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Modulating Perception in Interior Architecture Through Décor: An Eye-Tracking Study of a Living Room Scene

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Abstract: The visual perception of interior architecture plays a crucial role in real estate marketing, influencing the decisions of buyers, interior architects, and real estate agents. These professionals rely on personal assessments of space, often drawing from their experience of using décor to influence how interiors are perceived. While intuition may validate some approaches, this study explores an under-examined aspect of interior design using a mobile eye-tracking device. It investigates how decorative elements affect spatial perception and offers insights into how individuals visually engage with interior environments. By integrating décor into the analysis of interior architecture, this study broadens the traditional scope of the field, demonstrating how décor composition can modulate spatial perception using eye-tracking technology. Results show that effective styling can redirect attention from key architectural elements, sometimes causing them to be overlooked during the critical first moments of observation commonly known as the "first impression". These findings have important implications for interior design practice and architectural education.

Keywords: interior architecture; interior design; home staging; décor; eye-tracking; eye movement; modulation; control; real estate marketing

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1. Introduction

Visual perception of interior architecture plays a fundamental role in real estate marketing [1,2]. Buyers, interior architects, designers, home stagers, and real estate agents are guided through business decisions by subjective and personal assessments of the space. Professionals usually have broad individual experience regarding how to use décor to improve interior perception and direct attention toward or away from specific elements within a space [3,4]. Home staging practitioners operate based on subjective beliefs and experiences, assuming that décor influences perceptions of the interior [5]. Although intuition supports the validity of some of these ideas, the concept has not yet been explored scientifically. Therefore, the scope of this research is to objectify interior perception and demonstrate how human attention can be modulated through intentional design choices, whether the goal is to highlight certain features or distract from less-desirable aspects. To obtain data that can facilitate the exploration of this issue, an eye-tracking study was conducted to analyze sight paths in a sample living room scene. The scene was studied in three different scene variants, and the changes in sight paths were observed. The knowledge gained from this study contributes to understanding the efficiency of home stylists' actions in the real estate market. This can confirm or disconfirm the validity of a home stager's usefulness in renting or selling properties. Such an approach can be applied to both interior design and home staging in professional settings to optimize design outcomes.

1.1. Research Background

The eye-tracking method is a well-established tool in visual marketing research, as demonstrated by Wedel et al. [6]. The eye-tracking method was selected due to its ability to offer objective, real-time insights into visual attention and user engagement. By directly measuring where users focus, the duration of their attention, and what captures their interest, eye-tracking eliminates the biases inherent in self-reported data from surveys or interviews. This method quantifies visual behavior, making it more reliable than subjective techniques such as observational studies, while remaining more human-centered than computational models [7]. Furthermore, in the real estate context, it provides immediate feedback, whereas other methods depend on delayed user recall, which may not accurately capture real-time reactions. The main limitation of this method is the lack of insight into the emotions that accompany the visual engagement of the subjects, which is easy to obtain through surveys and questionnaires. In architecture literature, the application of eye-tracking methods in architecture, interior architecture, and interior styling have been analyzed, confirming a growing number of studies utilizing the eye-tracking method. These studies either focused on examining architectural structures themselves or on placing these structures in the broader context of other elements, both architectural and non-architectural. For example, a study by Lisińska-Kuśnierz and Krupa [8] explored the use of eye-tracking to analyze urban spaces, demonstrating its effectiveness in understanding how individuals visually interact with their surroundings. Another study by Rusnak [9] further confirmed the applicability of eye-tracking in architectural design, particularly when dealing with cultural heritage monuments. This study analyzed how the addition of logos and the use of specific colors affected the perception of existing monuments. Before conducting the eye-tracking experiment, a detailed survey was distributed to experts on architecture and cultural heritage sites. The findings not only validated the opinions of these experts, but also provided new insights into how visual stimuli, such as logos and colors, influence the perception of historical architecture. This underlines the high value of eye-tracking in architectural research, as it not only supports expert opinions but also offers additional data-driven perspectives on how architectural elements are experienced visually. An eye-tracking device provides valuable insights into interior elements that capture the most visual attention. Both stationary and mobile eye-tracking devices are commonly used in such studies. For instance, Tuszyńska-Bogucka et al. [10] employed a stationary eye-tracker to demonstrate that different spatial arrangements evoke varied reactions. Contrastingly, Rusnak and Ramus [11] conducted an on-site eye-tracking study of the Warsaw Uprising Museum's interior, using a mobile eye-tracker to identify the most visually engaging elements. Their research aimed to identify the elements within a museum's interior that captured the most visual attention from visitors. The applicability of the eye-tracking method to interior design is also confirmed through research conducted by Göktaş et al. [12]. In their study, a kitchen environment was analyzed to gather valuable data to improve the design of kitchen furniture. Using a mobile eye-tracker, the researchers identified kitchen areas that attracted the most visual attention. This information proved instrumental in guiding the decision-making process related to furniture design, ensuring that both functionality and aesthetic appeal were considered based on where users naturally focused their gazes. The key findings showed that eye-level components and those made from various materials consistently attracted the most visual interest. Additionally, lighting and the strategic placement of accessories play critical roles in drawing attention, helping designers optimize both the aesthetic appeal and functionality of their products. Regarding studies exploring interior architecture and different design approaches, the closest related research was conducted by Bo Hyeon Park and Kyung Hoon Hyun [13]. They examined the combinations of colors and materials used in interior design, recognizing the gap in

