relationship with architectural complexity and aesthetics.

Another limitation is that the study focused only on images of façades rather than three-dimensional models of real buildings. The perception of space created by architects is dynamic because it involves movement as one observes different points from one's vantage point. Researchers could use virtual reality (VR) or augmented reality (AR) devices to allow people to interact with different architectural structures to determine how these theories relate to each other in complex visual contexts. Although subjective (questionnaire-based) and objective (eye-tracking) measures were used in this experiment, emotional responses were not considered in the aesthetic evaluations. People's emotions towards designs may have a strong influence

on whether they find them beautiful or not, so further research on this is needed. To better understand the relationship between cognitive load, visual complexity, and physiological responses related to emotion, future researchers can combine eye-tracking technology with physiological measures such as heart rate monitoring, among others.

Notwithstanding such constraints, the current study possesses several notable strengths. Our study differed from previous perception studies by using both subjective and objective evaluations, rather than relying solely on subjective judgments from participants. By incorporating eye-tracking equipment, it became possible to analyze participants' subconscious brain activity as a component of the perception studies. While Gestalt theory holds significant importance in architecture, the correlation between complexity and Gestalt principles has not been thoroughly examined in existing research. The findings of this study may be beneficial for academics investigating the correlation between assessment and complexity, as well as for professionals engaged in the design and arrangement of architectural façades.

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APPENDIX A. Ethics Committee Approval



Bilkent Üniversitesi

Akademik İşler Rektör Yardımcılığı

Tarih : 25 Eylül 2022
Gönderilen : Çağrı İmamoğlu
Gönderen : H. Altay Güvenir
İnsan Araştırmaları Etik Kurulu Başkanı
Konu : "Using Eye ..." çalışması etik kurul onayı

Üniversitemiz İnsan Araştırmaları Etik Kurulu, 25 Eylül 2022 tarihli görüşme sonucu, "Using Eye Tracking to Understand the Impact of Visual Complexity and Perceptual Fluency on Viewers' Aesthetic Preferences" isimli çalışmanız kapsamında yapmayı önerdiğiniz etkinlik için etik onay vermiş bulunmaktadır. Onay, ekte verilmiş olan çalışma önerisi, çalışma yürütücüleri ve bilgilendirme formu için geçerlidir.

Bu onay, yapmayı önerdiğiniz çalışmanın genel bilim etiği açısından bir değerlendirmedir. Çalışmanızda, kurumumuzun değerlendirmesi dışında kalabilen özel etik ve yasal sınırlamalara uymakla ayrıca yükümlüsünüz.

