



Visually Induced Multisensory Perception in Modern vs. Traditional Architecture: A Comparative Virtual simulation study

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Abstract

Architecture stimulates all senses to reach comprehensive sensory experience within Immaterial Architecture, the problem emerges from the insufficiency of relying on a single sense to comprehend architecture.

Assuming that Visually perceived materials characteristics function as a stimuli for the remaining senses, and based on the hypothesis; a statistically significant variance in cognitive perception levels (ranging from sensory response to behavioral outcomes) resulting from the differences in characteristics of finishing materials and their applications between modern and traditional environments, these characteristics manifest through contrasting values (material, pattern, color, texture, detail, area of appliance) within the two environments, to investigate the impact of changing finishing material characteristics (within interior design) on the user's perceptual system.

The methodology depends on many steps to reach the objective; applying characteristics to the lobby of the Architecture Engineering Department at the University of Mosul, within virtual simulation to produce two environments, using (Autodesk Revit 2021) software for modeling and (Lumin 12) software for rendering, and collecting perception data by a structured questionnaire alongside virtual tour, with exposure time tracking.

The findings demonstrate that the modern environment possesses a higher degree of spatial intelligibility and a greater capacity to encourage prolonged stay (to some extent) compared to the traditional environment. In contrast, the traditional environment is (to some extent) more effective at evoking spatial memory than its in modern counterpart, confirming that altering characteristics of finishing materials in the environment generally leaves a distinct impact on the level of perception.

The architects' background and training in modern environment explain their perception of higher spatial intelligibility and inclination for prolonged stays in the modern environment. The sensory differences between the two environments did not translate into a significant variance in actual behavior. Future suggestions may deal with other environments related to different architectural styles or trends to be analyzed and tested, scientifically and practically.

Keywords: *Immaterial Architecture, Five Senses, Sensory experience, perception levels, virtual simulation, Modern, Tradition.*

1. Introduction

The architectural environment is shaped by the designer's vision and its impact on the recipient's perception, this perception is influenced by cultural background and the collaboration of the five senses [1], suggesting that relying on a single sense is insufficient to grasp the full reality [2].



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A rich human experience is achieved, and perceptual impact is deepened, through all five senses, the loss of sensation in one sense necessitates compensation for that deficiency [2], this is known as the multi-sensory experience, realized through the continuous interaction between the body's senses and the surrounding environment, this constant interaction can influence emotions, leave lasting memories, and even affect decision-making [3]. Architectural form responds to spiritual needs and is perceived through the five senses [1], turning architecture into an immersive sensory encounter that defines the human experience. According to Jerzy Vetulani (1936 - 2017), this distinction is what separates architecture from mere building [1], it accommodates users with diverse perceptual patterns, thereby enhancing the unique identity of a place [4] and creating architecture that resonates with various tastes and cultures [5].

Furthermore, sensory architecture manifests the designer's creative potential and elevate the design's value and quality by grounding it in user preferences, as well as improving the functional and commercial performance of buildings while enhancing their aesthetic and practical qualities [4]. Conversely, some literature highlights that focusing solely on visual environments leads to an inhuman architecture [2], that is perceptually distorted [3]. Thus, sensory architecture transcends being a silent physical entity to become an interactive experience [5].

The research tackles the impact of design characteristics on perception and sensory experience. To achieve this, the study will review previous literature to identify the most significant design characteristics and their subsequent effects on the five senses on one hand, and on attaining a comprehensive experience on the other. This review aims to explore the feasibility of conducting an empirical application on this topic, the importance is further manifested in the absence of an integrated activation of all senses within the formulation of the architectural form, identity of the place and the user's memory.

So, we can explain architecture according to the sensory phenomenon, since the comprehensive sensory experience within architectural perception involves a vital interaction between the observer's body and their environment through a series of sensory events, architecture transforms from an abstract physical entity into a deep emotional experience that achieves total harmony with its surroundings, this embodies the designer's multifaceted creative horizons, leading to multi-sensory architecture, such architecture stimulates all senses to reach what Juhani Pallasmaa (1936-) describes as Immaterial Architecture.

Immaterial architecture is the perceived absence of matter, rather than the lack of its physical existence; the entire architectural experience relies on the mental interpretation of what is present and absent within the space [6], this is achieved through various technical methods, such as hiding the building within nature, using optical camouflage and nanotechnology to render objects invisible, or even employing light as an element and a primary material [7].

Thus, architecture relies on interpretational perception, which stimulates the imagination and directs toward the abstraction of experience, strengthening the relationship between the design and its observer [4], [6].

Perception is a complex process reliant on sensation, varying according to the unique cultural circumstances of each individual and their differing responses to stimuli [1], this process involves recognizing and interpreting sensory data based on direct sensory input, combined with subjective elements such as time, thought, and memory. Although the process often begins with visual perception as a first stage, followed by the remaining senses [4], it is noted by Skaza that the visual response accounts for 83%, followed by auditory at 11%, olfactory at 3.5%, tactile at 1.5%, and finally gustatory at 1% [1]. According to Kellert (1944 - 2016), the integration of all senses generates an emotional connection to the place [8].

