

An Investigation into the Soundscape Harmony between Historic Mausoleum and Modern Urban Park

----Taking the Beiling Park in Shenyang as a Case

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Summary

As a main content of public open space, urban parks provide high-quality restorative environment for citizens. Beiling Park is a modern urban park centred on Zhao Tomb from the Qing dynasty, which is located in Shenyang, China, a typical high-density city. It is invaluable in the history, culture and urban wellbeing to Shenyang. Its quiet and solemn mausoleum area is adjacent to the uproarious leisure area, making sound harmony a concern. In this study, soundscape data were collected from both acoustic measurements and perceptual evaluations; Soundwalk and interview were taken to generate the distribution and composition of soundscape along the main touring route; a series of correlation analyses were carried out to confirm the relationship between the tourist's acoustic experience and soundscape characteristics to find out problems in soundscape harmony.

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1. Introduction

Located in the north of Shenyang, the Zhaoling Tomb is named after Beiling. It covers an area of 180,000 square meters. It was first built in 1643 as the tomb of the second Qing emperor, Huang Taji, and his empress Xiaoduanwen Borjite and finished in 1651. During the period when Kangxi, Qianlong, and Jiaqing were in power, several additions and alterations were applied to it, which formed the unique castle-style mausoleum building system. Zhaoling was the largest, most magnificent and most representative tomb of "three tombs in the northeast China" in the early Qing Dynasty. Moreover, it is also one of the most complete architectural complexes of imperial mausoleums in China. In 2004, Zhaoling was officially listed in "The World Heritage List".

In 1927, the government of Fengtian Province opened Zhaoling, together with the area in front and back, as an integrated urban park which covered an area of 3.03 million square meters, known as Beiling Park. After the expansion, the front area was a recreational, cultural place and the back area served as an old Chinese pine conservation.

Beiling park carries several functions such as the protection to historical buildings, resorts for public visits, a place for cultural and leisure activities, fields for sports and fitness[1]. It attracts a large number of tourists and citizens every day which brings much sound of leisure activities to the tranguil and majestic environment of the Mausoleum area. Lively in the south and quiet in the north, the giant contrast in soundscape make the harmony of the soundscape in Zhaolin a concern. The popularisation of the concept of soundscape started in 1969. Canadian composer Schafer (R.M.) conducted a series of soundscape collection activities in North America and Europe[2]. International Organization for Standardization (ISO) defined soundscape as the sound environment perceived by individuals or groups in a given scene[3]. The concept of the soundscape is different from the traditional sound environment. The soundscape is not isolated in the environment; rather, it is inextricably linked to people and the environment. The sound, the listener and the

environment combined to constitute the three basic elements of soundscape[4]. Therefore, studying the influence of environment on people's perception of the acoustic environment is an important field of study in the soundscape.

2. Object and Methods

2.1 Beiling Park

2.1.1 Functional layout

Beiling Park is divided into three major regions with Zhaoling as its core (see Figure 1): Mausoleum District, Old Chinese Pine Conservation, Recreational Culture Area in front, including the area around Mausoleum, botanical garden, water recreation area, children recreational area, sports field and entrance area.



Figure 1. The functional layout of Beiling Park.

The overall layout of Zhaoling is rigorous and symmetric. The site is aligned on a north-south axis set west of Shenyang city's old north axis. Main buildings lines along the axis and are dotted with the auxiliary buildings on both sides. The shape of the zhaoling is a rectangle which has a longer northsouth side. The dense pine forest inside and outside the Mausoleum area attracts a large number of birds to stay to build nests. Birds' chirping, accompanied by the rustling of leaves when the wind passes through, becomes the keynote sound of the Mausoleum, setting a quiet and tranquil atmosphere in the Mausoleum area. Tourists from around the country who came to visit the Zhaoling were impressed with the grandeur of the ancient mausoleum buildings. Due to Zhaoling's important historical and cultural values, the management of the area is stricter than other areas. Tourists need to purchase tickets to enter the area, which limits the number of tourists to a certain extent and also reduces the conflict to the architectural atmosphere of the mausoleum.

