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Psychological and Visual Perception of Campus Lightscapes Based on Lightscape Walking Evaluation: A Case Study of Chongqing University in China

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Abstract: The creation of lightscapes in colleges and universities are of great significance in enhancing the perception of the campus environment, improving physical and mental health, and shaping humanistic connotations. This research aims to examine lightscape perceptions and impacts of different campuses. At Chongqing University A and B Campuses, lightscape walking experiments, subjective questionnaires, objective luminance measurements, and HDR picture processing were used to examine lightscape perception and factors. The relevance and differences in the perception of circadian lightscapes in the two campuses were analyzed using SPSS software. The study found: (1) natural lightscapes such as sky light, cloud shadow, and lake water reflection were the most popular during the daytime, while artificial lightscapes, such as decorative lighting of buildings, were positively evaluated at night; (2) the frequency of visits by a crowd directly impacts the ambiance of the environmental area; (3) males showed strong emotional awareness and social interaction skills in daytime, leading to increased social activity and stronger emotional responses, but no differences in nighttime; (4) optimal nighttime luminance enhances the overall perception satisfaction of the illumination; (5) the amount and arrangement of outdoor space, vegetation, minor landscape design, and service facilities all affect the perception of circadian lightscapes. In conclusion, design concepts and proposals of landscapes were suggested to optimize college and university lightscapes.

Keywords: lightscape walking; colleges and universities; environmental perception; light sources

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1. Introduction

Colleges and universities serve as the physical platforms for higher education [1]. A well-designed and diverse campus environment contributes to the preservation of cultural traditions, improves spatial awareness, ensures environmental comfort, and fosters positive emotional experiences [2,3]. These factors stimulate creativity and enhance motivation for both teachers and students. Hence, it is imperative to provide a well-diversified landscape environment within colleges and institutions. In the 1960s, the Canadian geographer Porteous [4] introduced the idea of odor landscape, while the Canadian scholar R. Murray Schafer [5] founded the influential "World Soundscape Project". As a result, the diverse landscape started to gain significant global recognition. The diverse landscape has slowly gained significant attention. Multi-sensory experiences, incorporating sight, touch, hearing, taste, and smell, go beyond conventional visual and spatial patterns and serve interactive and therapeutic purposes [6–8].

To date, numerous researchers have conducted extensive diversified landscape studies at colleges, mostly employing case studies, data measurement, and physical simulation [9–11]. The objective is to assess the ambient comfort based on certain physical parameters [12,13]. Huiying Chen et al. [14] conducted a study in a cold region of China to examine the impact of acoustic perception on outdoor thermal comfort. They utilized meteorological measures, sound level meters, and questionnaires in five typical open spaces on a campus. The researchers also analyzed the relationship between acoustic perception and thermal comfort. Zhe Kong et al. [15] conducted laboratory studies using nine different aperture designs, two window sizes, and two types of sky to investigate the significant impact of natural light composition on the cognitive processes of individuals.

However, environmental comfort encompasses more than just objective factors like noise levels, luminance of light environment, and concentration of odors. It also involves the conscious and active perception of the environment, which is a valuable approach for understanding how humans perceive their surroundings [16–18]. For example, Mancini et al. [19] conducted a study that examined the soundscape experience at the University of Salerno's Ficino Campus. They compared and analyzed the physical and psychoacoustic parameters of the soundscape using sound pressure measurements and soundwalk questionnaires. The study demonstrated that considering people's perceptual and physical parameters when designing a place has several positive effects, including economic benefits, improved quality of life, enhanced spatial characteristics, and better feedback. By exploring sound perception, it is possible to gain a deeper understanding of the impact of sound on people themselves, which is more conducive to quality environmental design.

Lightscape is a significant area of research within the broader field of landscape research. It was initially proposed by academician Wu Shuoxian of China [20,21], referring to the landscape formed by natural or artificial light sources, light and shadow, and their variations [22]. It encompasses both natural and artificial lightscape, which create visually striking impressions, always researched by the method of lightscape walking to investigate human perception and the impact of various factors. For instance, Dietrich Henckel et al. [23] have highlighted the similarities between light and sound walking, giving further ideas for the study of modern lightscape perception. Lightscape walking involves organized walking that allows individuals to focus on the visual aspects of a specific area. This activity effectively captures people's visual and psychological responses to the environment [15,24]. It also plays a crucial role in investigating people's perception of indoor and outdoor light comfort, shaping their spatial awareness, and conveying cultural meanings. In addition, according to previous studies, the design of the campus lightscapes should adhere to various principles including humanism, functionality, aesthetics, sustainability, and safety [15,25,26].

In lightscape walking, semantic differential scales are typically paired with subjective perception surveys to assess the psychological and social aspects of light in campus settings [8]. Meanwhile, the physical characteristics are measured and verified using objective data measurement methods. For instance, Berkouk et al. [27] conducted a sensory walking experiment at Chetema University's campus, comparing and correlating the walking experience data of three different routes (outdoor, semi-outdoor, and indoor). They specifically examined the effects of light, heat, and auditory environments on the walking experience. Similarly, Qiu Jianzhen et al. [28] proposed four semantic evaluation classifications of lightscape, including emotional perception, lightscape characteristics, spatial environment, and social tendency, and 16 specific indicators. They used the lightscape walking methodology to analyze the morning, evening, and nighttime periods at the Wushan Campus of the South China University of Technology. They established an optimization sequence and provided suggestions for improving the campus lightscape. Therefore, the lightscape walking method is an effective approach to connect users' perceptions with lightscapes in campus open spaces, both visually and psychologically. This method has significant implications for the study of campus lightscapes.

This study not only investigates how physical indicators of traditional optics impact the creation of lightscapes, but also statistically evaluates individuals' subjective perception of lightscapes. The walking approach integrates subjective perception evaluation indexes and design elements from previous research [28], which are further refined and improved. The study will expand the sample size of lightscape spots according to existing research and analyze the perception of various campus lightscapes at the same time. This aims at examining the elements and characteristics that impact the perception of the campus lightscapes, as well as the differences in perception between daytime and nighttime, and assessing the association between light perception and common light preferences, surrounds, social behavior, and objective luminance. Ultimately, the study seeks to comprehensively categorize design ideas and guidelines for lightscapes on college campuses and develop a theoretical foundation for creating light environments in higher education institutions.

2. Materials and Methods

2.1. Case Study Site

Chongqing is situated in southern China and has a humid subtropical monsoon climate characterized by scorching summers and frigid winters. The city has intense solar radiation and extended sunlight hours during summer, while having low solar radiation and brief sunshine hours during winter, earning it the nickname "Fog City" due to its distinctive lightscape features. This study focused on Chongqing University Campuses A and B as the study sites. Chongqing Universities' campuses were founded in 1929, with Campus A covering a total of approximately 1062 acres and Campus B covering a total of approximately 595 acres. The two campuses are located north of Shapingba North Street and south of Hanyu Road, with a longitude of 106.46 East and latitude of 29.57 North, connected by an underground passage.

The disparity in the types and distribution of the lightscapes between Campus A and Campus B is substantial. The Campus A area is considerably larger than the Campus B and exhibits a higher level of affluence. It is centered around Democracy Lake, where the interplay of water and light creates a captivating shimmering effect. The surrounding buildings further enhance this distinctive lightscapes through the reflection of light and shadow. Furthermore, area A is distinguished by its historical sites, abundant cultural heritage, and expansive open spaces. On the other hand, Campus B boasts a vibrant residential atmosphere, flourishing foliage, a distinctive landscape, and fitness facilities. However, the campus facilities are somewhat run-down, the lighting lacks unique features, and there is a scarcity of open space. During nighttime, the quantity of luminaires in area A is considerably more than that in area B. Nevertheless, both schools suffer from inadequate illumination and dim outdoor areas.

In order to make an in-depth comparative analysis of the differences in the perception of the lightscapes of the two campuses and the factors affecting it, this study adopted the research framework of "theoretical research—test research—data analysis—design optimisation" to carry out the research on the perception of the lightscapes of the campus. In addition, it utilized a combination of lightscape walking, questionnaire statistics, and luminance measurement simultaneously, to comprehensively examine the various types of lightscapes present on a university campus. And the data were subjected by SPSS to analysis in order to determine any potential correlations and differences. Furthermore, it analyzed the impact of different lightscapes types, as well as factors such as gender, visit frequency, visit time, and multi-sensory environment, on individuals' evaluations of perceptions, providing new perspectives for creating lightscapes on modern campuses.

2.2. Lightscape Walking

Engaging in lightscape walking offers individuals an effective means to investigate the psychological attributes and spatial ambiance of their surroundings [29]. By partaking in organized lightscape walking, individuals can actively explore and perceive the lightscapes, thereby efficiently and realistically obtaining practical insights into their experiences with the lightscapes. Prior to the scheduled walking, the research team gathered data pertaining to the illumination conditions during both daytime and nighttime in different sections of the campus [30]. Subsequently, the customary illumination conditions in Campuses A and B were categorized into four distinct groups: natural direct, artificial direct, natural indirect, and artificial indirect. This categorization was based on the discernible attributes of the light sources, which were determined through on-site observations, photographic documentation, and an initial online survey on light perception (Table 1).

