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The Interplay Between Gender and Controlled Environments: A Study on Stimulus Perception

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Abstract

Understanding the interplay of gender and environmental perception is important in recognizing how architectural environments can either reinforce or challenge gendered norms and experiences. Literature reviews at a glance show differences between the environmental perception of women and men, which have significant implications for projects aimed at improving the quality of the environment. Thus, 240 architecture students were invited to participate in a photo exhibition of forty images of various architectural buildings and answer a survey questions regarding the content of photos in the current study. The purpose was to determine how students perceive the environment and to examine perceptual differences among them. Data obtained were collected based on inferential and comparative approaches and were analyzed with SPSS software using Pearson correlation tests and one-sample t-tests. Specifically, the results suggest that females pay more detailed attention to the environment's components than males, while males focus more holistically on the environment content. The results typically indicate that individuals are sensitive to all aspects when confronted with the environment, so all of their senses are active in such a process, accordingly, this should be considered when designing the environment so that all of the user's senses are stimulated in a desired manner.

Keywords: *Environment, gender, perception, senses, stimulus.*

Cinsiyet ve Kontrollü Çevreler Arasındaki Etkileşim: Uyaran Algısı Üzerine Bir Çalışma

Öz

Bulgular, kadın ve erkeklerin çevre algısı arasında farklılıklar olduğunu göstermektedir ve bu farklılıklar, çevre kalitesini iyileştirmeyi amaçlayan projeler için önemli sonuçlar doğurmaktadır. Bu nedenle, 240 mimarlık öğrencisi, çeşitli mimari yapıların kırk fotoğrafından oluşan bir fotoğraf sergisine katılmaya ve mevcut çalışmadaki fotoğraflarla ilgili soruları yanıtlamaya davet edildi. Amaç, öğrencilerin çevreyi nasıl algıladıklarını belirlemek ve aralarındaki algısal farklılıkları incelemektir. Sonuçlar, özellikle, kadınların çevrenin bileşenlerine erkeklerden daha ayrıntılı bir şekilde dikkat ettiklerini, erkeklerin ise çevrenin içeriğine daha bütünsel bir şekilde odaklandıklarını göstermektedir. Ayrıca, sonuçlar tipik olarak bireylerin çevreyle etkileşim kurduklarında tüm yönlere duyarlı olduklarını, dolayısıyla böyle bir süreçte tüm duyularının aktif olduğunu ve buna göre, kullanıcının tüm duyularının istenen şekilde uyarılması için çevre tasarlanırken bu durumun dikkate alınması gerektiğini göstermektedir.

Anahtar kelimeler: *Çevre, cinsiyet, algı, duyular, uyaran.*

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1. Introduction

Interaction with the environment requires perceiving environmental information by human beings. As an effector, the environment sends information in different dimensions and ways. As the receptor, sensory organs transmit the received data to the brain's neural system for processing and perceiving. The majority of this information is processed by the central nervous system after being received by the human sensory organs. Humans use artificial systems to convert imperceptible data into perceptible data to obtain information that their sensory organs cannot receive. The spectrum of human senses is thus expanded, and humans learn about new facets of the world. In truth, we receive information from our environment through our senses. Without sight, hearing, touch, smell, and taste, the human brain would not perceive its environment at all, a world defined by darkness, silence, numbness, odorlessness, and colorlessness (Iriguchi et al., 2018; Barati & Soleimannejad, 2011). Perception shapes man's interpretation of the environment and manifests itself into behavior in the environment. Therefore, the experience of the environment and how it is perceived is a necessary topic for studies of human-environment interaction. Since the neural and perceptual systems are responsible for establishing communication between humans and the environment, it is slopwork to contribute to the environment regardless of having a good command of the processes of environmental perception (Jeffery, 2021). When it comes to architecture and design, it is necessary to pay more attention to the sensation, perception, and cognition processes as eminent dimensions, which accomplish the spatial experience (Spence, 2020). In other words, to create environments compatible with the perceptual-behavioral needs of individuals, recognizing the relationship between the environmental elements and their effect on the users' behavioral, emotional, and perceptual levels is of particular importance. Whatever should be considered about perception is that although individuals have similar mechanisms of sensation and perception, each has a different understanding of the environment. Hence, different perceptions of similar stimuli arise from several factors, and just an influencing factor cannot determine what is perceived (Dixit & Bhattacharya, 2021). Indeed, there are relatively significant psychological differences in the perception of architectural space. Accordingly, architects and designers should give importance to the psychological understanding of human perceptions and behaviors in architectural space. In this context, there are distinct and individual cognitive frames between women and men that set them apart and shape their perspectives on the constructed environment (Basu et al., 2021). Wallhagen et al. (2018) have shown that professionals should improve both women's perceived and actual ability to influence environmental issues to improve environmental design. Ceylan (2020) has revealed that gender equality in the built environment and society have a mutual relationship so architecture needs to consider them as primary input data in design. Gou et al., (2021) have shown that gender as a moderating factor influences the impact of color meaning, color attitudes, and recognition of this aspect is critical to gaining a scientific understanding of how men and women perceive urban architecture and its visual and physical quality.