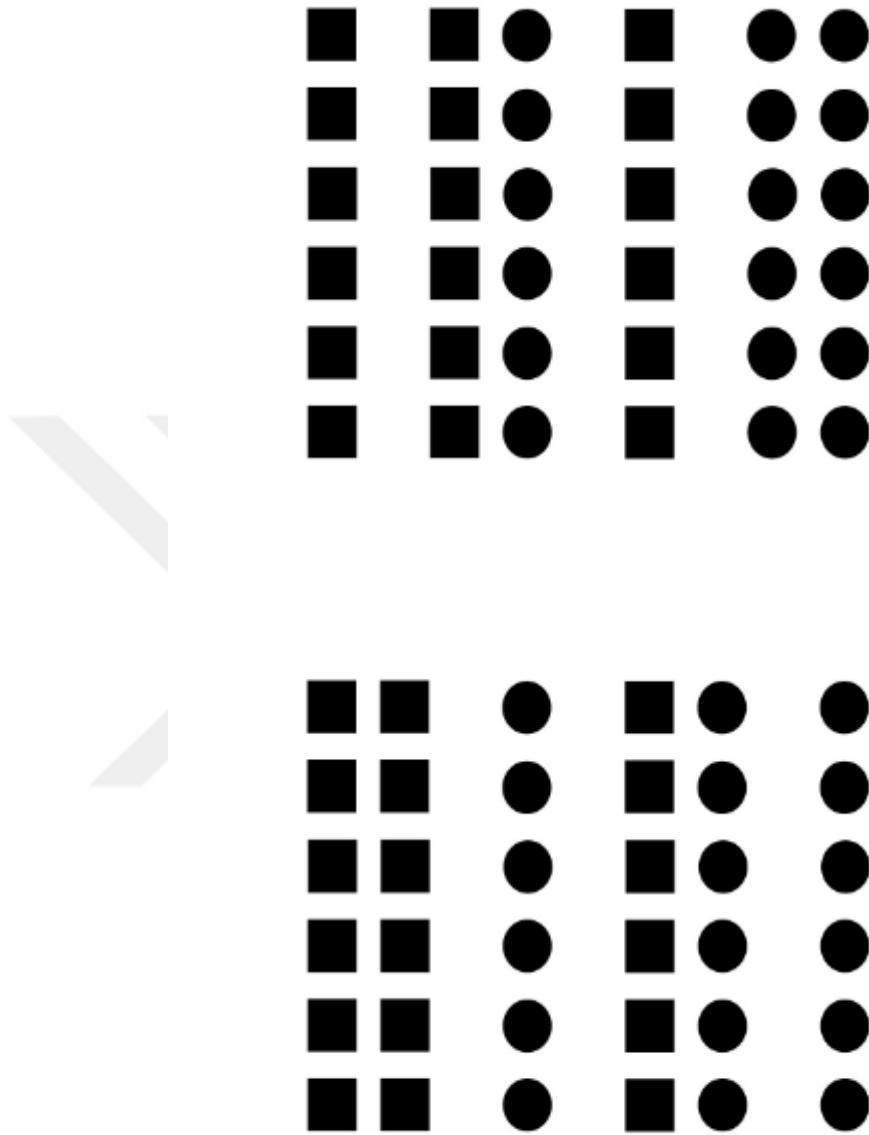
Kovid-19 salgını nedeniyle konulmuş olan kısıtlamaların yürürlükte olduğu süre içinde, tüm komite toplantıları elektronik ortamda yapılmaktadır; aşağıda isimleri bulunan Bilkent Üniversitesi Etik Kurulu Üyeleri adına bu yazıyı imzalama yetkisi kurul başkanındadır.

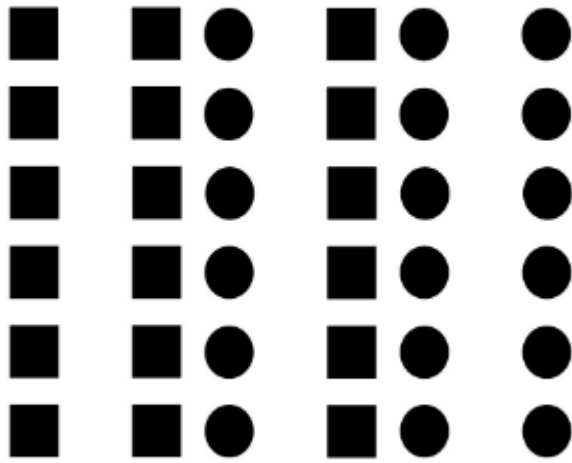
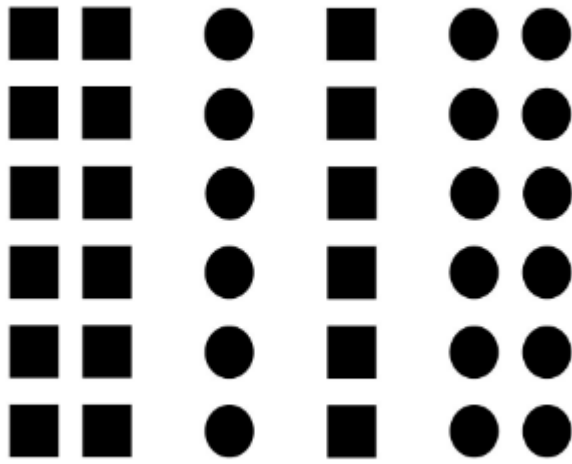
Etik Kurul Üyeleri:

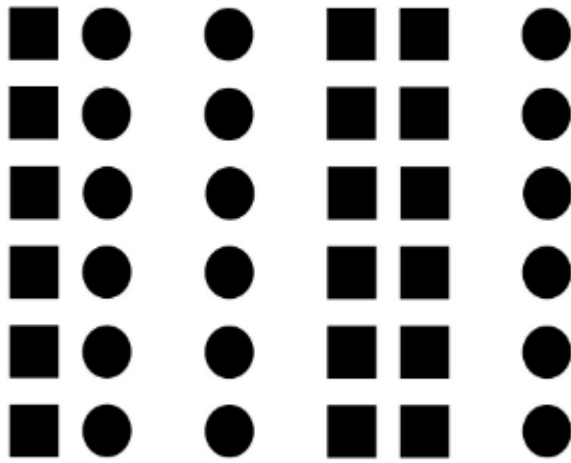
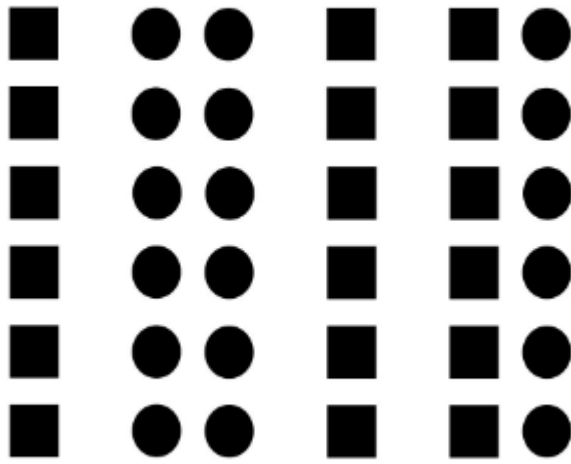
Ünvan / İsim	Bölüm / Uzmanlık	
Prof.Dr. H. Altay Güvenir	Bilgisayar Mühendisliği	Başkan
Prof.Dr. Erdal Onar	Hukuk	Üye
Prof.Dr. Haldun Özaktas	Elektrik ve Elektronik Müh.	Üye
Doç.Dr. Işık Yuluğ	Moleküler Biyoloji ve Genetik	Üye
Dr. Öğr. Üyesi Burcu Ayşen Ürgen	Psikoloji	Üye
Dr. Öğr. Üyesi Didem Özkul McGeoch	İletişim ve Tasarımı	Yedek Üye
Dr. Öğr. Üyesi A.Barış Özbilen	Hukuk	Yedek Üye

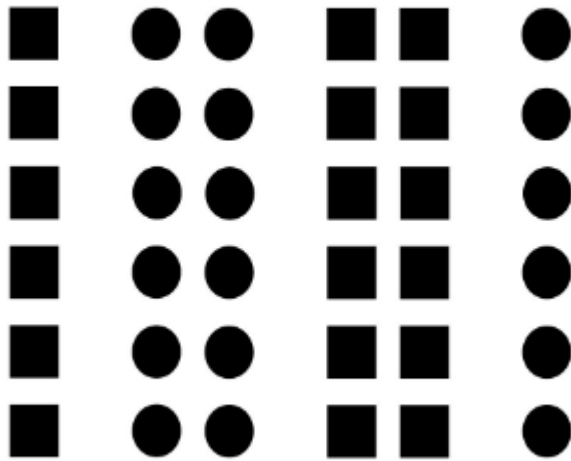
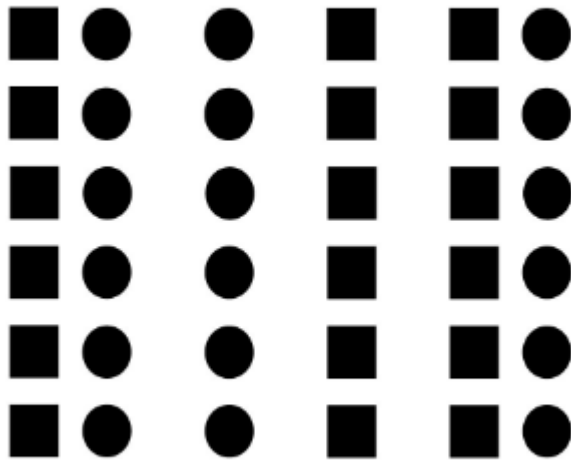
Kurul karar/toplantı No: 2022_09_25_01