Table 1. The lightscape types of Campuses A and B of Chongqing University.

Category	Specific Lightscape Types
Natural direct lightscapes	Sky light, sunset, moonlight, starlight
Artificial direct lightscapes	Decorative lighting of building exteriors, translucent lighting of building interiors, lighting of green vignettes, color-changing or flashing decorative lighting, static billboard lighting, changing billboard lighting, lighting of the Democratic Lake lakeshore, street lighting, passageway lighting
Natural indirect lightscapes	Cloud shadows, spots of light cast between leaves, shadows of plants, shadows on rocky mountain walls, reflections of plant leaves, light filtering through plant leaves, shadows of people, animals (birds), skyline of plant silhouettes, shimmering light from lakes, reflections of plants in lakes
Artificial indirect lights	Shadows of buildings, reflections of building roofs, facades and glass, reflections of metal installations, reflections of special materials on the ground, transmitted light, light transmitted by transparent glass, light transmitted by translucent materials, light transmitted by colored glass, shadows of moving vehicles, reflections of glass on moving vehicles, headlights of moving vehicles, skyline of building silhouettes

Additionally, the team generated visual representations of the illumination conditions in the form of maps (Figure 1). The entirety of the daytime and nighttime lightscape walking encompassed a distance of approximately 3.2 km. The evaluation procedure involved the utilization of 23 observation spots, which exhibited diverse types of lightscapes and characteristic spatial elements. Among them, the flow line of the lightscapes walk in Campus A is as follows: AB passage (A1)—Five Churches (A2)—Bell Tower (A3)—Library (A4)—Plaza outside the dormitory (A5)—Democracy Lake (A6) -Public Administration (A7)—Bishop's Building (A8)—Literature Lounge (A9)—College of Engineering (A10), and the flow of the light walk in Campus B is: Swimming Pool (B1)—Archives Corridor (B2)—The Square outside the Archives (B3)—the statue of Chairman Mao (B4)—the East Gate Square (B5)—the pond beside the Architecture Hall (B6)—the Architecture Hall (B7)—the Construction Hall (B8)—Library Recreation Square (B9)—Library Grand Steps (B10)—Connecting Corridor near Badminton Court (B11)—Second Student Canteen (B12)—Southwest Gate (B13).

Based on the findings of the initial online pre-survey, the designated timeframe for this excursion is scheduled to take place on a non-working day in April 2023. Specifically, the daytime slot spans from 9:00 to 12:00, while the evening slot spans from 19:00 to 21:00. These time periods have been identified as the ones with the most significant levels of public engagement. To gain a comprehensive understanding of the perception of daily campus lightscapes, a study was conducted involving student participants. The study included a daytime lightscape walk with 25 participants, consisting of 10 men and 15 women. Additionally, a nighttime lightscape walk was conducted with 24 participants, comprising of 12 men and 12 women. Daytime and nighttime walkers were recruited separately and differently so that the results of the two walks would not affect each other. A total of 376 valid questionnaires were collected from the daytime participants, while 412 valid questionnaires were obtained from the nighttime participants. The questionnaire size is substantial, ensuring a representative sample, which enhances objectivity and comprehensiveness in capturing the cognitive perception of the illuminated environment at Chongqing University.

(**a**)

(**b**)

Figure 1. Daytime and nighttime lightscapes of Campuses A and B. (**a**) Daytime and nighttime lightscape in Campus A. (**b**) Daytime and nighttime lightscape in Campus B.

The procedure for the walking activity was as follows: initially, the designated leader provided an introduction to the concept of lightscapes and took note of relevant details. Subsequently, the leader guided the team in an organized manner along the predetermined path. Upon reaching the observation location, the participants were instructed to remain there for around 2 min. During this time, the walkers engaged in observation and subsequently completed a questionnaire. Upon the completion of the questionnaire, the research team proceeded to the subsequent observation site. Subsequently, the team engaged in interviews with the individuals who partake in walking activities, with the aim of gaining further insights into their walking experiences, once all the questionnaires have been duly filled out.

2.3. Subjective Questionnaire Design

The questionnaire, which was in electronic form and completed by the ramblers through their mobile phones, consisted of four parts (Questionnaire S1–S4):

The first part collected personal information, including name, gender, age, grade major, etc.

The second part was in the form of a semantic differential scale for the daytime and nighttime lightscapes of the A and B Campuses, which were based on four dimensions, including emotional perception, lightscape characteristics, spatial environment, and social tendency, and used five quantitative scales (e.g., "2 Very Satisfied" to "−2 Very Dissatisfied") for the 27 indicators such as satisfaction and comfort. In the process of selecting indicators, the researcher utilized Qiu Jianzhen's research [31] indicator classification. Initially, over 40 indicators were extracted for the comprehensive evaluation of campus lightscape [28]. Subsequently, the questionnaire method was employed to screen the initial selection. A total of 50 participants were involved, and the criteria of conformity with the environment, ease of understanding, and non-overlapping concepts were followed. Ultimately, 4 major classifications and 23 refined lightscape evaluation indicators were retained (Table 2).

Table 2. Lightscape evaluation dimensions and indicators.

Evaluation Dimensions	Evaluation Indicators	Semantic Terms
01 Quality of emotional perception	Satisfaction	Satisfactory–Dissatisfactory
	Comfort	Comfortable–Uncomfortable
	Pleasantness	Pleasant–Worried
	Vitality	Vibrant–Dull
	Interestingness	Interesting–Boring
	Impressiveness	Impressed–Unimpressed
	Satisfaction	Satisfactory–Questionable
02 Lightscapes characteristic perception	Luminance	Bright–Dark
	Intensity	Blinding–Appropriate
	Luminance uniformity	Uniformity–Unevenness
	Mode of illumination	Direct–Indirect
	Light color	Warm–Cool
	Color richness	Richness–Homogeneity
	Dynamicity	Dynamic–Static
	Rhythmicity	Strongly rhythmic–Weakly rhythmic
03 Ambient spatial atmosphere	Cultural connotations	Cultural connotations–No cultural connotations
	Seasonal sense	Visible change–Insignificant change
	Aesthetics	Aesthetically pleasing–Not aesthetically pleasing
	Coherence	Coherent–Disordered
	Orderliness	Orderly–Disorderly
	Naturalness	Natural–Artificial
	Tradition	Traditional–Modern
	Seasonal sense	Visible change–Insignificant change
04 Social tendencies	Sociality	Social–Unsocial
	Safety	Safe–Unsafe

In the third section, a ranking was used to assess the degree of experience preference for each typical lightscape, to assess the most popular lightscape types for daytime and nighttime.

The fourth section explored the effects of environmental factors, gender, and frequency of visits on the evaluation of lightscapes, including the sensory environment and spatial components. Applying the semantic differential scale ("2—Very high impact" to "−2—Very low impact"), explored the extent to which people perceived lightscape experiences under the influence of multi-sensory influences.

2.4. Objective Luminance Measurement and HDR Image Analysis

High dynamic range imaging (HDRI) technology is a method that involves utilizing cameras with varying exposure levels to capture images and subsequently combining them to create a high dynamic range image [32–34]. This image may then be employed to assess the luminosity of the constructed lighting environment within the observed area. One of the key benefits of HDRI technology is its capacity to capture and present visual images. In comparison to low dynamic range images (LDRI), HDRI is capable of recording a greater range of luminance data, enabling a more accurate representation of the human eye's perception of luminance and contrast within a given scene.

HDRI technology serves as a valuable tool for data collection during the initial phase of image processing. Additionally, it can be employed immediately for the purposes of picture analysis and evaluation. The measurement principle relies on the disparity in dynamic range between the human eye and the camera. The human eye can adjust to a broad spectrum of light intensities, enabling clear visibility of details in both dim and bright conditions. Conventional camera sensors are unable to capture the complete range of luminance and typically only display features within a restricted range. HDRI technology functions by merging various photographs with varying exposures to capture a broader range of luminance, enhancing the detail and realism of the image. Luminance analysis software 1.0.0.0 can be used to analyze the luminance and mean value of each point within the circle in the field of view. This allows for deriving the overall luminance perception of the space within the field of view through human eye judgment. This process helps explore the relationship between different subjective sensations and the luminance percentage. The aim is to investigate the correlation between different subjective feelings and the percentage of luminance. The measurement of luminance was conducted concurrently with the field light walking experiment, and the protocol for testing was as follows:

(1) Firstly, the acquisition of images was conducted using a Canon 77D camera paired with an EF18-135 mm lens, capturing the primary observation angle for each measurement point (Figures 2 and 3). The whole process is fixed with a tripod to ensure the same position and stability of the photo day and night. A total of seven distinct exposures were captured for each light point, resulting in multiple photographs. Throughout this process, the ISO setting was maintained at 400, the aperture was fixed at 5.0, and the focal length was set at 18 mm.

Figure 2. Luminance measurement device.

