The influence of companion factors on soundscape evaluations in urban public spaces

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Abstract

'Soundscape' refers to how individuals or groups of people perceive sounds. This study focuses on whether and to what extent companion factors, compared with other demographic factors, influence the various aspects of soundscape evaluation. Two kinds of companion factors are studied here: one is companion status, the other is the social relationship intensity between companions. Based on a questionnaire and statistical analysis, both companion factors are found to influence evaluations of socially interactive sounds- sound made by human activity. People accompanied are more likely to notice speaking and children sound and prefer safe and social sounds. People involved in closer social relationships tend to notice children's sounds more and prefer human sound types and social sound. Other factors may offset the influence of companion factors, however. Site factors interfere with accompanied people's tendencies to prefer safe sounds and notice children's sounds, and participants' ages interfere with their tendencies to notice speaking sound. The results of this study suggest that human activity sounds can contribute to social sound among companions, whereas solo people may prefer more privacy and quietness. This study emphasizes companion factors in soundscape evaluations and suggests future sound- scape design to satisfy people with different companions.

Keywords: Companion factors, Social relationship intensity, Soundscape evaluations, Soundscape preferences, Urban public space

Introduction

In recent years, the process of urbanization has been accelerating. It was predicted that about two-thirds of the world's population would live in cities by 2050 (United Nations Department of Econimic& social affairs, 2018). Urbanization brings economic development and civilization, but also creates various environmental problems, such as pollution, flooding as well as urban noise (Chan& Chau, 2021; Aletta, Kang, Astolfi& Fuda, 2016). Health problems are also spreading, such as unhealthy diets and physical inactivity in the aspect of physical health (WHO, 2010; Leon, 2008), as well as rootless and isolation in terms of psychological health (Mental Health Foundation, 2010). The idea of the sustainable city was encouraged against the negatives of urbanization, which depends on three general issues- environmental, social and economic (Jenks, 2008). As one of the environmental factors, sustainable acoustic has become an important concern with more attention being paid to the problems brought by noise pollution (Yu, 2008). Researches of environmentally sustainable acoustic in the early stage emphasized more on the negative effects of urban noise and the methods to control and manage those noise pollution (Yu, 2008; Berglun, Eriksen& Nilsson, 2001). Urban noise was believed to damage people's physical and psychological health and obstruct the development of environmentally sustainable acoustic. Especially on the mental health aspect, the acoustic comfort level was considered to promote or impede psychological restorations (Zhang, Kang& Kang, 2017). Some researchers suggested to involve urban sound at the beginning of the planning process to control noise (Alves et al., 2016; Brown, 2010). Others focused on noise reduction in building design, such as acoustic cladding and building shapes can play a role in controlling noise (Badino et al., 2019; Echevarria Sanchez et al., 2016). However, it is impossible to eliminate all the harmful sounds. On the other hand, controlling negative sound sources may not necessarily result in a better acoustic environment, because even some negative sounds can provide meaningful information to people (Aletta, Kang& Axelsson, 2016; Rådsten-Ekman, Axelsson, & Nilsson, 2013).

'Soundscape' was introduced as the auditory atmosphere of cities as a part of people's holistic experiences of urban spaces (Bild et al., 2016; Bohme, 2000). Carpenter and McLuhan (1960) emphasized the ability of sound to 'fill' urban spaces and construct human's perceptions toward and understandings of cities. The emergence of 'soundscape' as a concept dates back to the 1960s–1970s when the Canadian composer R.M. Schafer (1977) and his colleagues defined soundscape as 'a[n] environment of sound (or sonic environment) with emphasis on the way it is perceived and understood by the individual, or by the society' (Truax, 1999, p. 65). They articulated this new concept in line with 'landscape' to stress the perceptual aspect of the acoustic environment. After this concept emerged, planners and designers started to wonder how the acoustic environment would influence the perceived quality of cities and how to integrate it into urban planning for sustainable cities (Aletta, Kang and Axelsson, 2016).

Recently, the International Organization for Standardization (ISO) (2014) released a standard definition where soundscape is '[the] acoustic environment as perceived or experienced and/or understood by a person or people, in context'. This definition further emphasised the perceptual aspect of sounds and took into account the listeners' backgrounds. Soundscape exists through human perception of the acoustic environment (Brown et al., 2011). It has both physical and social attributes, the physical being associated with sounds' energy waves and the social being associated with the listeners, their backgrounds and their subjective understandings (Yu and Kang, 2010). Thus, soundscape is a complex system that involves people's understandings of both physical and subjective attributes. In terms of physical aspects, sounds can be measured by frequency and pressure (Zwicker and Fastl, 1999). Evaluations of subjective understandings involve various aspects of the perceiving process, as mentioned in ISO (2014).