Based on the concepts, it can be suggested that several factors have an influence on the process of feeling, understanding and knowing the environment. On the other hand, environmental and gender preconditions also play an important role as important factors in the aforementioned process, causing differences in the extent and manner in which people feel, perceive, and experience place. Therefore, the present study aims to investigate the way people feel and perceive the controlled space and gender ratio as an effective factor in the perception of spatial elements. In this context, the study attempts to answer the following questions:

1. Is there a significant difference between the two genders in the recognition of spatial elements in the environment and spatial perception in a controlled environment?

2. Do gender differences cause differences in the perception of expected and unexpected environmental stimuli?

According to the conceptual model of the study, which is derived from the review of the basic concepts such as emotion, perception, and the gender variable in psychology, the study attempts to find answers to the aforementioned questions by showing a series of images of different environmental landscapes to 240 male and female architecture students. In this experiment, in addition to visiting the

photo exhibition, subjects were unintentionally exposed to other unexpected stimuli such as color, sound, and the smell of perfume. After visiting the exhibition, volunteers completed a questionnaire that asked about other stimuli in addition to the content of the images. Finally, the qualitative data obtained from this test were collected and then analyzed using inferential and comparative analysis, and the results were compared with the research hypotheses. At the end of the article, the summary of the test results is presented.

2. Theoretical Framework

2.1. Environmental and Sensational Perception

Perception of the environment is a process that is at the core of environmental behavior. The environment stimulates all the senses and causes a person to be confronted with information that is processed through cognitive experiences. In perceptual processing, the perceiver is considered part of the observed environment and plays an effective role in defining the boundaries and other features of the environment and space due to his or her spatial behavior (Marques et al., 2020). In this regard, perception is intertwined with sensation from the perspective of environmental psychology, especially when individuals separate the perception of objects from the perception of the environment (Steg & de Groot, 2018). The topic of sensation and perception is introduced in psychology under the title of sensation perception, which is based on the achievements of experimental sciences, especially physiology and experimental psychology (Goldstein & Brockmole, 2016). In these sciences, sensational perception is viewed as a process involving human response and psychological interpretation under the influence of environmental stimuli that results in environmental adaptation or environmental cognition (Munro, 2021). The cognition of the environment is a product of sensational perception and leads to the person's adaptation to the environment and the adaptation of behavior (Xue et al., 2017). Based on the above, it can be claimed that the three processes of sensation, perception, and cognition play an important role in the formation of individuals' sensational perceptions toward their environment. In this context, the process of sensation involves the stimulation of the human sensory organs by environmental stimuli and their conversion into electrical impulses and their transmission through the central nerves to the human brain. In this process, sight, hearing, smell, and touch function as the four most important sense organs. As the most basic sense, vision (sight) gathers information from the environment and transmits it to the brain so that distances, colors, shapes, textures, contrasts, and distinctions in the environment can be perceived with the help of this sense. Sound (authitory) provides little information to the human brain, but it is rich in emotion. Music, thunder, falling water, and the sound of the wind, for example, are all emotionally charged. Compared to hearing, it can be said that the human sense of smell (odor) has not made much progress and functions less than hearing in terms of providing information. But this sense is emotive. On the other hand, many human experiences with the tissues (touch) that shape the environment are obtained using skin sensors in the hands and feet when walking or sitting (Stone et al., 2018).