the field due to the lack of well-established principles or rules governing the application of interior design styles. As noted by the authors, "no specific principles or rules have been established" [13]. Their research emphasized the style of interior architecture rather than focusing solely on the visual impact or presence of individual styling components.

A study has been conducted on the perception of greenery in interior spaces, focusing on various arrangements of greenery, as presented in the paper, "Occulographic Study on Greenery in Interiors of Public Libraries" [14]. This research explored the potential for consciously designing greenery placements to capture and direct attention more effectively. An analysis of the preceding studies reveals that the research presented in this study introduces a new perspective within the field of interior architecture, as no research has been conducted on the modulation of perception in interior architecture through décor. This study expands the traditional scope of interior architecture by integrating decorative elements into the analysis of spatial perception, thereby deepening scientific research in this area.

To obtain a broader perspective, the VOSViewer application was used to visualize a bibliometric network of terms. A keyword map (Figure 1) was created based on 79 search results for "eye tracking interior" in the Web of Science search engine. A total of 457 keywords were analyzed, with a minimum occurrence threshold of one. The graph shows the largest set of connected items, consisting of 388 keywords. Figure 2 zooms in on the connections for the keyword "interior design", revealing 43 links. This suggests that the established connection for the terms "eye tracking" and "interior design" is not very strong, further highlighting the novel character of the research area.