The evaluation of sound is often influenced by various factors, such as psychological and physiological factors, social context, cultural background as well as physical environment factors, which increase the difficulty of soundscape evaluations (Yu and Kang, 2008; Calleri et al., 2016). Zhang and Kang (2007) summarised four basic elements for examining soundscape evaluations: sound, space, people, and environment. These four elements suggest researchers should pay attention to what sounds occur, where those sounds occur, who (considering cultural backgrounds, ages and past experiences) listens to those sounds and the interactions between acoustics and environment (including effects of space boundaries and elements). Yu and Kang (2010) analysed the effects of social, demographic, behavioural and psychological factors on soundscape evaluations in urban public spaces and found that age and education level are two factors that generally influence sound preference and that cultural differences also show a degree of influence. Older and more educated people preferred natural sounds and were more annoyed by mechanical sounds. Cultural factors have been frequently studied because they are considered to be important regarding people's judgements and preferences (Yang and Kang, 2005). For instance, preferences for bird sounds were found to be higher for males then females in Sheffield (UK) but higher for females then males in Shanghai (China), likely due to cultural differences (Yu and Kang, 2010). Preferences for speech sounds have been found to vary greatly across countries, with more than 50% of people in Thessaloniki (Greece) feeling annoyed by such sounds and less than 1% in Kassel (Germany) and Sesto San Giovanni (Italy) feeling the same way (Yang and Kang, 2003). The International Organization for Standardization (2014) found that different factors can exert influence at different stages of sound-perception. In the auditory-sensation stage, evaluations can be influenced by factors from the acoustic environment, such as meteorological conditions, hearing impairments, and hearing aids. Experiences and expectations, including culture and reasons for being somewhere, as well as other environmental factors, like visual impressions and odours, can affect interpretations of auditory sensations.

Social relationships as factors affecting interpretations of auditory sensations have long been neglected in previous studies. Accepting the definition of soundscape mentioned above, the subject perceiving the soundscape can be a group as well as an individual, which implies the existence of a companion factor. General environmental psychological studies consider that people are willing to be involved in a stable and enduring affective bond. And company can even enhance (or degrade) the restorative quality of people's experience (Baumeister& Leary, 1995). Staats and Harti (2004) have confirmed that social context increases preferences for urban environments but not for natural ones when they seek for restorations. Bild et al. (2018) pointed out that influences from social relationships are intertwined with activities. The activities different groups engaged in involve different levels of social interactions. In other words, social relationships can influence soundscape evaluations through the social-interaction levels associated with their activities. In Bild et al.'s (2018) study, they focused on the differences between solo and accompanied listeners. Solo and accompanied listeners supposedly evaluate soundscapes differently depending on their activities. Three aspects were evaluated (disruption, simulation, and overall suitability) to analyse whether the acoustic environment supports or obstructs activities. As a result, it was found that accompanied users offered higher suitability and lower disruption ratings than solo users, which suggested they had qualitatively different auditory experiences. Although Bild et al.'s (2018) research mentioned the influences from companion factors, they analysed this influence as it related to the activities. The relationship between companion factors and soundscape evaluations was not considered, nor the possible influences of different relationship intensity. There remains a gap in the literature as to whether and how social relationships affect users' soundscape evaluations and preferences.

To evaluate soundscapes accurately, effective measurements are urgently required (Aletta and Kang, 2016). In previous studies, a number of measurements have been used to focus on negative aspects of soundscapes, such as noise annoyance levels (Preis, 1997; Fields et al., 2001). Recently, however, researchers have gone beyond noise by focusing on how sound subjectively affects people, both mentally and physically (Payne, 2012; van Kempen et al., 2014). Soundscape descriptors have been introduced as measurements for soundscape evaluations. Based on interview data from sound walks, Davies et al. (2013) found that three concepts inform interviewees' soundscape understandings: sound sources, sound descriptors and soundscape descriptors. Sound descriptors are descriptions of sounds, which can be nouns, adjectives, or phrases. Soundscape descriptors are more abstract, describing the whole sounds in the space. Aletta, Kang, Axelsson (2016) addressed soundscape descriptors and indicators as the operational tools for evaluations. Soundscape descriptors are used to measure how people perceive acoustic environments and indicators are used to predict the value of soundscape descriptors.

Researchers have introduced various descriptors to deconceptualize soundscape perceptions. The two-dimensional coordinate, eventfulness and pleasantness or calmness and vibrancy, was developed to measure the quality of perceived soundscapes (Axelsson et al., 2010; Cain et al., 2013). Apart from these two descriptors, appropriateness has been identified as the third dimension (Aletta et al., 2016). It has been suggested that a poor soundscape might be accepted and evaluated as 'appropriate' because a person's sense of what is 'appropriate' may differ from what he or she desires (Axelsson, 2015). People have expectations for certain soundscapes and they may prefer a sound environment to be 'appropriate' rather than 'pleasant'. In short, the criteria for evaluating a soundscape should involve whether the acoustic environment is: (a) eventful (in a good way); (b) pleasant and (c) appropriate (Axelsson, 2015). To contribute to the understanding of how people involved in different social relationships evaluate a soundscape, descriptors were also adopted in this study.

Among various influential factors, companion factors were emphasised. The aims of this study are: (a) to investigate whether two kinds of companion factors (companion status and the intensity of the relationship) would influence people's soundscape evaluations; (b) to figure out how companion factors influence soundscape evaluations; (c) to compare companion factors with other factors, such as age, gender and site, to investigate to what extent companion factors influence soundscape evaluations. These three questions were analysed through factor analysis based on quantitative data collected through questionnaires administered in two public spaces in China and UK.

Method

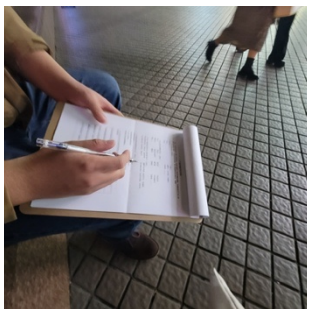
Sampling and research sites

To collect users' soundscape evaluations, 184 questionnaires were distributed by paper in Sheffield, UK and 120 in Suzhou, China (Table 1.). Each questionnaire usually took 3-10 minutes to complete. The questionnaire research was approved by the ethics committee from the University of Sheffield. The consent forms were obtained from the participants. The inter-rater reliability among the subjects is 0.733 (Cronbach's alpha). Generally, the inter-rater reliability value above 0.6 is acceptable, and 0.8 or greater is a very good level (Nunnally, 1978; Ursachi et al., 2015). Participants were selected by random sampling in order to ensure that the proportion of relationship types in the sample corresponds to the true proportion in public spaces. Before participants answered the questionnaire, the researcher had a small talk with them to inform them of the research aims and objectives. The researcher identified participants' hearing abilities through self- assessment according to the small talk. Distributions took place daily from 10 a.m. to 4 p.m. during April and May 2017 in Sheffield, and from 10 a.m. to 9 p.m. during June and July 2017 in Suzhou. The locations were busiest during these time ranges.