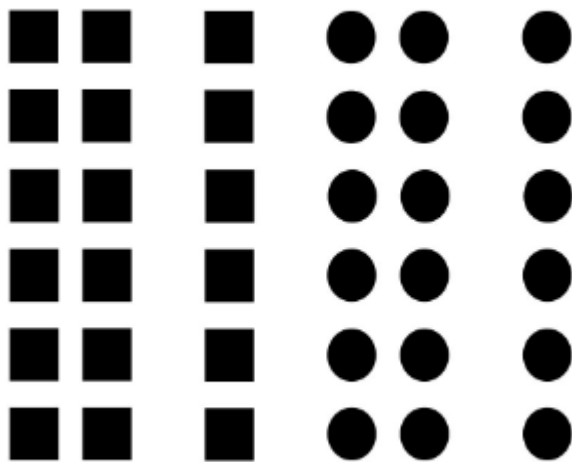
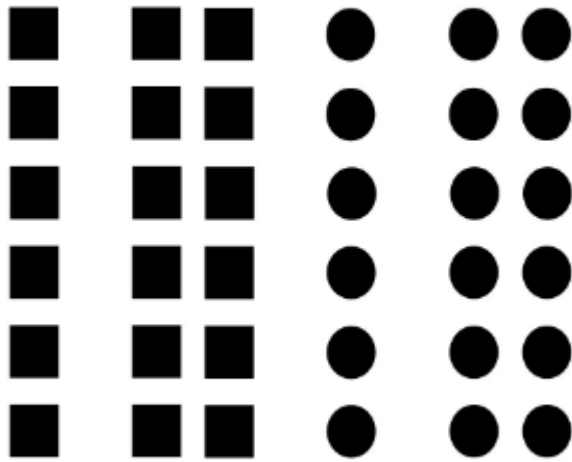
APPENDIX B. Stimuli of the Study I

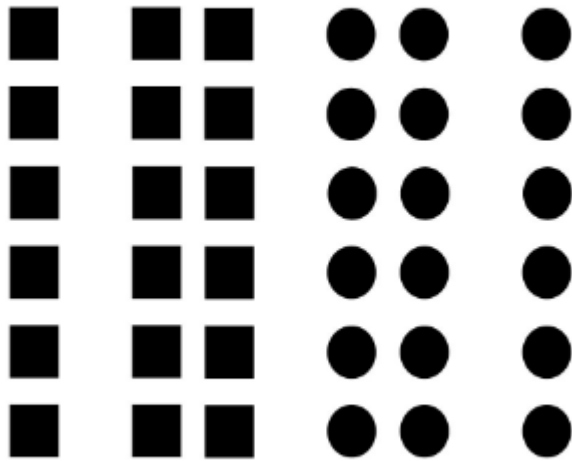
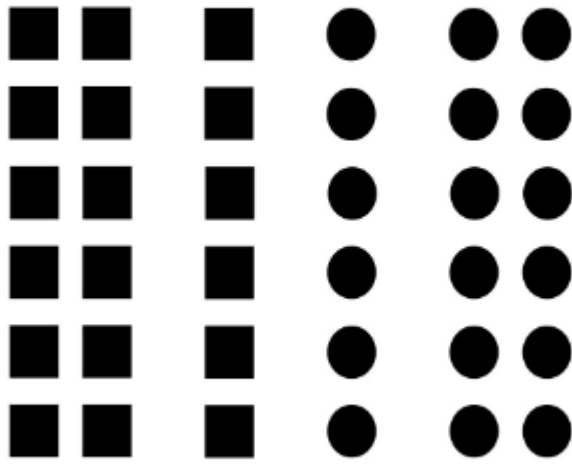