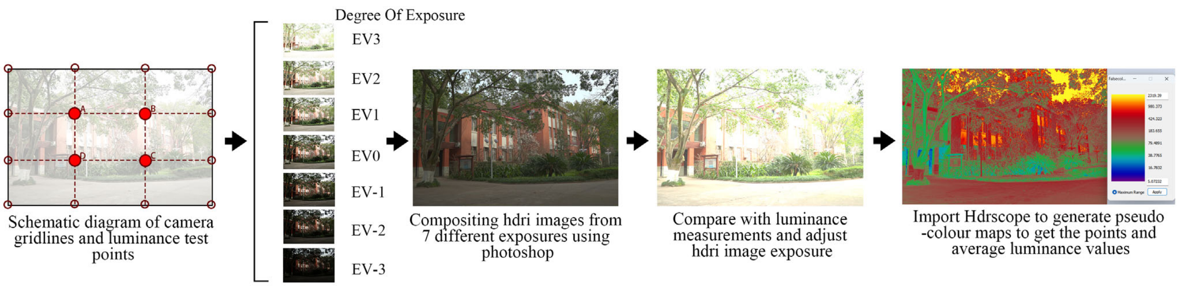


Figure 3. HDR image and pseudo-color figures synthesis process.

(2) Secondly, following the photography session, the EVERFINE SRC-2 Colour Spectral Luminometer (Table S1) was utilized to quantify the luminance of specific areas inside the field of vision. The measurement locations were selected at the 4-point array where the camera's viewport grids connect, specifically points A, B, C, and D as shown in Figure 3. Their average distribution at important locations in the image allows for a more accurate calculation of the luminance information of the photometric points and facilitates the luminance comparison with the HDR image. The measurement process involves aligning the circle of the luminance meter screen with each measurement point. Once the circle is stably and clearly aligned with the measurement point (indicated by turning green), the luminance value of the point is recorded by pressing the OK button.

(3) Thirdly, the “Merge to HDR Pro” command in Photoshop program was utilized to perform initial HDR photo compositing of the seven photos taken in pairs with varying exposures. The image mode was adjusted to 32-bit/channel. Then, the composite HDR image was exported.

(4) Fourthly, Hdrscope software 1.0.0.0 was utilized to open the HDR image [35–38], and view the luminance value of the four points in the image ABCD, and the actual measurement of the luminance value for comparison. If there was a gap, then re-adjusted the exposure of the HDR image in Photoshop 2022, so that the luminance value of the four points in the synthesised HDR image was basically the same as the luminance value of the test point, which could complete the correction of the luminance of the HDR image.

(5) Lastly, Hdrscope software was utilized to export the final pseudo-colour map and obtain the points and the average luminance data, which were used to analyze the objective luminance situation of each lightscape point.

2.5. Statistical Analysis

The raw data from the questionnaire were recorded and processed using Microsoft Excel in this study. An independent sample *t*-test was performed using SPSS 23.0 software to analyze the significance and differences in overall light perception between the two campuses. This analysis was based on 27 indicators of overall day and night semantic perception evaluation of light walking spots in Campuses A and B. Additionally, the study compared the differences in day and night perceptions between the two campuses in terms of four perceptual dimensions: emotional perception, light characteristics, spatial environment, and social tendency. The independent sample *t*-test was used to assess the variability in day and night perception between the two campuses, taking into account gender characteristics. All hypotheses were confirmed, and the statistical assumptions were met.

Furthermore, the weighted average approach was employed to determine the rankings of the various light sceneries, taking into account both the frequency of selection and the ranking score. The Pearson’s approach was used to analyze the link between light preferences, frequency of visits, other environmental characteristics, and impressions of the two campuses in four dimensions.

3. Results and Discussion

The items in this questionnaire were arranged in a random order to prevent any influence induced by the predictable sequence of sensory navigation. A total of 795 questionnaires were distributed during the lightscape walking. Out of these, 788 questionnaires were collected and considered valid, resulting in a recovery validity rate of 99.1%. Specifically, 380 questionnaires were distributed during the daytime, and 376 valid questionnaires were recovered, resulting in a recovery validity rate of 98.9%. Additionally, 415 questionnaires were distributed during the nighttime, and 412 valid questionnaires were recovered, resulting in a recovery validity rate of 99.3%. The reliability test for all questions demonstrated a Cronbach’s α value of 0.762. Additionally, the Cronbach’s α values for the two time periods’ questionnaires were 0.753 and 0.840, both exceeding the threshold of 0.7, indicating strong internal consistency.

3.1. Evaluation of Overall Perception of Day and Night Lightscapes

Based on the statistical results of the semantic differential scales (Table 3), it can be seen that the overall evaluation of the lightscapes of the two campuses presents a positive trend, and the participants’ evaluation of the overall daytime and nighttime environment of Campus A is better than that of B. At the same time, the evaluation of the daytime and nighttime environment of Campus B is better than that of Campus A. At the same time, independent sample *t*-tests were conducted on the evaluation items and dimensions during daytime and nighttime, and the differences in the evaluation of the lightscapes in the two different time periods can be summarized as follows.

Table 3. Statistical results of semantic differential scale in School Districts A and B.

Evaluation Dimensions	Evaluation Indicators	Semantic Terms (−2–2)	Groups	Average Value-A	T-A	Average Value-B	T-B
01 Quality of emotional perception	Satisfaction	Unsatisfactory–Satisfactory	D N	0.806 0.392	2.989 **	0.526 0.068	3.788 **
	Comfort	Uncomfortable–Comfortable	D N	0.776 0.386	2.988 **	0.493 0.059	3.618 **
	Pleasantness	Worried–Pleasant	D N	0.648 0.347	2.277 *	0.450 0.526	3.41 **
	Vitality	Dull–Vibrant	D N	0.236 0	1.741	0.068 0.493	3.371 **
	Interestingness	Boring–Interesting	D N	0.352 0.142	1.536	0.059 0.450	1.999 *
	Impressiveness	Unimpressed–Impressed	D N	0.503 0.256	1.695	0.038 0.213	1.999 *
	Quality of emotional perception		D N	0.554 0.254	2.556 *	−0.174 0.109	3.53 **
02 Lightscapes characteristic perception	Luminance	Dark–Bright	D N	0.394 0.051	2.564 *	−0.119 0.284	5.136 **
	Intensity	Appropriate–Blinding	D N	−0.291 −0.244	−0.39	0.042 0.346	2.156 *
	Luminance uniformity	Unevenness–Uniformity	D N	0.103 −0.227	2.575 *	−0.014 0.246	3.217 **
	Mode of illumination	Indirect–Direct	D N	0.145 0.244	−0.705	−0.339 −0.294	2.857 **
	Light color	Cool–Warm	D N	0.085 0	0.639	−0.513 0.024	3.717 **
	Color richness	Homogeneity–Richness	D N	−0.024 −0.5	1.833	−0.335 0.194	4.587 **
	Dynamicity	Static–Dynamic	D N	−0.467 −0.591	3.416 **	−0.161 0.161	2.31 *
	Rhythmicity	Weakly rhythmic–Strongly rhythmic	D N	−0.03 −0.097	0.921	−0.258 −0.009	1.885
	Cultural connotations	No cultural connotations–Cultural connotations	D N	0.242 0.256	0.483	−0.521 −0.308	1.253
	Overall perception of lightscape characteristics		D N	0.018 −0.123	−0.091	−0.568 −0.123	5.185 **
03 Ambient spatial atmosphere	Seasonal sense	Insignificant change–Visible change	D N	−0.121 −0.568	2.896 **	−0.223 −0.449	1.753
	Aesthetics	Not aesthetically pleasing–Aesthetically pleasing	D N	0.606 0.256	2.599 **	0.498 0.038	4.065 **
	Coherence	Disordered–Coherent	D N	0.836 0.557	2.2 *	0.602 0.292	2.688 **
	Orderliness	Disorderly–Orderly	D N	0.703 0.545	1.214	0.441 0.292	1.268
	Naturalness	Artificial–Natural	D N	−0.333 −0.5	1.082	−0.246 −0.542	2.446 *
	Tradition	Modern–Traditional	D N	−0.424 −0.494	0.447	−0.46 −0.669	1.798
	Ambient spatial atmosphere		D N	0.211 −0.034	2.905 **	0.102 −0.173	3.896 **
04 Social tendencies	Sociality	Unsocial–Social	D N	0.261 0.29	−0.198	0.085 0.157	−0.544
	Safety	Unsafe–Safe	D N	0.848 0.756	0.669	0.692 0.305	3.039 **
	Overall tendency to socialize		D N	0.555 0.29	0.258	0.389 0.231	1.461

Notes: A ** denotes $p < 0.01$, A * denotes $p < 0.05$, "N" represents nighttime, "D" represents daytime.

(1) Both A and B campuses exhibit significant differences in emotion perception dimensions during both daytime and nighttime. There are variations in satisfaction (2.989** and 3.788**), comfort (2.988** and 3.618**), and pleasantness (2.277* and 3.41**). Additionally, there is a notable difference in interestingness (1.999*) and impressiveness (1.999*) between the B areas, indicating a significant contrast in people's perception of campus lighting between day and night. Furthermore, the assessment ratings are much higher during the day compared to at night. The difference in lighting between daylight and evening may influence people's emotions. Bright and warm daytime lighting is more likely to elicit good emotions, whereas dark nighttime lighting can lead to chilly and gloomy sensations. Thus, improving the campus's night lighting landscape design to boost emotional perception is crucial.