Pilot studies were conducted in advance to check whether the sites were suitable for this study. They took place in January 2017 in Suzhou, China and March 2017 in Sheffield, UK. In the pilot study, four study sites were selected and tested: Peace Garden and Devonshire in Sheffield, Central Park Square and Guanqian Square in Suzhou. Sound tests were conducted four times in each square, twice between 10 a.m. and 12 a.m., twice between 12 a.m. and 9 p.m. Each test lasted for three minutes long. Sound tests involved two objectives: one was to test the sound levels, the other was to test sound, user, activity types. Sound levels were measured by a sound level meter (01 dB solo, Limonest, France). The researcher listened and wrote down sounds as well as user, activity types on notes, while sounds of sites were recorded by cell phone app (voice recorder Pro on iPhone 8). Afterwards, the researcher compared the notes with the sound recordings to avoid missing anything. Sounds were classified manually according to their sources and then comparing to the previous studies to further categorize (Yu and Kang, 2010; Kang et al., 2017; Brown et al., 2011).

As a result, Peace Garden and Guanqian Square met the standard. Devonshire and Central Parks square were cancelled because of their monotonous sound types and user types. LAeq of Peace Garden is between 65.0 dB to 71.7dB and LAeq of Guanqian Square is between 70.8dB to 75.2 dB, which corresponds to the comfortable sound level of urban public spaces defined by Yang and Kang (2005). Various types of users and activities appeared in the squares and they stayed for long periods of time. Various types of sounds, both positive and negative, occurred in the two squares. Four sound types occurred in both locations were classified as: (a) Natural sounds: wind, birds, water, trees; (b) City sounds: store music, traffic, construction; (c) Human sounds: speaking, footsteps, children; (d) Instrumental sounds: music, bells.

Table 1. Sites locations and distribution process (photo credit: authors)

		
Peace Garden (Sheffield, United	Guanqian Square (Suzhou,	Distribution of

Kingdom)	China)	questionnaire (Guanqian)

Questionnaire design

The sound evaluation questionnaire included four sets of questions: (a) Sound sources: multiple answers questions regarding noticed sounds and preferred sound types; (b) Sound features: scale questions regarding particular sound features; (c) Sound preferences: scale questions regarding preferred soundscape descriptors; and (d) Sound psychological reactions: multiple answers questions about psychological reactions triggered by sounds. Sound sources are referred to the physical entities that make up sound environment, such as wind, water, etc. Sound features are focused on the relationship between single sound sources and the whole sound environment. Sound preferences consist of preferences over various soundscape descriptors. Soundscape descriptors are adjectives descriptions about various aspects of sounds, such as noisy, quiet. Sound psychological reactions are referred to people's feelings and emotions evoked by sounds.

In terms of sound sources, two multiple answers questions sought to identify noticed sounds (what sounds people noticed at the site, such as wind, traffic, talking and bells) and preferred sound types (nature, city, human and instrumental). Even though different people may have similar hearing abilities, they may notice and prefer different sound sources because of their varied personalities, ages, and occupations. Companion factors may also affect what sounds they notice and prefer. Also, the first noticed sounds may not necessarily be the loudest. 'Sound marks' were raised to describe the particular sounds that are regarded by a community and its visitors, in analogy to landmarks. Sound marks may not be the loudest, but they are tightly tied to the space (Kang and Yang, 2016). In Peace Garden, water sound was considered as the sound mark (Yang and Kang, 2005). In Guanqian Square, there is no noticeable sound mark.

In terms of sound features, there were two pairs of features, defined as variety and integrity as well as particularity and stereotype, with six statements describing these four features. By way of example, the statement 'When you hear various kinds of sounds mixed' represented the feature of 'variety'. Participants chose one of the options from a five-point scale, ranging from 1 (not annoying at all) to 5 (extremely annoying). Among the six statements, 1, 2 and 4 represented variety and integrity, which focused on the annoyance level associated with the mixed and tuneless soundscape. Statements 3, 5 and 6 represented particularity and stereotype, which focused on the annoyance level associated with the inappropriate and unusual soundscape.

Preferences over soundscape descriptors included various aspects of sounds: noisy-quiet, eventful-calm, ambiguous-clear, directional-everywhere describing the physical attributes of sounds; monotonous-various, distinctive-ordinary, harmonious-conflicting describing the sound features; friendly-unfriendly, safe-unsafe, social-unsocial, offensive-polite describing the psychological reactions triggered by sounds. Responses were given on a seven-point scale: e.g. very noisy, fairly noisy, a little noisy, neutral, a little quiet, fairly quiet and very quiet. The seven- point scale adopted in this study followed the suggestion from Kang and Zhang (2010)'s research. Compared to the five-point scale suggested by ISO/DIS 12913-2 (International Organization for Standardization, 2017), seven-point scale is more suitable for subjective sound evaluations because it divides finer sound scales.