Thus, the concept of comprehensive Perception emerges where the architectural experience shifts from visual dominance to a comprehensive sensory experience. According to James J. Gibson (1904 - 1979), the senses do not function as separate systems but are deeply tangled. For this reason, Pallasmaa views architecture as an art for mediating between the self and the world [8].

The comprehensive sensory experience, achieved through the integration of the visual path and the evaluative response resulting from the synergy of the other senses, contributes to activating the space's message, identity, and function. This approach generates "Immersive experiences" that interact with the environment and extend to address users' emotions and memories, enhancing the sense of comfort and deep connection to the space [5], [10], and granting individuals meaningful moments [10], that support their flourishing, health, and well-being [11].

Here, the Architect bears the responsibility of organizing the space so that its sensory attributes provide positive stimulation, encouraging users to remain within it and achieving emotional, mood, and behavioral interaction and impact [11], [8]. This is considered an indicator of design success, whether historical/ traditional or contemporary/ modern [10], and an indicator of the importance of the comprehensive sensory experience [11].

It can be argued that the characteristics of the built environment, across its various styles from traditional to modern, possess the capacity to stimulate the sensory system simultaneously, thereby enriching the user's comprehensive sensory experience.

It appears that most architectural practices of Modernism are designed for the sense of sight, leading to what is termed sensory deprivation [11]. Pallasmaa pointed out the dominance of sight in architecture and arts, driven by the influence of culture and technology [8]. However, it cannot be said that modern architecture entirely neglected the other senses; rather, it adopted a mono-sensory approach in architecture and urban design. Pallasmaa further emphasized that the dwelling was designed for the "pleasure of the eye" rather than the well-being of the inhabitant, causing architecture to lose its sensory essence [3]. Interest in the remaining senses has only recently begun to shift into professional practice at a very slow step [11].

The study of Marku [12] analyzes the physical projects of pioneering architects Peter Zumthor (1943 -) and Juhani Pallasmaa and concludes that designing with comprehensive sensory perception grants individuals a feeling of unity. It successfully re-alerts building inhabitants, significantly boosting their psychological and physical quality of life [12].

Despite Plato considering the sense of sight as the most important in the field of perception during the early eras, many historical architectural styles aimed to create environments that deeply stimulate all senses, such as Greek and Roman

theaters. Furthermore, the trend toward immateriality began with the beginning of the Renaissance, where the focus shifted to the abstract value of form, away from its material properties. Then, the philosopher George Berkeley (1685 - 1753), who is regarded as the founder of Immaterialism, considered that the sense of touch contributes to the perception of objects, enriching the experience with three-dimensional information about details, and making perception temporal and collective. Consequently, the concept of Tectonics emerged in the 19th century, where each material has its own expressive language linked to its structural nature [6].

Many studies critique modernist architecture for its visual dominance over external form, advocating instead for the activation of multiple senses, in this way, traditional city centers can be revitalized, and the identity of buildings can be enhanced according to their historical or political associations [13]. Abbas's study emphasizes the importance of the integration of the five senses in creating a holistic space that enhances the sense of place and emotional attachment to it. Furthermore, the multiplicity of stimuli increases the clarity of the mental image; this is achieved by utilizing materials with contrasting textures to stimulate the sense of touch, alongside generating sound resonance and directing lighting in unconventional ways [14].

Architectural styles have historically varied in their position toward material characteristics, ranging from attempts to stimulate all senses to a strict focus on the sense of sight, therefore, the research classifies and isolates the design characteristics (in a theoretical framework) associated with each of the five senses, to identify the common characteristics among them, thereby allowing the research to examine them methodically and enabling the designer to manipulate them during the design process.

So, the research focuses on investigating the impact of changing finishing material characteristics (within interior design) on the user's perceptual system, these characteristics manifest through contrasting values within distinct design environments, which were modern and traditional environments.

2. Theoretical framework

There are several indications in the literature regarding the role of each individual sense in enhancing perception; In his book, Pallasmaa pointed out the dominance of sight in architecture and arts [8] therefore designing for the "pleasure of the eye" may cause architecture to lose its sensory essence [3]. Also, he believes that the sense of touch perceives the texture, weight, and temperature of a material, as well as the density of the space surrounding us. Meanwhile, the sense of smell can evoke the strongest memory of a space or place, connecting us to the past and identity of the place [15]

In his book, Zumthor focuses on the sensory experience and considers buildings to address the five senses; architecture is a living experience that reflects memories and a specific sense of place using materials and precise detailing. Furthermore, light gives life to material; the mood of a rough concrete wall and a warm wooden piece is determined by how light falls upon them [16]. Pallasmaa defines the comprehensive experience by stating that when we enter a great architectural space, we do not view it as a mere scene, but experience it with our entire being; we pass through it, feeling its weight, its pressure, its openness, and the shifts in its temperature [17]

2.1. Sense of sight

The relationship between sight and architecture is fundamental [1], as this sense is characterized by its superior ability to explain the material characteristics of architectural space [5]. Visual perception is achieved through the analysis of several design levels, starting with the geometric form of the space (straight lines, curves, and angles) [4], moving through its dimensions, proportions, and directionality.