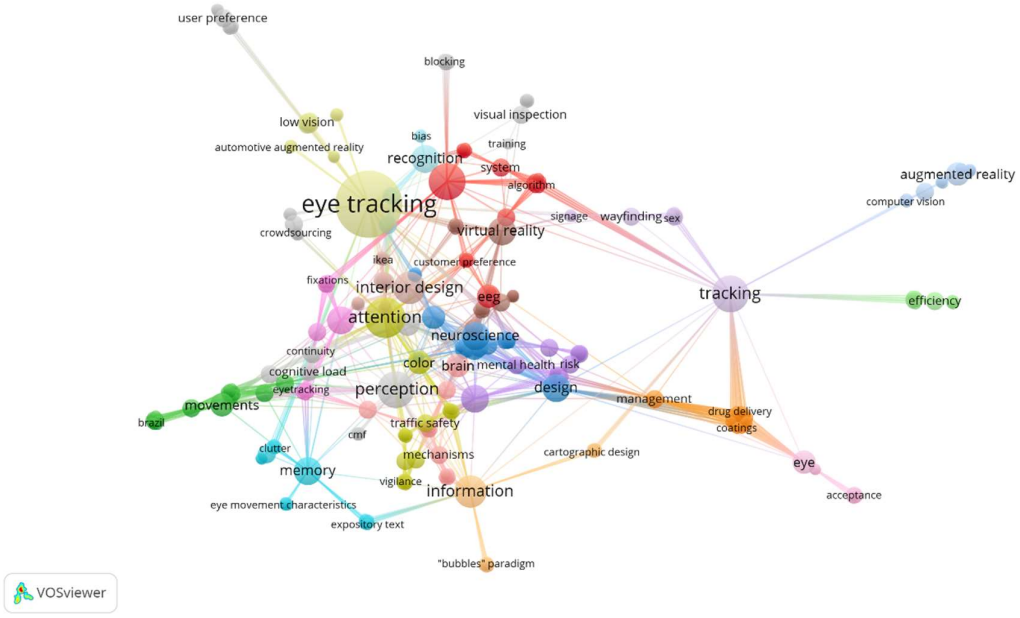

Figure 1. Keywords map, created in VOSViewer. The set of 392 connected items. Source: W. Wlazly.

The keyword map shows the current trends in eye-tracking research on interior design. Regarding graphics, this study explores interior design in the context of perception, design evaluation, on-site experience, color, and the impact of décor. However, this study does not explore the emotions and judgements of the study participants.

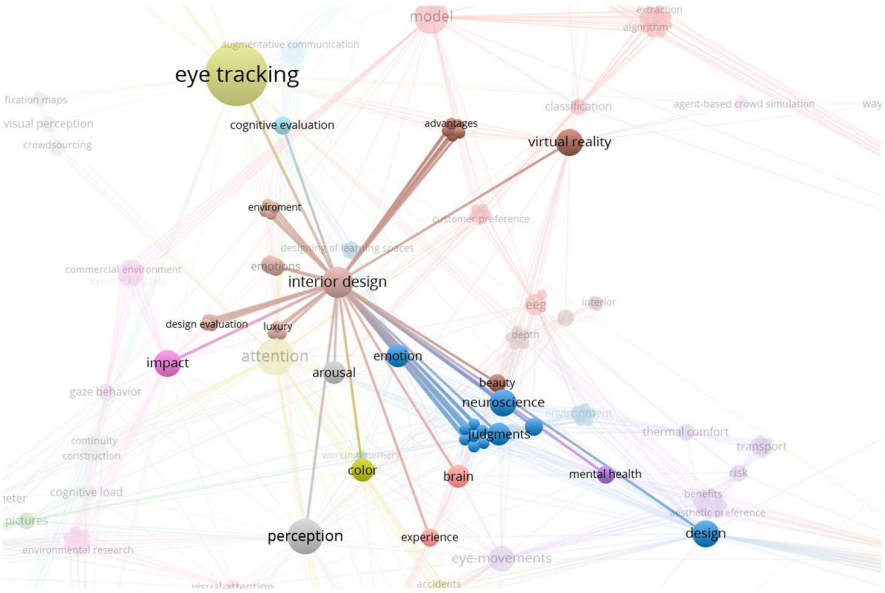

Figure 2. Keywords map, zoomed to keyword "interior design", presenting 43 links, created in VOSViewer. Source: W. Wlazly.

1.2. Aims of Study

The objective of the current study is to investigate whether it is possible to modulate perception in interior architecture through décor, and, in doing so, to provide scientific insights into the impact of décor styling in design processes.

Décor refers to the arrangement and selection of elements within a space that contribute to its aesthetic, functional, or symbolic attributes [15]. These elements may include furniture, textiles, vases, plants, tableware, paintings, artwork and similar elements. According to the *Collins Dictionary*, décor denotes the style or mode of decoration, construction, and ornamentation. Interestingly, the term is also used in the context of theater, where it refers to scenic decoration and scenography [15]. This dual association is particularly relevant in the context of home staging, where the purpose is to create an illusion, the right mood, and atmosphere for the clients.