Psychological reactions were considered as one of a stage of the sound perceptions (Schulte-Fortkamp and Fiebig, 2006). Those reactions were gathered via descriptors describing feelings and emotions summarized from the previous studies. Descriptors included sociable, natural, eventful, peaceful, happy, etc. Multiple answers questions were asked. Two repetitions—sociable and eventful—were asked for purposes of double testing.

The influencing factors studied were site, age, gender, group size, companion factors, and activity type. The sites were the two public squares where questionnaires were distributed, Guanqian Square, Suzhou, and Peace Garden, Sheffield. The activities asked about in the questionnaire were as follows: keeping children/elderly persons company, meeting friends, participating in sports and other activities for fun, relaxing, enjoying being alone, enjoying nature and passing by. Two categories of companion factors were studied: alone vs. accompanied and relationship intensity. Intensity was measured by Hall's distance measurement (1973), which suggested that people in more intense relationships tend to stay closer. Further, Gehl (1987) summarized four types of social relationships according to distance theory: 1) intimate (zero to 45cm), observed as lovers; 2) personal (46cm to 1.30m), observed as close friends or families; 3) social (1.31m to 3.75m), observed as friends, acquaintances and so on; 4) public (> 3.75m), observed as informal situations among strangers. Therefore, for the purposes of this study, relationship intensity was determined by distances commonly associated with partner/spouse, family, and friend relationships. People who reported being alone were classified as having no relationship intensity.

Data analysis

This study aimed to investigate whether and to what extent companion factors, compared with other factors, influence the various aspects of soundscape evaluation. Data of the two sites were analysed together in order to include the site factor. Data from the two sites were verified statistical compatibility from two aspects: one is comparing sound levels and types through the sound test in the pilot study; the other is comparing the distributions of age, gender, group size and companion types through t-test/ Chi-square test. They showed consistency in both aspects, so their data were combined for analysis. The binary regression test, chi-square test, mean differences, and Spearman correlation coefficient were applied according to the different data types. Regression analysis was adopted to verify further which factors were more influential on soundscape evaluations.

According to Table 2, independent variables included social/demographic and behavioural factors: age (15–90), gender (male/female), group size (1 people, 2 people, 3 people…), companion factors (alone or accompanied by partner/spouse, friends, or families), activity types (keeping children/elderly persons company, meeting friends, participating in sports and other activities for fun, relaxing, enjoying being alone, enjoying nature, passing by and others) and site (Peace Garden or Guanqian Square). Dependent variables involved four aspects of soundscape evaluations: sound sources, sound features, sound psychological reactions and preferences. All analyses were performed with IBM SPSS Statistics software.

Table 2. Variables used in the analysis

(1) Categories of independent variables

Soundscape Evaluation aspects	**Details**	**Categorization and scale**

Noticed sound sources	Wind, birds, water, speaking, footsteps, children, traffic, store music, construction, music, bells sounds	1-Noticed, 0- not notice
Preferred sound types	Nature, city, human, instrumental sounds	1-Preferred, 0- not preferred
Sound features	Various kinds of sound mixed together; High level of sound that you cannot hear others' speaking; Hearing other people's conversation; High pitch sound (e.g. children's scream); Eventful sound from festivals or street performances; Hearing unusual sound (e.g. hearing the ambulance)	1-Not annoying at all to 5-extremely annoying, 5-point- scale
Soundscape preferences	Noisy- quiet; friendly- unfriendly, safe- unsafe, monotonous- various, directional- everywhere, eventful- calm, distinctive- ordinary, social-unsocial, harmony- conflict, offensive- polite, ambiguous- clearly	e.g. -3- very noisy to 3-very quiet, 7- point- scale
Soundscape psychological reaction	Sociable, natural, eventful, peaceful, happy, sweet, relaxing, beautiful, thoughtful, warm, safe	1-Preferred, 0- not preferred

(2) Categories of independent variables

Relationship intensity	1-partner/spouse; 2-family; 3-friends; 4-alone
Companion status	1-accompanied; 2-alone
Site	1-Peace Garden; 2-Guanqian Square
Group	1, 2, 3…
Age	15–90
Gender	1-male; 2-female

Results

Soundscape evaluations concerning companion status

As shown in Tables 3and 4, companion status had no significant influence on the evaluations of preferred sound types, sound features and psychological reactions. However, it influenced the participants' capacities for noticing the sounds of speaking at 0.05 level and the sounds of children at 0.01 level. In Table. 5, figures of odd ratio predicted the probability of an event occurring based on a one-unit change in an independent variable when all other independent variables are kept constant. Odd ratio indicates that accompanied people are 1.767 and 2.153 times more likely to notice speaking and children sounds than solo people. Companion status also influenced the sound preferences for 'safe-unsafe' and 'social-unsocial' at 0.05 level and 0.01 level according to Table 4. Comparing the means of solo and accompanied people in terms of 'safe-unsafe' and 'social- unsocial', accompanied people were found to be fonder of safe and social sound than were alone people, with the average figures being -2.18 to -1.78 and -1.56 to -1.09. For 'social-unsocial' sound, the means of solo users' scores are significantly lower than those of accompanied participants.

Table 3. The significance levels of noticed sounds/preferred sound types/sound psychological reactions in relation to relationship intensity, group size, age, gender, site, and companion status in binary regression analysis. *p <0.05, **p < 0.01.

