sustainability

Article

How Do Spatial Forms Influence Psychophysical Drivers in a Campus City Community Life Circle?

Shi-Ying Li [1], Zhu Chen [2], Lian-Huan Guo [1], Fangbing Hu [3], Yi-Jun Huang [1], Dan-Cheng Wu [1], Zhigang Wu [1,*] and Xin-Chen Hong [1,4,*]

[1] School of Architecture and Urban-Rural Planning, Fuzhou University, Fuzhou 350108, China; 211520031@fzu.edu.cn (S.-Y.L.); lianhuan.guo@outlook.com (L.-H.G.)
[2] Institute of Environmental Planning, Leibniz University Hannover, Herrenhäuser Str. 2, 30419 Hanover, Germany; chen@umwelt.uni-hannover.de
[3] Department of Forest Resources Management, University of British Columbia, Vancouver, BC V6T 1Z4, Canada; fangbing.hu@outlook.com
[4] School of Architecture, Southeast University, Nanjing 210096, China
* Correspondence: klins@fzu.edu.cn (Z.W.); xch.hung@outlook.com (X.-C.H.)

Abstract: The physical environment of urban public facilities is an important driver for public health and work efficiency. Unfortunately, citizens are exposed to negative physical environments because of inappropriate spatial forms in urban growth boundaries. This study aims to explore psychophysical drivers and their spatial distribution in campus city community life circles during the COVID-19 pandemic. Questionnaires and measuring equipment were used to gather psychophysical information in a 15 min campus city community life circle in Fuzhou, China. To this end, acoustic, light and thermal environments were used to map spatial distributions. We then explored relationships between spatial form and psychophysical parameters. The study results show that the distance to road (DTR), green area ratio (GR) and street width (SW) are all potential spatial drivers for psychophysical information. Furthermore, the acoustical, light and thermal environments provide interactions for the public understanding of the environment. These findings contribute to the understanding and evaluation of psychophysical drivers, spurring regional industry in community life circles and contributing to developing suitable plans and industrial distribution in urban areas.

Keywords: urban public facilities; equal time circle; physical environment; community life circles

check for updates

Citation: Li, S.-Y.; Chen, Z.; Guo, L.-H.; Hu, F.; Huang, Y.-J.; Wu, D.-C.; Wu, Z.; Hong, X.-C. How Do Spatial Forms Influence Psychophysical Drivers in a Campus City Community Life Circle? *Sustainability* **2023**, *15*, 10014. https://doi.org/10.3390/su151310014

Academic Editor: Robert Krzysztofik

Received: 13 May 2023
Revised: 19 June 2023
Accepted: 20 June 2023
Published: 24 June 2023

1. Introduction

The urbanization process in China is currently experiencing a rapid development. However, this process has resulted in high-intensity development and rapid expansion that have significantly impacted the urban environment. This has triggered a series of urban diseases, such as the heat island effect, noise pollution, light pollution, air pollution, etc., which have seriously reduced the quality of the urban living environment. Multiple studies have focused on the elements of thermal, acoustic and light environments in urban areas, which indicate that poor urban physical environments can have a significant negative impact on people's physiological and mental health [1,2]. For instance, urban noise exposure may cause annoying moods and insomnia, increasing the probabilities of hypertension and cardiovascular disease, as well as negative effects on the auditory and nervous systems [3]. The urban thermal environment also poses a significant risk factor for death and related diseases in the population, especially cardiovascular and respiratory diseases, during heat waves [4,5]. Furthermore, the light environment directly affects not only the ambience of public spaces, but also people's behavior, sleep and mood [6]. These urban physical environments potentially influence public health in communities.

A community living circle is the basic constituent unit of urban space where most daily activities occur. In contrast to traditional communities, campus cities should integrate the campus, community and industrial areas in a symbiotic and complementary way. Communities are an extension of commerce, residence and education within universities in the campus city, enriching the spatial pattern of the university town and promoting diversified development from traditional teaching spaces. At the same time, with the popularization of the concept of a "shared campus" and "shared community", sharing public facilities between campus city communities and universities has become an inevitable trend [7]. The sharing of sports facilities and resources has brought great convenience to the community. The Fuzhou city campus is rich in sports facility resources, and can serve social services and radiate sports activities of surrounding residents. It can also provide a sharing platform for staff and college students to effectively use venue resources and participate in sports activities. The outbreak of the COVID-19 pandemic changed public recreational and commercial activities in community living circles. During the pandemic period, residents' need for fitness and leisure increased, and sports facilities in university town communities became important public activity places for community residents, college teachers and students.

Against this backdrop, it is indispensable to provide suitable community utility services in community life circles, especially in emergency quarantines, contributing to building an urban organic system of healthy cities in terms of a healthy environment and a healthy society [8]. The quality indicators of a healthy city are derived from both the objective aspect, such as the average regional environmental noise, the land area of sports facilities per capita and greening coverage, and the subjective aspect, such as satisfaction with environmental quality [9].

This requires high-quality community public facilities to meet the needs of residents for their daily activities. Public activity spaces are a complex environment containing many factors, among which physical factors, such as the thermal environment [10], acoustic environment [11], visual environment, etc., can affect individual perception [12]; other factors can also affect individual perception, and can affect one another, influencing people's perception of the overall environment. Different factors jointly affect the physical environment, and many studies have focused on the relationship between physical environmental factors and environmental comfort, conducting research on thermal comfort and acoustic comfort [13,14]. A large body of research has also focused on the effects of noise and its sound pressure levels on individual thermal perception. Some scholars used the temperature and noise sound pressure level (SPL) in different durations to explore the subjective effects of the acoustic environment and thermal environment on people [15]. Some scholars also used the equivalent continuous sound pressure level (Leq) to study the relationship between the background soundscape and thermal environment, finding that noise is an important factor affecting thermal perception [16]. In a study of the perception of the visual environment, visual factors mainly included the surface materials, shadows and lights of buildings or roads [17,18]. Some scholars found that under different thermal environment conditions, solar light illumination (LUX) had a crossmodal effect on thermal sensation, which could alleviate the thermal discomfort in outdoor public spaces by improving visual comfort [19]. Therefore, public facilities, as important activity spaces of community life circles, should take environmental comfort as a necessary condition for outdoor activities, and comprehensively consider the influence of acoustic, light, thermal and other factors.

Notably, sports facilities are one of the most important types of public facilities in campus city community life circle, contributing benefits to physical fitness, the residents' health status, the efficiency of operations and buying inclination [20]. Plenty of studies have paid attention to the environments around urban stadiums, having become a topic of interest [21–23]. A previous piece of research explored the relationship between reverberation time, activity noise levels and human comfort in the acoustic environment of a stadium [1]. In addition, the typical thermal environment of a university gymnasium was effectively simulated based on the thermal building layout, building orientation, natural lighting and ventilation [24]. The gymnasium building form may affect thermal comfort in subtropical humid and hot regions, especially in summer [25]. Furthermore, internal relationships may exist among natural light, stadiums and visitor behavior from a combined subjective and objective perspective [26]. However, there is a lack of the comprehensive consideration of acoustic, light and thermal environments and the visualization of psychophysical spatial distribution in stadiums in community living circles.

Thus, this study was conducted to fill the above gaps, aiming to: (1) explore the data interval for the best-perceived effects of environmental elements in the study area; (2) observe psychophysical relationships between acoustic, light and thermal environments; (3) and visualize the psychophysical drivers influencing spatial distribution through the use of a geographic information system (GIS).

2. Methods

2.1. Study Area and Observation Sites

The study area was in Fuzhou, which is located on the southeastern coast of China, eastern Fujian, downstream of the Min River, at latitude 25°15′~26°39′ N and longitude 118°08′~120°31′ E. It is a central subtropical climate zone with warm winters and hot summers, high temperatures and heavy humidity, small annual and daily temperature differences, an average annual temperature range of 17° to 26° and an annual relative humidity of approximately 77%. The Fuzhou University City Sports Center is located in the central shared area of the University City in Minhou County, Fuzhou City (see Figure 1 left), covering an area of 2.9 hectares, with a 20,000-seat stadium, a 4000-seat gymnasium and a standard outdoor swimming pool, with a large area of green landscapes and rest facilities inside.