The process of perception in a mental way is actively responsible for selecting, ordering, and giving meaning to sensory information. In this phase, the received information is first identified, then the associated elements are integrated and classified according to previous or new mental concepts (Akoğlu & Akten, 2022). In general, previous sensory experiences, concepts, and individual motivations are effective factors in this process. Other factors that influence the perception process include individual psychological factors (sadness and happiness), physical factors, environmental factors (crowd and loneliness), cultural factors, gender, and personality characteristics (Peat, 2022). After the phase of gathering information and the process of perceiving and interpreting information, the process of cognition takes place. Cognition is the process of acquiring, storing, retrieving, processing, and using knowledge and information. Namely, when we understand from perceived information what that information refers to and how we should respond to it, cognition is achieved (Green, 2020). From the above material, it is clear that the processes of sensing, perception, and cognition involve complex phases and influencing factors. When a person recognizes tangible facts through sensory perception, he or she is informed by sensory receptors of the existence of external or internal world realities. This

sense, after interpretation and interpretation, leads to perception, and the development of this perception ends in the recognition of phenomena.

2.2. Gender and Its Effect on Perception

Gender has a tremendous impact on how people view the world around them. Gender norms and expectations impact how we interpret and understand numerous areas of life from an early age. Gender stereotypes can affect a variety of areas, including social interactions, personal relationships, and professional endeavours. Gender stereotypes, for example, frequently impact how people judge the behaviour, talents, and emotional displays of others. Because of gender biases, men and women may be seen differently in terms of assertiveness, empathy, and leadership abilities. Furthermore, gender can impact how people see their own identities and experiences, since people may internalise cultural messages about what it means to be a man or a woman. Overall, the effect of gender on perception emphasises the need of recognising and fighting these prejudices in order to create a more inclusive and fair society (Kobayasi et al., 2018).

As an important component in relation to spatial design, special attention should be paid to gender. Gender is not defined by the boundaries of people's bodies but is linked to social relationships and is shaped and extended by space. Gender encompasses behaviors, actions, and social thoughts that the dominant culture in any society assigns to both men and women. In terms of gender roles, stereotypical ideas about both genders are observed in society, defining the range of expectations for both genders (Hawes, 2016). Due to the difference between men and women in terms of gender, women and men have different needs. Gender represents a type of relationship in which women and men have different experiences in life. Men and women not only use space in different ways, but they also experience it differently (Palumbo et al., 2021). Studies that have focused on gender in recent decades have moved into architectural and urban space, opening up another topic of social knowledge about space. In general, identifying the differences between men and women can play a role in influencing the behavior of each party. These differences can be studied in the context of various issues. Knowing the differences is important for compatibility, vitality, health, and peace in personal and social life. It is also possible to observe other dimensions of familiarity in the social environment and in the design of spaces, and to consider a kind of balance in this area, considering the psyche of both sexes (Toccaceli et al., 2018).

