Evaluating the Restorative Potential of Different Green Strategies in Streets

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Abstract:. The contemporary urban lifestyle, marked by heightened stress levels, contributes to a global surge in mental health issues. Urban sidewalks, where daily interactions occur, offer potential respite, making the design of restorative urban streets crucial for enhancing mental well-being. While previous research acknowledges the restorative value of urban green spaces, there is a pressing need for new studies to identify effective green strategies for mental health promotion. This study focuses on identifying urban green spaces positively affecting mental health and assessing various green strategies from the pedestrian perspective. Using virtual reality (VR), participants evaluated 3D model urban scenes on mobile screens within VR glasses, featuring different sidewalk vegetation and building facades, resulting in 16 experimental conditions. Participants, including individuals from architectural and non-architectural backgrounds and undergraduate students and professionals, expressed unanimous preference for green areas on sidewalks and building facades. The most restorative model featured trees on sidewalks and open front yards on building facades. Additionally, a positive correlation emerged between "Restorative Potential" and Attention Restoration Theory (ART) components, shedding light on factors influencing urban green space preferences. In conclusion, this study provides valuable insights into designing urban green spaces for promoting mental well-being. Policymakers and planners can leverage this evidence to craft urban environments offering restorative benefits, enhancing residents' overall quality of life in cities worldwide.

Keywords: Urban Green Spaces, Attention Restoration Theory (ART), Perceived Restorativeness Scale (PRS), Urban Streets, Virtual Reality (VR)

Sokaklarda Mekânı Oluşturan Farklı Yeşil Stratejilerin Onarıcı Potansiyelinin Değerlendirilmesi

Öz: *Çağdaş kentsel yaşam tarzı, artan stres seviyeleri ile belirlenmiş olup, küresel ölçekte mental sağlık sorunlarında bir artışa katkıda bulunmaktadır. Günlük etkileşimlerin gerçekleştiği kentsel kaldırımlar, potansiyel bir dinlenme alanı sunarak, ruhsal iyi olma durumunu artırmak için restoratif kentsel sokakların tasarımını önemli kılar. Önceki araştırmalar, kentsel yeşil alanların restoratif değerini kabul etse de mental sağlık teşviğine yönelik etkili yeşil stratejileri belirlemek için yeni çalışmalara acil bir ihtiyaç bulunmaktadır. Bu çalışma, mental sağlığı olumlu etkileyen kentsel yeşil alanları belirleme ve yaya bakış açısından çeşitli yeşil stratejileri değerlendirme odaklıdır. Katılımcılar, sanal gerçeklik (VR) kullanarak, farklı kaldırım bitkilerini ve bina cephelerini içeren 3D model kentsel sahneleri mobil ekranlarda VR gözlükleri içinde değerlendirmiş ve 16 deneme koşulu oluşturmuştur. Mimarlık ve mimarlık dışı alanlardan ve lisans öğrencilerinden ve profesyonellerden oluşan katılımcılar, kaldırımlar ve bina cephelerindeki yeşil alanlara eğilim göstermiştir. En restoratif model, kaldırımlarda ağaçlar ve bina cephelerinde açık avlular içermektedir. Ayrıca, "Restoratif Potansiyel" ile Dikkat Restorasyon Teorisi (ART) bileşenleri arasında pozitif bir korelasyon ortaya çıktı, bu da kentsel yeşil alan tercihlerini etkileyen faktörlere ışık tutmuştur. Sonuç olarak, bu çalışma, mental sağlığı teşvik etmek amacıyla kentsel yeşil alanların tasarımı konusunda değerli içgörüler sunmaktadır. Karar alıcılar ve planlamacılar, bu kanıtları kullanarak dünya genelinde şehir sakinlerinin genel yaşam kalitesini artıran restoratif faydalar sunan kentsel ortamlar oluşturabilirler.*

Anahtar Kelimeler: *Kentsel Yeşil Alanlar, Dikkat Restorasyon Teorisi (ART), Algılanan Restoratiflik Ölçeği (PRS), Kentsel Sokaklar, Sanal Gerçeklik (VR)*