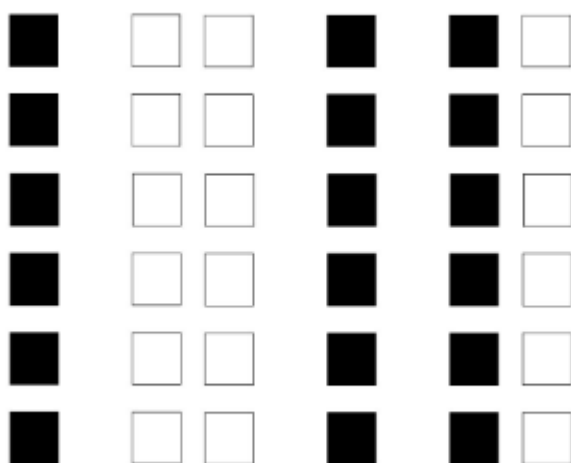
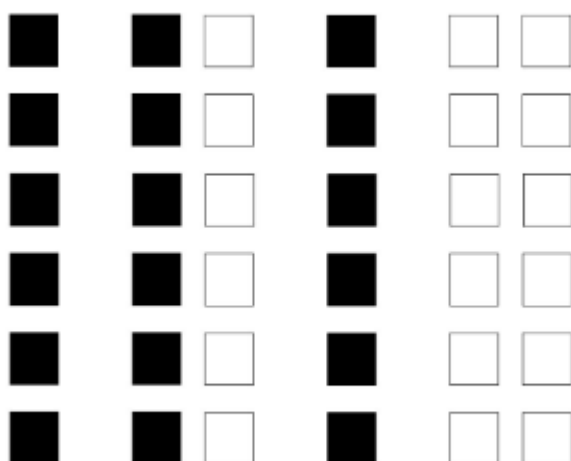


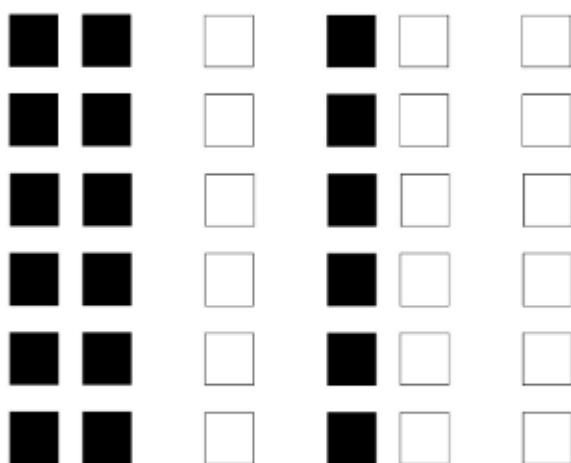
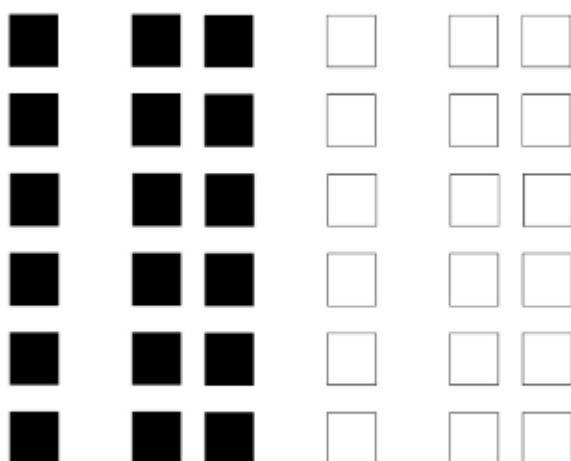