As far as the perception of gender is concerned, there are various factors, each of which includes a number of viewpoints. For instance, mental visualization is considered a factor in the three-dimensional perception of space. In this regard, Xin et al. (2019) show that men and women have different cerebral processes when it comes to geographic knowledge. According to studies, men outperform women when it comes to transforming two-dimensional maps into three-dimensional representations. Women's cognitive maps are less extensive, but more detailed and rich than men's. Women's cognitive maps are not standard but are based more on internal information (Cocquyt et al., 2022). Visual-spatial perception is another factor that distinguishes men from women. Men and women have different perspectives on the world. This is because women have partial perception, while men have broad perception. Women see details, but men perceive broad lines. In this regard, women have faster perceptual processing (Yuan et al., 2019; Fider & Komarova, 2019). In addition, men and women differ in imagination and auditory perception. Women's hearing is better than men's, and women excel at recognizing sounds (Krizman et al., 2020). Research has shown that women hear almost all of the hundred sound stimuli. Men can hear bass tones better because of their larger heads. For this reason, men often prefer speakers that produce clear and bright bass tones. Women, who often have trouble hearing very low tones, usually prefer those hi-fi devices that provide undistorted sounds. This means that a woman's ear is sensitive and needs appropriate music (Krizman et al., 2021).

Based on reviewing the literature, the study's conceptual model, which shows the interaction between gender and controlled environment in stimulus perception, is presented in Figure 1:

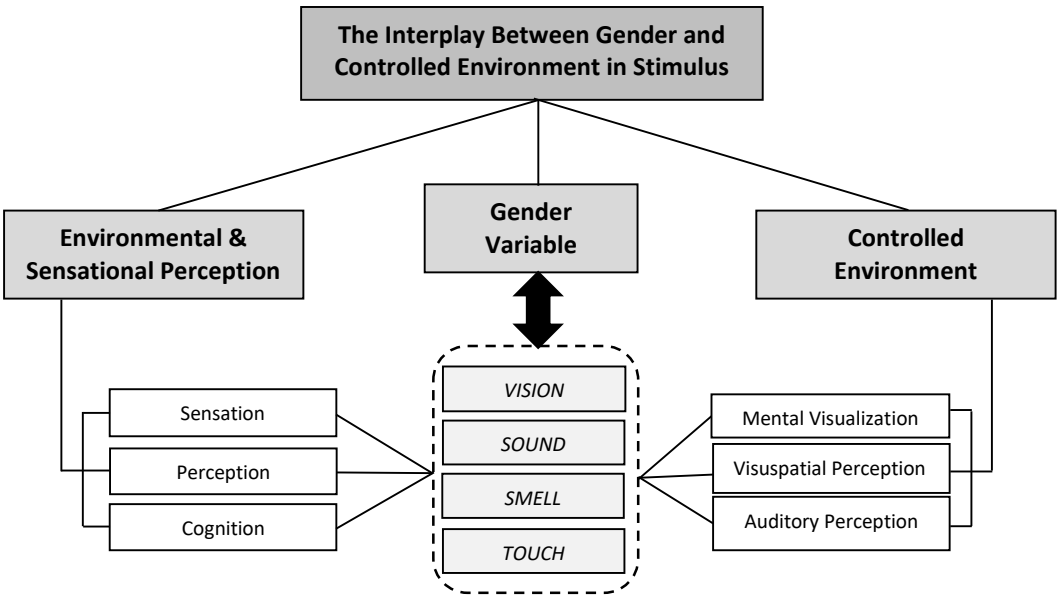

Figure 1. The conceptual model of the study (Khaleghimoghaddam, 2023)

