Visual perception of traditional Village Landscape: An Eye Tracking Experiment

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Abstract. In order to objectively quantify the visual perception of traditional village landscape, 50 university students were recruited to make eye-tracking experiment of different landscape elements in the countryside and analyze the data to assess the attractiveness of different elements. Eye-tracking experiment quantifies the experimental information. The experimental results show that mountain and landscape structure can mostly attract attention of observers in actual observation process, but this result is different from subjective preference of questionnaire. By comparing the results of eye-tracking experiment and questionnaire, it can be concluded that the observation time of landscape elements depends on the proportion of elements in space; subjective preference depends on the observation time of landscape elements. Therefore, eye-tracking data can assess subjective preference of observers for the landscape, and then have a certain guiding role for the planning and construction of rural landscape.

1. Introduction

Vision is the most important medium for people to perceive external information, and 80% of external stimuli are obtained by vision[1], As far as Subjective activities of human beings are concerned, 75%-90% of them are also caused by subjective vision. Therefore, the main way for people to perceive the landscape is also vision. The process of eye movement observation is a physiological process, but vision can transform external stimuli into experience and cognition containing many personal preferences[2].

Landscape visual perception regards landscape as a stimulus. It is a comprehensive aesthetic experience of complex cultural characteristics, spatial types and landscape aesthetics in the landscape[3]. This process mainly includes two modes: the bottom-up mode and the top-down mode. The former refers to the external stimulus being felt and making subjective judgment on it; The latter is caused by subjective experience and ideas[4-6]. It can be seen that the perception of landscape is affected by the subject's psychology, physiology, experience, knowledge reserve and so on. There is a certain deviation in the landscape perception of different subjects, which is caused by the landscape perception preference. Preference is a potential emotional expression, researches of it mostly focuse on people's feedback and evaluation of vision. This evaluation has strong population characteristics[7]. In order to more accurately define the visual perception of different landscapes, the landscape preference characteristics of different people are the key, and the exploration.

Using objective data to quantify the abstract evaluation system makes it easier to obtain objective and accurate evaluation results. With the development of technology and the proposal of more scientific research methods, it can greatly make up for such deficiencies. Eye tracking technology is a scientific and convenient tool for landscape research. Use the infrared reflection to locate the fixation point of the eye. Eye tracking technology records the eye movement data of the observer in the observation process, such as the sequence of observation points, dwell time of observation points, visual focus analysis, etc., to obtain the observation elements and the nature of observation process[8].

This paper records and analyzes eye movement information of human eyes when observing traditional village landscape through eye movement tracking experiment, and collates it into objective eye movement data. Different from the previous village landscape research, eye tracking experiment takes the elements such as buildings and construction in villages and the surrounding environment as the research object, and quantifies Subjective perception. Establishing a link between landscape perception and objective indicators. By comparing the objective data obtained from eye movement experiment with subjective landscape preference, this paper explores the relationship between eye movement data and subjective feeling of landscape. Furthermore, from the perspective of landscape vision, it provides quantitative analysis methods for the landscape evaluation of traditional villages, and provides data and theoretical support for protecting and enhancing the landscape value of traditional villages.

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2. Materials and methods

2.1 Study Area

The experimental site is in the western mountainous area of Beijing (Figure 1). There are many types of traditional villages in the area, of which mountain villages of Mentougou and Fangshan are the representatives. Most of these villages are Chinese traditional ancient villages, whose history can be traced back to the Ming and Qing dynasties or even earlier. There are many protective buildings in the village, which have a great impact on the village landscape[9].After investigation and research, Malan village and Shuiyu village are finally selected as experimental villages. The two villages are typical valley villages in western Beijing. The landscape elements in villages include all kinds of landscape elements of valley villages, and the landscape style and the proportion of landscape elements are consistent with the characteristics of valley villages in western Beijing.