		Relationship intensity	Group size	Age	Gender	Site	Companion status	Activity type
Noticed sounds	Wind	0.551	0.867	0.045*	0.157	0.499	0.227	0.579
	Bird	0.052	0.828	0.873	0.267	0.000**	0.218	0.023*
	Water	0.051	0.673	0.331	0.350	0.000**	0.965	0.059
	Speaking	0.694	0.441	0.002**	0.526	0.332	0.031*	0.696
	Footsteps	0.776	0.312	0.431	0.764	0.972	0.562	0.388
	Children	0.002**	0.690	0.743	0.330	0.001**	0.004**	0.277
	Traffic	0.564	0.140	0.150	0.020*	0.032*	0.206	0.311
	Store music	0.211	0.797	0.485	0.809	0.000**	0.442	0.506

	Construction	0.564	0.428	0.102	0.485	0.054	0.071	0.639
	Music	0.768	0.539	0.377	0.322	0.028*	0.733	0.817
	Bells	0.401	0.174	0.025*	0.285	0.000**	0.883	0.543
Preferred sound types	Natural Sounds	0.161	0.426	0.507	0.260	0.000**	0.890	0.455
	City Sounds	0.618	0.259	0.732	0.290	0.099	0.324	0.741
	Human Sounds	0.040*	0.586	0.522	0.405	0.050	0.058	0.256
	Instrumental Sounds	0.899	0.279	0.241	0.468	0.000**	0.484	0.622
Sound psychological reactions	Sociable	0.239	0.339	0.101	0.476	0.000**	0.190	0.891
	Natural	0.689	0.932	0.970	0.256	0.093	0.185	0.733
	Eventful	0.649	0.289	0.013*	0.800	0.907	0.991	0.399
	Peaceful	0.476	0.086	0.751	0.221	0.000**	0.329	0.524
	Happy	0.128	0.636	0.244	0.969	0.569	0.702	0.804
	Sweet	0.799	0.319	0.281	0.910	0.000**	0.542	0.697
	Relaxing	0.670	0.592	0.011*	0.588	0.000**	0.170	0.622
	Beautiful	0.422	0.114	0.275	0.202	0.014*	0.658	0.364
	Thoughtful	0.766	0.863	0.616	0.139	0.001**	0.399	0.178

Warm	0.662	0.203	0.490	0.725	0.006**	0.195	0.968
Safe	0.617	0.577	0.008**	0.448	0.408	0.899	0.911

Table 4. Correlation coefficient of sound features/ sound preferences in relation to relationship intensity, group size and age; mean differences between males and females, Peace Garden and Guanqian Square, solo and accompanied; and chi-square of activity type. *p < 0.05, **p < 0.01 (two- tailed test of statistical significance).

		Relationship intensity	Group size	Age	Gender	Site	Companion status	Activity type
Sound features	1.Various kinds of sounds mixed	0.030	0.008	0.029	1.893	-2.091	0.158	0.130
	2.Sounds so loud that you cannot hear others speaking	0.028	0.088	-0.082	0.823	0.363	0.102	0.488
	3.Other people's conversations	-0.001	-0.061	0.074	0.231	1.772	-0.045	0.377
	4.High-pitched sound (e.g. children's screams)	-0.002	-0.006	-0.188**	2.364	-1.055	0.807	0.599
	5.Eventful sounds from festivals or street performances	0.070	-0.011	0.115*	2.552*	-5.096**	-0.176	0.677
	6.Unusual sounds (e.g. hearing the ambulance)	-0.014	0.001	-0.011	0.632	-0.154	-0.022	0.232
Sound preferences	Noisy-Quiet	-0.054	-0.033	0.184**	1.285	-4.695	0.038	0.185
	Friendly-Unfriendly	-0.011	-0.059	0.027	1.333	-2.869	-0.121	0.063
	Safe-Unsafe	0.110	-0.121*	0.063	2.357	-2.899**	-0.355*	0.023*
	Monotonous-Various	-0.050	-0.057	0.054	-1.954	0.287	0.011	0.079

Directional-Everywhere	0.063	-0.029	-0.011	0.400	1.111	-0.231	0.804
Eventful-Calm	0.090	-0.106	0.135*	1.005	-2.579	-0.431	0.532
Distinctive-Ordinary	0.086	-0.070	0.102	1.036	-1.342	-0.377	0.253
Social-Unsocial	0.113*	-0.167**	0.128*	1.530	-2.159	-0.499**	0.285
Harmonious-Conflicting	-0.008	-0.098	-0.011	1.186	2.184*	-0.195	0.320
Offensive-Polite	-0.042	0.017	0.012	-1.687	0.125	-0.032	0.533
Ambiguous-Clear	0.011	0.012	0.031	1.063	-5.152	-0.170	0.858

Table 5. Binary regression between noticing speaking sound/ children sound and companion status

	Noticing speaking sound			Noticing children sound		
	Regression coefficient (B)	Significance level (P)	Odd Ratio (95% CI)	Regression coefficient (B)	Significance level (P)	Odd Ratio (95% CI)
Companion status (alone vs accompanied)	0.570	0.031	1.767	0.767	0.004	2.153
Constant	0.124	0.579	1.132	-0.173	0.437	0.841

In summary, whether people have companions influences their evaluations of socially interactive sounds. Speaking and children sounds both occur during social interactions and represent sociability. Accompanied people were found to prefer socially interactive sounds, while solo users had less preferences for those sounds. It was surprising to discover that accompanied people desired safer soundscapes than did people who were alone. It may be because people who are more concerned about safety would not travel to a given location alone. Moreover, it is possible some people are not worried about their own safety, but they are worried about their vulnerable companions, like the elderly and children.