INTRODUCTION

Research indicates that interacting with natural areas, whether actively through activities like gardening or passively through observation, offers numerous health benefits such as disease prevention, blood pressure control, headache relief, and aiding addiction recovery (Keniger et al., 2013). Green spaces also aid in post-surgery recovery and enhance well-being (Pazhouhanfar & Kamal, 2014). Access to urban green spaces correlates with better population health and reduced health disparities (Mitchell & Popham, 2008). Engagement with nature reduces depression, anxiety, and stress while boosting happiness and life satisfaction (De Vries et al., 2003; MacKerron & Mourato, 2013; Ambrey et al., 2014). Regular contact with nature significantly enhances overall well-being (Signoretta et al., 2009; Shaftoe, 2012). As urbanization increases, nature interaction becomes crucial for mitigating stressors like pollution and traffic (Van den Bosch et al., 2018). There exists an innate human connection with nature, promoting well-being and appreciation for surroundings (Signoretta et al., 2009). However, disruptions to this connection contribute to various health issues (Souter-Brown, 2014). Restorative environments aim to replenish energy, promote relaxation, and restore mental clarity by providing opportunities for breaks, facilitating rest,

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and reducing stress. Attention Restoration Theory (ART), developed by Kaplan and Kaplan, suggests that natural environments uniquely enhance cognitive function, particularly the capacity for sustained focus, and generally possess greater restorative potential compared to urban settings (Hartig et al., 2003; Kaplan and Kaplan, 1989).

Study background

Thwaites et al. (2005) suggest that environments replenished with energy possess healing potential, historically utilized to confer restorative benefits, as acknowledged by the WHO (2017). Natural settings consistently enhance psychological well-being, fostering stress reduction and cognitive restoration (Hartig, 2007; Hartig et al., 2014). With global urbanization on the rise, the imperative for restorative environments becomes increasingly urgent (United Nations, 2018). Urban inhabitants enduring perpetual mental fatigue require access to restorative environments for cognitive rejuvenation (Kaplan and Kaplan, 1989). Prolonged absence of restoration detrimentally affects performance and well-being (Hartig et al., 2011), positioning contact with green spaces as a public health priority (De Vries et al., 2003).

Scientific research validates stress reduction and attention restoration in natural settings (Ulrich et al., 1991; Tennessen and Cimprich, 1995; Staats et al., 2003). Constructed settings are deemed less restorative than natural ones (Korpela and Hartig, 1996; Purcell et al., 2001; Staats et al., 2003), underscoring the significance of urban nature for restoration (Staats et al., 2003; Hartig and Staats, 2006). Natural landscapes are preferred and considered more restorative due to their intrinsic qualities (Shaftoe, 2012; Purcell et al., 2001; Hartig and Staats, 2006). Furthermore, exposure to natural surroundings or constructed environments with natural elements better facilitates restoration (Song et al., 2014; Wang et al., 2016), fostering joy and mitigating anger (Hartig et al., 2003).

Attention Restoration Theory (ART) underscores the restorative potential of natural environments, characterized by four components: 1. Fascination: Natural environments elicit effortless attention, thereby providing respite from the cognitive demands of directed attention and mitigating mental fatigue. 2. Being Away: Psychological or physical separation from routine activities and stressors facilitates mental rejuvenation. 3. Extent: Environments that are sufficiently rich and coherent promote a sense of exploration and connectedness, thereby enhancing the restorative experience. 4. Compatibility: The alignment of the environment with an individual's needs and preferences fosters a sense of belonging and comfort (Kaplan and Kaplan, 1989; Hartig et al., 1996). Green spaces in urban locales are pivotal for restoration amidst urbanization (James et al., 2009; Nielsen and Hansen, 2007; WHO, 2017), with smaller green areas increasingly acknowledged as essential for restoration (Thwaites et al., 2005). Vegetation, particularly trees, lining urban streets, enhances calmness and quality of life (Lohr et al., 2004; Schroeder et al., 2006), with tree-lined streets preferred over those devoid of greenery (Getz et al., 1982; Sommer et al., 1990; Wolf, 2009). Components such as shrubs and flowers also contribute to the restoration of urban streets (Todorova et al., 2004).