Furthermore, the detailed elements of interior spaces, whether through their repetition according to a specific rhythmic pattern or the diversity of their styles, contribute to shaping the visual experience [2], [4]. The choice of materials and their textures, the graduation of colors (warm and cold), and their distribution areas play a crucial role in stimulating emotional responses. In this context, lighting (both natural and artificial) emerges as an influential factor, working to reveal those material characteristics or alter their perception, which grants the architectural space its visual impact [2], [4], as shown in Table 1.

Table 1: Sense of sight (Visual Perception Variables) (Researchers)

Vocabularies	Variables	Values
Space Design	Form Dimensions Directionality	
Elements	Repetition Details	
Materials	Type	Natural / Manufactured

	Surface Area	
	Treatment	
	Techniques	
	Details	
	Color	
Influential Factors	Light and Shadow	Natural / Artificial

2.2. Sense of touch

Pallasmaa emphasizes the perceptual priority of this sense, noting that it is more precise and less disposed to error compared to the sense of sight [2]. Materials constitute the primary physical foundation stimulating this sense due to their tangible characteristics, which vary according to their origin (natural or artificial) and thermal properties (warm or cold), tactile perception is influenced by the surface area the material occupies within the space [5], [7], as well as surface treatment techniques and details that grant the material its tangible identity, this tactile response is not limited to the perception of an isolated material but extends to encompass material diversity, as the contrast between textures actively enhances the perception of spatial directionality, guiding user movement within the built environment [5], as depicted in Table 2.

Table 2: Sense of Touch (Tactile Perception Variables) (Researchers)

Vocabularies	Variables	Values
Physical Characteristics	Single Material	Color
		Material Type
		Surface Area
		Treatment Techniques
		Details
	Multiple Materials	Directionality
		Warm / Cool
		Natural / Artificial
		Smoothness / Roughness
		Softness / Hardness

2.3. Sense of hearing

The perceptual value of sound stems from its unifying nature; while sight isolates, sound incorporates [2]. The hearing sense in architecture is stimulated through the integration of two types of characteristics; First, physical characteristics (visually perceived) auditory perception is closely linked to the geometry and volume of the interior space, the response varies between vast spaces and narrow spaces [2], [5]. Furthermore, semi-open spaces with vaulted or domed ceilings contribute to generating an acoustic echo that grants the place a vibrant character or the feeling of quiet isolation, depending on the nature of the sound wave reflection. Material selection and arrangement methods play a crucial role in absorbing or reflecting sound, thereby shaping the acoustic identity of spaces [2]. Second, immaterial characteristics (non-visually perceived), these consist of emitted sounds, which are divided into; Natural sounds such as the sound of footsteps on gravel [2], or the soft rustling of trees [5], the role of water droplets emerges as an active acoustic element that works to shape the space and perceptually list its volume [1], artificial sounds such as music integrated into the space, which constitutes an unconscious experience that stimulates the imagination and deepens the visual sight of the space [1], as shown in Table 3.

Table 3: Sense of Hearing (Auditory Perception Variables) (Researchers)

Vocabularies	Variables	Values
Physical Characteristics	Space	
	Design	
	Volume	Vast/ Narrow
	Material	Arrangement methods
	Proportions	
Non-Visually Perceived Characteristics	Form	
	Details	
	Sounds	Natural
		Artificial
		Rustling of trees
		Water droplets
		Footsteps on gravel
		Music

2.4. Sense of Smell

The olfactory sense acquires a unique perceptual specificity, as Pallasmaa notes that it becomes more active in conditions of silence and the absence of light, he asserts that the nose possesses a capacity for remembering that surpasses that of the eye, allowing for a deeper and more acute perception of space, and spatial variations [2].

Table 4: Sense of Smell (Olfactory Perception Variables) (Researchers)

Vocabularies	Variables	Values
Physical Characteristics	Heritage Spaces	Historical/ Traditional
	Natural Integration Spaces	
	Materials	Organic/ Nonorganic
	Surface area	

Non-Visually Perceived Characteristics	Traces Materials	Natural/ Artificial
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The efficiency of this sense manifests across several temporal dimensions; Spatial memory, historical and heritage spaces are characterized by a high capacity to stimulate olfaction through specific traces linked to distinct memories, granting the place a tangible temporal identity [2], [1]. Spaces that open to the natural environment enrich the sensory experience through botanical fragrances and organic materials, enhancing the connection to the natural origin of the place [1].

