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The Impact of Virtual Immersive Public Art on the Restorative Experience of Urban Residents

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Abstract: This study explores the role of virtual immersive public art in improving the psychological well-being of urban residents. The research is set in the context of urban environments, where virtual immersive public art has the potential to foster innovation, integrate technology, and organically blend into public spaces. The study evaluates the impact of such art on psychological restoration by focusing on three key dimensions: interactive themes, interactive mechanisms, and artistic characteristics. A questionnaire survey was conducted to collect participants' real-life experiences and reactions to these art installations. The results show that virtual immersive public art significantly contributes to the restorative experience of urban residents, offering valuable insights into how these installations can promote mental health. Based on the findings, the study provides practical design recommendations for incorporating virtual immersive public art into future urban planning and design projects to enhance urban living conditions and support psychological recovery.

Keywords: intelligent interactive technology; interactive experience; urban environment; human well-being; virtual reality art

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1. Introduction

This paper explores the impact of virtual immersive public art on the psychological recovery experiences of urban residents. The rapid development of artificial intelligence (AI) technology is transforming our interactions with the environment [1,2]. Virtual immersive technology engages all five human senses within digital environments, providing captivating and interactive art experiences [3,4]. Visitors interact with intelligent environments through devices that allow the manipulation of elements such as color, light, and audiovisual content [5,6]. This continuous interaction provides sensory feedback, making virtual environments feel vivid and lifelike, mirroring the natural world and offering a comprehensive, engaging experience [7].

With urban residents experiencing increased levels of mental stress due to fast-paced lifestyles, there is a pressing need for restorative environments that alleviate stress and replenish mental energy. Providing such experiences has become a major focus within urban planning and social sciences [8–11]. Immersive public art offers a unique opportunity for urban residents to access restorative environments through intelligent, interactive art that enhances psychological well-being [12].

In the post-pandemic era, studying intelligent interactive public art as a restorative environment in urban spaces remains a relatively unexplored field. In China and other countries, urban research has primarily focused on using information technology to tackle urban planning and construction challenges, with limited exploration of public art as a restorative element within city environments. Most existing research on public art discusses traditional forms, lacking insights into the potential of future urban public art. Therefore,

examining intelligent interactive public art as a restorative environment presents a novel approach, with few studies currently addressing this area.

This study aims to investigate how AI-driven virtual immersive public art impacts the restorative experiences of urban residents and to explore how various artistic elements—such as interaction themes, forms, and artistic characteristics—shape these experiences. The research provides practical insights for urban planners seeking to create environments that enhance the well-being of urban residents [13,14].

In the design themes of public artworks, Victor Papanek emphasizes the role of cultural symbols and meanings in evoking emotional resonance [15], while Don Norman argues that the emotional atmosphere created by themes can enhance the user experience [16]. Additionally, Hekkert and Reber contend that themes aligned with users' esthetic preferences lead to pleasure and emotional engagement [17,18]. Regarding interaction modes, Schifferstein underscores the value of multisensory experiences in fostering esthetic pleasure [19]. When considering artistic characteristics, Roger Fry explores the topic from the perspectives of formalism and visual esthetics, noting that the colors and shapes of art create visual appeal, resulting in esthetic satisfaction and enjoyment [20,21]. Arthur Danto further asserts that visual esthetics meet users' esthetic needs and enhance the overall emotional experience [22]. Based on these insights, this study examines the three dimensions of design themes, interaction modes, and artistic characteristics within public artworks to assess their impact on the user experience.

2. Public Art Linked to Immersive Experiences and Perceived Restoration

Virtual immersive public art represents a contemporary form of artistic expression that transcends traditional limitations, fully immersing viewers in an interactive and multisensory experience [23–25]. Utilizing advanced virtual and AI-driven technologies, these installations are designed to engage all five human senses, offering users an engaging and realistic experience that mirrors aspects of the natural world [26,27]. Through this integration, virtual immersive public art aims to create environments that foster a sense of restoration and well-being, a concept that becomes increasingly relevant as urban lifestyles become more fast-paced and stressful.

Restorative environments have been extensively explored through two primary theoretical frameworks: Attention Restoration Theory (ART) and Stress Reduction Theory (SRT). According to Kaplan's ART, environments that provide a break from everyday demands help restore cognitive function, particularly attention, by reducing mental fatigue [28]. This theory outlines four characteristics that contribute to an environment's restorative quality: being away, fascination, extent, and compatibility. "Being away" refers to the mental and physical distance from daily routines that facilitates an escape from obligations. "Fascination" pertains to the ability of an environment to effortlessly capture attention, allowing for cognitive rest. "Extent" encompasses the coherence and scope of the environment, while "compatibility" indicates the degree to which an environment aligns with an individual's goals and needs. In this regard, immersive public art can offer virtual environments that replicate these qualities, providing individuals with a sense of mental escape and relaxation [29].

On the other hand, Ulrich's Stress Reduction Theory (SRT) emphasizes the role of nature in alleviating stress by eliciting positive emotions and diminishing negative ones [29]. According to SRT, exposure to restorative environments has the potential to lower stress and evoke calmness, thereby supporting mental recovery. Immersive public art, by replicating aspects of natural environments such as green spaces and water features, can potentially mirror these stress-relieving properties. The sensory engagement provided by virtual immersive art may mimic the natural stimuli found in physical restorative environments, allowing urban residents to experience similar psychological benefits even in artificial settings.