(2) There are notable variations in luminance, luminance uniformity, and dynamicity between Campus A and Campus B during both daylight and evening. There are notable differences in the perception of lightscapes features, color richness, intensity, and mode of

lighting between area A and area B. Nighttime scores for different indicators are generally lower than daytime scores, indicating a lower overall evaluation of lightscape characteristics at night. The indicators that need improvement in lightscape creation are brightness, intensity, uniformity of brightness, mode of illumination, color richness, dynamicity, and rhythmicity, for the purpose of enhancing participants' visual and mental perception.

(3) In the spatial environment dimension, A and B were rated significantly higher during daytime and nighttime in aesthetics and coherence. B was rated higher in Naturalness. A and B were rated lower in seasonal sense, naturalness, and tradition during day and night in the school district. In addition, the ratings of seasonal sense (−0.568 and −0.449) at night in Campuses A and B are relatively low, demonstrating that the feeling of seasonal shift at night is less evident and the perception of light at night is less impacted by the season. Hence, enhancing the seasonal variation in daytime lighting on campus is essential. Additionally, including natural and traditional features is crucial for enhancing the cultural ambiance of the campus while designing a contemporary lightscape.

(4) In the social tendency dimension, there is no significant difference between zones A and B in nocturnal sociability (−0.198 and −0.544), indicating high ratings and a strong social tendency in both daylight and nights. In the security aspect, the disparity (3.039**) was more significant and received a worse rating in zone B compared to zone A. The issue may be due to insufficient illumination during nighttime in zone B, leading to a perceived decrease in security.

The comparative examination of the day and night lightscapes at Chongqing University's A and B Campuses reveals disparities in overall satisfaction (Tables 4 and 5). Areas A and B will exhibit similar levels of emotional perceived quality (0.067), perceived lightscape features (0.657), environmental spatial ambiance (0.182), and social inclination (0.161) throughout the daytime. During the night, areas A and B do not exhibit significant variations in ambient spatial atmosphere (0.063). However, there are substantial differences in emotional perception quality (0.012*), light feature perception (0.001**), and social inclination (0.011*). The difference is due to the personal factor of volunteers, who have varying psychological tendencies towards different campuses, and the environmental factor, where the design styles and layouts of the two campuses do not achieve aesthetic unity. When designing the lightscapes, the design should be adapted to the local conditions, taking into account the respective cultural and landscape characteristics of each campus. Furthermore, the average nighttime perception value in both the A and B regions is lower than that of daylight, indicating a need for enhanced lighting design throughout the night.

Table 4. Results of *t*-test analysis for daytime at Campuses A and B.

	Campus (Mean ± Standard Deviation)		*t*	*p*
	Campus A (n = 165)	**Campus B (n = 211)**		
Perceived quality of emotion	0.554 ± 1.115	0.346 ± 1.065	1.837	0.067
Perception of lightscapes' characteristics	0.018 ± 0.728	−0.015 ± 0.675	0.444	0.657
Ambient spatial atmosphere	0.211 ± 0.830	0.102 ± 0.726	1.337	0.182
Social orientation	0.555 ± 1.162	0.389 ± 1.118	1.403	0.161

Table 5. Results of *t*-test analyses for nighttime at Campuses A and B.

	Campus (Mean ± Standard Deviation)		*t*	*p*
	Campus A (n = 165)	**Campus B (n = 211)**		
Perceived quality of emotion	0.254 ± 1.050	−0.014 ± 1.087	2.511	0.012 *
Perception of lightscapes' characteristics	−0.123 ± 0.688	−0.357 ± 0.715	3.336	0.001 **
Ambient spatial atmosphere	−0.034 ± 0.728	−0.173 ± 0.761	1.867	0.063
Social orientation	0.523 ± 1.115	0.231 ± 1.158	2.571	0.011 *

Notes: A ** denotes $p < 0.01$, A * denotes $p < 0.05$.

3.2. Correlation between Lightscapes Perception and Typical Lightscapes Type Preferences

Based on the findings from the lightscape walking analysis (Figure 4, Tables S2 and S3), the preference of daytime and nighttime lightscapes in areas A and B can be assessed. Different colors indicate various preference ranking ratios: blue for 1st preference, green for 2nd, yellow for 3rd, red for 4th, and green for 5th. This study uses ranking ratios as the primary evaluation criterion for preference and computes the weighted average of preference to support the thesis. Results indicate that during the daytime, areas A and B are primarily characterized by natural lightscapes, with sky light and cloud shadows being favored by most individuals. Its highest proportion of favoritism for the 1st ranked (blue) is 31.47% and 34.24%, respectively, with weighted composite scores of 8.1 and 8.18, respectively. Meanwhile, the plant silhouettes in the skyline account for 18.25% and 19.34%, while the light patches amid the leaves make up 21.85% and 25.44%. The building silhouettes in the skyline are the most popular. A total of 25.44% of respondents favored the building silhouette skyline, while 19.3% and 16.9% favored other light aspects. Hence, it is essential to enhance the diversity of building and landscape silhouettes to form a complex and dynamic daytime lightscape. The falling shadow on the mountain rock staircase in area A and area B is rated the least favorite, ranking last with percentages of 36.84% and 50%, and weighted composite scores of 0.91 and 0.88. Furthermore, reflections on unique surfaces like the ground are rated unfavorably, with percentages of 37.84% and 47.83% in green, and weighted composite scores of 1.82 and 1.17. The design should prioritize the environmental arrangement and the skyline shape when designing. The design should prioritize environmental layout, material selection, and light settings to prevent and reduce the use of highly reflective materials like steel and smooth marble surfaces, which could create a mirror effect. Additionally, the arrangement of plants on the mountain rocks should focus on achieving a balance between sparse and varied configurations, with light hitting the leaves to provide a pleasant and comfortable visual and psychological experience.

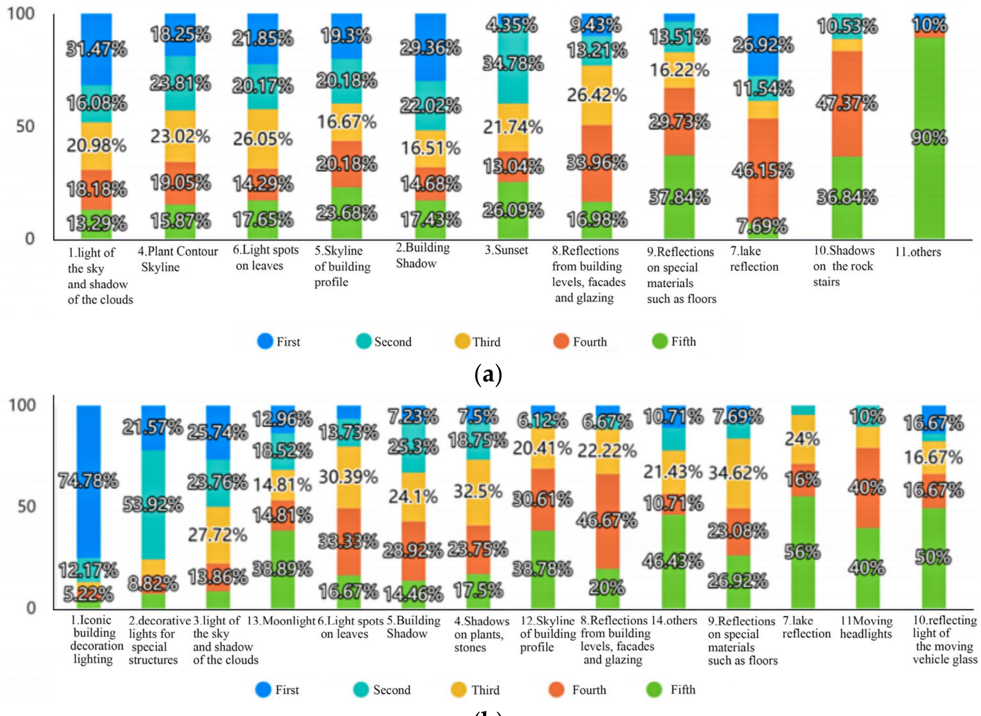


Figure 4. Typical daytime and nighttime light favoritism of Chongqing University A Campus. (**a**) Daytime lightscapes perception on Campus A. (**b**) Nighttime lightscapes perception on Campus A.