The working hypothesis proposes that gaze points and fixation distribution, measured with an eye-tracking device during the first 8 s of visual exposure, are influenced by the composition of the décor. This study highlights the importance of décor placement in real estate marketing, leading to more informed business and design decisions. This could also initiate a discussion on the potential for modulating perception in interior spaces using not only a designer's taste and experience, but also scientific methods.

2. Materials and Methods

An eye-tracking method was employed to demonstrate how décor modulates perception in interior architecture [16]. As a research approach, eye-tracking offers valuable insights into how the audience perceives and interacts with a space, providing data-driven evidence to guide design decisions [17]. This study was conducted at the Faculty of Architecture of the Poznan University of Technology. A mobile eye-tracking device, Pupil Invisible Glasses (200 Hz), was used. The results were developed using iMotions 9.3 software. The authors chose a mobile eye-tracking device to record true on-site experiences, maintaining a real sense of distance from the objects being viewed and viewing them on a real scale.

The study consisted of three phases, in all of which each participant was expected to participate. As a result, there were supposed to be three recordings for each participant.

Initially, there were 20 participants, all without significant visual impairment or who were wearing lenses. However, the results of the study were aggregated for 18 participants with all three recordings. Recordings of two participants were excluded, due to the following reasons:

One participant took part only in the first phase of the study; therefore, there was only one recording for this participant.

One recording was missing due to an unknown technical issue, so the other two recordings of this participant were also excluded from the study.

The object of this study was a living room. In each phase of the study, the stimuli were the same static scene, arranged differently (Table 1).

Table 1. Study scenes' characteristics (by Authors).

Scene	1. Basic living room scene (control trial)	2. Styled living room scene	3. Styled living room scene
			
Independent variable (interior design)	Interior architecture elements: -floor, -wall, -table, -four chairs		
Independent variable characteristics	Elements of the interior in minimalist modern style. Gray floor made of ceramic tiles, and dark Gray panel wall. Modern light wooden furniture.		
Dependent variable (décor/styling)	Dependent variable absent	Décor arrangement on the table consisting of the following Dominant elements: textiles (also on two of the chairs), flower composition in a vase. Complementary elements: candles, two glasses, walnuts.	Décor arrangement on the table consisting of the following Dominant elements: textiles, candles, flower composition in a vase. Complementary elements: walnuts, apples
Dependent variable characteristics	Dependent variable absent	Composition: Harmonious dispersal Colors: Subdued colors, smooth color transitions.	Composition concentrated taller elements Colors Vivid, expressive colors, contrast.

An exposure time of 8 s per stimulus was chosen based on earlier research by Rusnak and Szewczyk [11,18], who revealed that, during their study, participants moved their heads after the first 8.6 s. Based on this research, a time lapse of 8 s was used to record the first impression.

The research scenario was prepared in advance and implemented during the study. The study began with an introduction to interior architecture and a description of home staging. The participants were informed that the scenes were elements of a residential

space. They were told that they were going to observe the arrangement of a sample living room scene—part of a potential house—in different setups. However, the participants were unaware of the study's aims. The task given to participants at the beginning of each phase was as follows: "Evaluate the aesthetics of the scene." The task was intended to enable the participants to explore the scenes freely without pointing out any elements.

There was a marked place within 2 m of the scene, which was the same for each phase (Figure 3) The distance was determined to be similar to the distance from which the scene would be observed under the conditions of apartment presentation. The lighting conditions were identical for all participants during all phases.