While both ART and SRT have predominantly been applied to physical natural environments, they offer valuable frameworks for understanding how virtual immersive

public art might similarly foster restoration. The integration of sensory elements in virtual immersive art closely aligns with the characteristics described in ART, such as fascination and extent, which are pivotal for attentional recovery. Similarly, the design of virtual environments that incorporate natural elements aligns with SRT's focus on emotional relief and stress reduction.

There is a growing body of evidence indicating that engagement with virtual natural environments can lead to positive psychological outcomes, such as stress reduction and improved mood [30–32]. Virtual immersive public art thus provides a unique opportunity to recreate the restorative qualities of nature within an urban context, potentially serving as a surrogate for natural settings where access to physical green spaces may be limited due to infrastructure or financial constraints [10,13,33].

In the realm of urban design, few studies have examined the potential of intelligent interactive public art as a restorative environment. As AI technology advances, public art installations are becoming increasingly sophisticated, offering more immersive and interactive experiences that may rival the restorative benefits of physical natural environments [34–36]. Consequently, this study aims to explore how virtual immersive public art can be designed to harness the restorative qualities highlighted by ART and SRT, thereby expanding our understanding of how artificial environments can support psychological well-being in urban settings.

Recent studies have explored the psychological effects of virtual environments, underscoring their potential to replicate the restorative qualities typically associated with natural settings. For instance, Yu et al. found that virtual reality simulations of forest and urban environments can elicit significant physiological and psychological responses, with virtual forest environments inducing more relaxation and stress reduction compared to urban ones [37]. Similarly, Valtchanov et al. demonstrated that virtual environments have substantial restorative effects, improving both mood and overall affect [12]. Furthermore, Lee et al. conducted a systematic review on the psychological impacts of virtual green experiences, concluding that virtual nature environments can effectively mimic the restorative benefits of physical nature, such as enhancing mood and reducing stress [38]. These studies provide a robust foundation for applying Attention Restoration Theory (ART) and Stress Reduction Theory (SRT) to virtual immersive public art. By illustrating that virtual environments can achieve similar psychological benefits as natural settings, this research emphasizes the potential for virtual immersive public art to serve as a restorative experience within urban spaces, thereby bridging theoretical frameworks with practical applications in contemporary urban design.

3. Materials and Methods

3.1. Research Location

In this study, we have selected teamLab Borderless, designed by the Japanese art collective teamLab, and the Wuhan Optics Valley AI Intelligent Art Exhibition as our research materials as shown in Figure 1. Established in 2001, teamLab is an interdisciplinary collective composed of experts from various fields, including artists, engineers, CG animators, architects, and mathematicians. The collective excels in integrating art and technology to explore the relationship between humanity and the world, showcasing the unique characteristics of virtual immersive art by dissolving the physical boundaries between people and art.

teamLab Borderless features highly interactive artworks where the audience is not merely an observer but also a participant who can influence the artwork's expression through their actions and choices. This participatory and interactive nature is a core characteristic of virtual immersive art. Participants engage in dialogue and interaction with the artworks, exploring and creating an interconnected artistic world. This boundaryless experience aligns seamlessly with the goals of immersive public art.

The choice of teamLab Borderless in Shanghai and the Wuhan Optics Valley AI Intelligent Art Exhibition was based on factors such as proximity, visitor traffic, and duration of

engagement. Since its debut in November 2019, teamLab Borderless in Shanghai has welcomed over 1.2 million visitors, with an average annual attendance ranging from 550,000 to 650,000. Selected pieces from teamLab Borderless, such as Butterfly Flower Sea, and the Starry Sky series from the Wuhan Optics Valley AI Intelligent Art Exhibition have achieved high levels of public engagement. In the artwork Butterfly Flower Sea, the terrain is sculpted into small hills, with flowers and streams blooming and flowing sequentially over the landscape. As in nature, petals scatter and dance around visitors who enter the floral space. Streams flow gracefully, parting as visitors approach, enhancing the naturalistic feel of the environment.

Figure 1. Butterfly Flower Sea and Starry Sky.

3.2. Research Sample

The study will use a purposive sampling method to recruit urban residents aged 18 to 59, aiming to achieve diverse representation across key demographic categories, such as age, gender, education level, and experience with similar activities.

The sampling approach will consider several demographic factors. Age: Participants will be recruited from a wide age range, with a focus on younger and middle-aged individuals who are more likely to be familiar with digital and immersive art forms. Including various age groups will help capture potential differences in restorative effects across different life stages. Gender: the study aims to balance male and female participants to explore potential gender-based differences in responses to immersive public art. Educational Background: participants will be selected to represent a range of educational levels, from high school graduates to those with advanced degrees, to investigate how education influences perceptions and restorative experiences. Experience with Similar Activities: by including individuals with prior exposure to public art, particularly virtual immersive experiences, the study ensures that participants will have relevant context for the research focus.

This diverse sampling strategy is designed to enhance the study's representativeness and support the generalizability of findings across broader urban populations. By capturing a variety of demographic characteristics, the research aims to explore how these factors influence the restorative experience of virtual immersive public art. This design will provide a comprehensive understanding of how immersive public art affects different segments of the urban population.

3.3. Methods of Data Collection and Analysis

The purpose of this structured questionnaire is to investigate urban residents' perceptions and experiences and the impacts of virtual immersive public art. The survey addresses participants' engagement, interactivity, and perceptions of the art installations. The Perceived Restrictiveness Scale (PRS), developed by researchers Rachel and Stephen Kaplan, serves as a psychometric tool in this study to assess the quality of perceived restoration from natural environments. Based on Attention Restoration Theory (ART), the PRS posits that exposure to natural environments can aid in replenishing attentional resources depleted by mental fatigue. This study has designed a research questionnaire based on the PRS to explore these concepts.