MATERIAL and METHOD

Aims and Objectives

This study aims to assess pedestrians' preferences for green areas in urban streets, determine the restorative potential of various green strategies, and investigate their effects based on the Perceived Restorativeness Scale (PRS) derived from Attention Restoration Theory (ART). The objectives are to identify pedestrian preferences for green areas, understand the restorative potential of different green strategies in urban streets, determine the most effective green strategy, and explore their restorative properties and relationships. The research utilizes virtual models to examine relationships between driveways, green spaces, sidewalks, gardens, and building facades in diverse street sections, considering various urban street characteristics.

Virtual Reality (VR) technology in restorative perception

The application of virtual reality (VR) in environmental perception assessments represents a notable advancement in the analysis of landscapes. VR methods provide users with a realistic or simulated environment, enabling them to experience a sense of telepresence and interact with the environment in real time (Mineev, 2017). This technology facilitates dynamic interaction with landscapes, offering a distinct advantage over traditional methods that utilize static images (Bishop et al., 2001). Social scientists have increasingly utilized various data collection tools to study people's perceptions and behaviors concerning built environments and natural settings. These tools have evolved from static photography to dynamic media, interactive walkthroughs, and immersive virtual simulations (Ewing and Cervero, 2010; Stamps, 2010). VR technology enhances users' sense of presence and provides objective perspectives, enabling unrestricted exploration and assessment of restorative benefits (Mineev, 2017). High-performance graphics facilitate the creation of realistic virtual urban environments, allowing manipulation of design factors and control of variables (Rohrmann and Bishop, 2002). However, the reliability and validity of VR methods come with certain limitations. While VR can more accurately replicate settings compared to static images, the synthetic sensory input used may not fully capture the complexities of real-life experiences (Blascovich et al., 2002). Additionally, the controlled nature of VR environments can influence user behavior and perceptions in ways that may differ from

natural settings (Welch et al., 1996). Despite these limitations, VR's potential for offering contextual information and new avenues for landscape perception research makes it a valuable tool for researchers (Smith, 2015). This study employs a VR-supported system to positively influence participants' affective states and attention restoration, utilizing an inexpensive and user-friendly mobile VR device to ensure usability.

Study Design

After receiving approval from the Social and Human Sciences Human Research Ethics Committee at Istanbul Technical University, participants were recruited from four distinct groups: 20 undergraduate architecture students, 10 professional architects, 10 undergraduate students from other disciplines, and 10 professionals from other disciplines. In total 50 participants were recruited. These groups were selected to investigate whether there exists a heightened awareness and preference for restorative models among professionals and students in architectural and other disciplines, and to ascertain any innate human inclination toward green environments, even subconsciously. Additionally, the study aimed to assess the impact of architectural education on these preferences. They were informed about the study and invited to participate in a 30-minute survey on environmental perception, without any monetary incentives offered. This study was conducted with a total of 50 participants, as it included prolonged and intense visual stimuli, surpassing the statistical minimum number of participants and ensuring an equal distribution between students and professionals.

Prior to the experiment, participants were instructed to carefully read all guidelines. Detailed instructions were provided, and scenes were presented on a 6.4-inch phone screen integrated into Virtual Reality (VR) glasses. To create three-dimensional visualizations, a freely accessible virtual environment was used, developed in SketchUp and Unity. Ground-level perspectives were employed to depict scenarios, capturing the impression of traversing paths (Figure 1). The limitation of employing this methodology in our study is that only visual stimuli were presented to the participants, who responded to the questions without taking other senses into account.

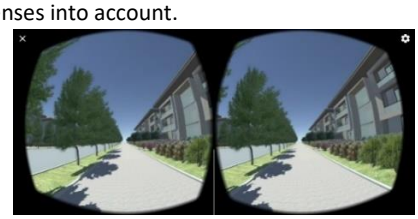

Figure 1. A scene from a virtual reality environment on a 6.4-inch phone screen

Figure 2 displays 16 experimental conditions of the same environment design, each showcasing a distinct green strategy (4 Facade types × 4 Sidewalk vegetation types). According to previous research, integrating green strategies such as trees and understory vegetation in urban settings offers numerous benefits (Lohr et al., 2004; Schroeder et al., 2006; Getz et al., 1982; Sommer et al., 1990; Wolf, 2009; Todorova et al., 2004). Based on these findings, the chosen scenes for evaluation in this study represent four different types of vegetation on sidewalks: 1) trees, 2) shrubs, 3) grass, and 4) no vegetation, as well as four different facade types: 1) open front yards, 2) hedge vegetation, 3) green walls, and 4) solid walls.

