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Effect of sound-related activities on human behaviours and acoustic comfort in urban open spaces

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HIGHLIGHTS

- Human behaviours can be changed by sound-related activities.
- Acoustic comfort can be improved by changing sound-related activities.
- Acoustic comfort of visitors and citizens can be different with some activities.

GRAPHICAL ABSTRACT

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ABSTRACT

Human activities are important to landscape design and urban planning; however, the effect of sound-related activities on human behaviours and acoustic comfort has not been considered. The objective of this study is to explore how human behaviours and acoustic comfort in urban open spaces can be changed by sound-related activities. On-site measurements were performed at a case study site in Harbin, China, and an acoustic comfort survey was simultaneously conducted. In terms of effect of sound activities on human behaviours, music-related activities caused 5.1–21.5% of persons who pass by the area to stand and watch the activity, while there was a little effect on the number of persons who performed excises during the activity. Human activities generally have little effect on the behaviour of pedestrians when only 1 to 3 persons are involved in the activities, while a deep effect on the behaviour of pedestrians is noted when >6 persons are involved in the activities. In terms of effect of activities on acoustic comfort, music-related activities can increase the sound level from 10.8 to 16.4 dBA, while human activities such RS and PC can increase the sound level from 9.6 to 12.8 dBA; however, they lead to very different acoustic comfort. The acoustic comfort of persons can differ with activities, for example the acoustic comfort of persons who stand watch can increase by music-related activities, while the acoustic comfort of persons who sit and watch can decrease by human sound-related activities. Some sound-related activities can show opposite trend of acoustic comfort between visitors and citizens. Persons with higher income prefer music sound-related activities, while those with lower income prefer human sound-related activities.

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1. Introduction

With the regeneration of city centres, urban open spaces are reconceptualised with the new 'urbanity' (Thwaites et al., 2005). To create a friendly environment, rethinking the urban landscape from an ecological viewpoint is important (Yu and Kang, 2010). Sound quality is considered as a key part of ecological/sustainable development of urban landscape (Zhang et al., 2006). In recent years, the soundscape was usually used as a key method to increase the sound quality in urban open spaces. The concept of the soundscape is a broad one, accommodating the complete sound environment in a location and the human response to it (Brown et al., 2011; Davies et al., 2013). According to ISO, the soundscape is the acoustic environment as perceived or experienced and/or understood by a person or people in context (ISO, 2014). For urban planning and landscape design, one key attraction of the soundscape is that it seems to be a better fit than noise level to the many factors influencing human experience in the urban open spaces, since previous studies indicated that human reaction to a sound is not just physical perception but also an aesthetic sensation that one receives from the environment (Aucouturier et al., 2007). Therefore, a thorough analysis of the function of soundscape or soundscape characteristics such as human behaviours and evaluation of acoustic comfort is very important to landscape researches in urban open spaces.

Human behaviours in urban landscape have been considered in many previous studies in relation to sound and soundscape perception, since it is important for urban landscape design (Carles et al., 1999; Yang and Kang, 2005). Kang (2006) indicated that sound quality of an urban area will depend on how long people have been living there. A study by soundwalk shows that positive sound such as bird sounds in urban spaces may affect the behaviours of people (Davies et al., 2013). Meng and Kang (2013) indicated that acoustic comfort is influenced by the reason for visit, frequency of visit, and length of stay with correlation coefficients of 0.10 to 0.30. The users who were waiting for someone were found to have lower acoustic comfort than those who were shopping. The interactions between aural and visual behaviours are also an important research topic in soundscape studies (Southworth, 1969; Forza, 2002). A study under laboratory conditions with controlled aural and visual stimuli suggested that the visual parameter was a predominant variable with regard to aural–visual interactions (Viollon and Lavandier, 2000). All the visual information had different ways and different efficiencies in affecting the auditory judgement. The more urban the visual settings were, the more contaminated was the auditory judgement (Viollon et al., 2002; Guastavino, 2006; Zhang and Kang, 2007). The aural–visual interaction was also studied in the field of product sound quality. A study on the sound quality evaluation of construction machines showed that the 48 urban soundscape results obtained by presenting only sound were more unpleasant, more powerful and sharper than those obtained by presenting sound with scenery (Kang, 2006).