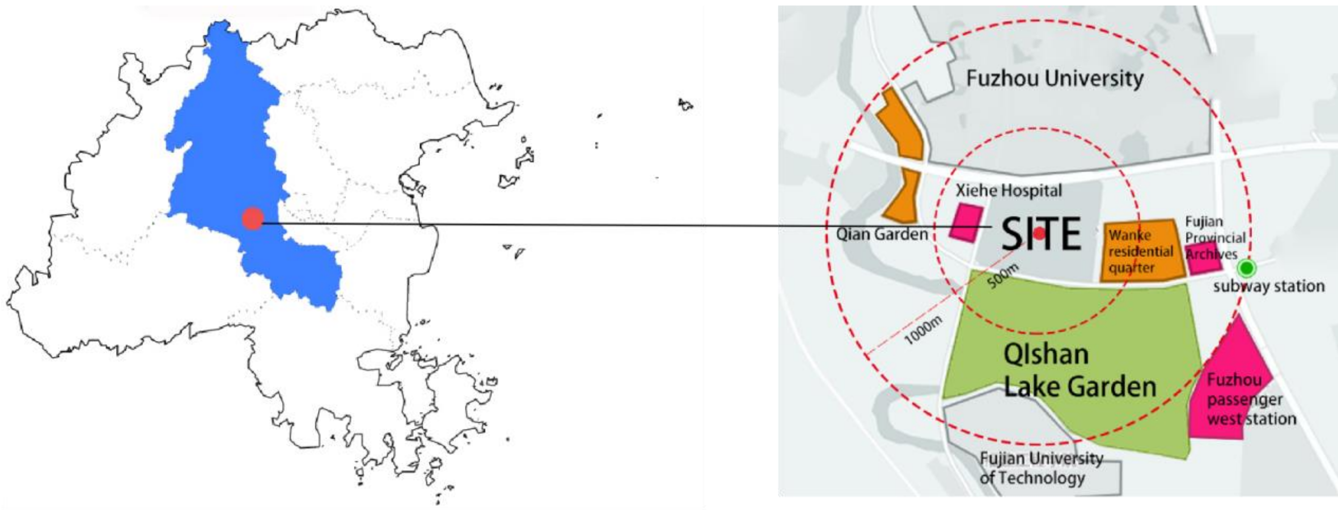

Figure 1. Location (**left**) and surrounding environment (**right**) of the university town sports center.

The sports center is adjacent to Fuzhou University to the north, Qishan Lake Park to the south and is 0.6 km from the subway station, making public transportation more convenient. The surrounding land is mainly occupied by residential areas, higher education institutions and green park spaces, with a small part occupied by public facilities and cultural facilities, such as hospitals and archives (see Figure 1, right). The main guests of the sports center are university students and surrounding residents. Although the number of events in the gymnasium decreased during the pandemic, the internal green square and sports facilities were still open for residents. Thus, the sports center was an important place for sports and leisure in the campus city community life circle during the pandemic.

The center point of the Fuzhou University City Sports Center was used as the origin of the campus city community life circle, with a 15 min walking circle from the origin in the study area. We divided the study area into several 100 × 100 m grids. The grids were required to occupy the full study area, and removed less than 50% grids in residents' movable spaces. Eighty-six observation sites were selected (see Figure 2). The gathering of physiological and soundscape information was conducted on sunny days (except for holidays) between 9:00 and 15:00 in October and December 2021, with an average temperature of 16–23 °C.

Figure 2. Research area and observation sites.

2.2. Gathering Subjective and Objective Data

2.2.1. Equipment Measuring

Acoustic environment parameters were gathered with type-1 sound level meters (Aihua Co., Ltd., made in China). The parameters included an equivalent sound pressure level (L_{Aeq}) and statistical noise level (L_{90}, L_{50}, L_{10}).

Light environment parameters were gathered with multifunctional environmental detectors. The illumination uniformity was the ratio of the minimum illuminance to the average illuminance on a given plane (sometimes the ratio to the maximum illuminance). We measured open space illumination (E_n) and ground reflection illumination (E_w). Then, we obtained the surface light environment coefficient, which was the ratio of E_n to E_w in external spaces.

Thermal environment parameters were gathered using multifunctional environmental detectors. The combination of temperature and humidity reflected the heat exchange between the human body and the surrounding environment. We measured the temperature (T) and humidity (f) at each observation site. Then, we obtained the temperature–humidity index (THL) and level division of the THL (see Table 1). Furthermore, the equation used for the THL was as follows:

$$THL = T - 0.55(1 - f)(T - 14.47) \quad (1)$$

Table 1. Level division of temperature–humidity index [27].

THL	>28	27–28	25–26.9	17–24.9	15–16.9	<15
perception	burning hot	hot	warm	comfort	cool	cold

Equation (1) is the evolution of the temperature and humidity index formula proposed by the Russian scholar Oliver. Its physical significance is the temperature after a humidity revision, which could be used as an index to comprehensively consider the influence of humidity and temperature on human comfort.

2.2.2. Questionnaire

This paper discusses the correlation mechanism of acoustic, light and thermal environment by analyzing the subjective satisfaction and the correlation between acoustic, light and thermal environments. In this study, the score of subjective satisfaction played the role of the dependent variable, while the equivalent traffic noise level (Leq), surface illumination uniformity, external space surface light environment coefficient and temperature and humidity index were a group of independent variables. The analysis of independent variables and dependent variables established a subjective satisfaction model about the physical environment of the university town sports center; the model was verified. The subjective satisfaction (psychological) data were collected through the use of a questionnaire survey, measuring the physical data in a grid. The questionnaire was randomly distributed and given to university town sports center facility residents and pedestrians. It was used to assess the subjective satisfaction of the respondents to the acoustic a thermal environments. Each grid included at least two questionnaires, which represented each grid including at least two more respondents.

The questionnaire included two parts. The first part was about the satisfaction of the acoustic, light and thermal environments, as well as a satisfaction evaluation of the natural environment (the allocation of flowers, plants and trees, the natural landscape, etc.) and overall environment. They were graded according to a Likert scale, which is commonly a 4-, 5- or 7-point order scale that respondents use to rate the extent to which they agree or disagree with a statement [28]. In this study, the questionnaire was scored from 1 to 5, with participants being enquired about perceived satisfaction: not satisfying at all (+1), slightly satisfying (+2), moderately pleasant (+3), very satisfying (+4) and extremely satisfying (+5). The second part asked respondents to select the most important physical environmental indicators that they believed affected their willingness to stay, including the noise, quiet, hot, cold, brightness and dimness. To reduce the discrete subjective evaluation data to the same order of magnitude, the subjective evaluation scores were normalized to between 0 and 1. Table 2 shows the content of the questionnaire containing the Likert scale used in this study.

Table 2. Questionnaires on the acoustic, light and thermal environments around the University Town Sports Center.

Question	Likert Scale [28] 1	 2	 3	 4	 5
1.How satisfied are you with the surrounding acoustic environment? 2. How are you satisfied with the surrounding light environment? 3.How are you satisfied with the surrounding thermal environment? 4.How satisfied are you with the surrounding natural environment? 5.How satisfied are you satisfied with the transportation around you? 6. How satisfied are you with your overall environment?	Far from satisfied	Not very satisfied	General	More satisfied	Very satisfied
7. Do you think the hot environment has an impact on your current willingness to stay? 8. Do you think the cold environment has an impact on your current willingness to stay? 9. Do you think a quiet environment will affect your current willingness to stay? 10. Do you think the noisy environment will affect your current willingness to stay? 11. Do you think the bright environment will affect your current willingness to stay? 12. Do you think the dark environment will have an impact on your current willingness to stay?	No impact	Less impact	Have an impact	Greater impact	Significant impact

A total of 268 questionnaires were collected with 243 valid responses. The recovery efficiency was 90.7%. The age distribution of the respondents ranged from 18 to 65 years old, with a high proportion of people aged 18–34 years old, with respondents mostly being college students. In terms of the gender ratio, there were 132 females and 111 males. The reliability and validity of the questionnaire were analyzed using SPSS 24.0 software. The results showed that the alpha reliability coefficient was 0.860, and the KMO number was 0.83 ($p < 0.05$). The questionnaire had good reliability and validity.

2.2.3. Spatial Form Indicators

To explore the relationship between the spatial factors and subjective and objective environmental indicators, we selected the spatial environmental factors that could best reflect the spatial and environmental characteristics of the campus city community life circle, including three dimensions of land cover, block road network and population density. The land cover dimension included the three indicators building density (BD), green space ratio (GR) and water area ratio (WR). The road network dimension included the three indicators distance to the road (DTR), street width (SW) and road density (RD). The population density dimension included a POI point (commerce, catering, office, etc.).