Soundscape evaluations concerning relationship intensity

In the previous section, companion factors were analysed. To further clarify the influences from companion types, companions were ranked in descending order of relationship intensity: partner/spouse, family, friends, and solo. According to Table 3., it was found that relationship intensity significantly influences whether people notice children's sounds at 0.01 level; relationship intensity influenced preferences for human sounds at 0.05 level. Odd ratio in Table 6 identified how and to what extent social relationship intensity influences the two aspects. It showed the predicted probability of different relationship groups noticing children's sounds/preferring human sounds.

Solo people are defined as the last group and have a value of 1.000, and each of the other groups' values were multiple times higher. As intimacy increased, more people tended to hear children's sounds and prefer human sounds. Moreover, noticing children's sounds decreased more rapidly, and couples paid more attention to children's sounds than did other relationship types. According to the correlation coefficient in Table 4, relationship intensity had no significant influence on six sound features; it did, however, influence the preferences for 'social-unsocial' sound at 0.05 level. The positive correlation coefficient (0.113) suggested that with an increase in social relationship intensity, people tended to prefer social sounds.

Table 6. Binary regression analysis between social relationship intensity and noticing children's sounds, preferring human sounds and preferring sociable soundscape descriptors.

	Odd Ratio (95% CI)	
	Noticing children sound	Preferring human sounds
Partner/spouse	4.400	2.845
Family	2.588	2.265
Friends	1.841	1.236
Alone	1.000	1.000

Corresponding to the companion status, social relationship intensity also related to socially interactive sounds. People involved in closer social relationships were more likely to prefer sounds related to human and sociable sounds. In other words, in addition to the companion status, relationship intensity also influenced evaluations of socially interactive sounds. In this study, social relationship intensity was measured by the physical distances among group members. People in closer relationships tend to stay closer and engage in more intimate behaviours, like touching, hugging and even kissing. They also have longer conversations and social interactions with each other.

Comparing companion factors with other demographic factors

Other independent variables analysed in Tables 3 and 4 included age, gender, group size, activity type, and site factor. These factors were also found to affect many aspects of soundscape evaluations. According to Tables 3 and 4, the site factor influenced a majority of aspects of the sound evaluations, especially in regard to noticing sounds and sound preferences. It indicated that varied sound sources at the two sites significantly influenced soundscape evaluations. Like companion factors, site factor also influenced people noticing children's sounds at 0.01 level. To rule out the influence from the site factor, data were split between two sites, and it was found that relationship intensity and companion status still influenced noticing of children's sounds in Peace Garden at 0.05 level and 0.01 level, respectively. While no significant influence was observed in Guanqian Square.

Both companion status and age were found to influence whether people noticed speaking sounds at 0.01 level. When putting both factors into a binary regression analysis (Table 7), it was revealed that age still affected noticing of speaking sounds at 0.01 level, while companion status turned out to have no significant effect. The negative coefficient figure (-0.025) implied that the number of people noticing speaking sounds decreased with age. The Odd Ratio predicted that the probability of noticing speaking sounds was 0.975 times less for each additional unit of age. This implies that age had a more significant effect on noticing speaking sounds and that older people were more unconcerned about others speaking.

Another indicator to be noted was the preferences for 'social-unsocial' sound. According to Table 4, the 'social-unsocial' sound was influenced by both group size and companion status at 0.01 level and relationship intensity and age at 0.05 level. Using linear regression and stepwise method to analyse these factors, it was found that companion status was the only influential factor at 0.05 level, as shown in Table 8. The model summary suggested the independent variables could explain 2.7% of the total variation in the dependent variable social sound. It indicated there may have been other influential factors that were not accounted for in this research. The sig. column of the ANOVA table indicated the regression model significantly predicted the outcome variable at 0.05 level. Figures of collinearity statistics in the coefficients table suggested there was no multicollinearity between the independent variables. Also, the normality and homogeneity of data were verified by Kolmogorov-Smirnov test and Levene's test, respectively. The significance value of Kolmogorov-

Smirnov test is 0.331, greater than 0.05, which indicates the data is normal. The significance value of Levene's test= 0.066> 0.05, which approves the homogeneity assumption.

In short, preferring 'social-unsocial' sound was mainly influenced by companion status, and accompanied people tended to prefer social sounds than did solo people. At the same time, this factor has relatively little explanatory power. Although the low R square indicates a limited explanatory power, it is acceptable in a social science context. R square is adopted in various research disciplines, there is no standard guideline to determine the level of predictive acceptance (Henseler et al., 2009). R square lower than 10% is generally accepted for studies in the field of arts, humanities and social sciences because human behaviour cannot be accurately predicted. The low R square indicates that the dependent variables may be affected by other factors in addition to the ones considered in the analysis. It is more important to emphasize the intention of establishing a particular causal relationship, not to prepare a full list of the various causes of a phenomenon (Moksony, 1990).

According to Table.4, it was found that four influential factors (companion status, site, activity type, group size) all influenced the preferences for 'safe-unsafe' sound. Companion status, group size and activity type influenced at 0.05 level, while site influenced at 0.01 level. Companion status, group size and activity type all lacked significant influence when data were split by site. People in Peace Garden preferred a safe soundscape with means of 2.52 compared to 2.28 in Guanqian Square. It may indicate that users in Peace Garden were more concerned about the safety issue and had a higher demand for safety. Alternatively, there were some negative sounds heard in Peace Garden that triggered unsafe feeling, which led to people demanding safety.