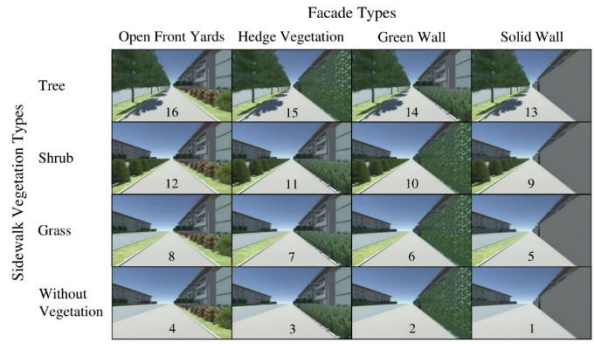

Figure 2. 16 Experimental conditions with different green strategies implemented (4 Facade types × 4 Sidewalk vegetation types)

Questionnaire design

The questionnaire is organized as follows:

• Section 1: Gathering socio-demographic data.

• Section 2: Two questions on preference for viewing green areas in 16 scenes based on given scenarios.

• Section 3: Rating the restorative potential of selected scenes from the previous section using a restorative environment concept question.

• Section 4: Assessing the restorative properties of the selected scene through seven questions based on the Perceived Restorativeness Scale (PRS), focusing on Attention Restoration Theory (ART) components: Fascination, Being away, Extent, and Compatibility, along with restorative potential items.

Procedure of questionnaires

Participants, opting to participate voluntarily, followed these steps after providing socio-demographic data:

Firstly, participants were briefed about the 3D environment they would encounter. Before starting the experiment, they were presented with a scenario to maintain consistency and relevance in assessment (Hartig et al., 1997; Staats et al., 2003). Participants imagined themselves taking a leisurely stroll after a mentally taxing day, setting the context for the evaluation.

In the initial step, participants virtually walked through street models with different green space strategies, indicating their preference for green areas between driveways and sidewalks, and between building facades and sidewalks, based on the provided scenario. Undesirable strategies were eliminated based on their responses. If multiple models remained, participants proceeded to the

next step; otherwise, they skipped to the third stage (Figure 3).

In the subsequent step, participants were briefed on restorative environments and their benefits (Hartig, 2007; Hartig et al., 2014; WHO, 2017). They then evaluated the remaining street sections, rating their restorative qualities on a 10-point Likert scale.

Lastly, participants walked through the street model with the highest score from the previous step and answered survey questions based on factors outlined in Table 1, using the Perceived Restorativeness Scale (PRS), which is based on Attention Restoration Theory (ART) components: Fascination, Being away, Extent, and Compatibility, along with two items representing restorative potential, rated on a five-point Likert scale. The goal was to analyze the restorative properties and their relationship with the most restorative green strategy from the previous step.

Data analysis

After survey completion, data underwent digitization and coding, analyzed using IBM SPSS Statistics 26. Data coding preceded transfer to aid statistical calculations.

In the third section, descriptive statistics compared means and standard deviations of preferred model scores, assessing restorative potentials of different green strategies. The final section employed descriptive statistics to compare means and standard deviations of scores for seven questions. Additionally, a T-test determined correlation significance. Means of scores for five evaluation factors based on the highest-scoring model were compared. Pearson correlation analyzed relationships between restorative properties of the selected model. A significance level of $\alpha \leq 0.05$ was utilized.

Research Ethics

Ethical permissions were secured for this study, ensuring voluntary participation. Participants had autonomy to decide without external influence and could withdraw at any time without consequences. Information in the consent form was available for clarification before participation.

