There Has Been a Long Road for Blind Road--Dujiangyan Blind Road System Research Based on Space Perception

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Abstract. In recent years, with the continuous increase of the number of blind people in China, the construction of blind roads and their ancillary facilities has become the focus of urban road pedestrian space planning and design. However, in practical use, the existing blind path does not really solve the problem of blind people's travel and there are few blind people on the blind path. We use part of the primary and secondary trunk road and branch of the blind road in Dujiangyan city as an example. By simulating the blind, feeling the blind track system in person, using the SD method to evaluate the status quo of the use of the existing blind road, we analyse and summarize the blind road system of Dujiangyan city from the angle of space perception, so as to provide certain reference and reference for the blind road system planning of city road pedestrian space.

1. Introduction

About 450,000 people go blind in China every year⁴, which means that almost every minute there is a new blind person, a new blind user. In addition, when the length of urban blind road becomes an important index to measure urban civilization, a large number of urban blind road construction does not have a positive impact on the blind group⁵. Through the interviews with the visually impaired and the on-site investigation of the blind road in the main pedestrian space of Dujiangyan city, it is found that there are some problems in the actual use of the blind road, such as the lack of unified planning in construction, management and design.

Blind track plays an increasingly important role in the daily travel of the blind. In order to bring practical convenience to the blind, it is particularly important to investigate and analyse the present situation of the blind track system in walking space. At present, there are relatively few researches on blind road in cities⁶-⁸, and there are relatively few targeted researches from the perspective of blind road users themselves. Therefore, this study is based on spatial perception, taking the blind road in Dujiangyan city as an example, it simulates the blind road walking space perceived by blind road users, focuses on their psychological feelings, and puts people first to explore the construction of the blind road system in Dujiangyan.
2. Research Path

2.1. Research Methods

This study used situational simulation to guide spatial perception, site reconnaissance and interview questionnaire survey as the main research methods and SD semantic difference method as the later analysis method.

| methods          | Simulation scenario                                                                 | Site survey                                                                 | Semantic difference                                      |
|------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------|
| Specific          | Simulate the blind person walking in the blind space with blindfold and a blind cane.| Find out the current status of blind road design and management for various graded roads in the site. | Quantify the feelings into a semantic difference scale. Score the space environment. |
| operation        | Recording the psychological changes.                                                |                                                                             |                                                            |
| Application      | Experience the mental state of the blind. Extract the semantic difference vocabulary from the perception. | Analyze the relationship between our psychological changes in the scenario simulation and our material space, and obtain data. | The evaluation and analysis of blind space from the perspective of psychological perception. |

2.2. Subjects

In this study, Xuanhuamen of Dujiangyan city was selected as the core in blind track system and Dujiangyan Avenue as the main axis. The fan-shaped area formed by Kuiguang Road and Puyang Road as well as Guanjing Road as the case area. There are a large number of massage shops for the blind in this area.

Secondly, the blind track system of road walking space is the main research object and the blind and passers-by on the road section are the objects of questionnaire survey and interview.

Figure 1. Research route.
3. Analysis of Space Environment

The total length of research route of the spacial environment analysis and investigation is about 18.79 kilometres, of which the main road is about 3.67 kilometres, the secondary road is about 7.34 kilometres and the branch road is about 7.78 kilometres. There are about 13.24 kilometres of blind roads in the region, accounting for 70.5% of the total length of the research routes. Among them, the non-blind areas are mainly concentrated in residential functional areas, and some are scattered in commercial functional areas or at the junction with other areas. Even in the area where the blind massage shop is located, the blind path system of walking space is not perfect enough.

According to the analysis, the above problems can be divided into two levels: construction design and management. At the level of construction design, blind road problems are mainly manifested in the interruption of blind road, construction brick errors, no indication of turning angle, blind road dislocation, too close to tree pool and too steep slope of margin stone. At the level of management, the problem of blind road occupied is particularly prominent. The occupancy of blind road is divided into long-term occupancy and short-term occupancy. The long-term occupancy includes: occupancy of municipal facilities (mainly well cover occupancy), occupancy of shop activities, occupancy of tree pools and sundries, etc. The short-term occupancy is divided into occupancy of crowd activities and occupancy of parking vehicles.

3.1. Space Environment of Main Roads

The main road in the research plot is composed of a section of Guanjing road and Qingcheng road. Through analysis, about 41 blind road damages can be found per kilometre of Guanjing road on average (all kinds of problems that hinder the walking of blind person are called blind road damages). On average, about 68 blind road damages can be found per kilometre of Qingcheng road. Damage, interruption and occupancy are the main problems in the environmental space of the main blind road.