Comparing companion factors with the other factors, companion status and relationship intensity affected the noticing of children's sounds only in Peace Garden with the site factor controlled. Companion status more significantly influenced preferring 'social-unsocial' sound than did other factors. Age more significantly influenced the noticing of speaking sounds than did companion status. Moreover, the site significantly influences the 'safe-unsafe' sound; with this factor controlled, other factors were found to have no significant influence.

Table 7. Binary regression analysis of age and companion status concerning noticing speaking sounds. *p < 0.05, **p < 0.01.

	Regression coefficient (B)	Significance level (P)	Odd Ratio (95% CI)
Age	-0.025	0.004	0.975
Companion status	-0.397	0.148	0.673

Table 8. Linear regression analysis among social-unsocial sound and relationship intensity, group size, age, and companion status. *p < 0.05, **p < 0.01.

(1) Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.165[a]	0.027	0.024	1.261	1.937

(2) ANOVA table

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.517	1	14.517	9.133	0.003[b]
	Residual	475.237	299	1.589		
	Total	489.754	300			

(3) Coefficients table

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-2.049	0.224		-9.139	0.000		

Companion status	0.477	0.165	0.165	2.895	0.004	1.000	1.000

Discussion

Social interactions and socially interactive sounds

‘Based on the results of the analysis, it was found that companion factors affect the evaluation of noticing human sounds and preferring ‘social-unsocial’ sound. The relationship between the human sounds and ‘social-unsocial’ sounds is that human sounds are the outcomes of social interactions, and social feeling is made up of human sounds, especially from activities. Two points require further discussion: one is that it should be considered how would human sounds make up the social sound feelings; the other is to consider why companions contribute to the preferences for socially interactive sounds.

First, in urban public space studies, researchers have mentioned that people not only value their activities but also look forward to and enjoy hearing and seeing strangers (Whyte, 1980). Seeing and hearing others are the biggest attraction that brings people into urban public spaces. Also, seeing and hearing others is believed to be the primary stage for social interactions and generates more social interactions, such as talking with strangers (Gehl, 1987). In other words, hearing human sounds, especially sounds from others’ activities, can cause the social feeling, and a social soundscape may stimulate more social interactions.

Second, people with companions prefer social soundscapes, whereas single users prefer them less. This corresponds to Bild et al.’s (2018) research, which found that a larger proportion of accompanied respondents expected the presence of others when considering using public spaces, whereas solitary respondents did not. Accompanied people expected high levels of interaction and dynamism from others’ activities. The different requirements for sociability were also reflected in the ways the spaces were occupied. 'Edge effect' was used by Whyte (1980) to summarize that people tend to prefer staying in peripheral areas and edge places, like columns and gates. Between solo and accompanied people, solo users tended to stay in the edge places (Cao and Kang, 2019). It was pointed out that staying in edge places can reduce the possibilities of exposure to others' activities and provide more privacy and protection (De Jonge, 1967). In other words, solitary users may require more protection and privacy, which results in their occupancies of the edges as well as their lower preferences for socially interactive soundscapes.

The square, as a centre of public activities, has often been considered by researchers to stimulate social interactions among strangers. Researchers have often suggested adding designs to the square that promote social interactions. Based on results from this study, human activity sound can positively increase people's social feelings. However, it is also necessary to keep in mind the needs of individual users who have lower social willingness. Maybe proper soundscape design, as well as architecture design, are required to both increase comfort and privacy for solitary users and sociability level for accompanied people.

Site factors in the soundscape evaluations

In this study, the site factor was found to affect most aspects of soundscape evaluations, which reflected the considerable interference that site brings to the experiment. Firstly, the site factor has a radical effect on sound sources compared with other factors because site determines what people can hear. The site factor affected seven of the 11 sound sources options, which indicated the varied sound sources between the two sites. Although both located in the city centre, the water sound in Peace Garden was the featured sound that screened many negative sounds. Guanqian Square, on the other hand, is located in the old town district with high-density roads and a few old trees that provide a weak sound barrier. People can hear many typical city sounds, especially the sounds of commercial promotions. Secondly, the different cultures at the two sites may significantly influence soundscape preferences. Seven of 11 descriptors were preferred differently between the two sites, which suggests a varied judgement system. The reason why the influences of site factor on this aspect were considered as the cultural differences is that those descriptors focus on a more emotional level of judgement. For the sound sources and features, people usually shared common opinions in preferring positive types. Preferences, cultural background, past experiences and personal differences lead people to have different judgements (Yang and Kang, 2005). While, because the main focus of this study was whether and how companion factors influence soundscape evaluations. Whether and how the site factor gives influences may require further studies in the future.

Many previous studies have investigated and recognized venue factors' influences on soundscape evaluations. Similarly, this study's results also confirmed the influences of the site factor on multiple aspects of soundscape evaluations. However, the impact of companion factors on socially interactive sounds was not affected by the site factor. This suggests that companion factors also need further investigation in addition to the site factor.

Conclusion

This study focused on if and how companion factors, in comparison to other factors, influence people's soundscape evaluations. This research took place in two popular public spaces in Sheffield, UK, and Suzhou, China, with a questionnaire and statistical analysis. Two categories of companion factors were used: companion status (solo/accompanied) and relationship intensity (partner/spouse, family, friends and alone). Both companion factors were found to influence socially interactive sounds, which consist of human sounds. Accompanied people were more likely to notice speaking and children's sounds and prefer safe and social sound. People with closer relationship intensities also noticed children's sounds more and preferred social sound. And relationship intensity influenced the preferences for human sound type positively. Other factors, however, interfered with the influences from companion factors. Companion status and relationship intensity affected noticing children's sounds only in Peace Garden. Site and age factor turned out to have greater influences than other factors on preferring 'safe-unsafe' and noticing speaking sounds, respectively. Companion status had the most significant influence on the preferences for social sound. Results from this study stress the relationship between human sounds and social sound. Human sounds, especially sounds from others' activities, can contribute to the social soundscape and stimulate more interactions among accompanied users, while solo people tend to have lower social willingness and prefer more privacy and quietness. Besides companion factors, the large influence from the site factor suggested the sound sources and cultures of the two sites significantly influenced the results of soundscape evaluations.