3. Material and Method

In order to examine the effect of gender on the perception of stimuli in a controlled environment, a photo exhibition was held at the Faculty of Architecture and Design, Konya Technical University. According to the conceptual model of the study, the four emotional-perceptual factors of vision, smell, hearing, and touch were measured. Therefore, 20 photographs depicting different architectural buildings were selected. Three scales were used to evaluate visual perception: Color (blue and white), architectural style (modern and traditional), and the presence of a tree in all photos. For this purpose, 6 images of blue buildings (3 modern buildings and 3 traditional buildings) and 6 images of white buildings (3 modern buildings and 3 traditional buildings) were presented (see Figure 2). The aim was to evaluate the participants' recognition of the common elements of the images, i.e., color, architectural style, and tree. In addition, 8 images were shown to evaluate tactile perception. For this purpose, 4 architectural places were built with real materials and 4 images of modeled places were displayed using 3D drawing software. The aim was to evaluate participants' recognition of real and virtual materials. To evaluate participants' olfactory perception, four mango incense sticks were secretly lit in the four corners of the exhibition hall. In addition, a musical device in one corner of the exhibition played the piano continuously with a relatively soft tone. It was important that other elements, including two big maquettes, were placed in addition to the pictures in the hall and in the way the pictures were displayed so that they would not directly attract the attention of the participants. The statistical population of this study includes a total of 240 architecture and urban planning students at Konya Technical University in Turkey. 120 architecture students (60 males & 60 females; M=20.65) and 120 urban planning students (60 males & 60 females; M=21.45) volunteered to participate in this study. Volunteers were asked to enter the hall one at a time, move along a designated path to view the images (such that each image could only be viewed once), then exit the hall and answer a few questions. At the end of the visit to the exhibition, each candidate was given a questionnaire in which they were asked to answer the following questions:

1) What were the colors used in the depicted buildings? 2) In terms of design style, what kind of buildings were exposed in the pictures? 3) What constant factor do you think was repeated in all the images? 3) How many maquettes do you think were present in the exhibition hall? 4) Was music played in the exhibition hall? If so, can you remember the music? 5) Did you notice a certain smell in the exhibition environment, and what do you think it was? 6) What were the images that you did not like and what was the reason?

To ensure that all conditions were as equal as possible, the timing of the test was considered on three consecutive days between 14:00 and 16:00. The validity of the questionnaire was confirmed by a pilot

study with 20 participants (10 women and 10 men). Questionnaire data were analyzed with SPSS software using Pearson correlation tests and one-sample t-tests ($p < 0.01$). Confirmatory factor analysis was performed using structural equation modeling. The reliability of the questionnaire was determined to be 0.787 using Cronbach's alpha test.

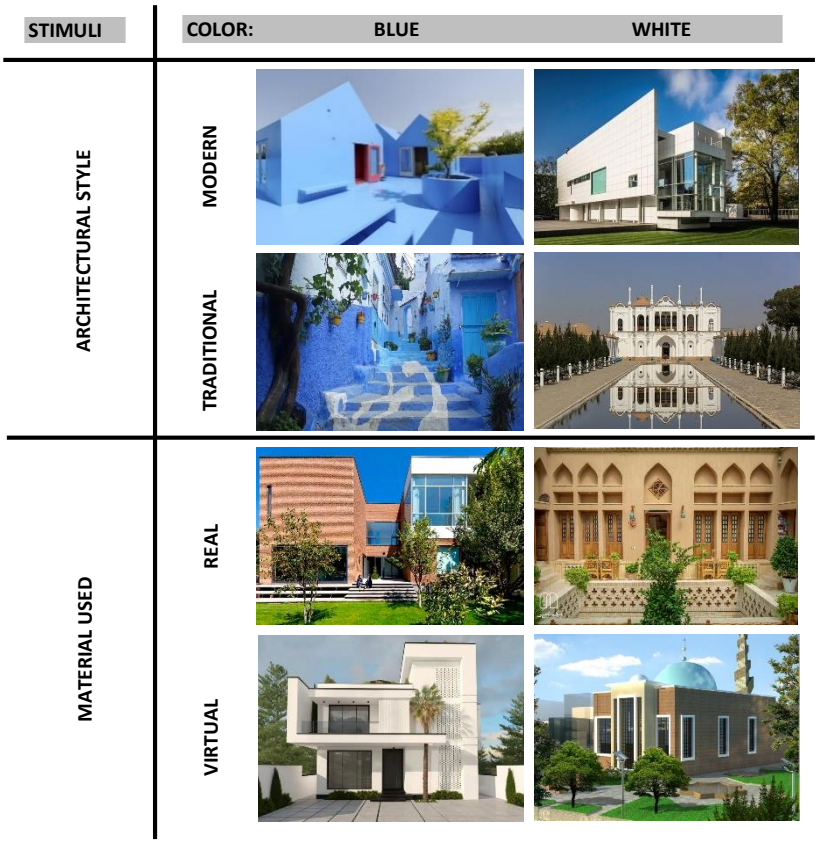

Figure 2. Examples of used architectural stimuli in the study (Khaleghimoghaddam, 2023)