The primary focus of the survey is on art gallery visitors who have experienced immersive public art installations. Before completing the questionnaire, participants receive

a brief overview of the content to enhance their understanding. In total, 168 questionnaires were distributed, with 161 deemed valid, resulting in a response rate of 95.8%.

Data analysis was conducted using SPSS 25.0. Descriptive statistics were utilized to summarize the sample characteristics, while correlation analysis was employed to explore relationships between variables. Regression analysis and analysis of variance (ANOVA) were conducted to test predictive effects and group differences. These methods help to determine the relationship between AI-enhanced virtual immersive public art and the restorative experiences of urban residents. This study aims to provide a comprehensive understanding of the multifaceted impact of virtual immersive public art on urban residents' restorative experiences within the context of the AI era.

3.4. Research Hypotheses

Based on a review of the relevant literature and an understanding of theoretical foundations, the researcher aims to demonstrate that the three dimensions of public art design positively impact and contribute to the restorative experiences of respondents. Therefore, this paper proposes the following view: virtual immersive public art has a positive impact on the three dimensions of restorative experience—being away, fascination, and compatibility.

H1. *Virtual immersive public art has a positive impact on the dimension of being away in the restorative experience of urban residents.*

H2. *Virtual immersive public art has a positive impact on the dimension of fascination in the restorative experience of urban residents.*

H3. *Virtual immersive public art has a positive impact on the dimension of compatibility in the restorative experience of urban residents.*

4. Data Analysis

4.1. Sample Analyses

Based on the data presented, 85.09% of respondents from the valid sample reported having visited a virtual immersive art gallery, while 14.91% indicated that they had not. This suggests that virtual immersive art galleries are gaining popularity as a form of entertainment and culture, with an increasing number of individuals beginning to appreciate and engage with this novel artistic medium. Notably, 68.94% of participants were between the ages of 18 and 29, constituting most of the sample. In contrast, a minority of respondents, specifically 7.45%, were aged 40 or older, while 20.5% fell between the ages of 30 and 39. Overall, it is evident that young adults and middle-aged individuals aged 18–39 represent 88.9% of the total respondents.

The sample comprised 62.11% females, surpassing the 37.89% male, indicating a greater proportion of female participants in the survey. Additionally, 70.8% of respondents identified as single, and 68.94% held a bachelor's degree or higher, suggesting that the sample is relatively well-educated and culturally aware. Regarding occupations, the primary groups included students (40.1%), teachers and workers in other industries (23.6%), and employees of design firms (8.7%).

As shown in Figure 2, exercise and walking were the most frequent recreational activities engaged in, comprising 49.69% and 49.07%of the total valid visits, respectively. This may indicate that individuals value their physical well-being and prefer outdoor pursuits. Furthermore, the percentage of individuals engaging in music listening and video game playing was 52.17% and 60.87%, respectively, suggesting that music and video games are significant forms of recreation and entertainment in contemporary society. Engagement in activities such as gardening, reading, and painting/crafts was recorded at 33.54%, 38.51%, and 27.95%, respectively. These pursuits may require specific tools and environments, indicating that individuals dedicate their free time to quieter, artistic

endeavors. Socializing and watching movies or television series accounted for 60.25% and 29.81%, respectively. This suggests that people often watch films and dramas as a means of socializing and unwinding, highlighting the significance of social activities in modern life.

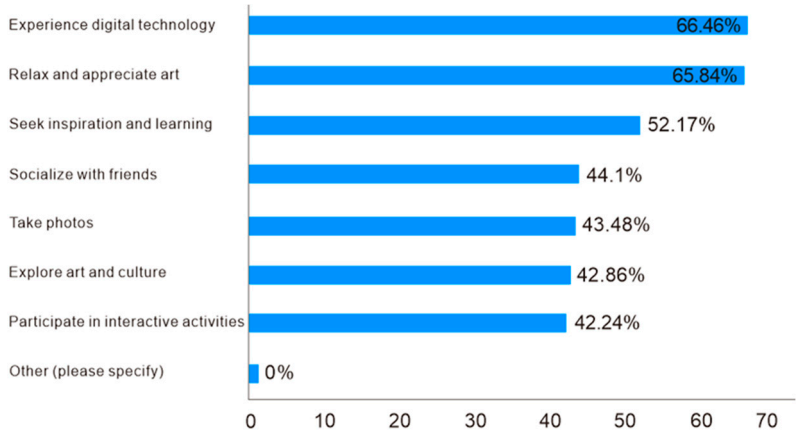

Figure 2. People's preferred leisure methods.

Overall, as shown in Figure 3, 6.46% of visitors to the exhibition indicated that they intended to gain experience with digital technology. Other popular motivations included discovering sources of inspiration (52.17%), emotional cultivation and relaxation (65.74%), attending social gatherings with friends (44.1%), and engaging in interactive exercises (42.24%). These choices reflect the primary objectives and incentives of the visitors. The emphasis on socializing, learning, and experiencing digital technology suggests that these were the main goals of the exhibition, while engaging in interactive activities and gaining knowledge about art and culture were of secondary importance. Additionally, some attendees expressed interest in supplementary activities, such as card piercing and photography. This segment of the population may exhibit a particular affinity for the components or activities featured in the exhibition.