This study highlights the soundscape preferences of both accompanied and solitary people, providing new entry points for future public square soundscape design and even architectural design. A more inclusive soundscape design for urban public spaces is required to promote social interactions and, at the same time, provide quiet and private places for people who only want to watch others from a distance. This study includes the cross-nation sites as one of the influential factors, which adds to the richness of the sound types. It also introduces the significant differences brought by site factor. Various factors influence soundscape evaluations, and more factors need to be studied to discern the extent of companion factors' influence.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Urban Environment Evaluation

1. Who are you here with?

☐Partner/Spouse ☐Family

☐Friends ☐Alone

☐Others: _______

2. What sounds do you hear in public spaces? (Multi-choice)

☐Wind	☐Birds	☐Water	☐Speaking
☐Footsteps	☐Children	☐Traffic	☐Store music
☐Constructions	☐Music	☐Bells	☐Others:_________

3. What sounds do you prefer in public spaces? (Multi-choice)

☐Nature sounds (birds, water, etc.) ☐City sounds (store music, traffic, etc.)

☐Human sounds (speaking, footsteps, etc.) ☐Instrumental sounds (music, bells, etc.)

4. What is the main reason for you to visit this place? (Multi-choice)

☐Give company to children/elderly ☐Meeting friends

☐Sports or other activities ☐Relaxing

☐Enjoy loneliness ☐For the nature

☐This place is on my route (e.g. on my way to work or home) ☐Other: ________________

5. How do you feel about different sounds in public spaces?

Sound features	Rate (1) not annoying at all to (5) extremely annoying				
Various kinds of sound mixed together	1	2	3	4	5
High level of sound that you cannot hear others' speaking	1	2	3	4	5
Hearing other people's conversation	1	2	3	4	5
High pitch sound (e.g. children's scream)	1	2	3	4	5
Eventful sound from festivals or street performances	1	2	3	4	5
Hearing unusual sound (e.g. hearing the ambulance)	1	2	3	4	5

6. What is your preferred sound environment in public spaces?

	Very	Fairly	Little	Neutral	Little	Fairly	Very	
1Noisy								Quiet
Friendly								Unfriendly

Safe								Unsafe
Monotonous								Various
Directional								Everywhere
Eventful								Calm
Distinctive								Ordinary
Social								Unsocial
Harmony								Conflict
Offensive								Polite
Ambiguous								Clearly

7. What phrases best describe your preferred soundscape? (Multi-choice)

☐Sociable ☐Natural ☐Eventful ☐Peaceful

☐Happy ☐Sweet ☐Relaxing ☐Beautiful

☐Thoughtful ☐Warm ☐Safe

Gender: ________ **Age**: ________

广场环境评价问卷

您好！我是英国谢菲尔德大学的学生，在进行城市广场的声喜好调查，本调查将用于本人的博士论文的一部分， 无任何经济利益，衷心希望得到您的配合，谢谢！

1. 今天您是和谁一起来的？

☐伴侣 ☐家人

☐朋友 ☐独自

☐其他: _______

2. 您在这里听到哪些声音？（多选）

☐风声 ☐鸟叫 ☐水声 ☐说话声

☐脚步声 ☐孩子玩耍声 ☐交通 ☐店铺音乐

☐施工 ☐音乐 ☐报时 ☐其他:________

3. 您在广场里喜欢听到什么类型的声音？（多选）

☐大自然的声音 （如鸟叫，昆虫声等） ☐城市的声音（如流行乐，交通等）

☐人群的声音（如说话声，脚步声） ☐乐器的声音（如音乐表演，钟声等）

4. 您来这里的主要原因是什么？（多选）

☐陪小孩或老人 ☐会朋友

☐运动健身或其他活动 ☐休息放松

☐一个人静静 ☐感受自然的气息

☐这个地方正好顺路路过 ☐其他: ______________

5. 对以下发生在广场里的不同情况的声音做出您的评价：

声音类型	评价级别从（1）不恼人到（5）非常恼人				
不同的声音交织在一起	1	2	3	4	5
太响的环境音导致听不到同伴说话	1	2	3	4	5
听到旁边人的谈话内容	1	2	3	4	5
高音调的声音（如孩子的尖叫声）	1	2	3	4	5
周围搞活动传来的热闹的声音	1	2	3	4	5
听到不寻常的声音（如救护车的声音）	1	2	3	4	5

6. 选择您偏爱的声音种类（在两个对应的类型中间选择您的偏向）

	非常	有点	一般	适中	一般	有点	非常	
吵闹								安静

友好的								不友好的
安全								不安全的
单一的								多样的
定向的								分散的
热闹的								平静的
特别的								普通的
社交的								冷漠的
和谐的								冲突的
冒犯的								礼貌的
模糊的								清晰的

7. 以下哪个词语可以最好形容你喜爱的声环境？（多选）

☐社交的 ☐自然的 ☐热闹的 ☐安详的

☐快乐的 ☐温馨的 ☐休闲的 ☐优美的

☐深邃的 ☐温暖的 ☐安全的 ☐其他:_______

性别: ________ **年龄:** ________