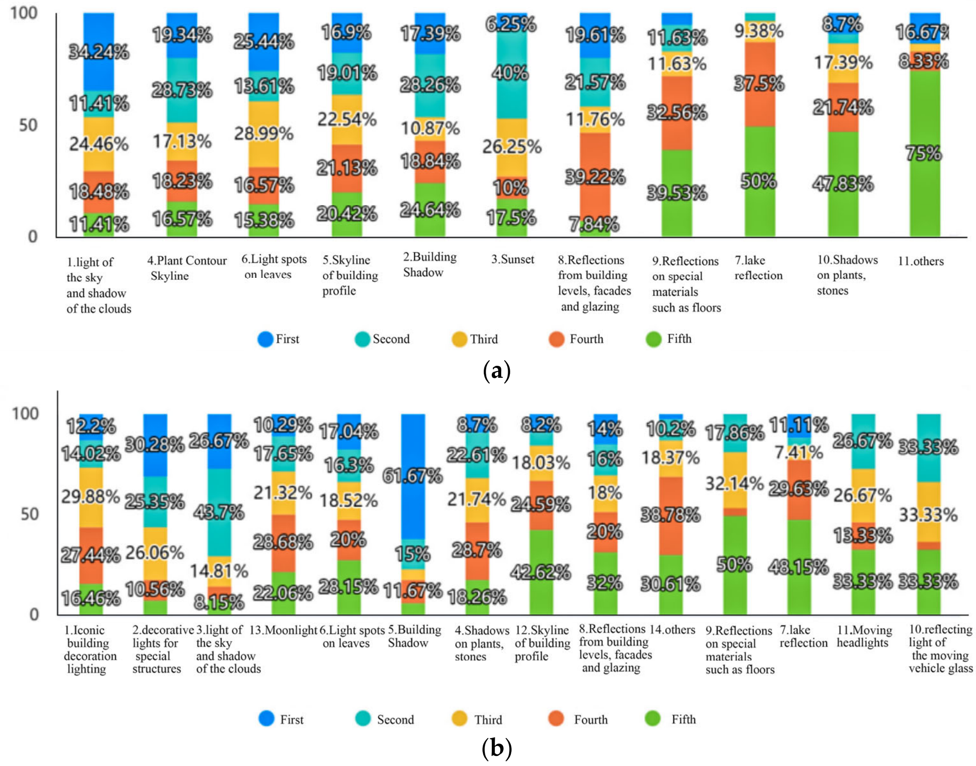


Figure 5. Typical daytime and nighttime light favoritism of Chongqing University B Campus. (**a**) Daytime lightscapes perception on Campus B. (**b**) Daytime lightscapes perception on Campus B.

During the night, areas A and B are characterized by artificial lighting, with area A featuring decorative lights on iconic buildings and area B showcasing night building shadows (Figure 5, Tables S4 and S5). These elements are highly popular, with a favorability ranking of 74.78% and 61.67%, respectively, both scoring a composite score of 8.19. Additionally, green landscape lights and special constructions (26.67% and 21.57%) and cloud shadows (30.28% and 25.74%) are also favored by countless individuals. Enhancing architectural and landscape decorative lighting design, emphasizing architectural and vignette shadow levels, and improving three-dimensionality and ambience are essential for enhancing people's psychological and visual perception of light. However, area A's lake reflection is ranked the lowest at 56%, with a weighted composite score of 0.62, which is due to insufficient luminance caused by inadequate lake night lighting. To enhance the beauty and appreciation of the lake reflection at night, lighting control should be utilized in the design to improve the overall nighttime lightscape's experience. In area B, the reflected lighting and other special materials receive the lowest favoritism rating of 48.15% with an average score of 0.15. Just like during the daytime, it is important to minimize the reflectivity of surfaces to reduce glare at night.

The above conclusion can be further verified by the correlation analysis of lightscapes preference and lightscapes perception in Campus A of Chongqing University (Tables 6 and 7), which shows that there are differences in the types of lightscapes that are generally preferred in Campus A and Campus B in both daytime and nighttime. During the daytime, the lake reflection and plant skyline were more typical of the commonly preferred lightscapes in Campus A. The lake reflection had a strong positive correlation with emotional perception (0.218**), light feature perception (0.282**), and spatial ambience shaping of the environment (0.261**), and the plant skyline had a positive effect on spatial ambience shaping as well (0.277**); at night, the light patches of leaves and the skyline of building contours were more typical of the generally favored light scenes, with the light patches of leaves showing a positive correlation in terms of both ambient (0.277**) and social inclination (0.162*) shaping, and the skyline of building contours favoring the quality of emotional perceptions

(0.238**). However, daytime drop shadows on rocky staircases and building and ground reflections were detrimental to the perception of campus light atmosphere, and nighttime cloud shadows showed a negative correlation for social tendencies.

Table 6. Correlation analysis between light preferences and light perception in Campus A.

Evaluation Dimensions	Daytime	Nighttime
	Lightscapes Preference	**Lightscapes Preference**
Perceived emotional quality	Lake reflection (0.218 **)	Skyline of building profile (0.238 **)
Perception of light characteristics	Light of the sky and shadow of the clouds (0.168 *) Lake reflection (0.282 **) Falling shadows on a mountain rock staircase (−0.177 *)	-
Ambient spatial atmosphere	Plant contour skyline (0.277 **) Lake reflection (0.261 **) Reflections from building levels, facades and glazing (−0.268 **) Reflections on special materials such as floors (−0.221 **) Others (0.181 *)	Shadows on plants, stones (0.202 **) Light spots on leaves (0.277 **) Lake reflection (0.237 **)
Social orientation	Falling shadows on a mountain rock staircase (0.172 *)	Cloud shadow (−0.148 *) Light spots on leaves (0.162 **)

Notes: A ** denotes $p < 0.01$, A * denotes $p < 0.05$.

Table 7. Correlation analysis between light preferences and light perception in Campus B.

Evaluation Dimensions	Daytime	Nighttime
	Lightscapes Preference	**Lightscapes Preference**
Perceived emotional quality	Light of the sky and shadow of the clouds (0.154 *) Sunset (−0.149 *) Spot of light between leaves (0.180 **) Reflections on special materials such as floors (−0.140 *) Others (0.147 *)	-
Perception of light characteristics	Reflections on special materials such as floors (−0.147 *)	Shadow of a cloud (−0.144 *) Building Shadow (0.145 *) Moonlight (−0.142 *)
Ambient spatial atmosphere	light of the sky and shadow of the clouds (0.240 **) Shadow of buildings (−0.238 **) Plant Contour Skyline (0.188 **) Building Contour Skyline (−0.217 **) Light Spots Between Leaves (0.191 **)	Green landscape, decorative lights of special structures (0.151 *)
Social orientation	Sunset (−0.170 *) Plant Contour Skyline (0.199 **) Light Spot Between Leaves (0.146 *) Lake Reflection (−0.210 **) Other (0.177 *)	Green landscape, decorative lighting of special structures (0.152 *) Moonlight (−0.202 **) Shadow of a cloud (−0.144 *) Building Shadow (0.145 *) Moonlight (−0.142 *)

Notes: A ** denotes $p < 0.01$, A * denotes $p < 0.05$.

Campus B has a resemblance to A but also exhibits distinctions. Daytime sky light and cloud shadow, plant outline skyline, and light spots between leaves are preferred elements. Sky light and cloud shadow are positively linked to emotional perception (0.154**) and environmental spatial atmosphere (0.240**). Plant outline skyline influences environmental spatial atmosphere (0.188**) and social tendency (0.199**). Light spots between leaves are favorable for emotional perception (0.180**), ambient spatial atmosphere (0.191**), and social tendency (0.146*). Green landscapes at night, decorative lighting of special structures, and shadows of buildings are also favored. Decorative lighting positively impacts ambient atmosphere (0.151*) and social tendency (0.152*), while shadows of buildings affect perceived light characteristics (0.145*) positively. Daytime sunset, ground reflection, building shadow, building silhouette skyline, and lake reflection do not support the molding of the lightscape in area B. Cloud shadows and moonlight may potentially negatively impact the impression of the lightscape at night.

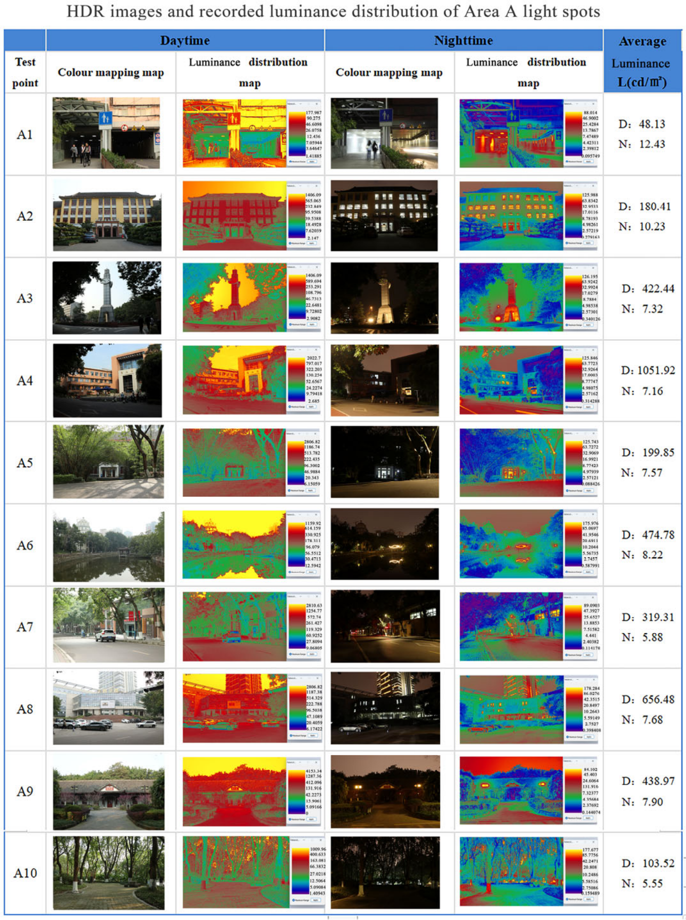
Based on the comprehensive analysis of the findings from campuses A and B, it is evident that individuals' preferences for the lightscapes are influenced by factors such as lighting conditions, visual effects, and the temporal context. Specifically, it is observed that during nighttime, individuals tend to exhibit a greater appreciation for lightscapes elements associated with art, romance, and visual appeal. Conversely, during daytime, their attention is more directed towards lightscapes elements that evoke emotional experiences of tranquillity, nature, and relaxation.