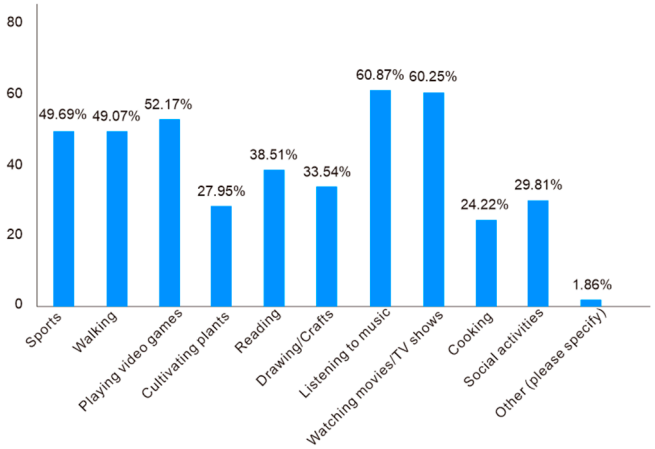

Figure 3. People's preferred leisure methods and exhibition purpose.

From Table 1, the correlation analysis indicates that participant motivations significantly impact restorative effects. Notably, the motivation of "experiencing digital technology" demonstrates significant positive correlations with both "fascinating" and "compatible". This suggests that participants motivated by digital experiences tend to perceive a stronger sense of attraction and compatibility, thereby enhancing their restorative experiences. In contrast, other motivations, such as "socializing with friends" and "taking photos", show no significant correlations, implying a minimal influence on restorative outcomes. Overall, these findings highlight the importance of specific motivations in shaping the restorative experiences of participants.

Table 1. Relationship between participant motivations and restorative effects.

Purpose	Pearson Correlation	Sig.	N
Experience digital technology	Faraway: 0.131	0.097	161
	Fascinating: 0.165 *	0.036	161
	Compatible: 0.155 *	0.049	161
Seek inspiration and learning	Faraway: 0.057	0.471	161
	Fascinating: 0.077	0.329	161
	Compatible: 0.064	0.423	161
Relax and appreciate art	Faraway: 0.015	0.847	161
	Fascinating: 0.056	0.481	161
	Compatible: 0.118	0.137	161
Socialize with friends	Faraway: −0.058	0.467	161
	Fascinating: −0.015	0.852	161
	Compatible: −0.016	0.844	161
Take photos	Faraway: 0.052	0.508	161
	Fascinating: 0.017	0.835	161
	Compatible: 0.003	0.970	161
Participate in interactive activities	Faraway: −0.073	0.355	161
	Fascinating: −0.011	0.891	161
	Compatible: 0.016	0.841	161
Explore art and culture	Faraway: 0.019	0.815	161
	Fascinating: 0.098	0.215	161
	Compatible: 0.022	0.785	161

* Indicates statistical significance at the 0.05 level.

In conclusion, while learning, socializing, and experiencing digital technology were the primary objectives of this exhibition, a subset of attendees also showed interest in engaging in interactive activities and expanding their knowledge of art and culture. The selections made by the visitors indicate their diverse interests and needs within the exhibition context.

4.2. The Influence of Demographic Variables on the Restorative Experiences of Residents

4.2.1. Gender Factor

From Table 2, the results of the one-way ANOVA reveal that gender does not have a statistically significant influence on variations in restorative experience, nor does it differentiate between the emotional states of males and females while observing the exhibition. With an F-value of 1.195 and a significance level of 0.276—substantially above the conventional threshold of 0.05—these findings indicate that the dependent variable, restorative experience, is not significantly affected by the independent variable, gender. Specifically, there is no statistically significant difference in the emotional experiences of males and females during the exhibition viewing session.

Table 2. The impact of gender on restorative experiences.

Option	Sample Size	Mean Value	Standard Deviation
male	61	4.16	0.82
female	100	4.30	0.73
F		1.195	
p		0.276	

4.2.2. Marital Status Factor

From Table 3, the data indicate that individuals who are in a relationship or married tend to have slightly higher mean scores (4.43) compared to single individuals (4.18), suggesting a more favorable perception or experience. The standard deviations are relatively

similar, though there is slightly more variability among those who are married. The F-value of 3.598 points to some observable variation between the groups; however, the *p*-value (0.060) is just above the conventional significance threshold of 0.05. While this difference is not statistically significant, it is close enough to suggest a potential trend that may warrant further investigation.

Table 3. The impact of marital status on restorative experiences.

Option	Sample Size	Mean Value	Standard Deviation
Table relationship/married	47	4.43	0.80
single	114	4.18	0.74
F		3.598	
p		0.060	

4.3. Reliability and Validity Tests for Scales

By conducting reliability and validity tests on the scale, we can ensure that the results are reliable, valid, and credible, thereby enhancing the scientific rigor of the research. The reliability of the measurement model was assessed using SPSS software (Version 26) applied to the valid data obtained from the questionnaire. The results revealed that the Cronbach's alpha values for the six latent variables included in the public art interaction design and restorative experience ranged from 0.899 to 0.933, as illustrated in Tables 4 and 5. This suggests that the scales demonstrate satisfactory internal consistency.

Table 4. Reliability analysis.

Sample Size	Questionnaire Item Count	Cronbach. α Coefficient
161	12	0.899
161	12	0.933

Table 5. Validity analysis.

KMO and Bartlett's Test		
KMO Quantity of Sample Suitability		0.903
Bartlett's test of sphericity	approximate chi-square	712.252
	degrees of freedom	15
	significance	0.000

In terms of validity testing, the KMO (Kaiser–Meyer–Olkin) measure was calculated at 0.903, indicating that the data are appropriate for factor analysis. The KMO value ranges from 0 to 1, with values closer to 1 indicating a stronger suitability for factor analysis.