There are over 2,000 pine trees on the back of the hill. The majority of the pines are more than three hundred years old, with some small paths interspersed among pine forests. There are no buildings or entertainment facilities, and no spaces for tourists to stay. Small groups of tourists, walking or jogging, can occasionally catch glimpses of squirrels jumping in the woods, hear birds chirping, or see slight sunlight through the leaves. All these combined with the rustling of leaves make the environment peaceful and secluded.

The leisure culture area in front of the mausoleum is a place for urban residents to enjoy relaxation, fitness, cultural and entertainment activities. The overall environment takes on the following: under the shade of green trees, lake pool and flat land are combined, creating open and secluded atmosphere; space design considers interest, walkability and swellability, extensive entertainment facilities, open space, and numerous space nodes not only offers tourists with the opportunity to perform a range of activities, but also provide plenty of space for the public to organise cultural and recreational activities for a large number of attendances, and business activities that comes with them. The north and south trunk roads divide the area in front of the mausoleum into eastern and western parts. In the east part, the east lake dominates, and the lake is open. Along the lake, recreational projects such as Amusement World, laser warships, and Shenqiao Pier are arranged, forming a water play area along the lake. The weeping willows along the lakeshore and the flowers and shrubs of the four seasons form the eastern part of the plant viewing area. Many tourists are attracted to the area for recreation and fitness activities. The west area is a plant viewing area dominated by the Fangxiu Garden, where tourists can stroll, watch, or stop in for a taste, take a nap, or have a picnic together.

2.1.2 Main tour route

The north-south trunk road from the entrance of Beiling Park to Zhaoling is the central axis of Beiling Park and the most spacious road in the park. The axis enters from the entrance of the park and passes through the bergamot flowering landscape, Huang Taiji Square, Shenqiao, the archway and the Zhenghong Gate, passing through Huabiao and the statues of the mythical beasts, the fruit house, the distillery room, the ceremonial room, and the tea house, reaching the tomb area in the Fangcheng. This is the main tour route of Beiling Park (Figure 2).

For most of the tourists who enter the area, they first enter the mausoleum area through this trunk road and then visit the turrets, east and west buildings, east and west temples, fire pits, dragon temple, crescent city and the Baocheng, where the tomb is situated; and for those who do not visit the Mausoleum only in the Mausoleum area, they will first cross the main road and pass through most of the mausoleum front and then get split into different areas. Therefore, compared with other space areas, the main route of the tour is rich in tourist activities. spatial points and soundscapes. The entire route runs through the internal and external transition area of the entrance, the active area of the soundscape, the transitional area outside the mausoleum area, and, most importantly, the mausoleum area. The environment of different sections of the road are significantly different, and activity status and environmental people's experience are also quite different. The problem of soundscape harmony brought about by the coexistence of historic cemeteries and urban parks is particularly prominent.



Figure 2. Main tour route of Beiling Park.

2.2 Methods

2.2.1 Soundwalk experience

Soundwalk experience, in conjunction with Acoustic Measurements and Tourist interview were conducted on a Sunday in October 2017, when the weather is fine, and the wind is not greater than level 3, the groups start measuring at 10 o'clock in the morning. At this time, the richness of the soundscape in the park at the peak and remains nearly stable.

Soundwalk [5] is a way for listeners to actively and comprehensively perceive the soundscape, that is, to slowly listen to the soundscape of each area along an established route. Soundwalk was conducted by two researchers and eight reviewers along with the main tourist route. Two researchers walk to the tomb from the entrance of the park along a roaming route, and then went back to the entrance on the same route. In that period, they observed and recorded the spatial characteristics of the main tour routes, the behaviour characteristics of tourists, and the acoustic events along the route in the way of photograph and videos file.