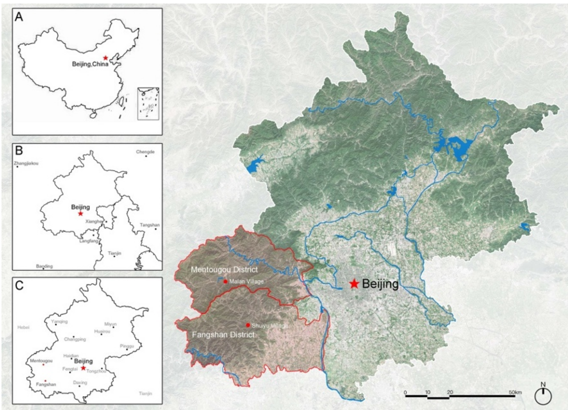

Fig. 1. Study site location.

2.2 Methods

According to the field investigation and the classification of rural landscape space and elements, 4 typical space types and 9 representative landscape elements in valley village are determined. Four typical space types are district space, edge space, street space and node space (Figure 2). The 9 representative landscape elements are sky, mountain, vegetation, tree, terrace, buildings, structure, water and path.

The typical landscape photos of the two villages were taken according to the four spatial types. Select 4 photos for each space of the two villages, a total of 32 photos. These 32 photos depict the typical landscape features and representative landscape elements of the valley villages. 9 landscape elements are defined with different colors, and different landscape elements are represented with corresponding colors in 32 photos . The total number of pixels per photo is 1920 × 1080. Calculating the pixel amount of each landscape element in the photo through Python. Then calculate the proportion of each landscape element pixel area . This is the pixel label of different landscape elements, that is, Area of Attention （AOA) of landscape elements.

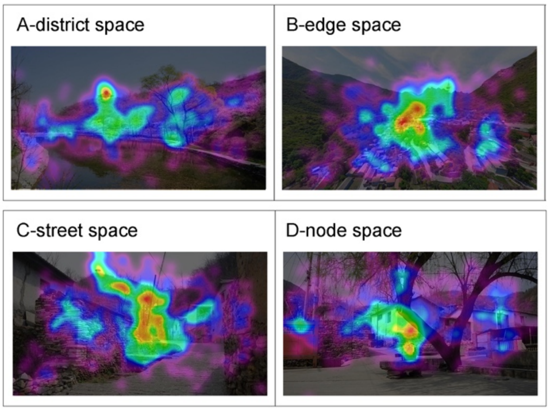

Fig. 2. Four typical space with eye-tacking heat map.

The observation points and time data in the eye tracking experiment are derived, and the coordinate information in the data can correspond to any point in the photo. In combination with the pixelation processing and color definition of different landscape elements in stage 1, Python is used to map the coordinate information to different colors of landscape elements in the photos, and finally determine the fixation time and the proportion of fixation time of different landscape elements. The proportion of fixation time of landscape elements in eye movement experiment is Gazing Time of Landscape Elements.

After the eye tracking experiment, the subjects were investigated with a questionnaire on landscape visual perception. The questionnaire includes three types of questions: choosing the most attractive one among the four photos of each space type; Ranking the landscape elements in each space according to their attractiveness; Selecting the most attractive space type in 4 spaces.

3. Results and discussion

3.1 AOA and Gazing Time

The distribution of landscape elements in different spaces can be calculated by using the pixel ratio of landscape elements. Through statistics and calculation of relevant data by SPSS, the proportion of different landscape elements in photos are obtained . According to the comprehensive analysis of the data, the landscape elements with the largest proportion of pixels in valley village are mountain and building; Secondly, the sky and vegetation; The pixel ratio of paving, terrace, landscape structure and tree is general; Water get the lowest proportion. By combining AOA with the fixation point position and time slot in eye movement experiment, we can get Gazing Time of different landscape elements in each photo (Figure 3). Comprehensive analysis of the overall data shows that: residential buildings and mountains have the longest gaze; The second is tree, terrace and vegetation; The gazing time of structure and water is general; The gazing time of sky and the path is lower.