Furthermore, the chi-square value obtained from Bartlett's test was 712.252, with a significance level of 0.000 and 15 degrees of freedom. This finding indicates that the observed correlation matrix is not a unitary matrix, as evidenced by the significance level of 0.000, confirming the existence of correlations among the variables.

The loadings represent the values of each variable within the component matrix. Specifically, "content" has a loading of 0.604, "form" is loaded at 0.854, "characteristic" at 0.919, "faraway" at 0.881, "fascinating" at 0.887, and "compatible" at 0.882. The prominence of the factor structure is evident. Through careful interpretation of the raw data, a more comprehensive understanding of how the public perceives intelligent interactive experiences in public art exhibitions can be achieved.

From Table 5, the KMO value of 0.903 indicates that the data are highly suitable for factor analysis. Additionally, Bartlett's test of sphericity produced a significance level of

0.000, suggesting that the data meet the necessary criteria of adequate degrees of freedom and homogeneity, thereby justifying their use in factor analysis.

4.4. Data Analysis of Immersive Public Artworks

From Tables 6 and 7, this dataset highlights audience preferences for interactive forms and visual effects in intelligent interactive public art. The data show that participants place a high value on visual effects and graphics (mean = 4.34), sound and music (mean = 4.33), and touch and gestures (mean = 4.13). Visual and auditory elements are highly appreciated, indicating that these sensory inputs play a crucial role in enhancing the overall interactive experience. The low standard deviation for visual effects (0.680) suggests a strong consensus among respondents regarding the importance of these elements.

Table 6. Mean value analysis of scales related to perceptions of intelligent interactive public art restoration—Restorative dimensions.

Theme Content of Intelligent Interactive Public Art	N	Minimum Value	Maximum Value	Mean Value	Standard Deviation
Favorite natural/architectural theme elements	161	1	5	3.91	0.984
Favorite fantasy/narrative theme elements	161	1	5	4.15	0.823
The theme inspired me	161	1	5	3.96	0.883
Form of intelligent interactive public art					
Graphics and visual effects	161	2	5	4.34	0.680
Sound and language	161	2	5	4.33	0.696
Touch and gestures	161	1	5	4.13	0.888
Artistic characteristics of intelligent interactive public art					
Highly interactive	161	2	5	4.24	0.797
Rich in visual elements	161	2	5	4.41	0.675
Captivating sound effects	161	2	5	4.22	0.790
Familiar cultural IP elements	161	1	5	4.02	0.894
Attractive light and shadow design	161	2	5	4.32	0.728
Mirror reflection design was interesting	161	2	5	4.29	0.770

Table 7. Mean value analysis of scales related to perceptions of intelligent interactive public art restoration—public artwork design dimensions.

Restorative Experience	N	Minimum Value	Maximum Value	Mean Value	Standard Deviation
Away from distractions	161	1	5	4.25	0.767
Do not need to concentrate	161	2	5	4.17	0.811
Escape from routine tasks	161	2	5	4.36	0.729
Let go of things I must do	161	2	5	4.16	0.836
This place is fascinating	161	3	5	4.30	0.723
There is much to discover and appreciate	161	2	5	4.36	0.746
Feels like a small world in itself	161	1	5	4.33	0.765
Elements blend naturally	161	2	5	4.28	0.718
Aligns with my personal desires	161	2	5	4.22	0.750
Easy to do what I want	161	1	5	4.04	0.876
Find ways to enjoy life on my terms	161	2	5	4.22	0.780
I like this place	161	1	5	4.34	0.750

Regarding the “immersive light space” artwork, the audience found the visual design (mean = 4.41) and sound effects (mean = 4.22) to be captivating. Additionally, the light and shadow design (mean = 4.32) and mirror reflection design (mean = 4.29) were highly rated, demonstrating their significant role in creating an immersive atmosphere. These elements

effectively contributed to a richer, more engaging experience, with many participants highlighting the captivating nature of the visual and interactive components.

The data also reveal that the audience felt a certain connection with familiar cultural IP elements in the exhibition (mean = 4.02), indicating that culturally relevant designs can effectively enhance the emotional connection between the audience and the exhibition. Overall, the audience gave high evaluations to the exhibition's design and the natural integration of elements (mean = 4.28). Many participants also felt that visiting the exhibition met their personal expectations (mean = 4.22), reflecting a strong alignment between the exhibition's content and the audience's expectations.

The exhibition also offers the audience a clear restorative experience. For example, the data show that visitors can effectively relieve daily stress during the exhibition (mean = 4.17) and focus on appreciating the artworks (mean = 4.36). The audience generally agrees that the exhibition environment is rich with opportunities for discovery and exploration (mean = 4.36) and that the space feels like a small, immersive world (mean = 4.33), providing opportunities for self-relaxation and enjoyment (mean = 4.22). These data demonstrate that art exhibitions not only provide visual and sensory enjoyment but also offer visitors psychological relaxation and opportunities for self-recovery.

In conclusion, the audience had a highly favorable opinion of the multi-sensory interactive format, visual design, and restorative experience in the smart interactive public art exhibition. The visual effects and sound design significantly enhanced the audience's immersion and depth of experience. Additionally, the exhibition fostered emotional resonance and psychological restoration, making it not just an appreciation of art but also a journey of physical and mental relaxation.

From Table 8, this correlation matrix reveals significant positive relationships between various aspects of the intelligent interactive public art experience, with all correlations being significant at the 0.01 level. The strongest correlation is between "characteristic" and "fascinating" (r = 0.811), indicating that the more fascinating the experience, the stronger the perceived characteristics of the public art. There is also a strong correlation between "characteristic" and "form" (r = 0.782), suggesting that interactive forms significantly influence the audience's perception of the art's features. Similarly, "compatible" is highly correlated with both "faraway" (r = 0.751) and "form" (r = 0.704), indicating that compatibility with personal preferences is closely tied to how distant and interactive the experience feels. Overall, the data show a complex, interconnected relationship between content, form, characteristics, and the emotional engagement of the audience.