3.3. Correlation of Light Perception with Multi-Sensory Environmental Factors

3.3.1. Objective Luminance Evaluation

Following the luminance measurement (Tables S6–S9), it is possible to assess the average luminance value and luminance uniformity of individual points (Figure 6). The lightscape spots observed in Campus A exhibit noticeable variations in luminance and an uneven distribution during both daytime and nighttime. Consequently, these lightscapes spots create distinct atmospheres and visual effects that differ significantly between daytime and nighttime. During daylight hours, several test locations exhibit a higher overall luminance, namely Five Churches (A2), Bell Tower (A3), Democracy Lake (A6), Public Administration (A7), Bishop's Building (A8), and Literature Lounge (A9), while AB passage (A1), Library (A4), Plaza outside the dormitory (A5), and College of Engineering (A10) display a comparatively lower overall luminance. During nighttime, the prevailing conditions in Campus A exhibit reduced luminosity, characterized by the presence of only a limited number of dispersed lights in specific locations, including AB passage (A1), Bell Tower (A3), Democracy Lake (A6), Public Administration (A7), and Bishop's Building (A8).

The lightscapes in Campus B exhibit varying degrees of luminance perception and distribution during both daytime and nighttime, albeit to a lesser extent when compared to the disparities observed in Campus A. During the diurnal period, the square outside the Archives (B3), the statue of Chairman Mao (B4), the pond beside the Architecture Hall (B6), and Library Grand Steps (B10) exhibit high luminosity and a consistent distribution of light. Conversely, the areas Archives Corridor (B2), the East Gate Square (B5), and Second Student Canteen (B12) are characterized by intense illumination but an uneven spatial arrangement. The Architecture Hall (B7), on the other hand, is relatively dim but maintains a uniform lighting pattern. Lastly, the Construction Hall (B8) and Connecting Corridor near Badminton Court (B11) are both characterized by a lack of luminance and an irregular distribution of light. During the nocturnal period, a significant proportion of the locations have a generally subdued appearance, characterized by limited illumination from a sparse number of light sources. In certain instances, these locations depend on artificial lighting to supply luminosity.



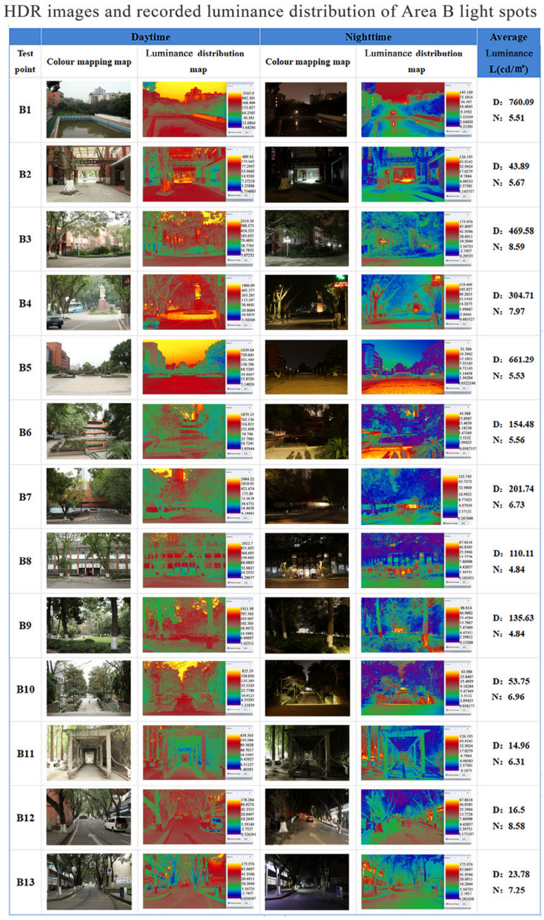


Figure 6. HDR images and luminance measurements of light spots A and B at Chongqing University. Notes: "N" represents nighttime, "D" represents daytime.

In addition, according to the HDR image results, it can be seen that only AB passage (A1) has an average luminance lower than 100 cd/m^2 during the daytime in Campus A, accounting for 10%, while the areas with an average luminance lower than 100 cd/m^2 during the daytime in Campus B are Archives Corridor (B2), Library Grand Steps (B10), Connecting Corridor near Badminton Court (B11), Second Student Canteen (B12), Southwest Gate (B13), accounting for 38.5%; the average luminance lower than 10 cd/m^2 during the nighttime in Campus A account for 80% of the total number of points, which are A3–A10, respectively. The average luminance of all points in Campus B at night is lower than 10 cd/m^2, and the average luminance of each light spot in Campus A at day and night is typically larger than that in Campus B. In addition, the percentage of the difference in average luminance of each light spot in day and night in Campus A exceeding 100 cd/m^2 is 80%, respectively, for A2–A9, and the percentage of the difference in average luminance of each light spot in day and night in Campus B exceeding 100 cd/m^2 is 61.5%, respectively, for the Swimming Pool (B1), the square outside the Archives (B3), the statue of Chairman Mao (B4), the East Gate Square (B5), the Architecture Hall (B7), Library Recreation Square (B9), so most of the difference in luminance of each light spot in day and night in Campus B is less than that in Campus A. In summary, it can be seen that the overall luminance of Campus A is larger than that of Campus B, and the luminance difference between day and night is substantial.

3.3.2. Other Multi-Sensory Environmental Influences

Based on the examination of the findings presented in Tables 8 and 9, it can be shown that there exists a correlation between each environmental component and the perception of lightscapes in Campus A. There is a positive correlation between temperature and humidity in the environment and the perceived quality (0.017 and 0.009) and environmental spatial ambience (0.069 and 0.184*) during both daytime and nighttime. However, there is a negative correlation between temperature and humidity and the perception of lightscapes characteristics and social tendency. On the other hand, the acoustic environment is positively correlated with social tendency (0.023) during the daytime but negatively correlated with the other three indicators. Additionally, the acoustic environment is negatively correlated with emotional perceived quality (0.041), light characteristics perception (0.076), and social tendency at night. The indicator with a coefficient of 0.023 showed a negative correlation with the other three indicators, but a positive correlation with perceived emotional quality (coefficient of 0.041), perceived light characteristics (0.076), and ambient spatial atmosphere (0.183*) during nighttime. It also exhibited a negative correlation with social tendency (−0.033). On the other hand, odor quality displayed a positive correlation with social tendency during daytime (0.029), but a negative correlation with the other three indicators. Additionally, it showed negative correlations with perceived quality (0.035), characteristics perception (0.035), and ambient spatial atmosphere (0.035) during nighttime. The study found significant positive correlations between three variables, namely outdoor space scale and division mode, greening, and landscape layout of vignettes and placement of service facilities, with all four markers of aesthetic quality, namely visual comfort (0.035), characteristic perception (0.03), and spatial atmosphere (0.151*), throughout both daylight and evening.

Table 8. Correlation analysis between environmental factors and light perception in Campus A of Chongqing University.

Environmental Factors	Quality of Emotional Perception		Perception of Lightscapes Characteristics		Perception of Environmental Spatial Ambience		Social Tendencies	
	D	N	D	N	D	N	D	N
Temperature and humidity environment	0.017	0.009	−0.063	−0.002	0.069	0.184 *	−0.104	−0.053
Acoustic environment	−0.073	0.041	−0.006	0.076	−0.058	0.183 *	0.023	−0.033
Odor quality	−0.083	0.035	−0.08	0.03	−0.039	0.151 *	0.029	−0.037
Outdoor space scale and division	0.095	0.1	0.101	0.12	0.087	0.241 **	0.092	0.225 **
Landscape configuration	0.305 **	0.114	0.209 **	0.031	0.346 **	0.280 **	0.095	0.189 *
Layout of service facilities	0.108	0.122	0.239 **	0.037	0.182 *	0.196 **	0.076	0.209 **

Notes: A ** denotes $p < 0.01$, A * denotes $p < 0.05$, D denotes daytime, N denotes nighttime.

Table 9. Correlation analysis between environmental factors and light perception in Campus B of Chongqing University.

Environmental Factors	Quality of Emotional Perception		Perception of Lightscapes Characteristics		Perception of Environmental Spatial Ambience		Social Tendencies	
	D	N	D	N	D	N	D	N
Temperature and humidity environment	−0.065	0.225 **	−0.128	0.220 **	−0.032	0.197 **	−0.134	0.096
Acoustic environment	0.011	0.188 **	0.123	0.259 **	−0.066	0.194 **	−0.024	0.182 **
Odor quality	−0.008	0.253 **	0.03	0.289 **	0.007	0.264 **	0.039	0.244 **
Outdoor space scale and division	0.127	0.227 **	0.03	0.168 **	0.098	0.337 **	0.111	0.248 **
Landscape configuration	0.224 **	0.244 **	0.107	0.153 *	0.205 **	0.309 **	0.162 *	0.190 **
Layout of service facilities	0.112	0.172 **	0.128	0.137 *	0.117	0.217 **	0.091	0.160 *

Notes: A ** denotes $p < 0.01$, A * denotes $p < 0.05$, D denotes daytime, N denotes nighttime.