The selection of construction materials and the surface area exposed to air play a crucial role in emitting traces and determining the nature of the comprehensive sensory encounter with the space, natural materials (such as wood and clay) possess an olfactory language that radically differs from artificial materials [1], as seen in Table 4.

2.5. Sense of Taste

Although there is no direct physical relationship between architecture and the sense of taste [1], this sense is stimulated within architectural space through mental associations with physical characteristics perceived visually and haptically. This connection manifests through the careful selection of materials (natural, such as wood and marble, or artificial), their treatment methods, and finishing details. This is further supported by spatial deployment of colors that evoke gustatory experiences, colors and textures possess the ability to simulate flavors in the mind, sharp red tends to stimulate a sensation of a spicy taste, whereas warm brown reminds us of sweetness, green may evoke bitterness or acidity, while yellow and orange gradations are associated with a sour taste [5]. Thus, warm colors and rich-textured materials act as indirect causes for the gustatory sense, completing the comprehensive sensory experience of the architectural space, as illustrated in Table 5.

Table 5: Sense of Taste (Gustatory Perception Variables) (Researchers)

Variables		Values
Physical Characteristics	Materials Type Treatment Details Colors	Natural/ Artificial

Table 6: Characteristics of materials affecting Senses (Perception Variables and Values) (Researchers)

Senses	Characteristics of materials/ Variables	Values
Sense of Sight	Origin	Natural Manufactured Mixed
	Geometry	Geometrical form Organic form
	Color	Warm (red, orange, yellow) Cold (blue, green, purple)
Sense of Touch	Roughness/ Texture	Smooth Rough
	Softness	Soft Hard
	Sensation	Warm sense Cold sense
Sense of Hearing	Kind	Stone walls Brick walls Wooden walls
		Natural Manufactured
		Ordinary Attractive
Sense of Taste	Color	Natural Manufactured
	Treatment and Details	Light
Influential factors		

While the sense of sight is stimulated exclusively by the physical characteristics of the environment, the remaining senses (hearing, touch, smell, and taste) can be activated through the interplay of both material and immaterial characteristics. Given that immaterial characteristics require direct field testing to measure their impact, which faces methodological challenges such as subjective variances among users and the difficulty of controlling and measuring variables accurately, this research will focus on physical characteristics (visually perceived) as the primary, controllable stimuli for the remaining senses, therefore, variables associated with the remaining four senses were not measured.

Based on the foregoing, it is evident that “Materials characteristics” across their various types represent the active driver for all five senses, and posit a direct correlation between the depth of perception and the probability of stimulating the comprehensive sensory system, in this instance, architecture transcends its physical domain, transforming into what is

termed “Immaterial Architecture”. Consequently, the impact of materials and their diverse characteristics on the users of the built environment will be investigated as the primary variable of this study, as illustrated in Table 6.

So, by assuming that visually perceived materials characteristics function as a stimuli for the remaining senses by activating advanced stages of perception, and by focusing on a hypothesis that a statistically significant variance in cognitive perception levels (ranging from sensory response to behavioral outcomes) resulting from the differences in characteristics of finishing materials and their applications between modern and traditional environments.

3. Methodology

The research focuses on investigating the impact of changing characteristics of interior design finishing material on the user’s perceptual system, these characteristics manifest through contrasting values within distinct design environments, to verify this variance, the research adopts the following procedures:

- Variables identification: Determining the extreme values of the selected characteristics of finishing materials (material, pattern, color, texture, detail, area of appliance), as presented in Table 7.

The characteristics of both environments were identified through literature review. Pallasmaa's critique of modern architecture focused on the characteristics of manufactured cladding materials such as glass, aluminum, plastic, and steel with a polished texture. Conversely, the traditional environment relies on natural materials such as wood, stone, plaster, and brick with a rough texture rich in patterns [15].

While Pallasmaa emphasizes how the contrast of cladding materials between the two environments creates a distinction between a purely visual, flat-dimensioned architecture and an architecture that invites interaction and reveals its age, Zumthor works on blending materials with contrasting characteristics to produce a unique and impactful environment [16].

- Models construction: Applying these values and materials within two contrasting virtual environments (a model representing the modern environment and another for the traditional one).

- Sample Selection: First, the two environment models were presented to a group of users within a pilot study to ensure their familiarity with the design, the participants recognized it immediately, with some pointing out the specific impacts and variations caused by the finishing materials. Second, presenting the models to two separated groups of respondents consisting of architectural experts within a virtual simulation to ensure sensory engagement. These experts were academics and postgraduate students, as they are fully aware of the research context, the primary objectives of the study, and pre-users of the software.