Based on the impact of the sound type on the sound environment experience[6][7], the evaluators assessed and recorded the sound perception significance of the corresponding area. The eight evaluators were all undergraduates of Shenyang Jianzhu University. Before the evaluation, they were trained on the soundscape evaluation to increase the credibility of the result and reduce the instability in the process. To eliminate gender differences, eight students were divided into to four groups, and every group has a girl and a boy; the tour route sequence design was taken to remove the effect of time and sequence. Two groups walked from the entrance of the park to the mausoleum, and the other two groups took the opposite direction. According to the distance, combined with the change of special characteristics, the entire tour route can be divided into eight experience areas (see f)figure 2). The evaluators performed soundscape perception followed the prescribed route. At the

same time, the dominance of perceived sound sources (natural sounds, sounds of sightseeing, recreational activities sound, commercial sound, and mechanical sound) was assessed. The evaluation is based on a 5-point system, 5) Dominates completely; 4) Heard comparatively significantly; 3) Heard moderately; 2) Heard slightly; 1) Do not hear at all. Take the means of eight people represents the dominance of perceived sound sources in every area.

2.2.2 Acoustic Measurements

Based on people's perception and experience, A sound level is used as the basic index for acoustic measurements[8][9]. As there are many spatial nodes and soundscape changes in the main tour route, 25m is applied as the basic unit to arrange measurement points combined with spatial patterns. The space from the entrance of the park to the gate of the mausoleum is linear with crowds and activities concentrated on the road and both sides. Therefore, the measuring points are arranged in the centre of the road totalled 49. After entering the Mausoleum, space was open. Tourists scattered to different regions according to their tour routes. Because of two elevations (ground and wall) in the Mausoleum District, the influence of the buildings on sound transmission needs to be taken into consideration. 29 measurement points distributed horizontally and at the wall elevation.

To keep the efficiency of the measurement and reduce the temporal differences in the soundscape caused by the measurement duration, all measurement points were divided into five measurement areas.

The ten pre-trained testers (undergraduate students from Shenyang Jianzhu University) were divided into five groups of 2 people each. At each measurement point, one person is responsible for the measurement: the secondary integral sound level meter was adjusted to fast gear and was placed horizontally on the same height as the chest one arm length away[10]. The sound pressure was measured at each point for 60 seconds; Another tester is responsible for recording video on the mobile phone. The picture of the video is a sound level meter reading, and the audio is the sound from the area.

2.2.3 Tourist interview

To measure the tourist' soundscape comfort, ten tourists were interviewed in the previous mentioned eight soundscape experience areas. The core content of the interview was the soundscape comfort of the area where the tourists were at the time. The 5-level Likert scale is applied, 2): very comfortable; 1): relatively comfortable; 0): neutral; relatively uncomfortable: -1): -2) verv uncomfortable, To avoid individual differences, interviewees were rationally distributed regarding age, gender, and behaviour state. The records also included whether they were residents, the frequency of visits, the purpose of visits, whether to visit Zhaoling, whether to have companies, and whether they felt disharmonious sound. At the same time, the gender, age characteristics, and behaviour state of respondents were also recorded.

3. Results

3.1 The soundscape experience

Combining soundwalk from the fieldwork, it was discovered that from the entrance to the inside of the mausoleum area, on the main tour routes, the change in soundscape was rich and varied, and it also showed a certain pattern.

At the entrance (Fig.3a), the general feeling is relatively quiet, and it contrasts sharply with the hustle and bustle of the city outside the park. The acoustic environment together with the visual environment has shaped a rare fresh environment in the city. Because they just entered the park, most of the tourists went straight through and stayed less; the trees on both sides of the area were lush, and no other acoustic events occurred. Natural sounds could be noticed more clearly. Because of the proximity to the city roads on the south side, traffic sounds were perceived.

