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THE EFFECT OF NATURAL SOUNDS ON SOCIAL INTERACTIONS IN URBAN PARKS

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ABSTRACT[*]

Numerous studies have found that nature sounds have a positive effect on individuals, but the effect of nature sounds on individuals' social interaction behaviors has not been investigated. This study conducted a soundscape intervention experiment in an urban park activity space and covertly observed people's social interaction behaviors in response to varying sound conditions. In the experiment, birdsong and water sounds were introduced as intervention sounds to alter the acoustic environment. Two variables were defined to represent the effects of the interventional sounds on social interactions: the frequency of social interactions, and the proportion of total time spent on social interactions. The results revealed that the intervention of birdsong and water sounds increased the frequency of social interactions in the study area compared to the control group. The sound of the water also promoted time spent on social interactions. This study provided evidence that nature sounds can encourage social interaction, and the results may contribute to the refinement of social interaction-friendly space design theory and the promotion of long-term social cohesion.

Keywords: *sound interventions, social interaction, natural sounds, urban park*

1. INTRODUCTION

Urban parks are an important part of a city's green infrastructure and play a vital role in promoting public health [1-3]. A well-designed park should have a high-quality sound environment as noise pollution can negate the positive effects of parks on citizens [4]. Research has shown that the sound environment of a park can influence a visitor's experience and that natural sounds can have beneficial effects on mood and mental restoration [5-8]. The soundscape approach, which views environmental sound as a resource, explores the positive effects of sound and adds pleasant sounds to enhance the existing soundscape [9-11]. Several studies have examined the positive effects of interventional sounds in urban parks and public spaces on people's perception and behavior at the individual level [12-14]. However, urban parks are also places where people gather and interact, and the impact of the sound environment on social interactions has not been explored. It is therefore reasonable to speculate that natural sounds may also have an effect on people's social interactions and to hypothesize that richer natural sounds in park activity spaces would facilitate more social interactions.

Social interaction, a vital component of human behavior, involves mutual communication, behavior, and exchange within a social context, and is strongly correlated with human health [15-17]. Understanding how sound impacts social behavior can have important implications for designing environments that facilitate social interaction and promote well-being. Therefore, this study aimed to investigate whether natural sounds can facilitate social interaction in urban parks. Through on-site interventional soundscape experiments conducted in urban parks, the study aimed to answer the following questions: a) Do natural sounds change the frequency of social interactions between individuals? and b) Do natural sounds affect the duration of social interactions between people?

2. METHODS

The sound intervention experiment took place in Tieren Park, Daqing, China, and used interventional sounds from loudspeakers to alter the sound environment of the site.

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Hidden cameras were used to capture the responses of park visitors and build a database for later behavioral analysis. factor. The cameras' resolution was lowered for personal privacy protection.

2.1 Study area and sound files

A rectangular recreational area in Tieren Park in Daqing was chosen as the experimental site, which is regularly used by people of all ages and occupations. The experimental area was a relatively independent space surrounded by vegetation for recreational activities, with a soft play area for children in the middle and outdoor gym equipment and benches on the perimeter (see Fig. 1). The participants of this study were adults, as the focus was on the acoustic environment for adults, rather than children's social behavior. For this experiment, two natural sounds were chosen: a bird song and the sound of water. The sounds were selected to be appropriate for an urban park environment, with a combination of multiple bird sounds and natural river sounds chosen. The bird sounds were intermittent and limited to a specific frequency band, while the water sounds were continuous with a wide band coverage and little variation. The original sound files were longer than 10 minutes and had no prominent sound events, ensuring that repeated sounds were not noticeable when looped. Spectrograms of the four sounds are shown in Fig. 2.