4. Results and Discussion

After completion of the testing procedure, the questionnaires were evaluated, and the data were extracted and analyzed quantitatively. In the analysis phase, first, the whole statistical population was considered and then the data obtained from the questionnaires were analyzed separately for each female and male group, showing the level of perception of each of the participating groups. As shown in Table 1 and Figure 2, 77% of the participants ($M=33.69$, $SD=8.62$, $p<0.01$) rated blue and white as the dominant colors of the depicted buildings in response to the question 'What colors were used in the depicted buildings?'. To the question 'What type of buildings were shown in the pictures?', 59% of the participants ($M=31.21$, $SD=7.14$, $p<0.01$) divided the style of the buildings shown in the pictures into modern and traditional. In response to the question 'What constant factor do you think was repeated in all images?', 48% of participants ($M=28.71$, $SD=6.43$, $p<0.01$) rated the tree as a constant factor in all images. In response to the question 'How many maquettes do you think were presented in the exhibition hall?', 53% of participants ($M=30.61$, $SD=7.27$, $p<0.01$) correctly remembered the number of maquettes presented in the hall. In response to the question 'Was music played and can you remember the music?', 62% of participants ($M=31.85$, $SD=6.87$, $p<0.01$) remembered music and the sound of the piano. 5) Did you notice a particular smell in the exhibition environment and what do you think it was? 51% of the participants ($M=29.00$, $SD=6.66$, $p<0.01$) recognized and remembered the smell that was spread in the hall. To the question 'Which images did you not like and what was the reason?', 79% of participants ($M=34.39$, $SD=8.82$, $p<0.01$) answered that they did not like the rendered images and considered them unreal and untouchable. As the results show, participants paid close attention to the stimuli of color and material. This implies that vision and touch have played roles as the most effective senses in shaping participants' perceptions.

Table 1. The level of perception of all participants (Khaleghimoghaddam, 2023)

Perceptual Variable	Stimuli	M	SD	*p-value*
Vision (Sight)	Recognizing blue and white colors used in buildings	36.39	8.62	0.000
	Recognizing the traditional and modern styles used in buildings	31.21	7.14	0.000
	Recognizing tree as the constant factor in all photos	28.71	6.43	0.000
	Recognizing the number of maquettes in the exhibition hall	30.61	6.77	0.000
Sound (Auditory)	Recognizing the music played during visiting exhibition	31.85	6.87	0.000
Smell (Odor)	Recognizing the smell of incense sticks	29.00	6.66	0.000
Touch	Recognizing real and virtual materials presented in the pictures	34.39	8.82	0.000

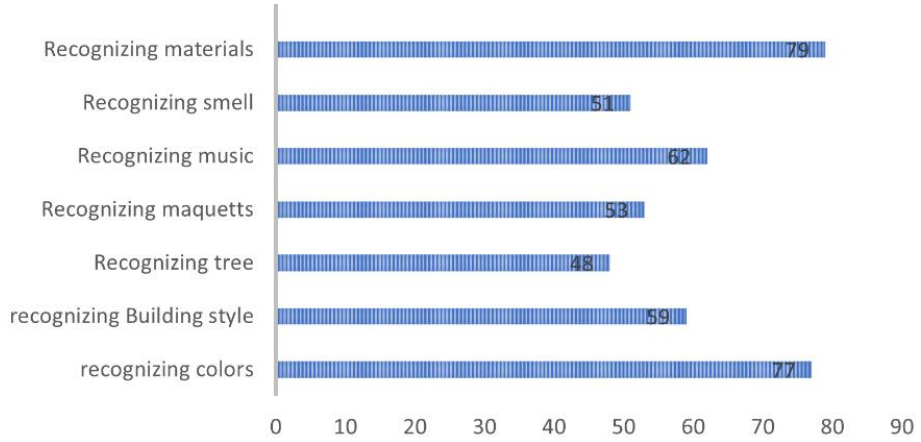

Figure 2. The perception of stimuli by all participants (Khaleghimoghaddam, 2023)