Heading North, some commercial vendors along the road appeared, playing pop music to solicit business, and tourists will stop for shopping (Fig.3b); on both sides of the open space, various dance and singing entertainment activities are present. The sound pressure level is very significant; there is a significant amount of entertainment activity on the east side of the amusement park; the atmosphere in the area is lively, and the tour activity is outstanding. The core space node Huang Taiji Square (Fig.3c) is open and crowded. Many tourists stop and take pictures. The sounds of sightseeing are rich. The sounds of these sightseeing events, the sound of entertainment activities, and the sound of distinctive commercial activities contain characteristics of city parks, and they have formed a prominent and active prospect sound.

Although both sides of the area are forest trees, a variety of prominent activities make natural sounds hidden and difficult to detect. There are also traders

and migrants in the northern part of the Huang Tai Chi-Square, especially the publicity broadcast (Fig.3d) from the lottery sales points. The volume is large, and the scope of perception is wide. The rich sound types and the significant perception of artificial sound are the characteristics of the soundscape on this section.

Walking past Tai Chi-Square, Huabiao Pillars appeared on both sides of the road, and the two subcars sections in the road were also cancelled. The axial feeling was even more intense. The landscape is more unified, and the atmosphere is changing to become more serious. Until the entrance of the Zhaoling Mausoleum, the bridge of the gods indicates that they are about to step into the Zhaoling Mausoleum. This is the transitional area on the main tour route, but from the road and the side of the Shenqiao open space entertainment sounds like Diabolo, Erhu, etc. are very loud. The propaganda of traders and cruise ships at the head of the Bridge of God also continued to be heard. On the outside of the entrance of the Mausoleum, tourists gather to take pictures, and the sounds of sightseeing were significant. In addition to recreational activities such as playing Diabolo

(Fig.3e) and Erhu, the two sides of the Shenqiao Bridge have significant predictable sound pressure levels; the trees on both sides of the road are rich in the shade, but natural sounds are hardly noticeable. Travelling to the outside of the entrance to the Mausoleum area (Fig.3f), tourists gather to take photos and observe the activities.

Entering the mausoleum area, tourists have increased their visual tasks and are affected by a peaceful resplendent and environment. Conversation noise is gradually reduced. The royal clothing leasing booth (Fig.3g) appeared at this location, and the sound of advertisements released by loudspeakers to attract customers is very prominent, and space is closed, and the predicted sound pressure level will show a distinct peak. As moving further towards the inside, natural sounds become more prominent in the nodes of Fangcheng (Fig.3h), Crescent City (Fig.3i), and Baocheng (Fig.3j), and the proportion of human voice becomes very low, with only slight voices. In a quiet atmosphere like this, people can fully feel the crisp sound of birds, the wind blowing the sound of leaves, the sound of worms and other natural sounds.



Figure 3. Typical space nodes and sound events on the walk route.

3.2 Spatial distribution of sound pressure

According to the results of sound pressure level measurements, the background noise level L_{90} and the intermittent noise peak value L_{10} at each measurement point are extracted and superimposed on the main tour route to form figure 4.

As can be seen from Figure 4, the distribution of the numerical values of L_{90} and L_{10} shows a certain correspondence with space. Near the entrance, within the scope of the No. 1 experience area, the sound pressure level is low, and the L_{90} of the four measurement points is lower than 55 dB(A).

Travelling inwards, in the No. 2-4 Experience areas, which is a recreational area in the park, the sound pressure level increases. 62.5% of the measurement points have L_{90} exceeding 55dB (A), with two peak areas. Corresponding to space and tourist behaviour recorded by the soundscape, and the video files recorded by acoustic measurements, it was found that the environment in the area was more lively than the entrance. The crowds on the road were more concentrated. Vendors selling food and tourist toys appeared along the road playing music to significant attract customers; there were entertainment activities on the east side of the road,

and singing and dancing activities were spontaneously formed on both sides of the open space. The peaks of the two sound pressure levels appear in the No. 2 area where commercial vendors and group singing and dancing activities are most concentrated; and the Huang Tai Tai Square, where the crowd is denser, and the atmosphere is more active. Entering the No. 5 experience area, the sound pressure level dropped slightly, and the proportion of measuring points with L₉₀ exceeding 55 dB(A) was 12.5%. Regarding space, the Huabiao Pillars appear on both sides of the road, and the atmosphere of the royal cemetery gradually emerges. This is a transitional space from the leisure area to the mausoleum area. The overall environment and tourists begin to calm down, but the space on both sides of the road appears