3.2. Space Environment of Secondary Main Roads

Secondary main roads include Kuiguang Road, Puyang Road, Jianshe Road, Dujiangyan Avenue, Yudaiqiao Street, Xin Road and Taiping Street. Among them, the blind road damages of Yudaiqiao Street is more serious; the space environment of Dujiangyan Avenue is better than that of other sub-trunk roads; the blind road design of Puyang Road and Construction Road is more standardized, but the invasion situation is prominent. The problem of long-term occupancy is the main environmental space of the blind road of the secondary main road.

3.3. Branch Space Environment

Blind branch road has a high interruption rate. Blind channel damage is more serious than the main and secondary roads as a whole. Moreover, because the pavement is too narrow, the narrow living space of residents leads to the problem of occupying the road prominently, and riverside with frequent commercial activities, a large number of people and traffic activities lead to serious damage to the blind road.

3.4. Summary and Analysis

From the overall situation, the situation of blind road damage is manifested as branch > secondary main road> main road. The average number of blind road damage is 59 times per kilometre in all the streets investigated. Blind road damage is negatively correlated with road grade and width, that is, the lower the road grade or the smaller the road width, the narrower the living space of the crowd, the more frequently the blind road space is occupied, and the damage degree of the blind road is also increased. Among all the damage problems, occupancy problem is the most prominent, of which long-term occupancy and short-term occupancy account for similar proportion. Due to the improper use of blind road management, the obstacles to the use of blind road are obviously more than those caused by unreasonable design and construction.
4. Analysis of Space Perception

The average height of the Chinese is 170cm. The front width of the white cane held by a blind person is 60-120 cm, the side width is 70-90 cm, and the diameter of a blind person rotating 180 degrees with a white cane is 150 cm. The team used scenario simulation to intuitively perceive the blind's walking space from the blind's perspective, and used human senses other than vision to perceive the spatial morphological changes that blind person encounter when they use the blind path.

4.1 Auditory Perception Space

Blind persons have advantages over normal people in speech perception, auditory memory, sound source localization and speaker identification. Sound can not only bring linguistic information to the blind, but also enhance their sense of direction and distance. Figure 3-1 shows that the sound source to the blind person in the blind space is mainly the sound emitted by the surrounding environment and the white cane when exploring the road. Sounds of different nature can bring different perceptual space experiences to the blind. The loudness of the sound, the distance of the sound source, the soothing degree of the sound and the preference of the percipient for the sound all affect the percipient's spatial feeling.

Figure 3-2 and 3-3 show that in noisy environments, when the sound source is close or large, there will be a narrow sense of space and a sense of panic. A certain sense of anxiety will weaken the perception of the distance and direction of the sound source, which leads to the percipient unable to make a judgment on the next action, resulting in a sense of fear of walking. When in a quiet environment, the sound source is far or small, it will produce a more spacious space feeling and a calm psychological feeling. The percipient can better concentrate on a certain guiding sound source and guide the direction through it.

Positive and beneficial perceptual space can be formed by the visual compensation effect acquired through audition, thus further improving the blind system. In the design of urban street space, the sound pressure level, spectrum, frequency of occurrence, duration, location of sound source, movement and distance between the sound source and the listener, as well as the psychological and social response of the listener to various sounds, should be considered[3].

4.2 Olfactory Perception Space

The space generated by olfactory perception is scattered, the form is abstract, and the discrimination ability is weak. The closer to the odor information source, the denser the space is. In the scene simulation, it is found that smell exerts influences mainly focusing on the psychological influence of the perceiver. For smell plays a less prominent role in the perception, when there is a strong smell, it will cause the perceiver's short-term attention, stimulate the perceiver's desire for perception, and assist the location capture and the association building of the perceived space. Pungent odors cause the perceiver to have negative psychological feelings, thus avoiding the location of the signal source. Harmonious, soothing and pleasant odors have a certain guiding effect on the perceiver.
4.3. Skin Perception Space

The abundant information, such as the change of microclimate, the suitability of temperature and humidity, the materials of handles and handrails, and the braille prompts on buttons, is the first-hand information obtained by the blind people who actively explore with their bodies and hands. As shown in picture 3-5, blind people can feel the blind path through skin sensation conveyed by the soles of feet and blind staffs when walking, and unknown objects in space can convey neural information through direct contact with limbs. The perceiver perceives the space by replacing the scene and finds that the phenomenon of occupying the blind path space, the lane, tree pool, eaves dripping, and blind path concave and convex damage, will bring some shock and fear to the blind. Due to the rapid perception generated by skin perception and stronger identification than other senses, the perceiver cannot know in advance the entity that is about to be contacted or dangerous. When receiving the skin perception information, the perceiver has already contacted with the entity, which often has safety risks. The only way to cushion the contact is to use blind sticks and other media.

It can be concluded that preceptors tend to use skin perception for spatial perception, and physical skin perception is more conducive to spatial association. Skin sensation is closer to the information that the perceiver actively explores and more targeted than that of other senses\(^9\), making it easier to judge the safe distance and more secure.