As shown in Table 2 and Figure 3, 86% of female students (M=38.25, SD=8.97, p<0.01) and 68% of male students (M=35.13, SD=8.84, p<0.01) distinguished the blue and white as two more used colors in buildings represented in photos. The 18% difference between female and male ratings shows that women pay more attention to the role of color in shaping the architectural space than men. Such result supports the study results of Fider & Komarova (2019) and Paramei et al. (2018), which have shown that women are superior to men in recognizing colors. This evidence may demonstrate that visual components impacting architecture are more important for women than men (Irguchi et al., 2018), and maybe women are more concerned with the function of color (Abramov et al., 2012). Regarding building styles, 57% of female students (M=28.72, SD=6.99, p<0.01) and 61% of male students (M=33.70, SD=7.23, p<0.01) recognized the categorization of buildings as modern and traditional styles. This shows that both gender groups recognized the distinction between architectural styles in the images almost to the same extent. The 4% difference between male and female ratings suggests that in line with the study results of Hidayati et al. (2020) and Li (2019), architectural styles attract more attention in terms of three-dimensional perception or geometric shapes in men than women.

60% of women (M=34.29, SD=8.23, p<0.01) and 36% of men (M=23.13, SD=4.63, p<0.01) distinguished trees as the constant component in all photos. This indicates that women have paid more attention to details, aesthetic aspects, and judging beauty in space than men. 58% of men (M=23.13, SD=4.63, p<0.01) and 48% of women (M=34.29, SD=8.23, p<0.01) remembered the three big maquettes in the exhibition hall. Such finding suggests that men's perceptions are broad, and they see the general in an architectural environment. It suggests that males who are exposed to architectural surroundings recall both the general and specific elements of the architectural space. This is related to the hormone testosterone, which plays an important role in mental visualization and spatial memory in males (Reinitz et al., 2015). Regarding recognizing the music played, 73% of women (M=36.79, SD=8.61,

p<0.01) recognized the piano sound, compared to 51% of men (M=26.91, SD=6.54, p<0.01) that recognized the piano sound. This supports the study results of Krizman et al. (2020), which show that Women's hearing is better than men's, and women excel at recognizing sounds. Recognizing the smell is concluded in 52% of females (M=26.91, SD=6.54, p<0.01) and 50% of men (M=26.91, SD=6.54, p<0.01). In both test groups, the perception of the smell stimulus differed by 2%. This minor difference has no statistical significance, therefore it can be assumed that the sense of smell in the female and male groups was practically similar. Finally, 87% of female students (M=38.30, SD=8.86, p<0.01) and 71% of male students (M=36.01, SD=8.50, p<0.01) recognized real and virtual materials used in photos and did not like the rendered images and considered them unreal and untouchable. According to Allison et al. (2017) and Liao and Dong (2017), this can be justified by the fact that women pay greater attention to the aesthetic features of environments. Men interpret space in three dimensions purely and mathematically. This could also be due to biological differences, in which women perceive the characteristics of a space in greater detail and pay more attention to material, colour composition, aesthetics, and light, whereas men pay more attention to the general and dimensional characteristics of the architectural space from a higher level (Pletzer et al., 2019; Sneider et al., 2015).