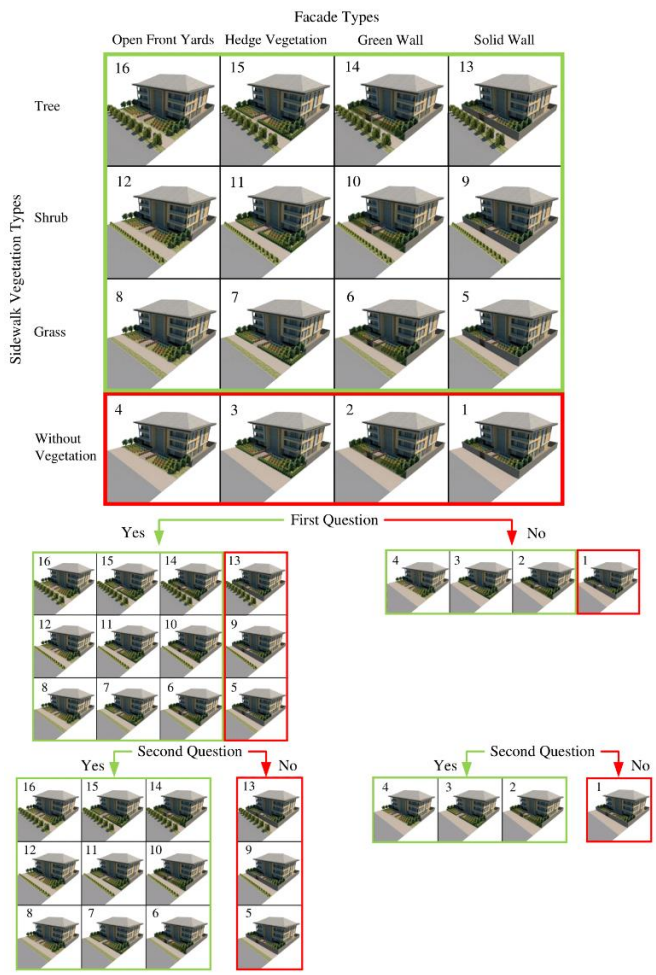

Figure 3. Four different possible situations after answering the two general questions in the first step

Table 1. Evaluation factors, utilizing the PRS, are categorized according to their intended subscale designations from ART, with the inclusion of items related to restorative potential (Kaplan and Kaplan, 1989; Kaplan, 1995; Hartig et al.,1996; Korpela and Hartig 1996; Bodin and Hartig, 2003; Herzog et al., 2003)

Evaluation factors	
Fascination	1. Encourages people to spend more time exploring the place, discovering its nuances, and becoming more familiar with it.
Being away	2. Offers a respite from people's daily routines and helps them feel distant from their everyday thoughts and worries.
Extent	3. Mentally engages people, immersing them in the environment and preventing them from thinking about anything else.
Compatibility	4. Induces a sense of relaxation, comfort, and a feeling of belonging and unity with the place.
	5. Provides enjoyment for people.
Restorative Potential	6. Facilitates mental restoration by allowing individuals to escape from life's stressors.
	7. Grants people the ability to rest, recuperate, and focus on their surroundings.

RESULTS and DISCUSSION

User Characteristics

Section 1 collects socio-demographic data to understand participant characteristics. Out of 50 participants, slightly more were female (52%) than male (48%), aged 18-35. The 18-25 age group had the highest participation (60% vs. 40% for 26-35). Undergraduate architecture students had the highest participation (40%), followed by undergraduates from other fields (20%), and professionals from both architectural and other fields (20% each) (Table 2).

Green Space Preference

To assess pedestrian preferences for green areas in urban streets, participants answered two questions about their preference for green spaces in 16 scenes. All 50 participants preferred green areas between driveways and pavements, as well as between building facades and pavements. Consequently, nine models with green areas on both sides of sidewalks (Models 16, 15, 14, 12, 11, 10, 8, 7, and 6) were favored, leading to the elimination of the remaining models (Figure 3).

Restorative Potential of Different Green Strategies

This section examines the restorative potential of various green strategies in streets. Participants rated nine preferred environments on a scale of 1 to 10, considering their restorative qualities. The aim was to understand the restorative potential of different environments. Among the nine models, only five (Models 16, 15, 14, 12, and 11) received a top score of 10. Model 16, featuring a tree-lined street design with open front yards, was preferred by 64% of participants, followed by Model 12 (18%), Model 15 (10%), and Models 14 and 11 (4% each). Model 16 also had the highest mean rating, followed by Models 12 and 15 (Table 3).

Comparing ratings based on employment and education status revealed that most participants favored Model 16, particularly among professionals in the architectural discipline. 80% of architectural professionals and 75% of architectural undergraduate students preferred this model, compared to 50% of professionals and 40% of undergraduate students from other fields (Table 4).