The study aimed to avoid subjective influences and the influence of other perceptual factors, such as the visual

Figure 1. Location and panorama photo of the study area

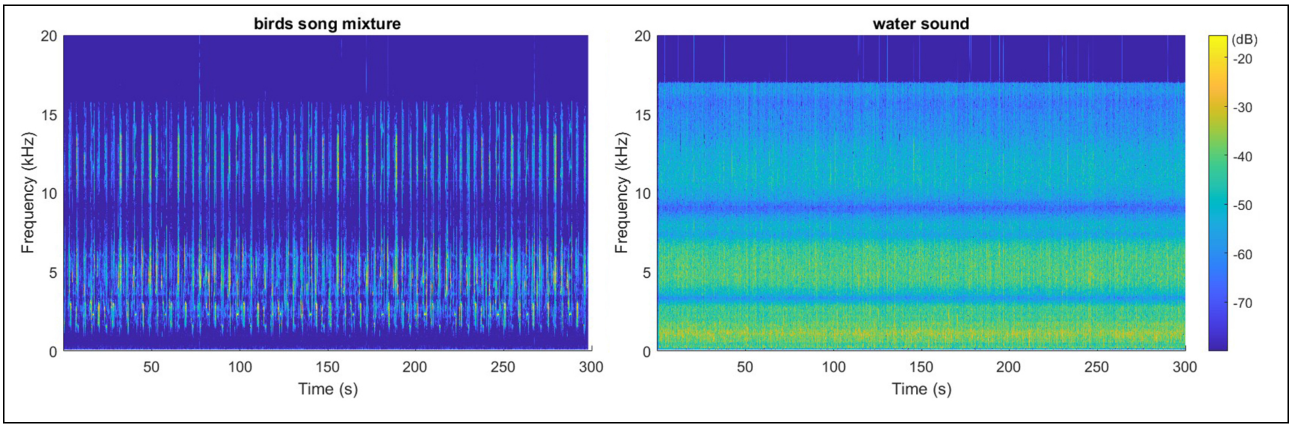

Figure 2. Spectrograms of bird song mixture and water sound as interventional sounds for this experiment (50 ms time resolution, 50% overlap, 48.0 kHz sample frequency, 24 bits)

2.2 Sound environment description

In the experiment, speakers were placed in stone-shaped boxes placed on the grass to reduce people's special attention, and these speakers were arranged 10-15 meters apart to ensure even sound distribution. Video recording was done from two angles using small recorders fixed in tree trunks at a height of 2.5 m, with low resolution to protect privacy. A class 1 sound level meter (BSWA 801, produced by BSWA-Technology Co., Ltd., Beijing, China) was used to measure sound pressure levels every 30 seconds.

Grid measurements were taken before and after the sound intervention at the experimental site, with the field divided into 5m x 5m grids. The sound pressure level was measured at the center of each grid cell using a class 1 sound level meter, with readings taken every 10 seconds for 3 minutes. The grid measurements showed a relatively uniform distribution of sound pressure levels at 52.7 dB in the area under quiet conditions. The intervention sounds were propagated homogeneously throughout the site, with slightly higher levels near the edges. The sound pressure levels of the intervention sounds were set to exceed the average background noise level by no more than 10 dB, with the goal of providing a perceptible sound intervention without interfering too much with people's interactions.

2.3 Procedure

The experiment had three comparison groups: two natural sound intervention groups and a control group with no sound intervention. It was conducted over a seven-day period with clear weather and temperatures between 22-32 degrees Celsius. Each intervention sound was played for 30 minutes each day between 3:30 pm and 6:00 pm. In the end, each intervention sound was played for 210 minutes and covered the time range of 3:30 to 6:00 pm. The experiment was recorded on video, and the sound pressure level was measured. People's social behavior was identified and recorded via video, and those videos that were affected by unexpected noise such as sudden loud music were excluded. According to the measurement, the maximum difference between different conditions was 1.9 dB. This suggests that the sound interventions did not significantly increase the sound pressure level but rather enriched or increased the audibility of natural sound.

2.4 Behavior recording and data analysis

The video recordings of the experimental sessions were processed using the BORIS (BORIS, v.2.95, University of Torino, Torino, Italy) software to identify and record participants' social behavior. Each behavior was observed directly throughout the observation period, and the results generated for each subject included the frequency, and duration of behavior. The determination of social interaction behaviors was based on the psychological bubble concept of personal space [18,19]. We considered subjects to be engaged in social interactions when they were within social distance from others and remained so for a period of time (>10 seconds). When signs of social behavior such as face-to-face and gestures were observed between subjects and others, that would be directly considered as social interaction occurring regardless of distance and duration. All participants in our study were adults, and we regarded each participant as an equal individual throughout the experiment. By observing their social behaviors over a specific timeframe, we gained insights into the social interactions occurring at the site. After collecting data on social behaviors in response to different sound interventions, nonparametric tests and Kruskal-Wallis H tests were performed using SPSS to determine the effect of the sound interventions on social interactions based on the 54 video excerpts.

