

Research on the impact of traditional soundscapes on physiology and subjective restoration in historical and cultural districts

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ABSTRACT

A healthy urban sound environment is the common pursuit of both residents and urban designers. The restorative effects of natural soundscape on physiology and psychology have been proved. However, the potential health benefits of the historical and cultural attributes of soundscapes are yet to be explored. This study took the traditional sound sources and environments in the historical and cultural district as the research object, and presented the audio-visual scenarios in the laboratory. Finally, 7 physiological indicators and subjective evaluation of perceived recovery soundscape scale (PRSS) of 37 subjects were assessed. The results indicate that historical soundscapes have an impact on subjective restorative factors such as Fascination and Being-Away. However, there is no significant influence on all physiological indicators. This suggest that the historical and cultural attributes of soundscapes might have a positive effect on psychological restoration, but the impact on physiology is not significant.

1. INTRODUCTION

Cultural heritage preservation is currently receiving international attention, most historical and cultural districts are gradually being well restored [1]. However, current focus on the protection and utilization of historical and cultural districts mostly emphasizes traditional layouts, buildings, and other visual factors, and the planning of sound environments mainly driven by noise control and commercial purposes. Due to the transient feature of sound, auditory elements in urban environments are richer and more variable in both time and space dimensions compared to visual elements, implying that auditory elements are more flexible and malleable, sometimes even more important than visual elements in overall environmental perception [2-4].

Soundscape is an important component of the environment in historical and cultural districts, directly affecting people's perceptual experiences [5,6]. Therefore, protecting and utilizing traditional sound sources in these districts can enhance the quality of urban landscapes. For historical and cultural districts, traditional sound sources associated with residents' life, together with the actual spatial environment, form the traditional soundscape, reflecting to some extent the local historical and cultural characteristics. This indicates that

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auditory factors must be fully considered in the assessment and protection of the environment in historical and cultural districts.

In the process of rapid urbanization, the accelerated pace of life and the compression of living space make it difficult for urban residents to release stress. Restoration theory suggests that a high-quality living environment can lead to psychological and physiological restoration [7,8]. Historical and cultural districts, as typical representatives of urban humanistic spaces, are popular destinations for people during their leisure time. With the revival of traditional culture, people aspire to escape the hustle and bustle and find relaxation for their mind and body in these districts [9,10]. A healthy urban acoustic environment is a common pursuit for residents and designers. The restorative effects of natural soundscapes on physiology and psychology have been proven [11,12], however whether the historical and cultural attributes of soundscapes also have health benefits remains to be explored. Research on the dual restoration effects of psychology and physiology can provide a more comprehensive theoretical basis for the environment design of historical and cultural districts, thereby alleviating fatigue and promoting physical and mental health. Therefore, this study aims to investigate the influence of traditional soundscapes and their underlying historical and cultural attributes on physiological and psychological restoration through physiological measurements and subjective questionnaires, hoping to provide more comprehensive strategic support for the evaluation and protection of soundscapes in historical and cultural districts.

2. METHODS

2.1. Participants

The participants in the experiment were 37 undergraduate and graduate students who volunteered. Their average age was 22.81 (variance=4.646; minimum=18; maximum=36), with 19 males and 18 females. All participants were long-term residents of the city where the study took place, familiar with the city's geographical and cultural attributes. They self-reported normal hearing, did not take any psychotropic medications, wore loose and comfortable clothing during the experiment, and reported no fatigue or discomfort at the time of the experiment.

2.2. Stimuli

In the experiment, the soundscape was presented using a combination of visual and auditory stimuli, with the visual stimuli consisting of seven typical areas selected by the researchers based on preliminary research surveys and references from previous literature, located in the city where the study was conducted (Harbin), as experimental scenes in the study, including: Central Street (a traditional European-style district), Jile Temple (a traditional Chinese-style district), Zhaolin Park (a traditional Chinese garden), Chinese Baroque District (a traditional district combining Chinese architecture with European patterns), Songlei Square (a nondescript commercial district), Jiangbei Office Area (a nondescript office area), and Lilac Park (a nondescript modern urban park). These scenes included four typical historical and cultural districts in Harbin city and three nondescript commercial and office areas as control groups in the study. Three most typical perspectives were selected for each scene and edited into 1-minute videos.

The sound stimuli are the most traditionally and culturally characteristic background sounds from the four typical historical and cultural districts mentioned above, specific sound conditions included: ambient sounds (conversations and footsteps in urban open spaces), Russian music + ambient sounds (traditional sound source in Central Street), Chinese classical music + ambient sounds (traditional sound source in Zhaolin Park), traditional peddling sounds + ambient sounds (traditional sound source in Chinese Baroque District), and chime

ringing + ambient sounds (traditional sound source in Jile Temple). The sound stimuli were edited into 1-minute audio clips and standardized to a sound pressure level of 65 dB(A).