For Campus B, the temperature and humidity environment is negatively correlated with all four indicators during the day and positively correlated at night; the acoustic environment is positively correlated with the perception of emotion (0.011) and the perception of light characteristics (0.123) during the day and negatively correlated with the other two indicators, and positively correlated with all four indicators at night. The quality of odor is negatively correlated with the perception of emotion (0.011) and the perception of light characteristics (0.123). During the day, odor quality is negatively correlated with emotional perception quality (−0.008) and positively correlated with the other three indicators, and it is positively correlated with all four indicators at night; outdoor space scale and division, greening, landscape configuration of vignettes, and arrangement of service facilities are positively correlated with the other three indicators during the day and night.

Meanwhile, the research team focused on the multi-sensory emotions other than vision in the post-interview. A total of 63.64% and 55.92% of the population, respectively, believed that daytime sound in Campuses A and B had the greatest impact on light perception, whereas taste, scent, and touch had little impact. Nearly 80% of respondents perceived the sound of birdsong in the environment, indicating that the daytime light environment of the two campuses was quieter and more pleasant; at night, 58.52% and 51.62% of respondents believed that sensory modes other than vision had little impact on the perception of the lightscapes in Campuses A and B, respectively. Some people continued to believe that the sound of birdsong in Campus A and the sound of people in Campus B had a greater impact on the lightscapes, and that the lightscapes in Campus A were more tranquil than that in Campus B.

In conclusion, the results of Campuses A and B indicate that when designing a lightscape, three visual indicators should be prioritized: outdoor space scale and division, greening or landscape configuration, and service facilities. Simultaneously, the design of the lightscapes can concentrate on integrating the natural soundscape to create a multi-sensory interactive experience.

3.4. Correlation between Light Perception and Social Behavioural Factors

3.4.1. Correlation between Lightscapes Perception and Visit Frequency

The results of the correlation analysis (Table 10) indicate that there is a weak and negative correlation between visit frequency and emotional perceived quality (−0.011), lightscapes characteristic perception (−0.022), and social tendency (−0.110). However, these correlations are not statistically significant ($p > 0.05$). There was a statistically significant negative correlation (−0.186*) observed between ambient spatial atmosphere and visit frequency, indicating that there is a correlation between higher frequency of visits and ambient spatial atmosphere.

Table 10. Test of the degree of difference between the frequency of visits to the major A and B Campuses on the perception of lightscapes.

	Quality of Emotional Perception	**Perception of Lightscapes Characteristics**	**Perception of Environmental Spatial Ambience**	**Social Tendencies**
Access frequency	−0.011	−0.022	−0.186 *	−0.110

Notes: A * denotes $p < 0.05$.

3.4.2. Differences in Light Perception by Gender

During the daytime in Campus A (Tables 11 and 12), the results indicate that men exhibited substantial attributes related to perceived emotional quality and social tendencies. Individuals with a heightened perception of emotional experiences may exhibit a greater propensity to experience favorable emotional and affective outcomes. Moreover, it is shown that males have a greater prevalence in social inclinations and are potentially more predisposed to initiate social encounters. Nonetheless, there were no statistically significant disparities observed between males and females in terms of their perception of light aspects and ambient spatial ambiance during daylight hours. In other words, both genders exhibited comparable capacities and inclinations in perceiving light features and environmental ambience. During the nighttime period, there were no statistically significant variations seen between males and females across all parameters. There were no statistically significant gender disparities observed in affective perceived quality, perceived lightscapes characteristics, environmental spatial ambience, or socializing tendencies. These findings suggest that gender plays a limited role in shaping perception and experience in nighttime environments, and may have a reduced susceptibility to the influence of light conditions. There was a lack of statistical significance observed in the light perception of Campus B during both day and night, indicating that there was no discernible disparity between males and females in their ability to perceive light.

Table 11. Differential analysis of light perception of different genders in Campus A of Chongqing University.

Evaluation Dimensions		**Male**	**Female**	**T**
		Mean ± Standard Deviation	**Mean ± Standard Deviation**	
Daytime	Perceived quality of emotion	0.967 ± 0.835	0.317 ± 1.188	4.102 **
	Perception of light characteristics	0.157 ± 0.615	−0.062 ± 0.777	1.88
	Ambient spatial atmosphere	0.186 ± 0.871	0.225 ± 0.810	−0.292
	Social orientation	0.858 ± 0.970	0.381 ± 1.230	2.582 *
Nightly	Perceived quality of emotion	0.361 ± 0.943	0.168 ± 1.125	1.211
	Perception of light characteristics	−0.132 ± 0.587	−0.116 ± 0.762	−0.165
	Ambient spatial atmosphere	−0.137 ± 0.695	0.048 ± 0.747	−1.678
	Social orientation	0.558 ± 0.947	0.495 ± 1.236	0.382

Notes: A ** denotes $p < 0.01$, A * denotes $p < 0.05$.

Table 12. Differential analysis of light perception of different genders in Campus B of Chongqing University.

Evaluation Dimensions		**Male**	**Female**	**T**
		Mean ± Standard Deviation	**Mean ± Standard Deviation**	
Daytime	Perceived quality of emotion	0.395 ± 0.957	0.308 ± 1.144	0.586
	Perception of light characteristics	0.060 ± 0.615	−0.073 ± 0.716	1.424
	Ambient spatial atmosphere	0.074 ± 0.722	0.123 ± 0.731	−0.485
	Social orientation	0.418 ± 1.001	0.366 ± 1.205	0.348
Nightly	Perceived quality of emotion	0.395 ± 0.957	0.308 ± 1.144	0.586
	Perception of light characteristics	0.060 ± 0.615	−0.073 ± 0.716	1.424
	Ambient spatial atmosphere	0.074 ± 0.722	0.123 ± 0.731	−0.485
	Social orientation	0.418 ± 1.001	0.366 ± 1.205	0.348

3.5. Suggestions for Campus Lightscapes Optimisation

Based on a thorough analysis of the research findings, it is evident that the design of the campus lightscapes should adhere to various principles including humanism, functionality, aesthetics, sustainability, and safety. Considering the aforementioned concepts and outcomes, optimization suggestions may be proposed for the illumination conditions during daytime and nighttime in both campuses [39–43].

3.5.1. Daytime Lightscape Optimization Recommendations

Based on the findings of the strolling experiment, it is possible to provide ideas for improving and transforming the issues observed in the daytime light spots of the major A and B Campuses.

(1) Improving the aesthetic appeal of key focal points—The entrances and exits of the A and B Campuses, as well as significant landmarks and pathways, serve as crucial focal points for conveying the spiritual and cultural ambiance of the campus. However, these nodes exhibit deficiencies such as inadequate lighting conditions and insufficient allure to encourage prolonged engagement. In the AB channel, it is recommended to incorporate glass translucent facilities, resting places, and landscape vignettes to enhance the overall aesthetic appeal and functionality of the area. Additionally, a rational approach to vehicle parking should be implemented to improve accessibility and convenience. In the vicinity of

the clock tower in Campus A, the introduction of interactive elements is advised to promote liveliness and address issues such as mismatched floral arrangements, limited interactive facilities, and a lack of visual interest. These enhancements will contribute to making this area more visually appealing. Furthermore, the exterior of the library in Campus A can be enhanced by adding a glass structure to the outer surface, thereby delineating boundaries and creating a more defined spatial experience. Additionally, incorporating more greenery in this area will facilitate a smoother transition between the library and its surroundings.

(2) Enhanced landscape levels and light and shadow design—The landscape level and light and shadow design in Campuses A and B are currently lacking diversity and are visually overwhelming, resulting in an unpleasant experience. This limits the ability to perceive emotions, light qualities, social tendencies, and the overall spatial environment. To address this issue, it is recommended to enhance the multi-sensory landscape level and incorporate thoughtful light and shadow design. For example, the vegetation around the President's statue in Campus B should be extended inwards to form more shadows, and various landscape plants should be added to enhance the landscape aesthetics and shading effect. The introduction of ornamental animals and music to Democracy Lake in Campus A, coupled with regular cleaning efforts, is recommended to enhance the aesthetic appeal of the lakeside landscape. Additionally, it is suggested to establish rest facilities in front of the Public College in Campus A. Furthermore, addressing the issue of reflections on the facade and ground of the Bishop's Building can be achieved by incorporating low-reflective-rate materials and planning a parking area in front of the building. The utilization of materials with low reflectivity has been employed as a solution to address the issues associated with reflections on both building facades and the ground surface.

(3) Optimize building appearance design—The optimization of building appearance has the potential to significantly enhance the recognition and tidiness of campus structures. For example, the construction hall in Campus B should improve the light transmission of the building, and at the same time, set up more stop facilities in the external space and strengthen the cleaning of fallen leaves, so as to create a more pleasant environment around the building.