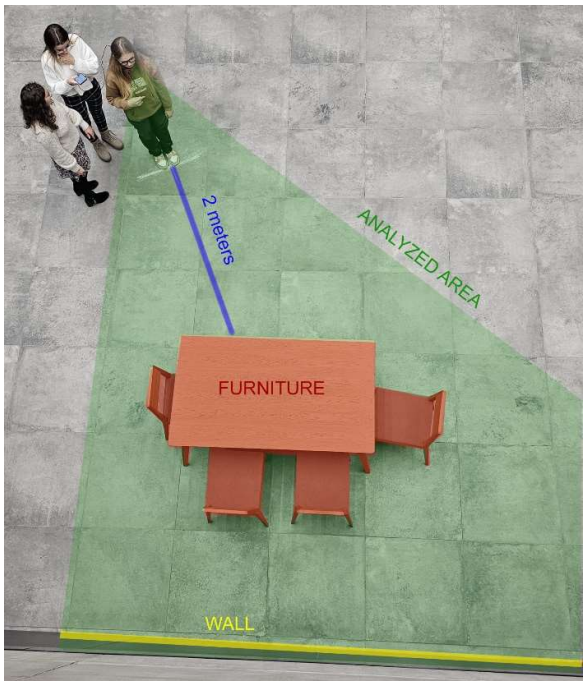

Figure 3. Study conditions. (by Authors).

The study was conducted in the afternoon and lasted for 2 h. No external stimuli were allowed to affect the participants' stress or tiredness levels. Two scholars carried out the study; one led the study, and the other supervised the equipment. Although the viewing angle was wider, the study group had to concentrate on a section of the space presenting the scene, which was considered in the subsequent analysis of the recording material.

3. Results

The results of the eye-tracking study are presented graphically in the form of heat maps (Figures 4–6) and Areas of Interest (AOI) (Figures 7–9), together with the parametric data for gaze- and fixation-based metrics in the second table in Section 3.2.

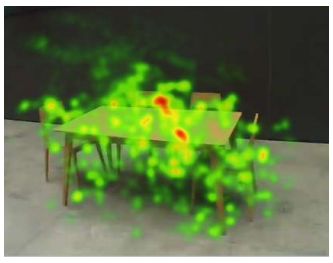

Figure 4. Scene 1. Basic living room scene (control trial). Aggregated Heat Map for 18 participants. Source: Authors.

Figure 5. Scene 2. Styled living room scene. Aggregated Heat Map for 18 participants. Source: Authors.

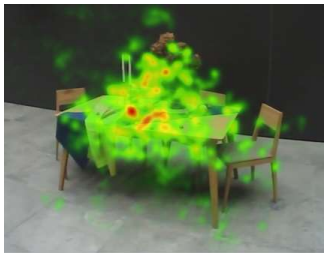

Figure 6. Scene 3. Styled living room scene. Aggregated Heat Map for 18 participants. Source: Authors.

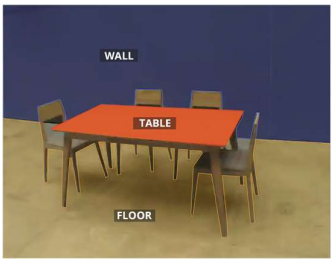

Figure 7. Scene 1—Areas of Interest: furniture with no décor. Control trial. Source: Authors.

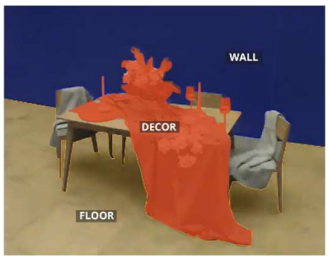

Figure 8. Scene 2—Areas of Interest: furniture with décor, version 1, subdued colors. Source: Authors.

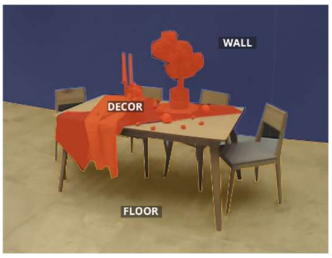

Figure 9. Scene 3—Areas of Interest: furniture with décor, version 2, expressive colors. Source: Authors.

3.1. Heat Maps

A heat map is a graphical display of the visual concentration areas. In this case, the heat maps represent the parts of the scene that were most often looked at, as they are

heat maps of the gaze data. They are readable not only for scientists, but also for people who may be interested in the results of the study, such as interior designers, home stagers, realtors, and real estate agents who are not familiar with scientific terms. The presented heat maps of gaze data were aggregated for 18 participants using iMotions 9.3 software. Green indicates low attention, while yellow to red shows where high attention is present (Figures 4–6).