Table 8. Correlation analysis.

	Correlation					
	Content	**Form**	**Characteristic**	**Faraway**	**Fascinating**	**Compatible**
Content	1	0.419 **	0.481 **	0.418 **	0.431 **	0.489 **
Form	0.419 **	1	0.782 **	0.682 **	0.684 **	0.704 **
Characteristic	0.481 **	0.782 **	1	0.771 **	0.811 **	0.747 **
Being Away	0.418 **	0.682 **	0.771 **	1	0.769 **	0.751 **
Fascinating	0.431 **	0.684 **	0.811 **	0.769 **	1	0.730 **
Compatible	0.489 **	0.704 **	0.747 **	0.751 **	0.730 **	1

**. At the 0.01 level (double tailed), the correlation is significant.

4.5. Regression Analysis and Hypothesis Testing

Given that the restorative scale consists of three dimensions—being away, fascination, and compatibility—and immersive public art is composed of three aspects—interactive themes, interactive modes, and artistic features—we propose the following hypothesis for the measurement model: the independent variables are the three dimensions of immersive public art, while the dependent variables are being away, fascination, and compatibility. We confirm that immersive public art has a significant impact on the audience's restorative experience.

From Table 9, the ANOVA results indicate a significant regression with a *p*-value of less than 0.001, suggesting that at least one of the independent variables significantly influences the dependent variable. This model's significance is further supported by an F-statistic of 17.618. While "being away" and "fascination" do not show a discernible impact on "content" within this model, "compatibility" demonstrates a substantial positive influence on "content". In summary, the effect of immersive public art design on the restorative perception of "being away" is notable.

From Table 10, the significance of the model is demonstrated by the F-statistic (103.939) and the ANOVA significance value ($p < 0.001$), indicating that at least one of the independent variables has a significant effect on the dependent variable. In this model, "content" and "form" have no significant effect on "fascination", while "characteristic" has a significant positive effect on "fascination".

From Table 11, The model's significance is demonstrated by an F-statistic of 82.901, with ANOVA indicating regression significance at $p < 0.001$. This suggests that at least one of the independent variables significantly affects the dependent variable. In this model, "content", "form", and "characteristics" all exert a significant positive influence on "compatibility".

Table 9. (a). Regression analysis model 1. (b). Regression analysis model.

(a)

Model		Square Sum	Degrees of Freedom	Mean Square	F	Significance
1	regression	41.832	3	13.944	82.770	0.000 b
	residual	26.449	157	0.168		
	total	68.281	160			

(b)

Model		Unstandardized Coefficient		Standardized Coefficient	t	Significance	95.0 Percent Confidence Interval for B	
		B	Standard Error	Beta			Lower Limit	Limit
1	(constant)	0.358	0.256		1.400	0.163	−0.147	0.862
	Content	0.043	0.049	0.050	0.879	0.381	−0.054	0.140
	Form	0.215	0.087	0.198	2.475	0.014	0.043	0.386
	Characteris-tic	0.656	0.092	0.592	7.155	0.000	0.475	0.838

a. implicit variable: being away. b. predictor variable: (constant), characteristic, content, form.

Table 10. (a). Regression analysis model 2. (b). Regression analysis model 2.

(a)

Model		Square Sum	Degrees of Freedom	Mean Square	F	Significance
2	regression	41.882	3	13.961	103.939	0.000 b
	residual	21.088	157	0.134		
	total	62.970	160			

Table 10. *Cont.*

		(b)						
	Model	**Unstandardized Coefficient**		**Standardized Coefficient**	**t**	**Significance**	**95.0 Percent Confidence Interval for B**	
		B	**Standard Error**	**Beta**			**Lower Limit**	**Limit**
1	(constant)	0.486	0.228		2.131	0.035	0.036	0.937
	Content	0.038	0.044	0.046	0.875	0.383	−0.048	0.125
	Form	0.128	0.077	0.123	1.651	0.101	−0.025	0.281
	Characteris-tic	0.737	0.082	0.692	8.996	0.000	0.575	0.899

a. implicit variable: fascinating; b. predictor variable: (constant), characteristic, content, form.

Table 11. (a). Regression analysis model 3. (b). Regression analysis model 3.

		(a)				
	Model	**Square Sum**	**Degrees of Freedom**	**Mean Square**	**F**	**Significance**
2	regression	40.681	3	13.560	82.901	0.000 b
	residual	25.681	157	0.164		
	total	66.361	160			

		(b)						
	Model	**Unstandardized Coefficient**		**Standardized Coefficient**	**t**	**Significance**	**95.0 Percent Confidence Interval for B**	
		B	**Standard Error**	**Beta**			**Lower Limit**	**Limit**
1	(constant)	0.285	0.252		1.130	0.260	−0.213	0.782
	Content	0.130	0.048	0.153	2.693	0.008	0.035	0.226
	Form	0.311	0.085	0.291	3.636	0.000	0.142	0.479
	Characteristic	0.488	0.090	0.447	5.396	0.000	0.309	0.666

a. implicit variable: compatible; b. predictor variable: (constant), characteristic, content, form.