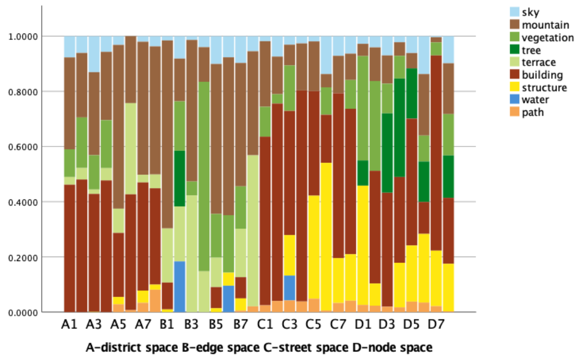

Fig. 3. Gazing Time of landscape elements

In order to explore the relationship between AOA and Gazing Time of landscape elements, Pearson correlation analysis was carried out on the attention and pixel proportion of the whole landscape elements and single landscape elements through SPSS. The results showed that there was a strong correlation between AOA and Gazing Time of the whole landscape elements. In a single landscape element, except for tree, water and path, gaze time and AOA of other elements also have a strong correlation, Landscape elements with the highest correlation between AOA and Gazing Time are mountain, and the lowest is sky. Tree and water are low proportion in villages, and the number of photos with these two elements is less, so the Pearson Correlation Analysis results may be inaccurate. Gazing Time of path is low in valley villages, but AOA is relatively large. So path has no correlation between Gazing Time and AOA of path.Through Linear Regression Gazing Time and AOA of the landscape element, it can be concluded that a more accurate regression model can be built between the two sets of data(Figure 4). There is a strong causal relationship between Gazing Time and AOA, and AOA is the reason for the change of Gazing Time.

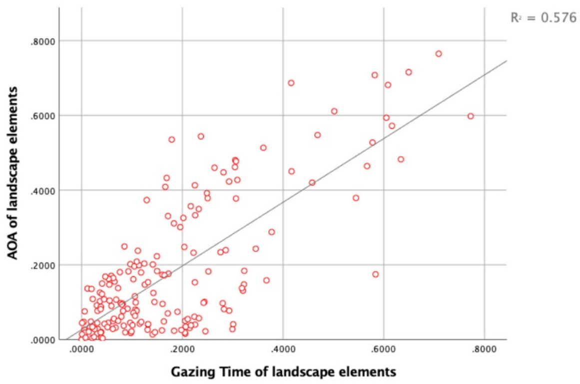

Fig. 4. Regression model of AOA and Gazing Time of landscape elements

The overall analysis shows that, except for path, the single landscape element basically conforms to the law of the correlation between Gazing Time and AOA of the whole landscape element. The number of samples of tree and water is insufficient, so there may be errors. Through regression analysis, it can be concluded that in the valley type villages in the west of Beijing, Gazing Time can be determined by AOA of landscape elements.

3.2 Gazing Time and Subjective Preference

In order to explore the correlation between Subjective preference and the Gazing Time of landscape elements in different spaces of the two villages, the relevant values were compared. The results show that in the district space, the mountain and building in the two villages have long Gazing Time and strong Subjective Preference. The differences are manifested in the mountain, terrace, building in Malan village and terrace in Shuiyu village. The attention of terrace and building in Malan village is far greater than Subjective preference, while the mountain is the opposite. In Shuiyu village, the results of terrace is opposite to that in Malan village. It shows that the terrace in Malan village and Shuiyu village get long Gazing Time of the observer, but in fact they do not attract too much time of the observer.

In the edge space,Gazing Time and Subjective Preference of the mountain are the strongest in the two villages. Gazing Time of terrace and building in Malan village is much longer than Subjective Preference, and Gazing Time of water is much shorter than Subjective Preference. In Shuiyu village, except the mountain, Gazing Time of other landscape elements is less than Subjective Preference, indicating that the actual landscape of most landscape elements in the edge space of Shuiyu village is poor, which does not meet the expectations of the observer.