Attention in scene 1 (Figure 4) was more widespread in comparison to the other two scenes (Figures 5 and 6), where attention tended to concentrate mostly on the composition placed on the table. There were two areas with the highest attention in Scene 1 (Figure 4). They were the edges of the table—one on the edge closest to the observer, and the other on the parallel edge. Little attention was paid to walls; however, it is clear that they spread horizontally. Both flower compositions attracted our attention (Figures 5 and 6). Nevertheless, more attention was paid to the composition composed of contrasting white and brown elements (Figure 5) despite them being slightly shorter and more in harmony with the rest of the arrangement. The appearance of the décor arrangements on the table resulted in an almost complete distraction from the floor (Figures 5 and 6). Therefore, attention to the floor was visible in a significant way only in Scenario 1 (Figure 4). The heat maps show that placing the décor on the table resulted in visual attention focused mainly on the décor. All high-attention areas were placed on the décor arrangement, and little attention was paid to the other elements of the scenes. Placing the décor changed the way in which the architectural elements of the scene were perceived.

3.2. Areas of Interest

To further analyze the collected data, we defined AOI that enabled the analysis of gaze and fixation data for a particular region within the stimuli. Three AOIs were defined for each scene (Figures 7–9) based on the variables listed in Table 1. Two of them were independent variables and were present in all scenes: the wall and floor. The third AOI was located in the table area and was defined differently in the first scene compared to the rest. In the first scene, it was defined as a table (Figure 7), whereas in the other scenes it was defined as a décor arrangement (Figures 8 and 9). AOIs defined as décor arrangements are larger in size than those in the AOI Table (Table 2).

Table 2. AOI Size (px2) in each scene. (by Authors).

	1. Basic Living Room Scene (Control Trial)			**2. Styled Living Room Scene**			**3. Styled Living Room Scene**		
AOI	TABLE	WALL	FLOOR	DÉCOR	WALL	FLOOR	DÉCOR	WALL	FLOOR
Size (px2)	27,578	196,090.75	181,664.01	82,585.14	170,765.19	152,849.22	42,472.55	171,831.32	185,148.77

The stimulus duration was the same stimulus duration seen in the study phase, namely 8 s. Because the scenes were static, the AOI duration in all cases was the same as the stimulus duration. There was a high score for valid data for all scenes, between 98 and 99. Aggregated data from 18 respondents were used for the AOI analysis.

Gaze- and fixation-based metrics for all scenes are presented in Table 3. In particular, similarities were sought in the parameters of Scenes 2 and 3 and in the changes in Scenes 2 and 3 in relation to the first scene. A subsequent result of the research was an increase in the number of fixations on the table area after adding décor. Additionally, expected changes would be, among others, in the dwell count, dwell time, AOI hit time, and time to first fixation (TTFF) on the AOI. These changes would confirm this study's assumption that it is possible to control perception by introducing eye-catching elements.

Table 3. Areas of interest gaze and fixation-based metrics. (by Authors).