5. Results

5.1. The Impact of Interactive Themes on Restorative Experiences in Virtual Immersive Public Art

Interactive themes in virtual immersive public art significantly enhance the restorative experience for observers. This suggests that by developing thought-provoking and captivating thematic encounters, designers can greatly amplify the therapeutic emotions of viewers. However, the thematic content of the artwork does not significantly influence the dimensions of distance and fascination in the restorative experience. In contrast, the compatibility dimension is notably affected by the content of the artwork. This indicates that observers are more likely to perceive positive impacts from publicly displayed artworks when there is a high level of compatibility with the content.

Furthermore, this suggests that compatibility plays a crucial role in fostering a favorable perception of the artwork's subject among the audience. Variations in interaction themes do not substantially impact the dimensions of being away and fascination. This may be attributed to the relatively mundane nature of public art theme design and the lack of emotional resonance in the details of empty themes, which diminishes the audience's emotional engagement. Therefore, future designs must enhance the ingenuity of the design motif to heighten the audience's sense of resonance and address the issue of vacant themes. Additionally, this emphasizes the need for designers to focus on theme innovation in virtual immersive public art to enhance the overall experience and perception of the audience.

5.2. The Impact of Interactive Form on Restorative Experiences in Virtual Immersive Public Art

Public art interactions significantly enhance the restorative experience for the audience. Interaction modes include various forms, such as haptic and gestural language, visual graphic language, and auditory and sound language. Regardless of the interaction mode

employed, users become fully immersed in the sensory experience, and the adaptable and appealing nature of the interactive design can strengthen the audience's connection with the artwork, thereby enhancing the overall experience of compatibility.

5.3. The Impact of Artistic Characteristics on Restorative Experiences in Virtual Immersive Public Art

Unique and captivating attributes of the artwork, such as the interplay of light and shadow and the incorporation of mirrors to enhance spatial perception, have a notable positive impact on the audience's sense of fascination. Specifically, when these attributes are present, the audience is more likely to be captivated, thereby enriching their restorative experience.

In contrast, neither the subject matter nor the structure of the artwork significantly influences the viewer's perception of fascination. This may indicate that the viewer's perception is not greatly affected by the artwork's form and content in this virtual immersive context, or that these factors play a relatively minor role in shaping the viewer's fascination. Therefore, when conceptualizing virtual immersive public art, it may be beneficial to emphasize the distinctive attributes and interactivity of the piece to enhance the viewer's therapeutic encounter. Additionally, this study provides specific recommendations for designers and artists seeking to create more engaging virtual immersive public artworks that positively affect the emotions of observers.

Table 12 and Figure 4 illustrate the significant impacts of interactive themes, interaction modes, and artistic characteristics on the three dimensions of restorative experience: being away, fascination, and compatibility. Specifically, certain artistic features, such as high interactivity and rich visual elements, demonstrate a notable enhancement of the audience's sense of being away, indicating that they effectively allow viewers to temporarily escape the pressures of everyday life, thus enhancing immersion. Additionally, most variables show significant effects on the fascination dimension, suggesting that they effectively capture the audience's attention and increase engagement and excitement. For example, the interplay of light and shadow, along with captivating sound designs, significantly enhances the audience's sense of fascination. However, some variables, such as auditory language, show a relatively minor influence on compatibility, indicating that not all design elements contribute equally to enhancing the audience's sense of compatibility.

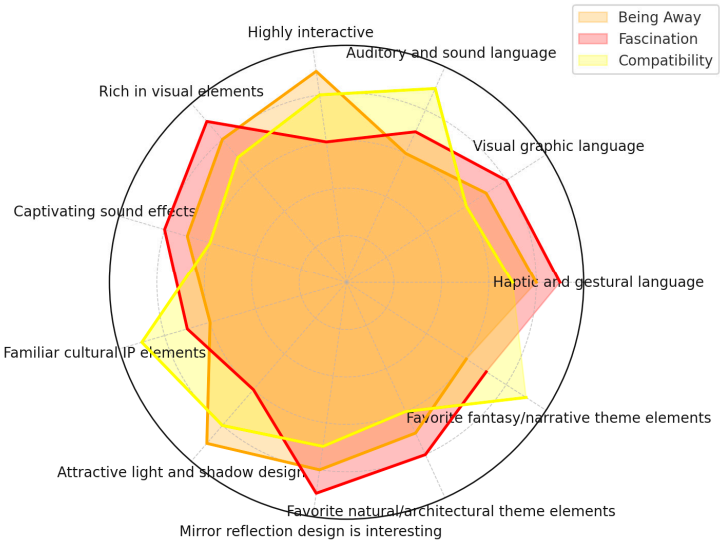

Figure 4. Impact of themes, form, and characteristics on restorative experience dimensions.

Table 12. Impact of themes, form, and characteristics on restorative experience dimensions.

Category	Variables	Being Away	Fascination	Compatibility
Theme Content	Favorite natural/architectural theme elements	Not Significant	Significant	Significant
	Favorite fantasy/narrative theme elements	Not Significant	Significant	Significant
	The theme inspired me	Not Significant	Significant	Significant
Interaction Form	Haptic and gestural language	Significant	Significant	Significant
	Visual graphic language	Significant	Significant	Significant
	Auditory and sound language	Significant	Significant	Not Significant
Characteristics	Highly interactive	Significant	Significant	Significant
	Rich in visual elements	Significant	Significant	Significant
	Captivating sound effects	Significant	Significant	Not Significant
	Familiar cultural IP elements	Significant	Significant	Significant
	Attractive light and shadow design	Significant	Significant	Significant
	Mirror reflection design is interesting	Significant	Significant	Not Significant

Based on the radar chart analysis, designers should focus on integrating those significant interaction modes and artistic features to maximize the restorative experience for viewers. Emphasizing emotional resonance and richness in thematic design can further elevate the audience's sense of immersion and fascination. Additionally, incorporating familiar cultural elements and visually appealing designs can enhance the audience's sense of compatibility, thereby increasing their identification with the artwork. This visual representation helps designers and artists identify effective design strategies to better meet the emotional and experiential needs of the audience.

