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Soundscape and social relationships in urban public spaces

By

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Abstract

'Soundscape' is defined as the acoustic environment as perceived or experienced and/ or understood in context by a person or people. In the context of urban public spaces, activities can be varied among different social relationship groups which might influence their requirements for soundscape.

Four studies were carried out in urban public squares of Suzhou, China, and Sheffield and London, UK to explore the mechanism between soundscape and social relationships. Behavioural observations (study 1) and interviews with Grounded Theory (study 2) were used to explore types of relationship in relation to their patterns of use and the public's perceptual structure of soundscape in urban public spaces. A questionnaire (study 3) then investigated how companion factors, compared with other demographic factors, influence soundscape evaluation. Finally, study 4 used survey and observations to explore how social willingness levels of various social relationship types might be enhanced through soundscape design.

Three types of social relationship were categorized and ranked by relationship intensities: Intimate Pair, Intimate Group and Social Group. People with closer relationships participate multiple activities at once and involve more social interactions. Grounded Theory generated four elements of soundscape, which form a three- level process: sound classifications- sound appraisals (sound features and psychological reactions)- and judgment (sound preferences). Companion factors were suggested to influence soundscape evaluations comparing to other demographic factors: closer groups tended to evaluate socially interactive sounds more positively. Human sounds and event sounds, as two kinds of socially interactive sounds, were both found to stimulate social willingness while event sounds negatively affect soundscape suitability. A balance between suitability and stimulation should be achieved to enhance sociability, especially for closer groups.

Results from this study give guidance for future urban public soundscape research addressing sound preferences of various relationship types. This study included a limited choice of urban public spaces and cities, and social relationships were limited to relationship intensities. Future research should consider methods such as face recognition and deep learning to more-efficiently recognize relationship types and sociability of urban public spaces.

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Chapter 1:

Introduction

1. Introduction

1.1 Research background

This research concerns the relationship between soundscape and listeners' social relationships in urban public spaces. Soundscape first emerged in Michael Southworth's (1969) article, *the sonic Environment of cities*, which was based on Southworth's Master's Thesis in city planning (Axelsson, 2020). An alternative proposal for the origin of soundscape is that it came from the study of contemporary music through the work of the Canadian composer R.M Schafer who defined soundscape as '*the study of the effects of the acoustic environment on the physical response or behavioural characteristics of creatures living within it*' (Schafer, 1977). Schafer's work dealt with the relationship between the ear, the human being, the sound environment and society. Later, the World Soundscape Project emerged and this focused on the way people perceive their environment and the chance to change the orchestration of the global soundscape (Kang& Yang, 2005). To address concern about the perceptual construct of soundscape, the International Organization for Standardization (ISO) recently published Part 1 of a new International Standard, ISO 12913, on soundscape, which defines soundscape as '*[the] acoustic environment as perceived or experienced and/or understood by a person or people, in context*' (International Organization for Standardization, 2014).

A *Social relationship* is defined as '*the sum of the social interactions between people over time*' (Psychology Dictionary, 2013). This is similar to the definition of urban public spaces as '*an area or place that is open and accessible to all peoples that develops interaction and social mixing*' (UNESCO, 2017). In other words, urban public spaces are spaces where social relationships can be enhanced. Thus, urban public spaces were chosen as the research sites because of its nature of developing 'interaction and social mixing' (UNESCO, 2017). Various kinds of social relationships show up in urban public spaces, and urban public spaces are usually considered as the social locations, where new social interactions emerge (Gehl, 1987). This helps with observing and analysing various social relationships and social interactions. The inclusivity and diversity of users, sound types and activity types in urban squares are also important for this research. To define

different social relationships in urban public space, Hall (1966) suggested to use distance theory to categorize social relationships because people are closer together as their relationship intensity increases. Based on distance theory, Gehl (1987) categorized four types of social relationships, intimate, personal, social and public, from close to distant.

Considering the social context of urban public spaces, various previous studies have put efforts on enhancing the sociability of urban public spaces (Drucker & Gumpert, 1998; Carmona et al., 2010; Gans, 1968; Whyte, 1980; Gehl, 1987). It was suggested that public spaces with a high level of comfort encourage users to stay for longer, and further to foster new social interactions (Carmona et al., 2010). The five environmental factors are considered as the key to the comfort in urban public spaces, which are thermal, wind, visual, acoustic, and olfactory aspects (Reiter& Herde, 2003; Baker, 2001). These factors are highly related to users' sensational experiences and preferences. Soundscape, as one of the environmental factors, also significantly influence people's social activities, as it determines people's hearing and speaking in urban public spaces. The theory of acoustic affordance emphasized whether the soundscape provide the actionable properties for an object (Andringa et al., 2013). Previous studies suggested to include suitability and stimulation levels to evaluate acoustic affordance. Stimulation represents whether a soundscape stimulates people's social activities, and suitability represents whether a soundscape is suitable for people's activities (Bild et al., 2018; Gaby& Zayas, 2017). Followed the acoustic affordance, the term of 'social willingness level' was emerged with the aim to evaluate whether an acoustic environment provides soundscape suitability and stimulations for social activities. Suitability is similar to Gehl's 'essential environment condition', while stimulation is similar to 'favourable condition'. Thus, social willingness level defined in this research includes the two levels of soundscape affordance, one is suitability, the other is stimulation.