Table 2. Comparison between the perceptional level of female and male (Khaleghimoghaddam, 2023)

Perceptual Variable	Stimuli	Gender	M	SD	t	*p-value*
Vision (Sight)	Recognizing blue and white colors used in buildings	*Female*	38.25	8.84	4.03	0.000
		Male	35.13	8.40		
	Recognizing the traditional and modern styles used in buildings	*Female*	28.72	7.05	3.54	0.000
		Male	33.70	7.23		
	Recognizing tree as the constant factor in all photos	*Female*	34.29	8.23	3.31	0.000
		Male	23.13	4.63		
	Recognizing the number of maquettes in the exhibition hall	*Female*	28.81	7.09	3.55	0.000
		Male	32.41	7.15		
Sound (Auditory)	Recognizing the music played during visiting exhibition	*Female*	36.79	8.61	3.68	0.000
		Male	26.91	6.54		
Smell (Odor)	Recognizing the smell of incense sticks	*Female*	26.94	6.56	3.69	0.000
		Male	26.90	6.54		
Touch	Recognizing real and virtual materials presented in the pictures	*Female*	38.30	8.86	4.34	0.000
		Male	36.01	8.50		

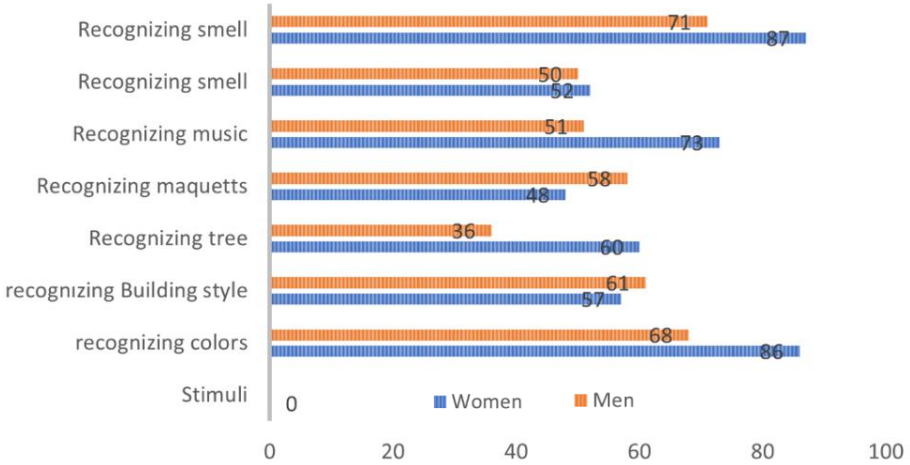

Figure 3. The perception of stimuli by two groups of female and male (Khaleghimoghaddam, 2023)

Generally, the results show that the female participants were more concerned with the conditions and characteristics of the exhibition environment, whereas the male participants were more concerned with the exhibition's content. As a consequence, it is clear that females perceive the controlled environment differently than male, and they pay more attention to the environment and its components.

5. Conclusion and Suggestion

Finally, this study, which focused on the interplay of gender and controlled environment, shed insight into the intriguing dynamics of stimulus perception. Gender has a significant influence on how individuals perceive and behave in controlled situations, according to this study. Such findings show that there are gender differences in how people interpret and interact with stimuli, highlighting the significance of a more nuanced understanding of gender's influence on perception. Indeed, these findings identify important factors that contribute to gender differences in stimulus perception by exploring several controlled conditions and employing rigorous methods. These features include social, perceptual, and physiological components that demonstrate the intricacies of gender and controlled environments. This study also emphasizes the need to recognize and remove gender biases in controlled environments. Recognizing the potential effect of gender on stimulus perception is crucial, as is ensuring fair and impartial treatment in controlled environment research, design, and implementation. Accordingly, further research is needed in the future to delve deeper into the processes behind these gender-related discrepancies in stimulus perception. Investigating the underlying cognitive processes and socio-cultural consequences will provide a fuller picture of how gender influences people's experiences in controlled environments. Finally, this study contributes to the growing body of knowledge about the interplay of gender and controlled environments, emphasizing the significance of a more inclusive and equitable approach to developing and analyzing such environments. By considering gender-specific challenges, we may create environments that welcome different points of view and improve the overall experience for all people.

Acknowledgements and Information Note

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Author Contribution and Conflict of Interest Declaration Information

1st author %100 contributed. There is no conflict of interest.

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