In general, the presence of comprehensive public art significantly influences the restorative experiences of observers, with a particular emphasis on compatibility. This implies that the interactive themes, mode of interaction, and artistic characteristics of immersive public art have a beneficial impact on the restorative experience of individuals residing in urban areas. By providing empirical support for immersive public art design, this study contributes to the advancement of public art and urban planning practice.

6. Discussion

This paper provides empirical support for the role of virtual immersive public art as a restorative environment. Perceived levels of the restorative power of virtual immersive public art, psychological benefits experienced during visits, and overall personal well-being were high. This provides additional evidence of the beneficial effects of spending time in virtual natural environments [39].

With the assurance of scale reliability and validity, this paper analyzes and evaluates the relationship between virtual immersive public art and users' perceptions of restorative well-being. This work identifies several key mechanisms that contribute to individual well-being. As expected, our data show that the experience of virtual immersive public art leads to an awareness of the restorative properties of this environment, contributing to personal well-being by increasing perceived psychological benefits.

The key findings on restorative properties are as follows: The findings suggest that virtual immersive public art contributes to increased perceptions of restorative properties among research participants. Specifically, immersive public art had a significant positive effect on restorative perceptions across three dimensions: distance, charm, and compatibility (See Table 13).

The findings suggest that virtual immersive public art contributes to increased perceptions of restorative properties among research participants. Specifically, immersive public art had a significant positive effect on restorative perceptions in three dimensions: distance, charm, and compatibility. In terms of the strength of the influence, the compatibility coefficient is the largest, followed by charm and distance. From the perspective of immersive public art, the respondents ranked public art according to the mode of interaction, art

features, and interaction theme in order of importance. These results are consistent with Hidalgo and Berto et al. [40].

Table 13. Impact of virtual immersive public art on restorative dimensions.

Dimension	Mean Score	Standard Deviation	Significance Level
Being away	4.30	0.75	$p < 0.01$
Fascinating	4.45	0.72	$p < 0.001$
Compatibility	4.50	0.68	$p < 0.001$

Finally, the literature on the impact of demographic characteristics on residents' restorative experiences is still scarce. Gender did not have a significant effect on differences in restorative experiences; there were no significant differences in how males and females felt while viewing the exhibit. However, significant differences were found in the effect of marital status on the restorative experience. The relationship between perceived restorative experiences and well-being was stronger for those who were married or in a stable relationship, whereas this relationship was diminished for those without a partner.

This finding is inconsistent with previous research on restorative environments. For example, Hartig [41] analyzed the role of social interactions in restorative experiences and found that the presence of others may diminish benefits in natural environments when perceived safety is controlled. Similarly, Scopelliti and Giuliani [42] suggest that social interactions influence the restorative potential of natural environments, which is higher when people are alone.

Social interactions in the natural environment may distract individuals from their relationship with the environment, which itself is a restorative factor. Carrus et al. [43] also found that social interactions had a similar detrimental effect on the positive outcomes of contact with nature. This inconsistency could be attributed to a smaller sample size, which may limit the ability to detect small differences, or a difference in the study's focus.

While other scholars have studied natural environments as restorative environments, this paper focuses on a virtual environment as a restorative environment, utilizing a variety of technological means to create settings where various sensing and interacting devices can be explored. This allows for a more in-depth exploration of the environment with family and friends, enhancing enjoyment and overall experience.

This study has several limitations. Firstly, while the project examined multiple locations, we focused solely on virtual immersive experiences due to the cross-sectional nature of our research, which limits our ability to assess whether the impact of this public art on psychological recovery is unique to urban residents or applicable to rural populations. The absence of a control group consisting of rural residents raises questions about the generalizability of our findings. Additionally, our sample primarily consisted of art gallery visitors, which may not represent the broader urban population. Furthermore, while virtual immersive public art significantly enhances participants' restorative experiences, it is important to consider that subjective preferences may influence the generalizability of the conclusions. Individuals have unique preferences for specific art styles and forms, which may directly impact their restorative experiences. Future research should adopt longitudinal studies or field experiments and incorporate physiological indicators (such as heart rate and skin conductance) along with cognitive assessments to provide a more comprehensive evaluation of restorative experiences using the Perceived Restrictiveness Scale (PRS).

7. Conclusions

Future research should consider a comparative analysis of virtual immersive environments and traditional physical restorative environments. This study could focus on how both settings influence psychological well-being and restoration in urban residents.

In summary, our findings suggest that the promotion of virtual immersive public art experiences is essential in densely populated urban environments, where a significant

portion of the global population resides. This research highlights the potential of such art forms to contribute positively to the well-being of city residents, reinforcing the need for urban planners and designers to integrate virtual immersive art into public spaces. By doing so, they can create environments that not only enhance individual well-being but also support the transition to more sustainable urban lifestyles.

In addition, this study contributes to the fields of environmental psychology and public art by demonstrating how innovative artistic methods can be employed to enhance urban resident engagement and foster a strong sense of place within urban environments. Future applications may involve collaboration among artists, technologists, and urban planners to create immersive public art installations that are accessible to diverse groups, thereby enriching the cultural landscape of cities while addressing pressing social and environmental challenges.

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