In the street space, Gazing Time and Subjective Preference of building in the two villages are the strongest. Except for the vegetation, Gazing Time of other landscape elements in Malan village is less than or equal to Subjective Preference. In Shuiyu village, there is a great difference between the Gazing Time and Subjective Preference of the landscape structure, and the former is much higher than the latter. It indicates that it has obtained more attention time than subjective expectation of the observer in the process of observation.

In the node space, the building in the two villages have strong perception, and Gazing Time of mountain and tree is far less than Subjective Preference. Gazing Time of structure in Malan village is greater than Subjective Preference. It shows that the structure in the node space occupy a lot of observation time in the observation process because of their location, information, form and other characteristics.

Gazing Time and Subjective Preference of mountain in district space and edge space are the strongest, and building in street space and node space are the strongest. This has a great relationship with the observation subjects and perspectives in different spaces. As far as the overall data is concerned, Gazing Time of the mountain is greater than or equal to Subjective Preference. It shows that the mountain has an absolute observation advantage when observing the landscape of valley type villages. In other spaces except edge space, building have long Gazing Time and strong Subjective Preference, and both of them are close. Subjective Preference of sky, water and path in the four spaces is almost stronger than Gazing Time, indicating that they do not attract much attention time of the observer in the actual observation process.

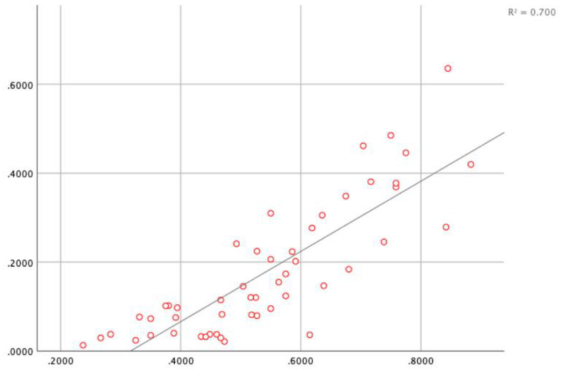

Fig. 5. Regression analysis of Subjective Preference and Gazing Time

The results show that there is a strong correlation between Gazing Time and Subjective Preference of the whole landscape elements(Figure 5). In the analysis of single landscape elements, water and tree are less distributed in the valley type villages in the west of Beijing, so the samples are insufficient, and the results may have large errors. The correlation between Subjective Preference and Gazing Time of sky, terrace, structure and path is low. Among them, the sky and path in the valley type villages rarely arouse the interest of observers. The correlation between Gazing Time and Subjective Preference of terrace and structure is poor. that is, the trends of these two sets of data are quite different. The correlation between Subjective Preference and Gazing Time of mountain, vegetation and building is high. Those are all higher than the correlation of all elements.

By regression analysis of Gazing Time and Subjective Preference of landscape elements, it can be concluded that a more accurate regression model can be built between them. There is a strong causal relationship between Gazing Time and Subjective Preference of landscape elements, and Gazing Time is the reason for the change of Subjective Preference of landscape elements.

4. Conclusion

The application of eye tracking technology to the evaluation of rural landscape resources can replace the traditional experimental methods that only use subjective experiments or rely on historical data. Through the comparative analysis of objective eye movement experiment results and subjective perception questionnaire, Subjective and objective perception rules for different landscape elements are obtained, and Subjective evaluation indicators are quantified.

The experiment studies the visual perception of the valley type villages in western Beijing, and obtains the perception of different landscape elements in the process of subjective and actual observation. Through the analysis, we can get some suggestions on the promotion, development and protection of such village landscape. Using this research method, we can also objectively evaluate the landscape of different villages and different spaces, identify their spatial specificity, analyze and assess the site.

Acknowledgments

We are grateful for the support of MOE (Ministry of Education in China) Project of Humanities and Social Sciences (18YJC850016) and the Fundamental Research Funds for the Central Universities of China (2019ZY43).

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