Table 7: Characteristics of finishing materials within both environments in models (Researchers)

	Traditional environment	Modern environment
Material	Natural (wood, brick, ...extra)	Manufactured (steel, aluminum, glass, ... extra)
Pattern	Organic	Geometric
Color	Warm (red, yellow, orange, extra)	Cold (blue, green, purple, ...extra)
Texture	Grain, scrab	Slick, glossy
Detail	Elegant, dense	Abstract, little
Area	Small area	Large area

3.1. Measuring tools and mechanism

University of Mosul
College of Engineering
Department of Architecture Engineering

Questionnaire for research purpose only

Qualification	Bsc	Msc	Phd
Experience	Academic	Practical	Both

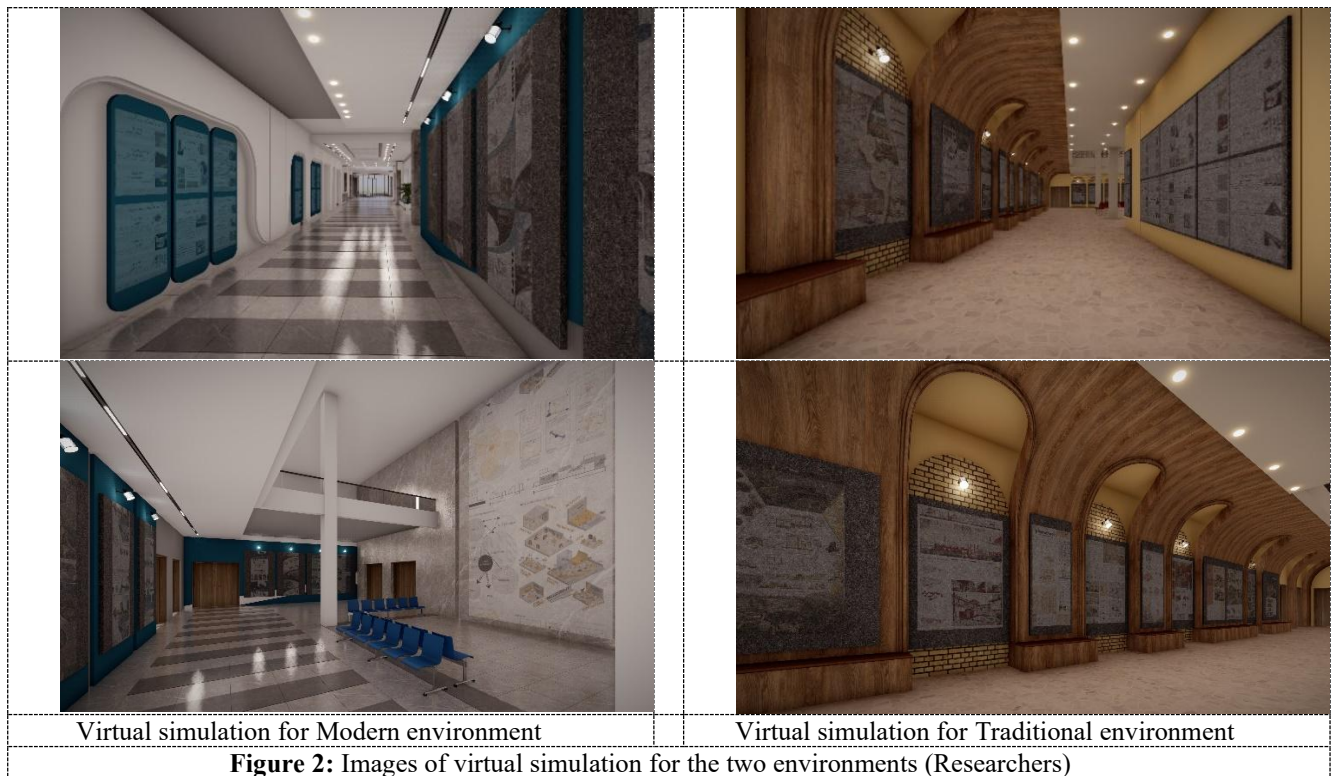
The space looks more legible than before	Strongly not agreed	Not agreed	Neutral	Agreed	Strongly agreed
The space needs more contemplation than before	Strongly not agreed	Not agreed	Neutral	Agreed	Strongly agreed
The space encourages prolonged stay more than before	Strongly not agreed	Not agreed	Neutral	Agreed	Strongly agreed
The space gives different feeling more than before	Strongly not agreed	Not agreed	Neutral	Agreed	Strongly agreed
The space flourishes memories more than before	Strongly not agreed	Not agreed	Neutral	Agreed	Strongly agreed

Is there any worthy thing to be mentioned...?
Consuming Time...?

Figure 1: The questionnaire (Researchers)

- Observing time during the virtual tour as a behavior indicator, allowing full freedom of movement sequence to measure the spent time independently of any subjective influences. Adopting the time indicator include its comprehensive nature, as it encompasses other indicators such as the need for contemplation and understanding details. Furthermore, it is easy to measure accurately during the participants' experience of the environment under testing. It can also be considered a primary indicator that is compatible with the tools used in the research. Additionally, adopting other indicators would require more complex and costly software that was not available to the researchers.
- Exploring the stages of perception through structured questionnaire, as seen in Figure 1.
- Analysis and Conclusion: Statistically processing the questionnaire data and time measurement results to extract the fundamental differences between the two environments, and subsequently formulating the final conclusions.