GIS 10.2 software was used to statistically analyze the above indicators. We used the building surface layer to calculate the different grids' construction land, green spaces and water cover areas. The measuring tool was used to calculate the distance from the measuring point to the motorway, the street width and the total length of the road in the grid. The road density was the ratio of the road length to the grid area. The number of POI points in different grids was calculated through spatial connection. The indexes of spatial environmental factors in the regional grid were studied, and the correlation between physical measurement indexes, subjective perception indexes and spatial environmental factor indexes was analyzed.

2.3. Statistical Analyses

We visualized the spatial distribution of psychophysical parameters using GIS. The Kriging method was used to visualize the spatial distribution in ArcGIS 10.2 [29]. Land use types and areas in the grids were systematically clustered using the hierarchical cluster analysis (HCA), which was carried out in SPSS 24. Furthermore, we conducted both regression and Spearman's rho analysis to explore the relationships between psychophysical and spatial drivers, which was carried out in Originl2021.

3. Results

3.1. Spatial Distribution of Environmental Drivers

Our results showed that L_{Aeq} ranged from 58.12 to 84.92 dB, presenting with a large fluctuation, and the overall average value was 67.71 dB, with 58% exceeding 70 dB. Previous research showed that it is difficult to talk in an environment with a sound level of 70 dB, suggesting a noisy and active environment [30]. We also found that foreground sound (L_{10}) ranged from 60.18 to 89.57 dB, and background sound (L_{90}) ranged from 39.52 dB to 75.64 dB, indicating various sound sources in this study area. Furthermore, we combined Figures 3–5 to explore spatial distribution characteristics more specifically.

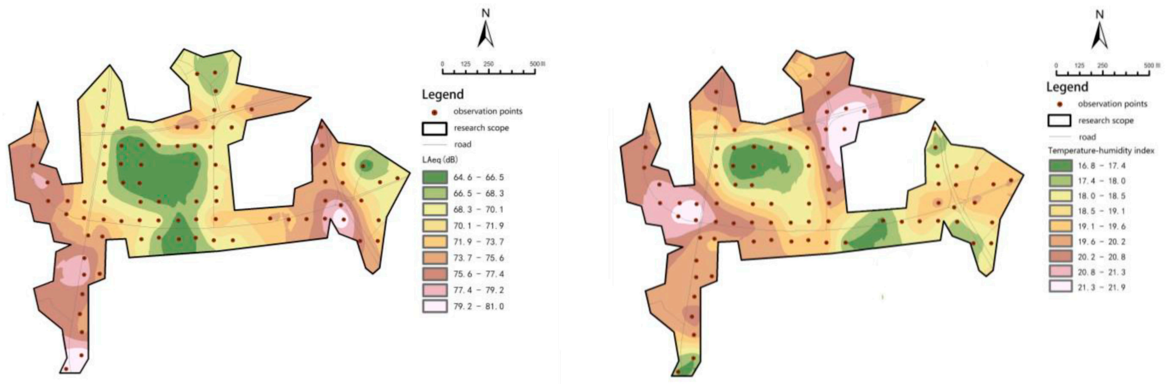

Figure 3. Spatial distribution of L_{Aeq} (**left**) and temperature–humidity index (**right**).

Figure 3 (left) shows the visualization of L_{Aeq}. From the spatial distribution, the equivalent sound pressure level near the University City Sports Center was the lowest, followed by the northern side of Qishan Lake Park and the living area of Fuzhou University. From the perspective of spatial distribution, the sound pressure level was greatly affected by the roads, surrounding land and population flow. The interval of the temperature–humidity index was [16, 22], indicating that the overall human feeling was relatively comfortable. Figure 3 (right) shows the spatial distribution of the temperature–humidity index. The temperature–humidity index in the sports center region was the lowest, followed by the value in the eastern region. The temperature–humidity index of the southwest and northeast of the sports center was the highest, and the maximum peak appeared in the road intersection grid. The overall temperature–humidity indexes were within the comfortable interval values, and the changes in different temperature–humidity indexes may have been affected by the measurement time, green space distribution and road density.

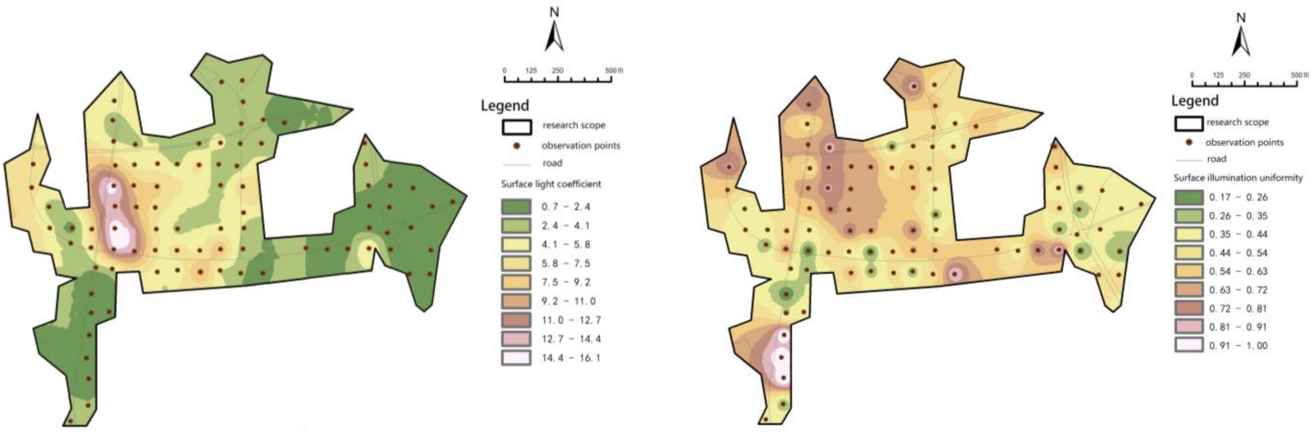

Figure 4. Spatial distribution diagram of surface light coefficient in outdoor space (**left**) and surface illumination uniformity (**right**).

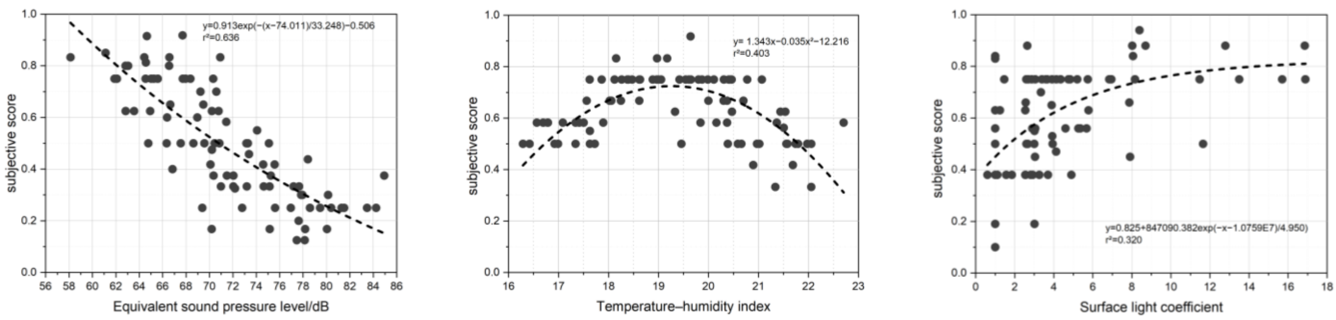

Figure 5. Regression curve of physical environment indicators and public satisfaction.

The interval in the surface light coefficient in the outdoor space was [1, 16.2]. Figure 4 (left) shows the spatial distribution of the light environment coefficient, showing obvious high-value areas. The area with the largest coefficient was the west side of the sports center along the road, followed by the south side along the road. The results showed that the optical coefficients of the eastern and southwestern regions furthest from the sports center were the lowest. The interval of the surface illumination uniformity in the study area was [0.2, 1], which was concentrated within [0.4, 0.7]. Figure 4 (right) shows the spatial distribution of the surface illumination uniformity. The high values of illumination uniformity were distributed in the sports center and its northwest side, Qishan Lake Park and southwest side near the riverbank. The results showed that the lowest value of illumination uniformity was distributed on the east side of the road.

3.2. Psychological Tendency of Public in Campus City Community Life Circle

3.2.1. Willingness to Stay

A multiple-response analysis was conducted on the results of six indicators related to the acoustic, light and thermal environments in a 15 min community life circle, which potentially affected willingness to stay for the public. We divided thermal environment indicators into cold and hot, acoustic environment indicators into noisy and silent and light environment indicators into bright and dim. The public responded with the willingness to stay through these six indicators. The results showed that the probability of willingness to stay was 29.90%, 16.90%, 24.10%, 10.10%, 9.00% and 10.00%, respectively. This suggested that the degree of coldness influenced the probability of willingness to stay in the space, followed by loudness and heat degree. These findings could potentially suggest that the willingness to stay was influenced by environmental perception.