	Scena 1			**Scena 2**			**Scena 3**		
	TABLE	WALL	FLOOR	DÉCOR	WALL	FLOOR	DÉCOR	WALL	FLOOR
Size (px2)	27,578	196,090.75	181,664.01	82,585.14	170,765.19	152,849.22	42,472.55	171,831.32	185,148.77
Gaze based metrics									
Respondent count	18	17	15	18	14	13	18	18	15
Respondent ratio (%)	100	94.44	83.33	100	77.78	72.22	100	100	83.33
Dwell count	4.22	3	4.07	5.06	4.43	2.08	5.94	3.17	3.53
Revisit count	3.22	2	3.07	4.06	3.43	1.08	4.94	2.17	2.53
AOI hit time (ms)	1147.56	1422.47	1027.87	287.78	1005.43	3791.38	811.72	1661.67	2291.8
Dwell time (ms)	2021.81	2039.6	2670.65	5239.31	1598.97	620.77	3119.13	1858.5	1390.2
Dwell time (%)	24.18	24.23	31.23	61.95	18.9	7.3	36.21	21.62	16.17
First dwell duration (ms)	434.33	704.88	1046.93	1165.33	558	300.23	516.72	599.33	329.93
Last dwell duration (ms)	619.61	949.18	992.73	1487.72	494	516	592.06	697.67	760.87
Skip count	1.39	0.53	1.27	1.44	1.29	1.31	1.83	0.72	1.93
Fixation based metrics									
Respondent count	16	17	13	18	14	6	16	15	10
Respondent ratio (%)	88.89	94.44	72.22	100	77.78	33.33	88.89	83.33	55.56
Dwells with fixations	2.62	2	2.54	2.5	2.86	1.5	4	2.33	2.1
Revisit count	1.62	1	1.54	1.5	1.86	0.5	3	1.33	1.1
Fixation count	7.31	6.24	9.46	15.44	6.64	2.33	12.56	6.6	3.9
TTFF AOI (ms)	1761.97	2251.65	1653.81	1568.47	2462.04	3469.33	1151.41	1725.43	3948.65
TTFF max. (ms)	2532.86	2612.11	3555.69	1568.47	3830.47	6794.28	1971.69	2864.36	6014.36
Dwell time (ms)	1137.03	957.91	1377.27	2041.53	913.64	309	1981.16	1071.93	493.95
Dwell time (%)	13.52	11.47	16.09	24.21	10.8	3.64	22.97	12.44	5.73
Fixation duration (ms)	155.43	137.2	143.44	122.26	168.57	169.17	167.64	168.45	126.01
First fixation duration (ms)	136.03	144.56	156.15	94.11	145	185.33	179.28	137.7	105.1
Last fixation duration (ms)	190.41	124.47	182.38	116.81	217.5	168.67	161.16	241.13	132.9
Dispersion (deg)	0.47	0.51	0.45	0.46	0.48	0.44	0.51	0.53	0.46

The first dwelling duration for the table area, AOI Décor in Scenes 2 and 3 compared to the AOI Table in Scene 1, was longer. The first dwelling duration in Scenes 2 and 3 was shortened for the wall and floor AOI. Respondents in Scenes 2 and 3 paid attention to individual AOIs in the following order: décor, wall, and floor. Contrastingly, for Scene 1, the control trial indicated an order of table, floor, and wall. Although the table was empty, it was the first area to be observed; however, the order of the architectural elements of the space was altered. When décor was added, the floor lost its importance. The number of fixations increased significantly in the table area after the décor arrangement was added. The number of fixations was 2.1 times more for AOI Décor in Scene 2 than for AOI Tables in Scenes 1, and 1.7 times more for AOI Décor in Scene 3 than for AOI Table in Scene 1. This shows that placing a décor arrangement, thereby styling the scene, results in a more focused eyesight on the area that was styled, and thus there is a conscious change. However, this is not related to fixation duration, which, despite the differences in each scene, does not exhibit a common tendency to change the arrangement compared to the first scene. For Scenes 2 and 3, the TTFF for the AOI Décor was shorter than the TTFF for the AOI Table in Scene 1. The TTFF reduction confirms the possibility of controlling the elements that first attract attention. The dwell time was similarly extended for the AOI Décor in Scenes 2 and 3, being 1.75 times longer compared to the dwell time for the AOI Table in Scene 1. After adding the décor arrangement, the number of people whose fixations were on the walls

and floor decreased. The decrease in the number of fixations on the wall and floor AOIs was greater for Scene 2 than for Scene 3. The number of people with fixations on the décor was the same or increased in relation to Scenario 1. It follows from this that architectural elements of the space that were independent variables lost their importance in Scenes 2 and 3 compared to Scene 1.