Table 2. Descriptives of study populations.

Factors		N	Percent
Gender	Women:	26	52%
	Men:	24	48%
Age Groups	18-25:	30	60%
	26-35:	20	40%
Employment and Education Status	Undergraduate students from other disciplines:	10	20%
	Professionals from other disciplines:	10	20%
	Undergraduate students from the architectural discipline:	20	40%
	Professionals from the architectural discipline:	10	20%
Total		50	100%

Table 3. Descriptive statistics results and score ratings of nine models

Score	Model 16		Model 15		Model 14		Model 12		Model 11		Model 10		Model 8		Model 7		Model 6	
	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
1	0	0%	0	0%	0	0%	0	0%	0	0%	1	2%	0	0%	3	6%	13	26%
2	0	0%	0	0%	0	0%	0	0%	0	0%	3	6%	4	8%	6	12%	15	30%
3	0	0%	0	0%	5	10%	0	0%	1	2%	4	8%	9	18%	14	28%	15	30%
4	0	0%	2	4%	3	6%	0	0%	2	4%	5	10%	13	26%	14	28%	6	12%
5	1	2%	0	0%	8	16%	2	4%	5	10%	19	38%	9	18%	8	16%	1	2%
6	0	0%	4	8%	7	14%	5	10%	15	30%	12	24%	6	12%	4	8%	0	0%
7	2	4%	5	10%	17	34%	7	14%	12	24%	6	12%	5	10%	1	2%	0	0%
8	3	6%	14	28%	6	12%	13	26%	9	18%	0	0%	4	8%	0	0%	0	0%
9	12	24%	20	40%	2	4%	14	28%	4	8%	0	0%	0	0%	0	0%	0	0%
10	**32**	**64%**	**5**	**10%**	**2**	**4%**	**9**	**18%**	**2**	**4%**	**0**	**0%**	**0**	**0%**	**0**	**0%**	**0**	**0%**
Total	50	100%	50	100%	50	100%	50	100%	50	100%	50	100%	50	100%	50	100%	50	100%
Mean	9.42		8.18		6.28		8.18		6.76		4.96		4.7		3.68		2.34	
Std. Deviation	1.012		1.366		1.762		1.38		1.492		1.428		1.705		1.377		1.062	

Table 4. Score ratings of five models generally, and also based on participant's employment and education status

Model Number	Undergraduate students from other disciplines		Professionals from other disciplines (Employees or Graduate students)		Undergraduate students from the architectural discipline		Professionals from the architectural discipline (Employees or Graduate students)		General	
	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
16	4	40%	5	50%	15	75%	8	80%	32	64%
15	0	0%	3	30%	1	5%	1	10%	5	10%
14	2	20%	0	0%	0	0%	0	0%	2	4%
12	3	30%	2	20%	3	15%	1	10%	9	18%
11	1	10%	0	0%	1	5%	0	0%	2	4%
Total	10		10		20		10		50	

Table 5. Descriptive statistics and one sample T-Test results of seven questions based on five evaluation factors about model 16

Evaluation factors	Question Number	N	Mean		Std. Deviation	t	Sig. (2-tailed) Test Value = 3
Fascination	1	32	4.22	4.22	0.706	9.760	0.000
Being away	2	32	3.66	3.66	1.066	3.483	0.002
Extent	3	32	3.50	3.50	0.842	3.357	0.002
Compatibility	4	32	3.69	3.72	1.030	3.777	0.001
	5	32	3.75		1.218	3.483	0.002
Restorative Potential	6	32	3.66	3.735	0.827	4.487	0.000
	7	32	3.81		0.780	5.890	0.000