3.2.2. Threshold and Interval Relationships between Environmental Drivers and Satisfaction of Environments

Figure 5 (left) shows the relationship between L_{Aeq} and the satisfaction of the acoustic environment through an exponential function curve. The results showed that the satisfaction of the acoustic environment gradually decreased with L_{Aeq} increasing, with the satisfaction values ranging from 0.1 to 1.0. The satisfaction values exceeded 0.8 when L_{Aeq} was below 62 dB; the satisfaction values ranged from 0.5 to 0.8 when L_{Aeq} ranged from 62 dB to 70 dB.

Figure 5 (middle) shows the relationship between the temperature–humidity index and the satisfaction values through polynomial curve fitting. The results showed that the satisfaction value was above 0.6 when the interval of the temperature–humidity index was [17.5, 21.5]. The satisfaction value tended to reach an optimal value when the temperature–humidity index reached 19.3. Furthermore, the satisfaction values showed a decreasing trend when the temperature–humidity index was higher than 21.5 and lower than 17.5.

Figure 5 (right) shows the relationship between satisfaction of surface light coefficient and outdoor space light environment coefficient through an exponential function curve. The results also showed that the satisfaction value tended to play a positive role in the light environment coefficient. The overall range of surface illumination uniformity fluctuated from 0.2 to 1.0, with satisfaction values concentrating in a range from 0.5 to 0.6.

These results suggested the effect of other potential drivers between environmental parameters and satisfaction, which suggested a need to also consider analyzing the correlation of these drivers.

3.3. Construction of the Environmental Satisfaction Prediction Model

3.3.1. Model Summary

To reveal the relationships between the environmental satisfaction and physical indicators, this study needed to construct a prediction model of environmental satisfaction and determine five assumptions, as shown below.

H1. *The equivalent sound pressure level has a certain relationship with the overall environmental satisfaction.*

H2. *The temperature and humidity index is related to the overall satisfaction of the environment.*

H3. *The surface light coefficient of external space has a certain relationship with the overall environmental satisfaction.*

H4. *There is a certain relationship between the illumination uniformity and the overall environment satisfaction.*

H5. *There is a relationship between age and overall environment satisfaction.*

To test the correctness of the five hypotheses H1, H2, H3, H4 and H5, a multiple linear regression analysis was performed in the SPSS 24.0 software. The coefficient of determination (R^2) between the final multiple linear regression model and the independent variables (noise, temperature and humidity index, light coefficient, illumination uniformity and age) and the dependent variable was obtained.

Firstly, to test the correctness of hypothesis H5 of this study, a correlation analysis was used to explore the relationship between age and the overall satisfaction of the environment. The Spearman's correlation analysis structure showed that age was not significantly associated with light, heat and the overall environment, but was associated with the acoustic environment satisfaction ($p < 0.01$) (Table 3). This indicated that the subjective satisfaction with the acoustic environment decreased with increasing age; the reason may be that the elderly are more sensitive to surrounding traffic noise, while young people are relatively more inclusive of the noise. Thus, the younger the respondents were, the less vulnerable they were to noise interference.

Table 3. Age and environmental satisfaction correlation analysis.

			Age and Environmental Satisfaction Correlation Analysis				
			Age	**Sound Environment Satisfaction**	**Light Environment Satisfaction**	**Thermal Environment Satisfaction**	**Overall Environmental Satisfaction**
Spearman Rho	Age	correlation coefficient	1.000	−0.207 **	0.002	−0.018	−0.079
		significance	0.000	0.001	0.974	0.777	0.199

** At the 0.01 level, the correlation was significant, Sig. (2-tailed).

An analysis of variance (ANOVA) is a statistical method used to test for differences between two or more averages [31]. In the relationship between illumination uniformity and overall environmental satisfaction, the analysis of variance showed that there was no significant relationship between illumination uniformity and overall environmental satisfaction (Table 4). Therefore, for the independent variables "respondent age" and "illumination evenness", the two independent variables were ignored in the dependent variable "overall satisfaction".

Table 4. ANOVA of illumination uniformity and overall satisfaction evaluation.

ANOVA [a] **Model**		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	0.267	1	0.267	0.532	0.468 [b]
	Residual	41.606	83	0.501		
	Total	41.873	84			

[a] Dependent variable: overall satisfaction evaluation. [b] Predictors: (constant) surface illumination uniformity.

To further demonstrate the relevance of these three models, in Table 5, we tested three different regression models using the stepwise method. Table 5 shows the variance test results of the overall satisfaction evaluation model. The model included the equivalent sound pressure level, temperature and humidity index and external surface space light coefficient. In the model, Sig, the equivalent sound pressure level, temperature and humidity index and surface light coefficient had a 0.000 ($p < 0.01$) confidence interval (CI) of 0.99, indicating that the three physical indicators were significantly related to the overall environmental satisfaction and could be used as predictors of the environmental satisfaction prediction model.

Table 5. Results of analysis of variance (ANOVA).

ANOVA [a] **Model**		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	9.158	1	9.158	20.890	0.000 [b]
	Residual	36.387	83	0.438		
	Total	45.546	84			
2	Regression	11.141	2	5.571	13.277	0.000 [c]
	Residual	34.404	82	0.420		
	Total	45.546	84			
3	Regression	20.190	3	6.730	21.499	0.000 [d]
	Residual	25.356	81	0.313		
	Total	45.546	84			

[a] Dependent variable: overall satisfaction evaluation. [b] Predictors: (constant) equivalent sound pressure level. [c] Predictors: (constant) equivalent sound pressure level and humidity–temperature index. [d] Predictors: (constant) equivalent sound pressure level, humidity–temperature index and surface light coefficient.

3.3.2. Coefficients and the Final Model

According to the column "Unstandardized coefficient (B)" in Table 6, the final multiple linear regression model (Model 3) was as follows:

$$\text{Overall satisfaction evaluation} = 7.509 - 0.321 \text{ equivalent sound pressure level} - 0.195 \text{ temperature and humidity index} + 0.456 \text{ surface light coefficient of external space.} \quad (2)$$

R = Pearson's correlation coefficient = 0.666.

R^2 = coefficient of determination (R Square) = 0.443.

Table 6. Regression coefficients and statistical tests using stepwise method for three models.

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	7.317	0.874		8.376	0.000
	Equivalent sound pressure level	−0.056	0.012	−0.448	−4.571	0.000
2	(Constant)	8.883	1.118		7.948	0.000
	Humidity–temperature index	−0.096	0.044	−0.211	−2.174	0.033
	Equivalent sound pressure level	−0.052	0.012	−0.416	−4.284	0.000
3	(Constant)	7.509	0.999		7.518	0.000
	Equivalent sound pressure level	−0.040	0.011	−0.321	−3.749	0.000
	Humidity–temperature index	−0.089	0.038	−0.195	−2.324	0.023
	Surface light coefficient	0.090	0.017	0.456	5.376	0.000

The equivalent sound pressure level L_{Aeq} (10 min) was expressed in decibels, dBA. The temperature in the temperature–humidity index was the ambient temperature in degrees Celsius, and the relative humidity was the ambient relative humidity expressed as a percentage. The optical environment coefficient of external space was the ratio of open space lighting (En) to ground reflection lighting (Ew) in external space, %.

In Equation (2), the value of the variable "external space surface light coefficient" was 0.456, which was the highest coefficient among the independent variables. Therefore, the surface light coefficient was the most effective predictor of overall environmental satisfaction, followed by the equivalent sound pressure level, with a coefficient of 0.321, and, finally, the greenhouse index with a coefficient of 0.195. This was different from the existing literature results, which may have been due to the small range of temperature and humidity values in the survey time of this study. Based on these findings, the influence of light and acoustic environments was shown to be relatively prominent. This means that during the autumn and winter season when the climate is more suitable, to improve people's satisfaction with the sound, light and thermal environments of the overall open space, more attention should be paid to the surface light coefficient to ensure a good experience of the light environment, and traffic noise should be reduced as much as possible.

3.4. Correlations between Environmental Drivers and Human Satisfaction of Environments

We performed a Spearman analysis of the correlation between acoustic, light and thermal physical index measurements and satisfaction with the acoustic, thermal and light environments. Figure 6 shows that overall environmental satisfaction was significantly positively correlated with satisfaction with the acoustic, light and thermal environments, with the highest correlation for satisfaction with the acoustic environment ($p < 0.01$). In addition, among the correlations between subjective and objective data, overall environmental satisfaction was positively correlated with light coefficient and negatively correlated with the temperature–humidity index and L_{Aeq}, suggesting that these drivers played a role in overall environmental perception.