3. RESULTS

3.1 Effects of natural sounds on the frequency of social interaction

The main aim of this experiment was to determine whether changes in the acoustic environment influenced the number of social interactions. To make behavioral observations comparable across video clips, we defined a variable that represents the mean frequency of social interactions per person (FSI) at the site over a given period of time. The reason for selecting frequency as the measure is its capability to quantify the precise count of social interactions, offering a more objective and comprehensive assessment of the level of social engagement. The frequency of social interactions during each observation time period was counted, and the value of the FSI variable is equal to the number of social interaction occurrences divided by the total number of subjects. Table 1 reports the total number of people observed, total number of social interactions, and mean FSI value under different sound intervention conditions.

Nonparametric tests were performed because of the non-normality of the distributions of the FSI values for the 54 video excerpts (see Fig. 3). Kruskal-Wallis H tests were performed to determine if there were differences in FSI scores between the three groups that differed in sound intervention. Values are mean ranks, unless otherwise stated. The distributions of FSI scores were not similar for all groups, as assessed by visual inspection of a boxplot. The mean ranks of FSI scores were significantly different between the groups, $\chi 2(2)=14.522$, p=.001. Thus, there were statistically significant differences in the frequencies of social interactions among the three sound intervention conditions. Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure, with Bonferroni corrections performed for multiple comparisons. The adjusted p-values are presented. Values are provided as mean ranks unless

otherwise stated. The post hoc analysis revealed statistically significant differences in FSI scores between the control (15.50) and bird-song mixture (32.25) (p=.005), control and water sound (33.74) (p=.002) groups but not between any other group combination (see Tab. 2).

Table 1. Frequency of social interactions that occurred in different sound intervention conditions over the 90 video excerpts. FSI: frequency of social interactions per person.

Interventional sounds	Number of excerpts	Number of users	Total number of social interactions	Mean FSI	Std. Dev. FSI
Bird song mixture	18	371	367	0.99	0.32
Water sound	19	472	476	0.99	0.25
Control (no intervention)	17	333	209	0.65	0.19

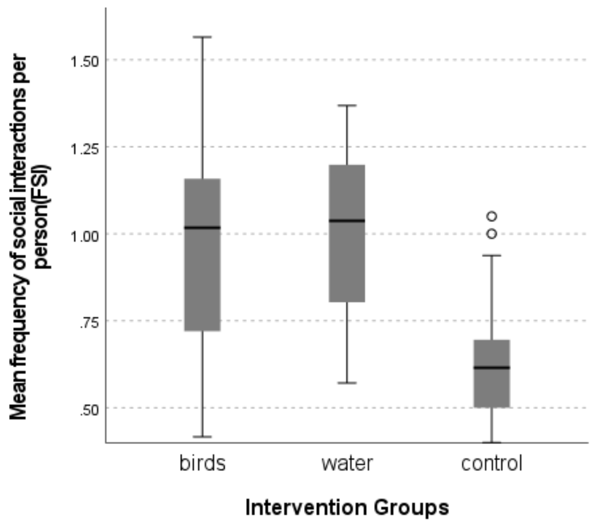

Figure 3. Differences in the FSI between different intervention groups

Table 2. Pairwise comparisons of groups regarding the frequency of social interactions.

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Control-Birds	16.750	5.320	3.149	.002*	.005*
Control-Water	18.237	5.251	3.473	.001*	.002*
Birds-Water	-1.487	5.174	-.287	.774	1.000

Each row tests the null hypothesis that the distributions of sample 1 and sample 2 are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

3.2 Effects of natural sounds on the duration of social interaction

The experiment also sought to determine whether different sound environments have an impact on the time spent on social interaction behavior. We defined a variable, the percentage of the total duration of social interactions (PTDSI), and it equals the total duration of social interaction divided by the total duration of all participants in the park in the corresponding time period. Table 3 reports the total duration of use, total duration of social interactions, and mean PTDSI value under three sound intervention conditions.