3.2. Application requirements

A virtual simulation was constructed for both the modern and traditional environments, applied to the lobby layout and circulation axis within the Department of Architecture Engineering building at the University of Mosul, (as shown in Figure 2). This approach ensures that respondents are not preoccupied by exploring the building's architectural design, thereby focusing their attention exclusively on the interior design finishing materials, the core layout of the building lobby was kept constant, including the same circulation system, structural elements, and door and window locations. However, the finishing materials for the ceilings, walls, flooring, and structural components were altered, and informational or advertising signage was added, in alignment with the distinct characteristics of both environments, previously mentioned.

The virtual simulation was developed using (Autodesk Revit 2021) software to create the 3D model and define spatial details, while (Lumion 12) software was used to apply materials and lighting, as well as to generate images and videos. Furthermore, (Lumion 12) provides real-time navigation within the space, enabling a comprehensive and immersive sensory experience through free movement and static observation, according to the participant's preferences.

The results were analyzed using (SPSS), utilizing statistical methods (The Pearson Correlation Coefficient was used because it determines the strength and direction of the relationship between two variables with quantitative data. Furthermore, it helps ascertain whether the relationship between the two variables is statistically significant or if it occurred by chance), (Spearman's Rank Correlation Coefficient was used because it measures the strength and direction of the relationship between two variables with ordinal data, as seen in the research variables based on preference scores), and (Mann-Whitney U test , A non-parametric test was used to compare the datasets of the two environments to determine the presence of statistically significant differences between both, particularly given the small sample size and the ordinal nature of the variables).

4. Results

4.1. Total results for the whole sample (60 respondents)

The findings indicated a positive correlation among the first, second, and third research indicators; meaning that as spatial clarity increases, the more need for greater spatial contemplation, thereby enhancing the space's capacity to encourage prolonged stay.

The findings revealed a positive correlation among the second, fourth, and fifth research indicators; meaning that a greater need for spatial contemplation produces a more distinct environmental sensation and a stronger evocation of spatial memory.

The findings demonstrated a positive correlation between the third and fifth indicators; meaning that the more a space encourages prolonged stay, the more effectively it flourishes memories.

The results further revealed that the correlation between the five perceptual indicators (1, 2, 3, 4, and 5) and the indicator of time was not statistically significant, as shown in Table 8.

Table 8: Result of Pearson Correlation between variables for the whole sample (Researchers)

		Q1	Q2	Q3	Q4	Q5	Time
Q1	Pearson Correlation	1	.305*	.440**	.124	.245	.151
	Sig. (2-tailed)		.018	.000	.347	.059	.250
	N	60	60	60	60	60	60
Q2	Pearson Correlation	.305*	1	.225	.255*	.321*	-.088-
	Sig. (2-tailed)	.018		.084	.049	.012	.504
	N	60	60	60	60	60	60
Q3	Pearson Correlation	.440**	.225	1	.017	.290*	-.064-
	Sig. (2-tailed)	.000	.084		.897	.024	.629
	N	60	60	60	60	60	60
Q4	Pearson Correlation	.124	.255*	.017	1	.195	.020
	Sig. (2-tailed)	.347	.049	.897		.136	.879
	N	60	60	60	60	60	60
Q5	Pearson Correlation	.245	.321*	.290*	.195	1	-.067-
	Sig. (2-tailed)	.059	.012	.024	.136		.610
	N	60	60	60	60	60	60
Time	Pearson Correlation	.151	-.088-	-.064-	.020	-.067-	1
	Sig. (2-tailed)	.250	.504	.629	.879	.610	
	N	60	60	60	60	60	60

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 9: Results of the whole sample (Researchers)

Whole sample	Strongly agreed	Agreed	Neutral	Not agreed	Strongly not agreed	Arithmetic Mean	Standard Deviation	Sample inclination
Q1	20	25	7	7	1	3.93	1.03	Agreed
Q2	15	39	4	2	0	4.12	0.66	Agreed
Q3	20	25	11	4	0	4.02	0.88	Agreed
Q4	32	27	1	0	0	4.52	0.53	Strongly Agreed
Q5	11	31	11	6	1	3.75	0.92	Agreed
Overall Mean	19.6	29.4	6.8	3.8	0.4	4.068	0.804	Agreed

4.2. The Modern environment (30 Respondents)

The findings revealed that the correlations among the six research indicators were not statistically significant, with a single exception of the relationship between the third and fifth indicators, (see Table 12).