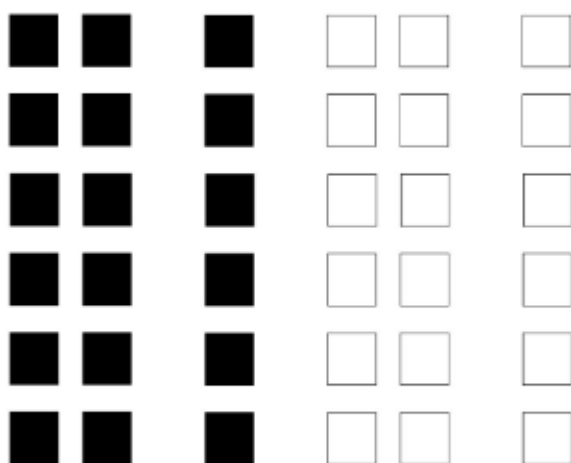
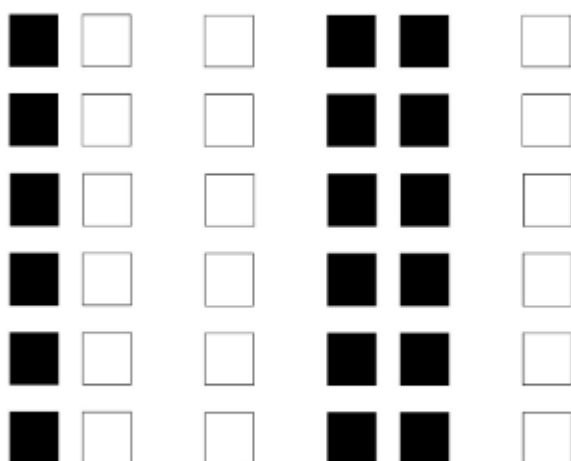


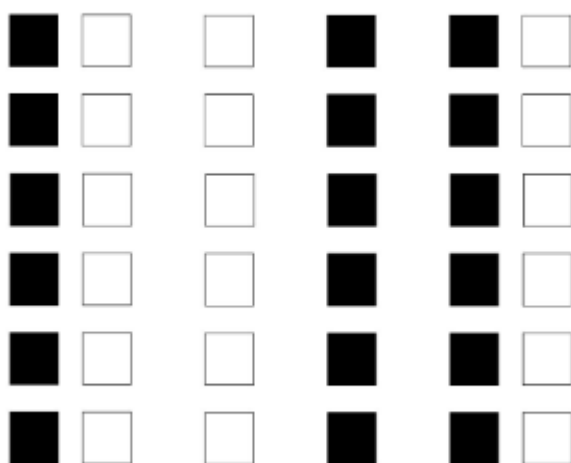
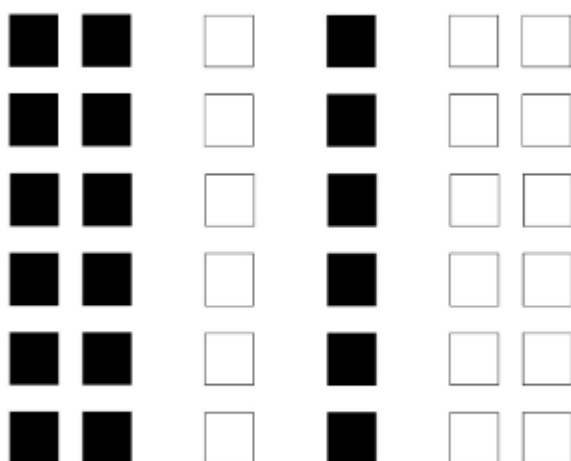