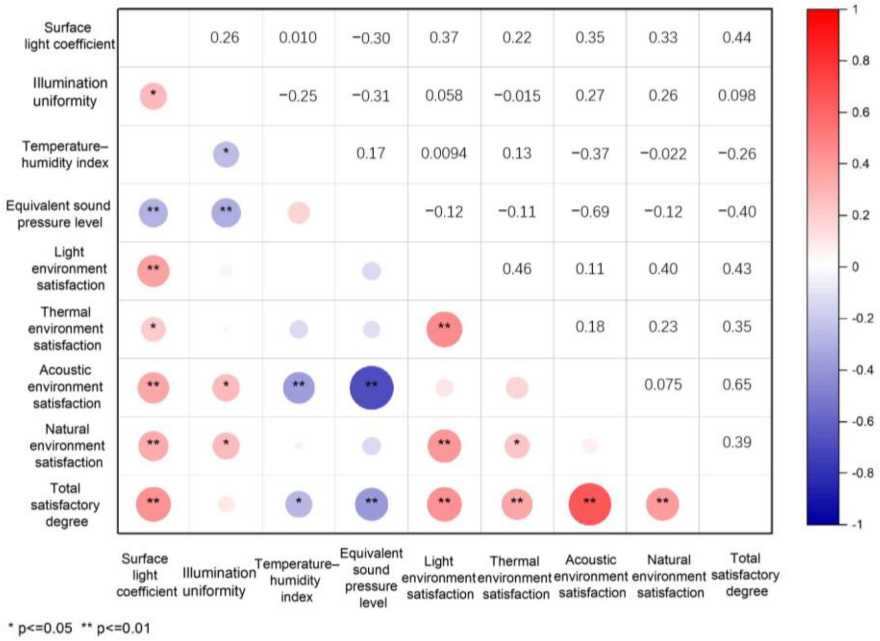

Figure 6. Correlation analysis between satisfaction and physical parameters.

The results showed that natural environment satisfaction was positively correlated with the light coefficient and illumination uniformity, suggesting a potential impact influenced by natural elements such as natural plant landscapes. Additionally, natural environment satisfaction had positive correlations with Light environment and thermal environment satisfaction, suggesting the positive influence of natural plant landscapes on vision. Acoustic environment satisfaction was negatively correlated with the temperature–humidity index and L_{Aeq}.

Furthermore, there was a negative correlation between the temperature–humidity index and illumination uniformity. Our findings also showed that L_{Aeq} was negatively correlated with illumination uniformity and light drivers. The high value of illumination uniformity was potentially due to spatial features with green vegetation, contributing to a dampening effect on L_{Aeq}. These results suggested the need to consider analyzing impact drivers for the surrounding spatial environment.

3.5. Impact Drivers of Spatial Forms

3.5.1. Cluster Analysis of Different Land Types

In order to explore the relationship between psychological and environmental elements of sound, light and thermal environments, as well as spatial elements, this study explored the current situation of the region. Plots of different land types often have different physical space and environmental characteristics, which may have different effects on psychology. Therefore, this study conducted a cluster analysis according to the divided land type of each grid and tried to explore the spatial elements affecting the acoustic, light and thermal environmental indicators. First, we conducted a cluster analysis using SPSS based on the area data of various land types within the grid, resulting in four types of land use: clusters A, B, C and D (see Figure 7). The results showed that cluster A was dominated by green spaces and surface water; cluster B was dominated by roads and green spaces; cluster C was dominated by roads and buildings; cluster D was a mixture of three types of roads, buildings and green spaces.

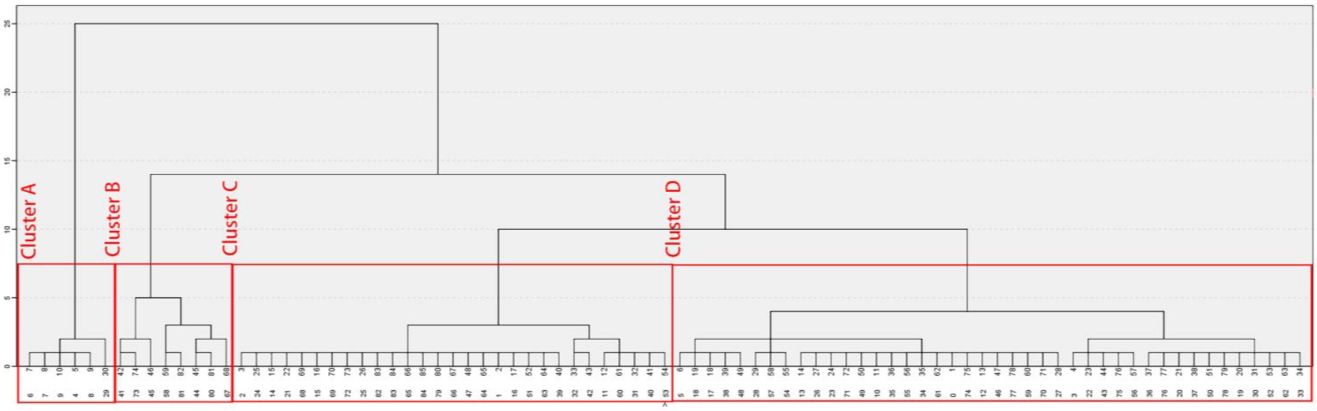

Figure 7. HCA of land use areas.

Figure 8 shows the physical conditions of different land use types. The results suggest that there were significant differences in the values of acoustic, light and thermal indicators corresponding to different site types. The site types with the highest values for the temperature–humidity index were roads and buildings, while the lowest were green spaces and water, with the difference between the remaining two site types being small. The site types with the highest mean value of surface illumination uniformity were green space and surface water, with the difference between the remaining three types not being significant, and the lowest were roads, buildings and green spaces.

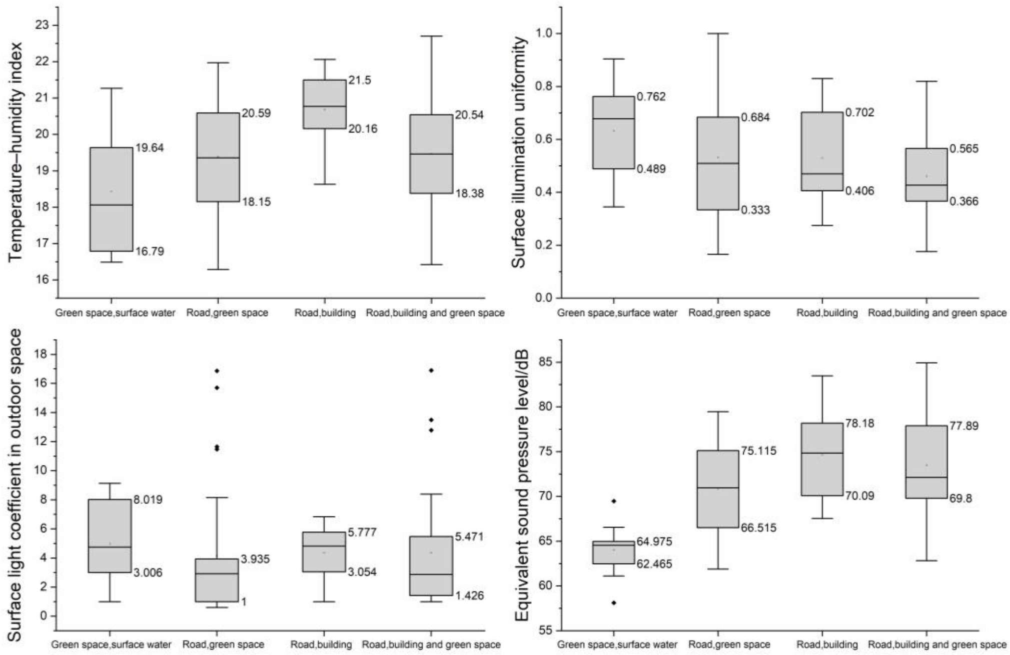

Figure 8. Physical conditions of different land use types.

Furthermore, our findings suggested that the site types with the highest value for the surface light coefficient in outdoor space were green space and surface water, while the lowest were roads and green spaces. There were some outliers in both road and green space land use and road, building and green space land use. The site type with the highest L_{Aeq} was road and building land use, and the lowest was green space and surface water land use, with a mean difference of 10.6 dB for roads and green spaces. The values for buildings, roads and green spaces were not very different, and were all higher than for green spaces and surface water, indicating that roads had a greater influence on the sound pressure level.