Table 6. Bivariate Pearson correlation results of five evaluation factors

Evaluation factors		Fascination	Being away	Extent	Compatibility	Restorative Potential
Fascination	Pearson Correlation	1	.232	.244	.440*	.549**
	Sig. (2-tailed)		.202	.178	.012	.001
	N	32	32	32	32	32
Being away	Pearson Correlation	.232	1	.521**	.443*	.482**
	Sig. (2-tailed)	.202		.002	.011	.005
	N	32	32	32	32	32
Extent	Pearson Correlation	.244	.521**	1	.351*	.454**
	Sig. (2-tailed)	.178	.002		.049	.009
	N	32	32	32	32	32
Compatibility	Pearson Correlation	.440*	.443*	.351*	1	.666**
	Sig. (2-tailed)	.012	.011	.049		.000
	N	32	32	32	32	32
Restorative Potential	Pearson Correlation	.549**	.482**	.454**	.666**	1
	Sig. (2-tailed)	.001	.005	.009	.000	
	N	32	32	32	32	32

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Relationship between restorative properties

To analyze the restorative properties and their relationship with the most restorative green strategy for urban streets, we examined the properties of Model 16, which received the highest ratings in the previous section.

This section includes questions from the Perceived Restorativeness Scale (PRS) and questions based on Attention Restoration Theory (ART) components. Participants rated Model 16 on seven questions related to restorative properties.

Question 1 obtained the highest mean score, followed by questions 7, 5, 4, 2, and 6. Descriptive statistics comparing the means of the five evaluation factors' scores for Model 16 showed that Fascination had the highest mean, followed by Restorative Potential, Compatibility, Being Away, and Extent (Table 5).

Using Pearson correlation, we found positive relationships between Restorative Potential and Fascination, Being Away, Extent, and Compatibility. Fascination and Compatibility were strongly correlated, as were Being Away and Extent. Being Away also correlated strongly with Compatibility, and Extent had a moderate correlation with Compatibility. These correlations were statistically significant ($p < 0.05$). However, there was no significant connection between Fascination and Being Away or Extent (Table 6).

Discussion

Prior research underscores the necessity of enhancing urban environments for better well-being. This study delved into elements augmenting the restorative potential of city streets.

Participants consistently favored green areas between driveways and pavements, as well as between building facades and pavements, aligning with prior research (Staats et al., 2003; Hartig and Staats, 2006; Signoretta et al., 2009; Shaftoe, 2012).

Secondly, participants evaluated green strategies in streets, with tree and shrub elements receiving top scores, echoing past studies (Getz et al., 1982; Sommer et al., 1990; Todorova et al., 2004; Wolf, 2004; Wolf, 2009). Designs featuring tree-lined streets and vibrant flower plantings beneath trees garnered the most favor.

Professionals and students from various disciplines were surveyed, revealing a preference for tree-lined streets among architectural professionals and students, indicating heightened awareness of restorative potential in architectural fields (Keller et al., 2011). This underscores an innate human inclination toward green environments, even subconsciously (Signoretta et al., 2009; Shaftoe, 2012).

Analysis of restorative properties showed strong endorsement of "Fascination" items and lower endorsement of "Extent" items, indicating the selected model's potential for exploration but less effectiveness in mental distraction (Kaplan and Kaplan, 1989; Kaplan, 1995; Hartig et al.,1996; Korpela and Hartig, 1996; Bodin and Hartig, 2003; Herzog et al., 2003).

Furthermore, a positive relationship was observed between "Restorative potential" and all other components, suggesting areas with higher restorative potential exhibit higher levels of Fascination, Being away, Extent, and Compatibility. Higher "Being away" levels were associated with greater "Extent", and higher "Compatibility" scores correlated with higher levels of "Fascination", "Being away", and "Extent". However, no significant connection was found between "Fascination" and "Being away" or "Extent"

CONCLUSION

This study assesses the restorative potential of urban sidewalks, providing insights for architects, urban designers, and landscape architects. Utilizing virtual reality (VR) techniques, it offers a novel approach to visualize streets, surpassing traditional methods like images and videos. Implementing 16 different models with varied green strategies expanded understanding of how these strategies influence perceptions and preferences.

Recommendations for local governments include incorporating green bands between roads and pavements, utilizing trees where space allows, and opting for unfenced front yards to enhance restorative qualities. Future urban designs could benefit from incorporating these features to encourage exploration and familiarity.

However, limitations such as the use of only visual stimuli, the absence of soundscapes and limited number of participants suggest avenues for further research. Incorporating roadway background noise and employing additional modalities like EEG data could provide more objective outcomes. Future studies could also explore how prior knowledge of the region affects perceptions and assess the impact of different types of vegetation on restorative potential.

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