Table 10: Result of Spearman correlation for the modern environment (Researchers)

Modern environment	Strongly agreed	Agreed	Neutral	Not agreed	Strongly not agreed	Arithmetic Mean	Standard deviation	Percent age	Sample inclination
Q1	12	15	0	3	0	4.2	0.87	84	Strongly Agreed
Q2	8	19	2	1	0	4.13	0.67	82.6	Agreed
Q3	15	11	3	1	0	4.33	0.79	86.6	Strongly Agreed
Q4	13	16	1	0	0	4.4	0.55	88	Strongly Agreed
Q5	4	12	8	5	1	3.43	1.02	68.6	Agreed

Overall Mean	10.4	14.6	2.8	2	0.2	4.1	0.87	82	Agreed
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4.3. The Traditional environment (30 Respondents)

The findings indicated that the correlations among the six research indicators were not statistically significant, with a single exception of the relationship between the first and fifth indicators, as seen in Table 13.

Table 11: Result of Spearman correlation for the traditional environment (Researchers)

Traditional environment	Strongly agreed	Agreed	Neutral	Not agreed	Strongly not agreed	Arithmetic Mean	Standard deviation	Percentage	Sample inclination
Q1	8	10	7	4	1	3.67	1.11	73.4	Agreed
Q2	7	20	2	1	0	4.1	0.65	82	Agreed
Q3	5	14	8	3	0	3.7	0.86	74	Agreed
Q4	19	11	0	0	0	4.63	0.48	92.6	Strongly Agreed
Q5	7	19	3	1	0	4.07	0.68	81.4	Agreed
Overall Mean	9.2	14.8	4	1.8	0.2	4.03	0.86	80.6	Agreed

4.4. Comparative results

The comparative findings indicated statistically significant differences between the two environments (modern and traditional) regarding the first, third, and fifth questions ($z = -1.977$ -, -2.877 -, -2.559 - respectively). Conversely, no statistically significant differences were observed in the respondents' answers to the second and fourth questions, as well as the time indicator ($z = -.237$ -, -1.622 -, $-.207$ - respectively), as presented in Table 14.

Precisely, the sample's inclination toward the first and third questions was more obvious in the modern environment than in the traditional one. On the other hand, the inclination toward the fifth question was more obvious in the traditional environment than in the modern one. See Table 9, Table 10 & Table 11.

Table 12: Result of Spearman Correlation for the Modern Environment (Researchers)

			Q1	Q2	Q3	Q4	Q5	Time
Spearman's rho	Q1	Correlation Coe.	1.000	.289	.352	.353	.213	.320
		Sig. (2-tailed)		.121	.056	.056	.258	.085
		N	30	30	30	30	30	30
	Q2	Correlation Coe.	.289	1.000	.275	.135	.350	.189
		Sig. (2-tailed)	.121		.142	.477	.058	.316
		N	30	30	30	30	30	30
	Q3	Correlation Coe.	.352	.275	1.000	.233	.468**	.092
		Sig. (2-tailed)	.056	.142		.216	.009	.629
		N	30	30	30	30	30	30
	Q4	Correlation Coe.	.353	.135	.233	1.000	.037	.074
		Sig. (2-tailed)	.056	.477	.216		.848	.697
		N	30	30	30	30	30	30
	Q5	Correlation Coe.	.213	.350	.468**	.037	1.000	-.043-
		Sig. (2-tailed)	.258	.058	.009	.848		.821
		N	30	30	30	30	30	30
	Time	Correlation Coe.	.320	.189	.092	.074	-.043-	1.000
		Sig. (2-tailed)	.085	.316	.629	.697	.821	
		N	30	30	30	30	30	30

** . Correlation is significant at the 0.01 level (2-tailed).

Table 13: Result of Spearman Correlation for the Traditional Environment (Researchers)

			Q1	Q2	Q3	Q4	Q5	Time
Spearman's rho	Q1	Correlation Coe.	1.000	.273	.316	.157	.515**	.089
		Sig. (2-tailed)		.145	.089	.406	.004	.640
		N	30	30	30	30	30	30
	Q2	Correlation Coe.	.273	1.000	-.088-	.284	.160	-.287-
		Sig. (2-tailed)	.145		.644	.129	.399	.124
		N	30	30	30	30	30	30
	Q3	Correlation Coe.	.316	-.088-	1.000	-.068-	.295	-.086-
		Sig. (2-tailed)	.089	.644		.720	.114	.653
		N	30	30	30	30	30	30
	Q4	Correlation Coe.	.157	.284	-.068-	1.000	.219	-.020-
		Sig. (2-tailed)	.406	.129	.720		.244	.917
		N	30	30	30	30	30	30
	Q5	Correlation Coe.	.515**	.160	.295	.219	1.000	.061
		Sig. (2-tailed)	.004	.399	.114	.244		.751
		N	30	30	30	30	30	30
	Time	Correlation Coe.	.089	-.287-	-.086-	-.020-	.061	1.000
		Sig. (2-tailed)	.640	.124	.653	.917	.751	
		N	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

Table 14: Result of (Mann-Whitney U test) for both Environments (Researchers)