3.3. Results Summary

The hypothesis that gaze points and fixation distribution during the first impression (within an 8 s time frame) are influenced by the composition of the décor has been confirmed. The arrangement of décor in an architectural interior has been proven to be a key factor in guiding the distribution of sight paths, as measured using an eye-tracking device. The data show that, in Scene 3, adding prominent vertical elements including candleholders with candles and a vase with flowers resulted in a predominantly vertical orientation of the gaze points. However, this was somewhat predictable. In contrast, Scene 2 yielded an unexpected result: despite the tablecloth creating a diagonal line in the décor arrangement, the gaze points did not follow this direction. Instead, they remained focused on a table, drawn from the various other elements present. Such a pattern would have been difficult to detect without eye-tracking studies. This confirms the usefulness of the chosen research method, as it reveals previously unnoticed patterns of visual attention. A comparison between scenes demonstrates how décor modulates perception, with different sight paths and gaze points emerging when observing the same space. Additionally, the décor in Scenes 2 and 3 diverted attention from the architectural elements, such as the walls and floor, which are visually important in Scene 1.

4. Discussion

4.1. Overview of Findings

Based on the publications referenced in Section 1.1 "Research Background", the use of eye-tracking technology for studying the perception of interior architecture is fully validated [19–21]. Given the lack of similar research on modulating perceptions by adding decorative interior styling elements, this study offers new insights into styling as a key component of the design process. The findings show that effective décor styling can significantly divert attention from key architectural elements to the point where these elements may go unnoticed during the critical first few seconds of observation—often referred to as the "first impression". This study confirmed that décor plays a crucial role in shaping how people perceive interior spaces. By introducing decorative elements, perception can be deliberately guided toward specific areas, shifting attention away from fixed architectural features. Therefore, décor should be recognized as a powerful tool for managing and enhancing perceptions of spaces. Although this concept has long been intuitively applied in practice, it has now been scientifically validated. This research also supports the effectiveness of real estate marketing strategies such as those employed by home stagers who use décor to enhance property presentations.

4.2. Results Contribution and Application

This study supports key concepts in real estate marketing and the home staging industry, providing evidence that can be used to demonstrate the value of home staging services to clients [22]. The results, illustrated through visual tools such as heat maps, clearly show how strategically placed décor can guide attention and improve the first impressions of a space. These findings have the potential to significantly enhance interior design education [23,24]. The insights gained from this study serve as a valuable resource

for interior architecture curricula, helping with understanding the importance of visual perception and learning how to consciously influence it in a purposeful way.

4.3. A Comparison of the Findings with the Literature

The aforementioned works in the Research Background demonstrate the applicability of eye-tracking methodology in both architectural studies [8,9] and interior design research [11,12]. This study further substantiates the utility of mobile eye-tracking devices in exploring the perception of interior spaces. Additionally, it supports the thesis of Gotkas et al. [12], which aims to facilitate decision-making in design processes, with the expectation that the insights gained from this study will contribute to informed decision-making in home staging practices. Furthermore, this research confirms the potential for purposeful arrangement to guide conscious visual pathways [14]. Finally, it expands the existing body of knowledge regarding home staging, a field that has previously been underexplored [3]. This article, unlike the existing literature, places particular emphasis on the presence of decorative elements. It introduces a new direction in interior architecture research, focusing on real estate marketing.

4.4. Recommendation for Future Research

This study examined the impact of a décor arrangement by comparing two different setups of the same living room scene and one scene without décor. Further research on the perception of interior architecture and the role of décor should delve more deeply into the individual elements of the composition, exploring their presence and visual appearance. Additionally, such studies could be expanded to include emotional responses elicited by décor, providing a more comprehensive understanding of whether attracting attention in specific instances positively or negatively affects the observer [23,24].

In future research, a comparison between expert expectations and the actual results of an eye-tracking study [25–27], as mentioned in Section 1.1, "Research Background", could be valuable. This would further validate our findings and offer deeper insight into the effectiveness of décor in influencing perceptions.

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