Spontaneous individual leisure activities such as diabolo, erhu, etc. Although compared with the group entertainment in the front area, these are small in number and the spatial sense conflict is not obvious, the resulting sound is louder, and the sound pressure level appears obvious peaking. In the No. 6-8 experience area, the sound pressure level gradually decreased, and the L₉₀ of all the measuring points was lower than 55 dB(A). However, there was still an unusual peak. Checking the walking record and live video, it was found that this locality is located in front of the entrance to Fangcheng, there is a booth for tourists to rent royal costumes, using loudspeakers to broadcast promotional audio to solicit business, contributing a great level of sound pressure.



Figure 4. Spatial distribution of L₉₀ & L₁₀ on the main tourist route.

3.3 Spatial distribution of sound types

The evaluations of different sound perception saliencies performed by the aforementioned eight reviewers were averaged to obtain the significance distribution of different sound categories on the main tour route, as shown in figure 5.

As can be seen from the figure, in different areas of the main tour route, the sounds of sightseeing are almost all significantly perceived sounds (significance ≥ 3), and only in the inner area of the Mausoleum area No. 6, weakened due to the unexpected commercial sound (significance = 4.4); in the entire area outside the mausoleum area, entertainment activity sounds in concert with the sound of sightseeing stand as the most dominant sound types (significance ≥ 3); natural sounds are significantly perceived within the mausoleum area (significance ≥ 4) but covered by sounds of entertainment activities and sounds of sightseeing outside the mausoleum area; the entire tour route was relatively far from urban roads, and the sound of traffic was not significant (for all areas, significance ≤ 3); the sound of commercial activities was only perceived anomalously in area No. 6 (significance = 4.4) and was not significantly perceived in other areas (significance ≤ 3).



Figure 5. Spatial distribution of sound types.

3.4 Sound comfort and correlation analysis

To explore factors related to the acoustic comfort of tourists, 80 interviewees were interviewed on the following information: gender, age, travel alone / accompanied, local residents/tourists, the frequency of visits to the park, purpose of coming to the park (multiple choice), see Table 1.

Table I. Basic information of interviewees.

gender	1	nale	female		
gender	3	7.5%	62.5%		
age	seniors	Middle-aged	teenagers	children	
	25.0%	37.5%	33.75%	3.75%	
com-	a	lone	accompanied		
pany	23	5.75%	76.7	5%	
source	Local	residents	tourists		
	6	7.5%	32.5%		
fre-	first time	occasionally	often	almost daily	
quency	38.75%	35.0%	21.25%	5.0%	
aim	sightseeing	accompanying family	relaxation	exercise	
	53.75%	15.0%	41.25%	17.5%	

The interviewees' sound comfort is assessed, and variance analysis is carried out for the eight interviewed areas. The results showed that the differences in sound comfort scores for each area were significant, as shown in Table 2. Based on this, the mean values of sound comfort in each area were calculated. The results are shown in Table 3.