Nonparametric tests were also performed because of the non-normality of the distributions of the PTDSI values for the 54 video excerpts. Kruskal-Wallis H tests were performed to determine if there were differences in the PTDSI scores between the three groups that differed in sound intervention. Values presented as mean ranks unless otherwise stated. The distributions of PTDSI scores were not similar for all groups, as assessed by visual inspection of a boxplot. The mean ranks of the PTDSI scores were significantly different between the groups, $\chi2(2)=7.539$, $p=.023$. Thus, among the three sound intervention conditions, there were statistically significant differences in the total duration of social interactions. Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure with Bonferroni corrections for multiple comparisons. The adjusted p-values are presented. Values are presented as the mean ranks unless otherwise stated. This post hoc analysis revealed statistically significant differences in the PTDSI scores between the control (19.12) and water sound (29.58) ($p=.024$) groups but not between any other group combination (see Tab. 4). The results indicated that the proportion of social interaction duration was significantly greater in the water sound condition than no additional sound conditions.

Table 3. Total duration of social interactions in different sound intervention conditions over the 54 video excerpts. PTDSI: percentage of total duration of social interaction.

Interventional sounds	Number of excerpts	Total duration of use (min)	Total duration of social interactions (min)	Mean PTDSI (%)	Std. Dev. PTDSI (%)
Bird song mixture	18	2502.4	1038.7	41.45	10.97
Water sound	19	3222.4	1304.7	38.79	16.29
Control (no intervention)	17	2183.1	622.3	28.82	13.06

Table 4. Pairwise comparisons of groups regarding the percentage of total duration of social interaction.

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Control-Birds	10.461	5.252	1.992	.046	.139
Control-Water	14.105	5.321	2.651	.008*	.024*
Birds-Water	3.643	5.175	.704	.481	1.000

Each row tests the null hypothesis that the distributions of sample 1 and sample 2 are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .050.
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

4. DISCUSSION

The present study aimed to investigate the impact of natural sounds on social interactions in an urban park. The results showed that the incorporation of natural sounds in urban park recreation areas could foster more social interactions. This may be because the sounds of nature, such as birdsong or running water, create a calm and pleasant atmosphere that can enhance people's mood and overall well-being. When individuals feel more relaxed and content in their surroundings, they are more likely to engage in social interactions. Additionally, natural sounds could probably serve as a common point of interest or conversation among park users. Given the health-promoting role of social interaction, we believe that more nature sounds in park spaces can lead to more favorable health outcomes for individuals by facilitating social interaction. These findings are consistent with previous research that has highlighted the positive effects of natural sounds on human well-being, including restorative effects and a sense of connection with nature [20,21]. This may be a valuable finding, given the increasing importance of public spaces in urban environments and the need for such spaces to promote social cohesion and well-being. The findings of this study may have practical implications for urban planners and designers. The incorporation of natural sounds in recreational parks could be a useful way to promote social interactions among park users. Moreover, the study findings could be used as a basis for creating more socially oriented park spaces and incorporating sound elements as a practical tool in designing such spaces. The study could also provide useful insights for the design of other public spaces, such as squares, plazas, and pedestrian areas.

However, some limitations of this study need to be acknowledged. Firstly, the cultural context in which the study was conducted should be considered when generalizing the results. Different cultures may have different perceptions of natural sounds and their impact on human behavior. Secondly, the results may not be applicable to exceptional circumstances, such as parks with limited people or extreme noise pollution. Thirdly, although the participants were in the same site, other environmental factors that may influence human behavior, such as lighting and visual factors, were not strictly controlled in the study.

5. CONCLUSION

This study explored how natural sounds affect social interaction in an urban park. An urban activity space was chosen, and the experimental area's sound environment was modified using loudspeakers. Social interactions were recorded based on covert behavior observations. The results indicated that the inclusion of natural sounds such as birdsongs and water sounds led to an increase in the frequency of social interactions. Additionally, the use of water sounds extended the duration of social interaction when compared to the absence of additional sounds. These findings suggest that incorporation of natural sounds, such as birdsongs and water sounds, could be an effective way to enhance the social experience and social interaction of park users. These findings may have implications for the design and management of public spaces, especially urban parks.

6. ACKNOWLEDGEMENT

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