We also performed a statistical analysis of the subjective satisfaction values for the four types of land use. Through the use of an analysis of variance, the overall environmental satisfaction among the four types of land was shown to be significantly different ($p < 0.05$), except for thermal environment satisfaction ($p > 0.05$). The numerical distributions of acoustic, light, heat and overall environmental satisfaction are shown in Table 7. From the average value of the data, the differences in light, sound and overall environmental satisfaction among the four land use types were large, except for the thermal environment (see Table 8). This may have been due to the small difference between the temperature and humidity index of all types of land, and the thermal environment was not significant in scale, being only 100 m, so there was no significant difference in the thermal environment satisfaction of all types of land. The overall satisfaction of green spaces and water areas was the highest. Among them, the satisfaction of the acoustic environment and optical environment was far higher than that of the other three types of land. It could be preliminarily judged that the positive influence of green spaces or water bodies on the satisfaction of the acoustic environment and light environment was significant. Road and green space land use had the lowest light environment, acoustic environment and overall environmental satisfaction, followed by road and building land use and road, building and green space land use. It could be preliminarily judged that the negative impact of roads or building on the satisfaction of the acoustic environment and light environment was relatively significant.

Table 7. Environmental satisfaction of different land use types.

	Land Type	Mean Value	Standard Deviation	Standard Error	Min	Max
Light environment satisfaction	green space and surface water	4.28	0.25	0.10	4.00	4.67
	road and green space	3.47	0.60	0.21	2.50	4.25
	road and building	3.75	0.44	0.08	3.00	4.33
	road, building and green space	3.68	0.45	0.07	3.00	4.50
Thermal environment satisfaction	green space and surface water	3.89	0.27	0.11	3.33	4.00
	road and green space	3.53	0.40	0.14	3.00	4.00
	road and building	3.55	0.48	0.09	2.50	4.33
	road, building and green space	3.56	0.64	0.09	2.00	5.00
Sound environment satisfaction	green space and surface water	4.17	0.28	0.11	4.00	4.66
	road and green space	2.52	0.68	0.24	1.67	3.50
	road and building	2.66	0.87	0.17	1.00	4.33
	road, building and green space	3.07	1.05	0.16	1.00	5.00
Overall environmental satisfaction	green space and surface water	3.78	0.62	0.25	3.00	4.33
	road and green space	2.80	0.52	0.18	2.00	3.75
	road and building	3.23	0.68	0.13	2.00	4.00
	road, building and green space	3.41	0.71	0.11	1.67	5.00

Table 8. ANOVA of environmental satisfaction of different land use types.

ANOVA				**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Light environment satisfaction	interblock	(assemble)		2.464	3	0.821	3.991	0.010
		linear term	Unweighted	1.217	1	1.217	5.913	0.017
			weighting	0.624	1	0.624	3.030	0.085
			deviation	1.840	2	0.920	4.471	0.014
Thermal environment satisfaction	interblock	(assemble)		0.638	3	0.213	0.687	0.563
		linear term	Unweighted	0.505	1	0.505	1.632	0.205
			weighting	0.241	1	0.241	0.777	0.381
			deviation	0.397	2	0.199	0.641	0.529
Sound environment satisfaction	interblock	(assemble)		13.345	3	4.448	5.085	0.003
		linear term	Unweighted	5.287	1	5.287	6.044	0.016
			weighting	0.514	1	0.514	0.587	0.446
			deviation	12.832	2	6.416	7.334	0.001
Overall environmental satisfaction	interblock	(assemble)		4.003	3	1.334	2.900	0.040
		linear term	Unweighted	0.242	1	0.242	0.527	0.470
			weighting	0.104	1	0.104	0.226	0.636
			deviation	3.899	2	1.949	4.238	0.018

3.5.2. Relationship between Spatial and Psychophysical Drivers

Below, we further explored which spatial elements caused differences in physical indicators and subjective satisfaction between different land uses. The indicators of each spatial element in different grids were analyzed and counted using GIS. We conducted a Spearman analysis for each of their corresponding spatial element indicators. The spatial data characteristics of the measurement grids are shown in Table 9.

Table 9. Data characteristics of grid space elements.

	Average	**Standard Deviation**	**Minimum**	**Maximum**
Green space ratio (GR)	0.532	0.297	0.126	1.000
Building density (BD)	0.069	0.150	0.000	0.680
Water ratio (WR)	0.031	0.103	0.000	0.685
Distance to road (DTR) m	39.077	43.545	0.920	230.760
Road density (RD) km/km^2	5.297	4.910	0.000	12.700
Street width (SW) m	26.341	14.561	0.000	45.000
Number of POI points (POIs)	2.106	3.071	0.000	13.000

Figure 9 shows that there were more spatial element factors that affected the satisfaction of the acoustic environment. The spatial element factors had the highest negative correlation with two indicators of the street network, SW and RD, followed by BD and POI. This result indicated that traffic factors had an impact on the perception of the acoustic environment. The larger the road width and the higher the road grade, the higher the driving speed and traffic flow of cars, contributing to the generation of traffic noise and, therefore, having a negative impact on the acoustic environment experience.

The spatial element factor positively correlated with the subjective evaluation of the thermal environment, and the subjective evaluation of the light environment was GR, which indicated that green space positively influenced the experience of the thermal and light environments. Our findings also showed that overall satisfaction was correlated with several spatial factors, except for water bodies, indicating that all three dimensions of spatial environmental factors of land cover, road network and population density had an impact on the overall environmental perception. There may be a potential reason for the low degree of landscape development and utilization of water bodies and the small size of water bodies.

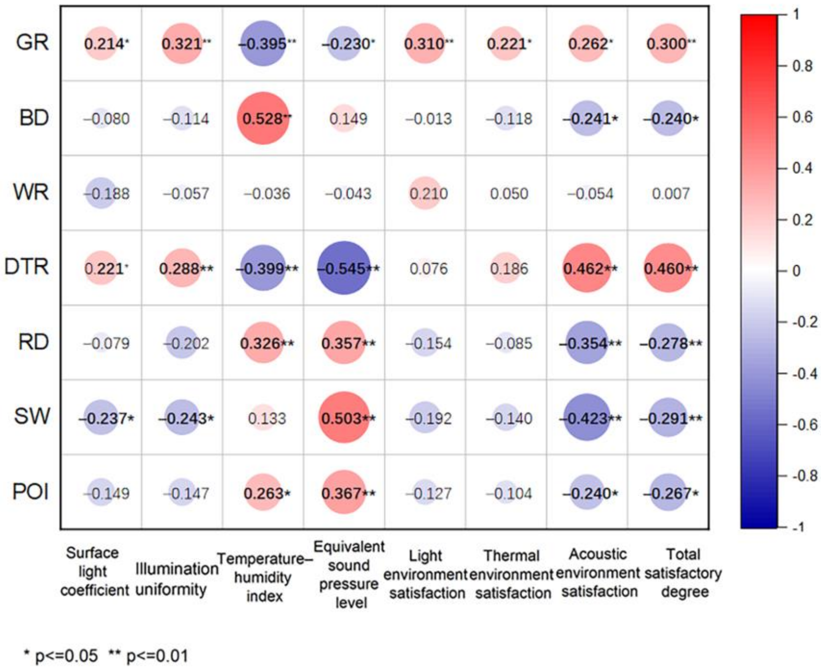

Figure 9. Correlation between spatial factors and subjective and objective indicators.

In the correlation analysis between the objective physical indicators and spatial factors, L_{Aeq} was positively correlated with RD, SW and POI, and negatively correlated with DTR and GR. We found that the biggest effect on L_{Aeq} was neighborhood road network factors. The temperature–humidity index was negatively correlated with DTR and GR, and positively correlated with BD, RD and POI. Furthermore, the values of the temperature–humidity index were influenced by roads, buildings and green spaces.

The light coefficient was positively correlated with GR and DTR, and negatively correlated with SW. More greenery and vegetation had a shading effect on solar illumination, and more greenery coverage was obtained away from the road. The large width of the road contributed to a weaker shading effect for surrounding buildings and green belts, which may have led to an increase in solar radiation intensity and a small ratio of sky illumination to surface illumination. Illumination uniformity was positively correlated with GR and negatively correlated with SW and DTR, which was similar to the results of the light coefficient. The illumination uniformity positively contributed to visual perception, such as green space, improving visual comfort, while roads contributed negatively to visual perception.