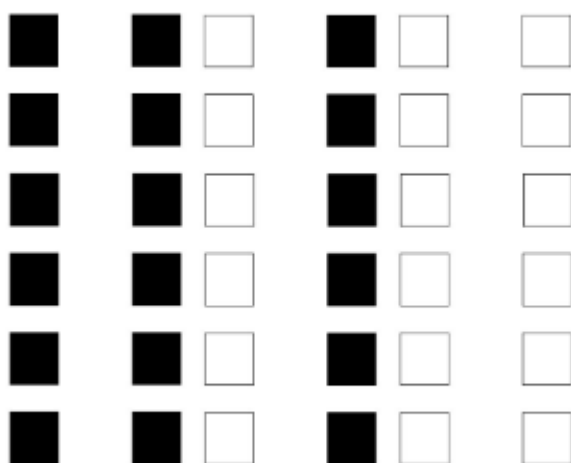
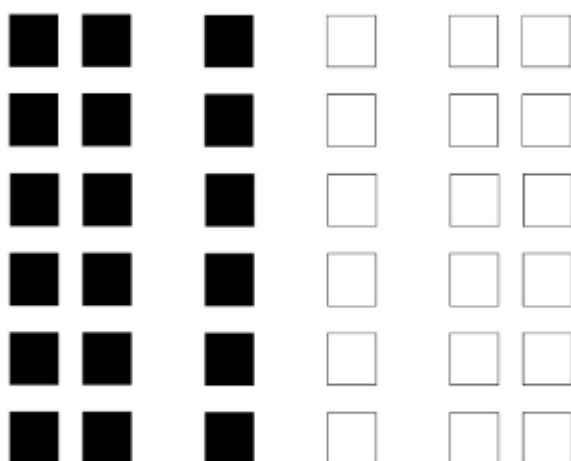


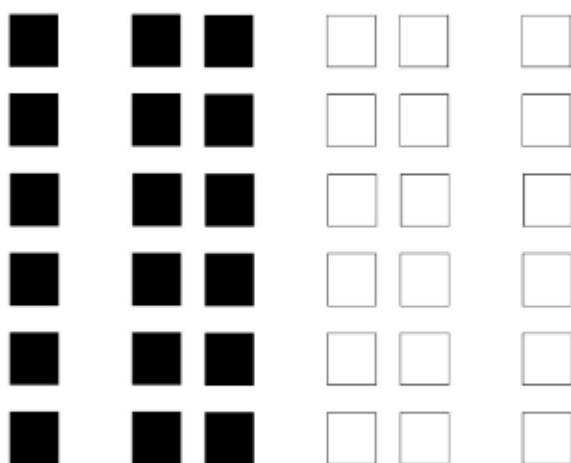
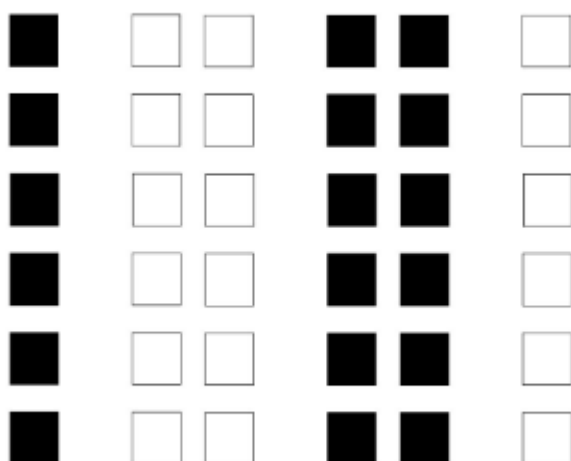












APPENDIX C. Hidden Figure Test

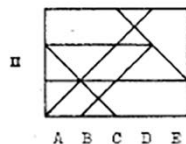
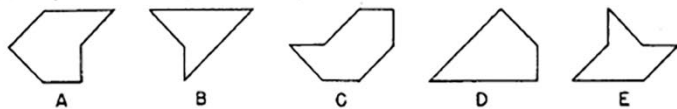
Name _____

HIDDEN FIGURES TEST — CF-1 (Rev.)

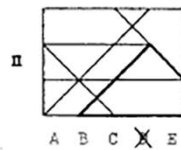
This is a test of your ability to tell which one of five simple figures can be found in a more complex pattern. At the top of each page in this test are five simple figures lettered A, B, C, D, and E. Beneath each row of figures is a page of patterns. Each pattern has a row of letters beneath it. Indicate your answer by putting an X through the letter of the figure which you find in the pattern.

NOTE: There is only one of these figures in each pattern, and this figure will always be right side up and exactly the same size as one of the five lettered figures.

Now try these 2 examples.



The figures below show how the figures are included in the problems. Figure A is in the first problem and figure D in the second.



Your score on this test will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have 12 minutes for each of the two parts of this test. Each part has 2 pages. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

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APPENDIX D. Stimuli of the Study II