3.5.2. Nighttime Lightscape Optimization Recommendations

In order to enhance the nocturnal ambiance of the campus, it is recommended to augment the variety of artificial lighting options.

(1) Optimize the lighting layout—Enhance the lighting arrangement to optimize aesthetics, ambience, and visual impact. The utilization of soft lighting in various outdoor areas such as flower beds, lawns, and pools contributes to the creation of an enchanting nocturnal atmosphere. The soft lighting is a prevalent photography technique that often involves diffused light, commonly seen on overcast days with minimal shadows. Diffuse lighting is common in overcast and foggy weather, as well as in cinematography using soft light modifiers like soft boxes and screens. The photo taken in soft light lacks prominent areas of light and backlighting, resulting in less contrast between light and dark, allowing for a more nuanced depiction of the subject's texture and depth. The opposite of hard light refers to direct light, such as in situations under sunlight, which has a clear shadow. Soft lighting is more gentle and warmer than standard light. Subdued lighting can be utilized to brighten outdoor areas and establish a romantic ambiance. It can evoke a romantic ambiance, calm one's emotions, and dispel anxieties. To enhance the overall lighting quality, it is recommended to augment the lighting arrangement at the intersection of libraries in Campuses A and B. Additionally, it is advisable to enhance the illumination within the library corridor, with particular emphasis on reinforcing the lights on the building facade to enhance nocturnal luminosity. Furthermore, it is suggested to improve the lighting configuration in dimly lit areas, such as the Student I House in Campus A, the Democracy Lake, and the entrance of the School of Public Administration.

(2) Improvement of photophysical indicators—In order to enhance the functionality and effectiveness of light indicators, some improvements can be made. Enhancing the

illuminance, luminance, correlated color temperature, color, and other aspects of lighting can effectively mitigate glare and create a more enjoyable and comfortable ambiance inside the campus environment. To illustrate, one potential approach to address the issue is to modify the light color of the AB channel to a lower correlated color temperature or decrease the luminance level in order to mitigate glare. Additionally, in the vicinity of the swimming pool located in Campus B, it would be beneficial to minimize the presence of vegetation, enhance the lighting conditions, and improve the overall facility experience. Lastly, in Campus B, it is recommended to enhance the President's statue by improving light uniformity and augmenting the number of lighting fixtures.

In addition, the design of campus night lighting should prioritize the selection of lamp specifications and types. LED lamps are commonly chosen as the lighting source for designing lamps and lanterns. LED lamps offer benefits such as high energy economy, long lifetime, high luminance, and accurate color reproduction. Consequently, they are increasingly replacing conventional fluorescent and sodium lamps. Landscape lighting on campuses typically requires 1000–3000 lumens and a luminance of no more than 1000 cd/m^2. Furthermore, the average luminance of the lighted surface should not exceed 10 cd/m^2. The correlated color temperature is set between 4000–4500 K to achieve a brighter lighting effect. Furthermore, campus luminaires must possess excellent color reproduction to enable students and staff to easily distinguish the colors of items. Campus street luminaires should have a correlated color temperature over 80. Campus streetlights should have a minimum lifetime of 50,000 h.

(3) Enhance the coordination of lighting with the landscape—One potential area for enhancement is the cooperation between lighting and landscape elements. In order to achieve a cohesive and unified nocturnal illumination scheme, it is imperative to comprehensively evaluate both the lighting and landscape elements. As an example, it is recommended that the plaza and stairs located in front of the library in Campus A be illuminated to a moderate degree. This lighting strategy aims to enhance the connection and consistency between the library building and its immediate environment. Conversely, in Campus B, the pedestrian passages and pathways should be equipped with gentle lighting that serves the purpose of guiding individuals without compromising the overall nocturnal aesthetic of the surroundings.

3.6. Research Limitations

This study has several constraints. Owing to constraints in volunteer recruiting, the majority of participants consisted of students and professionals in architectural design. Consequently, the sample size for individuals from other professional domains was limited, hence hindering the ability to draw comprehensive conclusions. To obtain more specific findings, it would be beneficial to include participants from diverse age groups. Furthermore, as a result of time limitations, the lightscape walking studies conducted on both campuses were focused exclusively on the spring season and did not take into account the impact of light on the campus during other seasons. Furthermore, only days with clear skies were taken into account for the leisurely strolls. Days with overcast skies and no direct sunlight were excluded from the analysis. In subsequent trials, our focus will be on examining the impacts of various individuals, seasons, and weather conditions on the perception of light.

4. Conclusions

Colleges and universities preserve cultural history, and ideal campus daytime and nighttime lightscapes support academic creativity and a congenial atmosphere. A comprehensive comprehension of individuals' visual and psychological perceptions of lightscapes within the context of college campuses assumes a significant role in fostering psychological well-being among both students and staff members. This paper summarizes offline lightscape walking tests and objective luminance measurements for Chongqing University's A and B Campuses.

(1) Lightscapes perception in general—Main campus lightscapes are mostly satisfactory, with Campus A scoring higher for daylight and nighttime illumination than Campus B. Daytime ratings of Campuses A and B outperform nighttime evaluations. Campus A personnel are more physically and mentally alert and have a higher level of satisfaction.

(2) Typical lightscapes perception—Campuses A and B had similar results in terms of typical light perception types. Many factors affect light perception in typical situations. Daytime sky, cloud shadows, lake reflections, and plant silhouettes against the skyline are preferred. Reflections from unique materials and mountain and rock shadows are less desirable. Green landscapes and beautiful lights on unique structures are preferred at night, whereas lake reflections and cloud shadows are less so. Nighttime lighting is scarce, resulting in insufficient luminance. Nevertheless, while comparing the two campuses, it becomes evident that Campus A exhibits greater satisfaction in terms of lake reflections and light spots between leaves, so establishing its superiority over Campus B in terms of water features and tree matching.

(3) Objective luminance perception—The light spots inside area A exhibit noticeable variations in luminance and an unequal distribution, both during daytime and nighttime. Moreover, there are distinct disparities in the atmospheric conditions and visual impacts between these two periods. The overall luminosity of area A surpasses that of area B, and there exists a substantial disparity in luminance between daytime and nighttime.

(4) Multisensory environmental factors and light perception—During the day, sound had the biggest effect on light perception at Campuses A and B, while taste, scent and touch had less of an effect. During nighttime periods, the influence of sensory modalities on the perception of illuminated environments at Campuses A and B was found to be minimal, with the exception of the visual modality. Furthermore, the auditory presence of avian vocalizations on Campus A and human activities on Campus B exerted a more pronounced influence on the visual ambiance, but the visual ambiance on Campus A exhibited a lower level of auditory disturbance compared to that on Campus B. The luminous environments on Campus A exhibited a lower level of auditory disturbance compared to the corresponding settings on Campus B. When conceptualizing lightscapes, it is imperative to prioritize three key visual indicators: the magnitude and division of outdoor space, the presence of greenery, and the arrangement of the landscape and service facilities. Simultaneously, the design of the lightscape can also prioritize the integration of the natural soundscape, so generating a multi-sensory interactive encounter.

(5) Visit frequency and light perception—Campuses A and B had a positive association between visit frequency and environmental spatial atmosphere. Visit frequency had a weak and negative connection with emotional perception, light perception, and social propensity. Thus, the frequency of visits is also an important factor influencing physical and mental states and environmental perceptions.

(6) Gender effects on light perception—Males in Campus A were more likely to participate in social activities and feel emotional during the day due to their emotional perception and social tendency. No significant difference was found between males and females in daylight light perception and ambient spatial atmosphere. There was no statistically significant difference between men and women at night. In Campus B, daylight and nighttime light perceptions were similar. In contrast, men are more susceptible to environmental influences on their physical and mental health than women.

Drawing from the aforementioned findings, this study puts forth environmental design principles and recommendations for an appropriate lightscape throughout both daytime and nighttime. The objective is to offer optimization strategies for the establishment of a lightscape inside college campuses, hence fostering the sustainable optimization of the campus environment from sociology, psychology, and optics perspectives.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/buildings14030753/s1, Questionnaire S1: Daytime lightscape walking survey in Campus A of Chongqing University, Questionnaire S2: Daytime lightscape walking survey in Campus B of Chongqing University, Questionnaire S3: Nighttime lightscape walking survey in Campus A of Chongqing University, Questionnaire S4: Nighttime lightscape walking survey in Campus B of Chongqing University, Table S1: Parameter information for the EVERFINE SRC-2 Colour Spectral Luminance Meter, Table S2. Composite scorecard of typical daytime lightscapes favoritism in campus A, Table S3. Composite scorecard of typical daytime lightscapes favouritism in campus B, Table S4. Composite scorecard of typical nighttime lightscapes favoritism in campus A, Table S5. Composite scorecard of typical nighttime lightscapes favoritism in campus B, Table S6. Record of daytime lightscape walking lu-minance data in area A, Table S7. Record of daytime lightscape walking luminance data in area B, Table S8. Record of nighttime lightscape walking luminance data in area A, Table S9. Record of nighttime lightscape walking luminance data in area B.

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Abbreviations

D	Daytime
N	Nighttime
HDRI	High Dynamic Range Imaging
LDRI	Low Dynamic Range Images
A	Campus A
B	Campus B
T	Student's *t*-test
P	Pearson

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