4. Discussion

The acoustic, light and thermal environment physical indicators in the urban environment affected the psychological feelings of respondents. In the overall environmental satisfaction evaluation, the equivalent sound pressure level, the greenhouse index and the external space surface light coefficient together affected the overall environmental satisfaction evaluation, with the external space surface light coefficient having the largest proportion, followed by the equivalent sound pressure level, which was mainly affected by road traffic noise pollution in this study.

Roads as potential drivers contributed to high L_{Aeq} levels in the western and eastern parts of the study areas located along Metro Line 2 in the southeast, which contained denser residential areas and construction sites with negative auditory perception. There were low L_{Aeq} areas near the campuses, parks and sports centers, which were less affected by road noise and had high subjective scores. Building density and POI facility points contributed to an increase in human and vehicle traffic, especially around public service facilities in the community living circle. Additionally, various activity sounds intertwined with natural sounds and peripheral traffic sounds to perform various rhythmic soundscapes [32–34]. Natural sounds, such as flowing water, wind, vegetation movement and birdsong were positive drivers influencing human perception, while human-generated activity sounds and traffic sounds were negative drivers [35]. We observed correlations between spatial and psychophysical drivers. DTR and GR positively correlated with the satisfaction of the acoustic environment, suggesting that the experience of the acoustic environment significantly improved when the public was away from road noise, and the area with a larger proportion of green space was less influenced by traffic, with green space having a certain barrier effect on traffic noise [36]. Our findings suggested the proportion of natural and biological sounds in green space was high, and that of artificial sound was low, contributing to improving the auditory experience. In urban green spaces, increasing natural soundscapes and reducing traffic noise could improve auditory satisfaction and levels of human health [37,38]. Previous research suggests that these positive effects of urban green spaces are directly related to the objective reduction in noise levels to the subjective perception of noise exposure [39]. Furthermore, the results suggested a significant correlation with POI points, where dense service points were also accompanied by greater crowd density, generating a concomitant increase in the proportion of activity and traffic sound.

Our findings suggested that the temperature–humidity index showed higher values close to roads with low greenery and high building densities, and a high percentage of green spaces and water bodies contributed lower values. Plant elements, such as trees, shrubs and turf, had a shading effect on the public spaces, contributing to reducing direct sunlight and external heat reflection through plant transpiration and improving the surrounding microclimate. There was a positive effect of building density on surface temperature in high-density urban built-up areas on the thermal environment, contributing to environmental warming [40,41]. This suggested a need for a certain increase in green space ratio to improve vegetation transpiration capacity and to enhance local convection, contributing to reducing the temperature–humidity index [42]. Road density levels were positively correlated with the average road temperature [43].

In the urbanization process, urban green spaces with low surface temperatures were transformed into other land use types with high surface temperatures, thus, negatively affecting the urban thermal environment [44,45]. The design of green spaces should be fully considered in the design of urban public facility spaces to mitigate the thermal environment problems. Our findings suggested a positive correlation between POI points and the temperature–humidity index because most of the POI points were for commercial services and public facilities, with high values in terms of building density and road density. Previous research suggests that areas of commercial buildings and alleys are important drivers for the increase in surface temperature [46]. In addition, dense POI points contributes to high temperature–humidity indexes.

Furthermore, the results suggested a high correlation between the light and thermal environments, both of which correlated with the spatial elements of green spaces. Landscape elements, such as vegetation configuration and the vignette arrangement of green spaces, improved the visual experience and microclimate, contributing to improving the satisfaction of the light environment. Previous research suggested that relevant elements of green spaces positively influence the subjective evaluation of human audiovisuals, and audiovisual satisfaction increased when the share of green-related elements was higher than that of traffic-related elements [47]. Considering warm winters and cool summers for climate characteristics of Fuzhou, the shading effect of green spaces plays a positive role in light and thermal environments. Therefore, the design and planning of green spaces should be considered in the construction of the physical environment of public facilities in Fuzhou. Suitable design and planning could contribute to improving the physical environment comfort, enhancing the efficiency of operations and vitality of business forms.

5. Conclusions

We used subjective questionnaires and objective physical measures to determine the effect of spatial forms on psychophysical perception. Spatial forms affected psychophysical drivers in the community life circle. The physical indicators of the acoustic, light and thermal environments in the urban environment affected the psychological feelings of the respondents. Our findings showed that: (1) The acoustic, light and thermal environments had an impact on overall environmental perception. The light coefficient, L_{Aeq} and temperature–humidity index were important environmental indicators that affected the overall environmental satisfaction. (2) The L_{Aeq} and temperature–humidity index of roads and construction land were opposite to those of green spaces and water bodies. (3) Green spaces played a positive role in the satisfaction of acoustic, light and thermal environments. (4) The density of roads, buildings and POIs played a negative role on satisfaction with the acoustic environment. (5) Green spaces and street width potentially influenced the light coefficient and surface illumination uniformity.

Our findings contribute to the basic data of urban public facilities and spatial physical environment evaluations. Exploring the impact of spatial factors on the psychophysical environment allowed us to understand which design elements in urban planning can provide higher comfort in public spaces and develop suitable suggestions for low-carbon planning and industrial distribution in urban areas. In addition to the acoustic, light and thermal environments, the comfort and satisfaction of community public spaces were also affected by other factors, including physiology, social culture, behavior, etc. The driving role of more factors on the psychophysical environment should be considered comprehensively in future studies.

Author Contributions: Conceptualization, S.-Y.L.; methodology, X.-C.H.; software, D.-C.W.; formal analysis, L.-H.G.; investigation, S.-Y.L.; data curation, X.-C.H.; writing—original draft preparation, S.-Y.L. and X.-C.H.; writing—review and editing, Z.C. and F.H.; visualization, Y.-J.H. and S.-Y.L.; supervision, Z.W. and X.-C.H. All authors have read and agreed to the published version of the manuscript.

Funding: The authors appreciate the valuable comments of editors and anonymous reviewers. This project was supported by the National Natural Science Foundation of China (grant no. 52208052), the Program of Humanities and Social Science Research of the Ministry of Education of China (grant no. 21YJCZH038) and the Fujian Natural Science Foundation, China (grant no. 2021J01639, 2023J05108).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Al-Arja, O.A. Acoustic Environment and Noise Exposure in Fitness Halls. *Appl. Sci.* **2020**, *10*, 6349. [CrossRef]
2. Deng, L.; Luo, H.; Ma, J.; Huang, Z.; Li, X. Effects of integration between visual stimuli and auditory stimuli on restorative potential and aesthetic preference in urban green spaces. *Urban For. Urban Green.* **2020**, *53*, 126702. [CrossRef]
3. Basner, M.; Babisch, W.; Davis, A.; Brink, M.; Clark, C.; Janssen, S. Auditory and non-auditory effects of noise on health. *Lancet* **2014**, *383*, 1325–1332. [CrossRef]
4. Chun, B.; Hur, M.; Won, J. Impacts of Thermal Environments on Health Risk: A Case Study of Harris County, Texas. *Int. J. Environ. Res. Public Health* **2021**, *18*, 5531. [CrossRef] [PubMed]
5. Eramitsoglou, I.; Daglis, I.A.; Amiridis, V.; Chrysoulakis, N.; Paganini, M. Evaluation of satellite-derived products for the characterization of the urban thermal environment. *J. Appl. Remote Sens.* **2012**, *6*, 061704. [CrossRef]
6. Englund, A.; Partonen, T. Mode of action of light and its significance for health. *Duodecim Lääketieteellinen Aikakauskirja* **2009**, *125*, 609–616.
7. Abdelaal, M.S.; Abdelaal, D. Towards an innovative community: Rethinking the urban configuration of the university campus within new cities. In *New Cities and Community Extensions in Egypt and the Middle East: Visions and Challenges*; Springer: Cham, Switzerland, 2019; pp. 237–256.
8. Noriko, H.; Kiyoko, H. A study of urban green open space for organic waste recycling. *Environ. Syst. Res.* **2004**, *32*, 101–109.
9. de Leeuw, E. Healthy Cities. In *Handbook of Settings-Based Health Promotion*; Springer International Publishing: Cham, Switzerland, 2022; pp. 91–104.
10. Lai, D.; Zhou, C.; Huang, J.; Jiang, Y.; Long, Z.; Chen, Q. Outdoor space quality: A field study in an urban residential community in central China. *Energy Build.* **2014**, *68*, 713–720. [CrossRef]