Table II. ANOVA (by area)

sound comfort	SS	df	MS	F	Sig.
among groups	17.288	7	2.470	2.920	.010
within groups	60.900	72	.846		
total	78.188	79			

Table III. Micall (Sound Connort	Table III.	Mean	(sound	comfort))
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Area	mean	SD	Area	mean	SD
1	1.4	.843	5	0.8	.919
2	0	.943	6	1.2	.789
3	0.7	.949	7	0.6	1.075
4	0.4	1.075	8	1.4	.699

As can be seen from Table 3, the changes in the soundscape comfort experience on the main tour

route, combined with the SPL distribution from figure 4, the sound category distribution from figure 5, and the record of the soundscape walk experience, it can be found that: the entrance area No. 1 has relatively low SPL because it is just into the park, people contrasting with the high-density urban environment outside the park makes the tourists' acoustic comfort experience highly evaluated, reaching 1.4; moving inward, the sound of the entertainment activities and the sound of sightseeing remain high, and the SPL increases. The evaluation of comfort is low, and the evaluation index of sound comfort in the leisure activity area is between 0-0.8; when entering the cemetery area, the index is higher again, but in area 7 it is evaluated 0.6 because of an extremely discordant commercial propaganda.

Variance analysis of acoustic comfort indicators for each of the information in Table 1 revealed only the correlations between the respondents' age and acoustic comfort scores, as shown in Table 4.

Table IV. ANOVA	(by age)
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	, 0				
Sound comfort	SS	df	MS	F	Sig.
Among groups	7.975	3	2.658	2.877	.042
Within groups	70.213	76	.924		
Total	78.188	79			

The correlation analysis was made on the sound comfort index, SPL, and various sound perception indices. The results are shown in Table 5. From the data, it can be seen that the acoustic comfort rating significantly negatively correlated with the is background noise level L₉₀ and the intermittent noise peak L_{10} at the 0.01 level; it is significantly positively correlated with the natural sound perception sensibility at the 0.05 level; and is significantly negatively correlated with the perception significance of entertainment sounds at the 0.05 level. In other words, the higher the L_{90} and L10 areas, the lower the acoustic comfort rating; For a certain area, the more significant the natural sounds, the higher the sound comfort rating; the

higher the sound level of the entertainment activity sounds, the higher the sound comfort rating.

Furthermore, the background noise level L_{90} and intermittent noise peak L_{10} are correlated with the perceived perceptual significance of various types of sound (Table 5). It can be seen from the data that both L_{90} and L_{10} are significantly negatively correlated with the perceptual significance of natural sounds (0.05 level). There is a significant positive correlation (0.01 level) with traffic noise, entertainment activity sounds, and sounds of sightseeing.

		SI	PL	Perception significance of different sounds types				\$
		L_{90}	L_{10}	Natural	Commercial	Traffic	Recreational activities	Sightseeing
Sound	Р	289**	304**	.253*	167	158	230*	.100
comfort	Sig.	009	.006	.024	.139	.160	.040	.377
L ₉₀	Р	-	-	968**	035	.866**	.913**	.383**
	Sig.	-	-	.000	.758	.000	.000	.000
L ₁₀	Р	-	-	961**	050	.846**	.911**	.379**
	Sig.	-	-	.000	.657	.000	.000	.001

Table V. Correlation analysis

4. Conclusion

The results of the study showed that: (1) The main tourist route on the central axis of Beiling Park runs from the entrance through the recreation area to the main tour route of the cemetery area. The soundscape is based on the spatial environment, function layout, and crowd behaviour. Showing the corresponding characteristics; (2) Overall, leisure and entertainment areas are busy, SPL levels are significantly higher than the cemetery area, entertainment sounds and sightseeing sounds perception is significant; cemetery area is quiet, and SPL is low. The perception of natural sound and sightseeing sounds is significant; (3) The acoustic comfort scores based on tourist interviews showed significant differences in different sections of the main tour route and were significantly positively correlated with SPL, had a significant negative correlation with natural sound perception significance, and had a significant Positive correlation with acoustic effects related to recreational activities.; (4) Summing up all analysis, Beiling Park soundscape has the following problems in terms of harmony: 1) In the leisure and entertainment areas, the significance of the sound of recreational activities and its significant impact on sound comfort experience; 2 The impact of commercial sound on the soundscape experience is even more serious; 3 There is a lack of soundscape transition between the liveliness of leisure and entertainment areas and the tranquility of the cemetery area.

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