	Test Statistics ^a					
	Q1	Q2	Q3	Q4	Q5	Time
Mann-Whitney U	324.000	436.500	267.000	354.500	290.500	436.000
Wilcoxon W	789.000	901.500	732.000	819.500	755.500	901.000
Z	-1.977-	-.237-	-2.877-	-1.622-	-2.559-	-.207-
Asymp. Sig. (2-tailed)	.048	.813	.004	.105	.010	.836

a. Grouping Variable: Model

5. Discussion

In results (for the whole sample) the five indicators are interrelated and mutually influential, confirming that the first five stages of perception operate sequentially. On the other hand, the behavioral stage (the time indicator) generated non-distinct values, its correlation with the initial five stages of perception did not reach statistical significance. This implies that introducing any modification could significantly and generally impact perception and its sequential stages. Consequently, this intensifies the responsibility of the architect, and subsequently the interior designer, regarding material selection and application techniques. However, the lack of correlation between the perceptual stages and the time indicator could be attributed to several factors. First, the virtual simulation tools may not have been sufficiently immersive to cause deep and long-term behavioral effects. Second, the modifications and variations in materials might have been relatively familiar, thereby failing to prompt distinct temporal variances during the virtual tour.

As for the (Modern environment) the outcome demonstrates an increased capacity of the space to encourage prolonged stay corresponds directly to a more effective evocation of spatial memory. This can be explained by the fact that modern environmental inputs possess a spiritual character that occasionally influences the subconscious, an outcome that modern architecture explicitly sought to achieve by evoking shared sensations fundamentals among observers, particularly for Le Corbusier. These findings confirm the assertions of certain scholars previously mentioned, such as Hadjiphilippou and Roy, who posited that modernist architecture did not entirely disregard the remaining senses in favor of a mono-sensory approach in architecture and urban design.

While the outcome demonstrates that within the traditional environment, a greater level of spatial intelligibility corresponds directly to a more effective evocation of spatial memory. This supports the assertions of certain scholars previously mentioned, such as Marku and Theart, that a holistic sensory experience can enhance the sense of place and identity, attributes closely tied to the traditional environment. This can be explained by the fact that the traditional environment is inherently familiar, thus enhancing its clarity through specific materials and intricate details serves to draw observers' attention to the quality and precision of craftsmanship, while attempting to establish its connection to heritage and collective memory.

These findings demonstrate that the modern environment possesses a higher degree of spatial intelligibility and a greater capacity to encourage prolonged stay (to some extent) compared to the traditional environment, which is (to some extent) more effective at evoking spatial memory than its modern counterpart.

The findings validate the research hypothesis, confirming that altering characteristics of finishing materials in the environment generally leaves a distinct impact on the stages of perception. Furthermore, a clear distinction emerges between the two environments regarding the nature and sequential phases of perception, thereby achieving the primary objective of the study.

6. Conclusion

This outcome can be attributed to the fact that the sample consists of architects who were raised and trained within a modern environment; consequently, they perceive the modern environment as possessing greater spatial intelligibility, a perception that directly manifested in their inclination to prolong their stay within it. Nevertheless, the traditional environment proved to be more effective at evoking spatial memory than the modern one.

This demonstrates a clear variance between the two environments in stimulating spatial intelligibility, the capacity for prolonged stay, and the evocation of memory. However, this sensory and cognitive stimulation did not translate into a significant variance in the respondents' behavioral outcomes regarding time exposure.

Ultimately, these findings signify that while a distinct divergence exists between the respondents' lived experiences within the two environments, this cognitive and sensory variance does not explicitly manifest at the behavioral stage.

In this regard, Pallasmaa noted that modern space has an immateriality character that evokes freedom, lightness, and modernity, it utilizes continuous glass walls, ultra-thin hidden structural elements, and smooth or reflective white surfaces to make the boundaries between inside and outside dissolve completely, making the user feel as though they are floating in space. Conversely, the approach toward materiality space that evokes stability and warmth requires natural materials, rich details, and a rough texture to provide a sense of security and intimacy, along with minimal glass areas, typically aligned with traditional environment.

This stresses the importance of careful selection regarding finishing materials in interior design, given their strong correlation with architectural styles on one hand, and their clear, varying impact on the stages of perception on the other. This furthermore enables control over the character and identity that the designer seeks to inspire within the space, thereby reinforcing the significance of exploring this subject more broadly and applying it both academically and practically.

7. Recommendation

The research highlights the need to use more accurate means to construct virtual reality and test the differences between both environments. Likewise, ideas regarding other environments related to different architectural styles or trends can be developed. These tools, methodologies, and results can be utilized to develop design and academic work, moving it toward a more scientific and practical level at the same time. On the other hand, the research methodology can be applied to explore the nature of perception among various groups of users, such as those interested in history, art, or ordinary people, to reveal their tendencies and how they relate to the functional type they occupy.

Availability of data and material

Data can be available by contacting the corresponding authors upon reasonable request.

Acknowledgement

All authors contributed equally to the preparation of this article, The authors appreciate the scientific and logistic supports from the College of Engineering/ University of Mosul.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding source

This study didn't receive any specific funds.

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