11. Jin, Y.; Jin, H.; Kang, J. Combined effects of the thermal-acoustic environment on subjective evaluations in urban squares. *Build. Environ.* **2020**, *168*, 106517. [CrossRef]
12. Geng, Y.; Hong, B.; Du, M.; Yuan, T.; Wang, Y. Combined effects of visual-acoustic-thermal comfort in campus open spaces: A pilot study in China's cold region. *Build. Environ.* **2022**, *209*, 108658. [CrossRef]
13. de Dear, R.J.; Akimoto, T.; Arens, E.A. Progress in thermal comfort research over the last twenty years. *Indoor Air* **2013**, *23*, 442–461. [CrossRef]
14. Yu, L.; Kang, J. Modeling subjective evaluation of soundscape quality in urban open spaces: An artificial neural network approach. *J. Acoust. Soc. Am.* **2009**, *126*, 1163–1174. [CrossRef] [PubMed]
15. Candas, V.; Pellerin, N. Effects of steady-state noise and temperature conditions on environmental perception and acceptability. *Indoor Air* **2010**, *14*, 129–136.
16. Tsai, K.-T.; Lin, Y.-H. Identification of urban park activity intensity at different thermal environments and visible sky by using sound levels. *Int. J. Biometeorol.* **2018**, *62*, 1987–1994. [CrossRef]
17. Rosso, F.; Pisello, A.L.; Cotana, F.; Ferrero, M. On the thermal and visual pedestrians' perception about cool natural stones for urban paving: A field survey in summer conditions. *Build. Environ.* **2016**, *107*, 198–214. [CrossRef]
18. Samira, L.; Saliha, A.; Sigrid, R. Effect of vegetation cover on thermal and visual comfort of pedestrians in urban spaces in hot and dry climate. *Nat. Technol.* **2017**, *17*, 30–42.
19. Lam, C.K.C.; Yang, H.; Yang, X.; Liu, J.; Ou, C.; Cui, S.; Kong, X.; Hang, J. Cross-modal effects of thermal and visual conditions on outdoor thermal and visual comfort perception. *Build. Environ.* **2020**, *186*, 107297. [CrossRef]
20. Sang, A.L.; Ju, Y.J.; Lee, J.E.; Hyun, I.S.; Jin, Y.N.; Han, K.T. The relationship between sports facility accessibility and physical activity among Korean adults. *BMC Public Health* **2016**, *16*, 1244–1253.
21. Kiuri, M.; Teller, J. Olympic stadiums in their urban environment: A question of design and cultural significance. *J. Cult. Herit. Manag. Sustain. Dev.* **2012**, *2*, 115–129. [CrossRef]
22. Dilalos, S.; Alexopoulos, J.D.; Tsatsaris, A. Calculation of building correction for urban gravity surveys. a case study of Athens metropolis (Greece). *J. Appl. Geophys.* **2018**, *159*, 540–552. [CrossRef]
23. Twardowski, M. Football stadiums—Icons of sports architecture. *Tech. Trans.* **2018**, *11*, 53–70. [CrossRef]
24. Ma, B.; Wang, D. The Analysis and Optimal Design for Thermal Environment of Gymnasium. *Adv. Mater. Res.* **2011**, *368*, 3682–3687. [CrossRef]
25. Huang, X.; Zhang, Q.; Wang, Z.; Ma, X. Thermal sensation under high-intensive exercise in naturally ventilated gymnasiums in hot-humid areas of China: Taking basketball players for example. *Indoor Built Environ.* **2022**, *31*, 139–154. [CrossRef]
26. Liu, Y.; Yu, G.; Zheng, S. Gymnasium Natural Light Environment Optimization Design Oriented by Environment-Behavior Studies. *Adv. Mater. Res.* **2013**, *831*, 223–227. [CrossRef]
27. Steadman, R.G. The Assessment of Sultriness. Part I: A Temperature-Humidity Index Based on Human Physiology and Clothing Science. *J. Appl. Meteorol. Climatol.* **1979**, *18*, 861–873. [CrossRef]
28. Sullivan, G.M.; Artino, A.R. Analyzing and interpreting data from Likert-type scales. *J. Raduate Med. Educ.* **2013**, *5*, 541–542. [CrossRef] [PubMed]
29. Childs, C. Interpolating surfaces in ArcGIS spatial analyst. *ArcUser July–Sept.* **2004**, *3235*, 32–35.
30. Morillas, J.M.B.; González, D.M.; Gozalo, G.R. A review of the measurement procedure of the iso 1996 standard. relationship with the European noise directive. *Sci. Total Environ.* **2016**, *565*, 595–606. [CrossRef]
31. Lane, D.M. Analysis of Variance. 2013. Available online: https://onlinestatbook.com/2/analysis_of_variance/ANOVA.html (accessed on 19 June 2023).
32. Zhang, R.; Zhu, L.; Zhang, Y. Investigation on the restoration effect of soundscape in parks in high-density cities: Taking Lu Xun Park in Shenyang, China as an example. In Proceedings of the 23rd International Congress on Acoustics, Aachen, Germany, 9–13 September 2019; pp. 876–883.
33. Hong, X.-C.; Liu, J.; Wang, Y.-S. Soundscape in Urban Forests. *Forests* **2022**, *13*, 2056. [CrossRef]
34. Chen, Z.; Zhu, T.-Y.; Liu, J.; Hong, X.-C. Before Becoming a World Heritage: Spatiotemporal Dynamics and Spatial Dependency of the Soundscapes in Kulangsu Scenic Area, China. *Forests* **2022**, *13*, 152. [CrossRef]
35. Jing, C.; Li, S.; Cao, S.; Ma, X. Study on influencing factors and influencing strength of urban green space relieving heat island effect—Taking Beijing as an example. *IOP Conf. Ser. Earth Environ. Sci.* **2020**, *601*, 012033. [CrossRef]
36. Mueller, W.; Steinle, S.; Prkk, J.; Parmes, E.; Liedes, H.; Kuijpers, E. Health effects of greenspace on outdoor physical activity and indoor pm2.5 and noise: A case study of four European cities. *Environ. Epidemiol.* **2019**, *3*, 277.
37. Payne, S.R. Urban park soundscapes and their perceived restorativeness. *Proc. Inst. Acoust.* **2010**, *32*, 264–271.
38. Hong, X.-C.; Cheng, S.; Liu, J.; Dang, E.; Wang, J.-B.; Cheng, Y. The Physiological Restorative Role of Soundscape in Different Forest Structures. *Forests* **2022**, *13*, 1920. [CrossRef]
39. Koprowska, K.; Łaszkiewicz, E.; Kronenberg, J.; Marcińczak, S. Subjective perception of noise exposure in relation to urban green space availability. *Urban For. Urban Green.* **2018**, *31*, 93–102. [CrossRef]
40. Deng, J.Y.; He, Y.; Dai, M. Evaluation of the outdoor thermal environment for three typical urban forms in Nanjing, China. *Build. Environ.* **2023**, *238*, 110358. [CrossRef]
41. He, B.J.; Ding, L.; Prasad, D. Urban ventilation and its potential for local warming mitigation: A field experiment in an open low-rise gridiron precinct. *Sustain. Cities Soc.* **2020**, *55*, 102028. [CrossRef]

42. Hong, X.C.; Wang, G.Y.; Liu, J.; Dang, E. Perceived Loudness Sensitivity Influenced by Brightness in Urban Forests: A Comparison When Eyes Were Opened and Closed. *Forests* **2020**, *11*, 1242. [CrossRef]
43. Zhao, Z.Q.; He, B.J.; Li, L.G.; Wang, H.B.; Darko, A. Profile and concentric zonal analysis of relationships between land use/land cover and land surface temperature: Case study of Shenyang, China. *Energy Build.* **2017**, *155*, 282–295. [CrossRef]
44. Jo, H.I.; Jeon, J.Y. Overall environmental assessment with soundscape and landscape indices in urban parks. In Proceedings of the 13th ICBEN Congress on Noise as a Public Health Problem, Stockholm, Sweden, 14–17 June 2021.
45. Liu, X.; He, J.; Xiong, K.; Liu, S.; He, B.J. Identification of factors affecting public willingness to pay for heat mitigation and adaptation: Evidence from Guangzhou, China. *Urban Clim.* **2023**, *48*, 101405. [CrossRef]
46. Yang, J.; Sun, J.; Ge, Q.; Li, X. Assessing the impacts of urbanization-associated green space on urban land surface temperature: A case study of Dalian, China. *Urban For. Urban Green.* **2017**, *22*, 1–10. [CrossRef]
47. Saher, R.; Stephen, H.; Ahmad, S. Effect of land use change on summertime surface temperature, albedo, and evapotranspiration in Las Vegas Valley. *Urban Clim.* **2021**, *39*, 100966. [CrossRef]