![Sensory Signal Source](image)

Figure 6. Audio Perceptual Source Map.

5. Crowd Psychological Analysis

5.1. Classification and Quantity Statistics of Blind People

According to the national standard of Disability Classification and Classification of Disabled Persons (GB/t26341-2010), visual disability refers to the fact that due to various reasons, the vision of both eyes is low and cannot be corrected or the visual field of both eyes is narrowed, thus affecting their daily life and social participation. Visual impairment includes blindness and low vision. According to the data of relevant professional associations, the ratio of male and female visually impaired people in Dujiangyan is close to 1.3 and the total number is as high as 2,152, among which the total number of first and second level blind people accounts for more than half of the total number of visually impaired people.

| Classification | Level                  | Best corrected visual acuity         | Number of DuJiangYan |
|----------------|------------------------|-------------------------------------|----------------------|
| Blind          | First-degree blindness | <0.02 to photoless sensation; or radius of view <5° | 573 person           |
|                | Second-degree blindness| <0.05~0.02; or radius of view <10° | 539 person           |
| Low Vision     | First-degree low vision| <0.1~0.05                           | 316 person           |
|                | Second-degree low vision| <0.3~0.1                           | 724 person           |
5.2. Psychological Analysis of the Blind

Through the interview with the visually impaired people, we found that blind men's walking feedback of feeling are similar with scene simulation experience results, the blind and preceptors are more difficult to ease the anxiety in the process of walking, many blind people have psychological barriers to walk outside and had "heart-pounding" walking outside experience. It is not an optimistic situation which exacerbated the resistance and fear of the blind of using blind track.

5.3. Psychological Analysis of Ordinary People

According to the results of the questionnaire survey, most ordinary people do not often see the blind walk on the blind road. Although the ordinary people can distinguish the blind road, only a few people often pay attention to the blind road. Most people believe that blind people rely on blind sticks to travel and that blind paths can be used without affecting blind people. It can be seen that most ordinary people know the blind path but do not pay enough attention to it, which leads to the invasion and loss of the blind path space for their own living needs. In addition, occupation and age showed a basic correlation with the degree of attention to blind track and the degree of attention to blind track decreased with the increase of age, while people engaged in occupations related to social behaviors paid more attention to blind track than other occupational groups.

5.4. Analysis of Perceived Differences

The results of spatial perception were quantitatively evaluated by SD semantic difference method. By describing the blind pedestrian space in the 14 adjectives by six perceivers, the evaluation results showed the situation of construction of blind roads is ordered: PuYang Road, Jiangandong Street, Jianshe Road, Jiangan Road, Taiping Street, Jiangan Central Road, among which Puyang Road and Jianshe Road are urban main roads, with good situation of blind track construction. The Jiangan Road is the urban trunk road; Jiangandong Street, Taiping Street and Jiangan Road are urban branch for the city. Jiangandong Street got a relatively good evaluation situation, because it has the wide sidewalk pavement and wide distance between street shops, as well as its less interference of group activities on the blind tracks.

The results of comparison between men and women showed that women have a larger range of perceptual activity than men. Most of the roads had a positive evaluation in terms of traffic flow, noise level and other surrounding environments, and a negative evaluation in terms of personal emotion and spatial accessibility. It can be seen that the construction and management of the blind track system itself are the reasons for the inconvenience to the blind.

![Figure 7. SD perception curve(The left is from female, the right is from male).](image-url)
6. Conclusions
This paper perceives the blind path walking space in Dujiangyan urban area through scene substitution and finds that there are significant differences between the attitudes and views of the blind path between the blind and ordinary people. Most ordinary people occupy the blind path to meet their own needs. Urban construction tends to focus on the main road, while the secondary main road and branch road are paid less attention, but they are directly connected with businesses and households, leaving the problems such as the occupation of commercial operation without management. Blind track system is a combination of touch, hearing and smell. Different facilities can provide blind people with different sensory feelings. However, the blind track system in the investigation and perception process has single sensory level and insufficient accessibility, which blocks the walking of the blind. According to status quo of the problem, the author suggested in field of use and management, we should call on the public attention to the blind and popularize basic knowledge blind, raise awareness and perception of urban blind road construction; We will improve the accountability mechanism and implement the system of rewards for public supervision and reporting. In terms of blind path design, multi-level senses are combined to improve the blind path system. Due to the design, the positioning and guidance for the blind can be realized not only by the blind path at the foot, but also by the roadside grass fence, special curb material, isolation belt and wall. Attention is paid to the design of personal guiding facilities, such as sensor bracelet. In addition, in some areas with high incidence of accidents, the warning of sensing space can be increased. In the olfactory aspect, we should spray the stimulation odor to remind the blind; Tactile indicators are set to connect traffic information at stations, junctions and other places with the blind stick sensing system to replace sound signals and reduce noise.

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