2.3. Procedure

The experiment took place in an acoustic laboratory, during which the participants' physiological indicators were recorded. Participants were required to sit comfortably 1.5 meters away from the screen, first relaxing for at least 10 minutes to measure baseline physiological data. Subsequently, participants were asked to view the 7 experimental scenes in a random order, with each scene randomly matched with one of the 5 sound stimuli. During each scene presentation, participants were instructed to imagine themselves being present in that environment as much as possible. After each scene was presented, participants were asked to fill out a subjective questionnaire and then relaxed fully for 2 minutes.

The measurement of physiological signals was conducted using the BIOPAC MP160 system. Seven physiological indicators were obtained by calculation of the collected physiological signals: heart rate (HR), R-wave amplitude (ΔR), heart rate variability (HRV), low-frequency band in HRV power spectrum (LF), respiration rate (RR), respiration depth (RD), and skin conductance level (SCL).

Subjective restoration was assessed through a subjective questionnaire, which included six evaluation indicators: Appealing, Linger, Engrossed, Doing-Different, Feel-Free, and Activities. These terms were selected from a simplified version of the perceived recovery soundscape scale (PRSS).

3. RESULTS

This study analysed whether sound stimuli during the experiment had an impact on physiological indicators and subjective evaluations. To allow for comparison of data among different participants, all physiological data in the experiment were normalized based on each participant's own baseline value. Subsequently, data analysis was performed using SPSS 25.0 software, with specific analytical methods including: (1) conducting analysis of variance (ANOVA) on physiological indicators to detect differences among different soundscapes; (2) using ANOVA to detect differences among different soundscapes in terms of subjective factors.

3.1. The impact of traditional soundscapes on physiological indicators

Establishing an analysis of variance model with soundscapes as the independent variable (with 5 sound stimuli as 5 levels) and the 7 physiological indicators as the dependent variables, as shown in Table 1.

Table 1: ANOVA of the impact of traditional soundscapes on physiological indicators.

Physiological Indicators	Type III Sum of Square	df	Mean Square	F	Sig.
HR	49.326	4	12.332	0.35	0.844
ΔR	56.299	4	14.075	0.261	0.903
HRV	7489.9	4	1872.475	0.527	0.716
LF	6503.795	4	1625.949	0.482	0.749
RR	223.408	4	55.852	0.128	0.972
RD	6753.096	4	1688.274	0.612	0.655
SCL	4597.988	4	1149.497	0.684	0.604

According to Table 1, there is no significant difference among all physiological indicators. This indicates that the historical and cultural attributes of soundscapes have no effect on physiological indicators. In the scenes presented in this experiment, regardless of whether the dominant sound source is traditional or not, there is no significant difference in people's physiological responses. The reason for these results may be that the selected sound stimuli

in the experiment have a relatively high degree of similarity in the frequency spectrum, and physiological indicators may have a closer relationship with the physical properties of sound compared to subjective evaluations. In summary, this study did not find that the historical and cultural attributes of soundscapes have any impact on physiological indicators.

3.2. The impact of traditional soundscapes on psychological restoration

Establishing an analysis of variance model with soundscapes as the independent variable (with 5 sound stimuli as 5 levels) and the 6 subjective evaluation indicators as the dependent variables, as shown in Table 2.

Table 2: ANOVA of the impact of traditional soundscapes on psychological restoration.

Restorative Factors	Type III Sum of Square	df	Mean Square	F	Sig.
Appealing	91.879	4	22.97	9.407	<0.001
Linger	125.253	4	31.313	12.558	<0.001
Engrossed	72.253	4	18.063	7.562	<0.001
Doing-Different	58.983	4	14.746	8.447	<0.001
Feel-Free	37.678	4	9.419	3.898	0.004
Activities	46.689	4	11.672	4.678	0.001

As shown in Table 2, it is evident that the impacts of sound stimuli on all subjective indicators are significant, indicating that traditional soundscapes can indeed influence people's subjective perceptions, and the historical and cultural attributes of soundscapes can have a restorative effect on the psychology. This result also demonstrates a difference between physiological indicators and psychological restoration. Previous studies have suggested that physiological indicators are more sensitive to the physical characteristics of sound, whereas subjective evaluation factors are based on the meanings underlying the sounds [11]. The specific reasons behind this phenomenon require further investigation.

4. CONCLUSIONS

This study focused on traditional sound sources and typical environments in historical cultural districts, conducting an experiment with 7 visual and 5 auditory stimuli on 37 participants, collecting 7 physiological indicators and a soundscape recovery scale. The results showed that traditional soundscapes had an impact on all subjective restoration evaluation indicators but had no significant effect on all physiological indicators. This indicates that the historical and cultural attributes of soundscapes can have a positive effect on psychological recovery but do not significantly affect physiology.

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