Acoustic comfort, which is the most important index to evaluate soundscape, was also widely studied in urban landscape. Among these studies, some have focused on urban landscape index in terms of acoustic comfort (Parsons and Towsey, 2012). Some previous studies show that when the landscape shape index of buildings and water areas (LSI_B, LSI_W) and the patch cohesion index of water areas (COHESION_W) were increased, the evaluation of acoustic comfort can also be increased (Liu et al., 2013, 2014a, 2014b). The different sound sources in urban landscape may also lead to different evaluation of acoustic comfort (Guski, 1997). Some previous studies have indicated that the evaluation of human sounds, nature sounds and machine sounds by people is different, for instance, a survey study in Japan showed that 45–75% of people favour nature sounds, while 35–55% of them are annoyed by machine noises (Tamura, 1998). Moreover, the type of sound in landscape may also influence the categorisation/classification. A study on the relationship between loudness and pleasantness shows that the pleasantness of stimuli at intermediate loudness levels is not influenced by its loudness, but for sound at relatively high loudness levels, there is a good correlation between the two (Hellbrück, 2000; Zwicker and Fastl, 2013). The different social background or behaviours of people in urban landscape may also lead to the difference in the evaluation of sound sources, for instance, a soundscape survey with a number of foreign residents in Fukuoka showed that there were considerable differences between the sounds they heard in Japan and in their home countries (Iwamiya and Yanagihara, 1998). Hoffman (1977) and Yang and Kang (2005) indicated a slight tendency for women to be more sensitive to sound than men, and evidence suggests that females generally have a higher acoustic comfort than males. Kang (2006) indicated that people aged over 65 years favour birdsongs, while the younger people, conversely, are more favourable to, or tolerant towards, music and mechanical sounds.

The effect of sound-related activities that contain special sound sources, vary according to social characteristics of the users and may lead different evaluation of aural-visual on human behaviours or acoustic comfort in urban landscape, however, has not been researched enough in previous studies. Therefore, this aim of this research is to determine the relationships between sound-related activities and human behaviours as well as their acoustic comfort. In this paper, the first step is to determine the effect of sound-related activities from different sound sources such as music and manmade sounds on typical human behaviours. The next step is to determine the effect of sound-related activities on the users' evaluation of acoustic comfort at 3 levels: sound environment, background of pedestrians and behaviours of pedestrians. A typical pedestrian street was chosen as the case site, and 7 typical activities and 4 typical behaviours of pedestrians at the case site were selected for further analysis; the sound level measurements and acoustic comfort survey were used for data collection.

2. Methodology

2.1. Survey site

Since some previous studies indicated that the environment or space differences may lead to the different evaluation of soundscape (Lercher and Schulte-Fortkamp, 2003; Kang and Zhang, 2010), the effect of sound-related activities should be studied generally in the same environment and places; therefore, a typical pedestrian street named Stalin park, in Harbin, China, was chosen as the case site, since there are many typical sound-related activities that simultaneously occur along the street.

Harbin is a typical international city in China, with long cultural and historical background; the sound-related activities in Harbin are common in China and most Asian countries and even in some European countries; therefore, the results of this case site are likely to be applicable to not only other areas in China, but also to some similar cases in Asian or European countries. The Stalin park, which was built in 1953, is nearly 1800 m in length and 30 m in width. A 10-m wide traffic road is present on one side of the park, while the Songhua River is present on the other side of the park. The Stalin park is a famous tourist site for visitors as well as a leisure place for local citizens; >20,000 users visit the park everyday (Yao, 2004). Therefore, there are enough investigation samples both on activities and users for this study. The map of Stalin park and the survey locations are shown in Fig. 1.

2.2. Sound-related activities

On the basis of the different sound sources, the activities were divided into two groups: one group is music sound-related activities, in which the persons perform activities with music, and the other group is human sound-related activities, in which the persons perform activities by speaking or creating manmade sounds. In the case site, 4 typical music-related activities and 3 typical human sound-related activities were chosen at different locations at >100-m intervals, since previous