To investigate how sounds are perceived and how they influence human activities, various kinds of soundscape measurements were summarized in the previous studies. Because of the complexities of sound perception, it is difficult to analyse and measure a soundscape. Previous studies have tried to break down soundscape into some components with indicators, such as the two- dimensional coordinate: pleasantness and eventfulness raised by Axelsson et al (2010), Kang&

Zhang (2009)'s four major factors of soundscape: relaxation, communication, spatiality and dynamics, Aletta et al (2016)'s eight main categories of soundscape: noise annoyance, pleasantness, quietness or tranquillity, music-likeness, perceived affective quality, restorativeness, soundscape quality and appropriateness. Further, some studies not only summarized dimensions of soundscape, but also investigate the relationships among those dimensions to represent the perceiving process of soundscape perceptions (Liu& Kang, 2016; Davies et al., 2013; Schulte- Forkkamp& Fiebig, 2006). However, because of the complexity of soundscape, the perceiving structure of soundscape in urban public spaces is still vague. Also, perceiving soundscape can be varied among people from diverse demographical and cultural background (Yu& Kang, 2010; Yang& Kang, 2005). 'Expert' and 'non- expert' listeners were found to understand sounds though different system (Lemaitre et al 2010; Kang& Zhang, 2010; Raimbault& Dubios, 2005). Thus, soundscape perceptions should be analysed with the considerations of listeners' context.

Companionships was also mentioned as one of the influential factors for soundscape perceptions (Bild et al., 2018; Warr, 1990). Gehl (1987) and Whyte (1980) suggested that people usually have different requirements for sounds because their varied social activity types. In general, for more distant relationships, they need a better soundscape to facilitate their social interactions, as their social activities does not necessarily have to happen. While, the mechanism between soundscape and social relationships in urban public spaces still lacks elaborate analysis.

1.2 Overall aims

The overall aim of this research is to investigate gaps in our knowledge about social relationship and soundscape. First, previous studies of companion factors merely focused on whether people have companions or the relationships intensity levels. Low attention was paid on defining social relationship types, how their demographical compositions and the patterns of their uses in urban public spaces. Second, in terms of the perceptual aspect of soundscape, it lacks a structure defining the process of how general users of urban public space perceive soundscape. Third, among various influential factors that affect soundscape evaluations, companion factors have not been fully

investigated. There existing gaps between various aspects of soundscape evaluations and social relationship types. Fourth, to enhance the sociability of urban public spaces, the different requirements of varied social relationships groups for soundscape were not clear. There was an inadequate knowledge about the soundscape design guidelines for different social relationship types.

Thus, four objectives make up the four core chapters, chapter 4, 5, 6 and 7 to fulfil the gaps identified from the previous works. Figure.1 shows the overall framework of this thesis. First objective (chapter 4) was to categorize and define social relationship types and their patterns of uses in urban public spaces. The next objective (chapter 5) was to investigate the main aspects of sound perceptions and the soundscape perceiving process to form a perceiving structure of general public's soundscape. Based on these two objectives, social relationship types and soundscape evaluations were clarified in the context of urban public spaces. The third objective (chapter 6) was to relate social relationships of users to the various aspects of soundscape in urban public spaces. In other words, the third objective was to investigate whether and how companion factors influence people's soundscape evaluations, compared to other demographical factors, such as age, gender and site factors. At the end, with the understanding of patterns of uses and soundscape preferences of varied social relationship types, the fourth objective (chapter 7) aims to explore how to enhance social willingness levels of different social relationship types through soundscape design in urban public spaces.

Cross- cultural sites (UK and China) were selected in this study with the aim to add the diversities to the human behaviours and sound sources, instead of for culture comparisons. Because people from varied cultural backgrounds usually join in different kinds of activities in the urban public spaces, as well as the different using times. Their varied patterns of use may be related to their sound perceptions. Therefore, with the aim to summarize the relationship between relationship intensities and patterns of use, cross- cultural sites were involved.

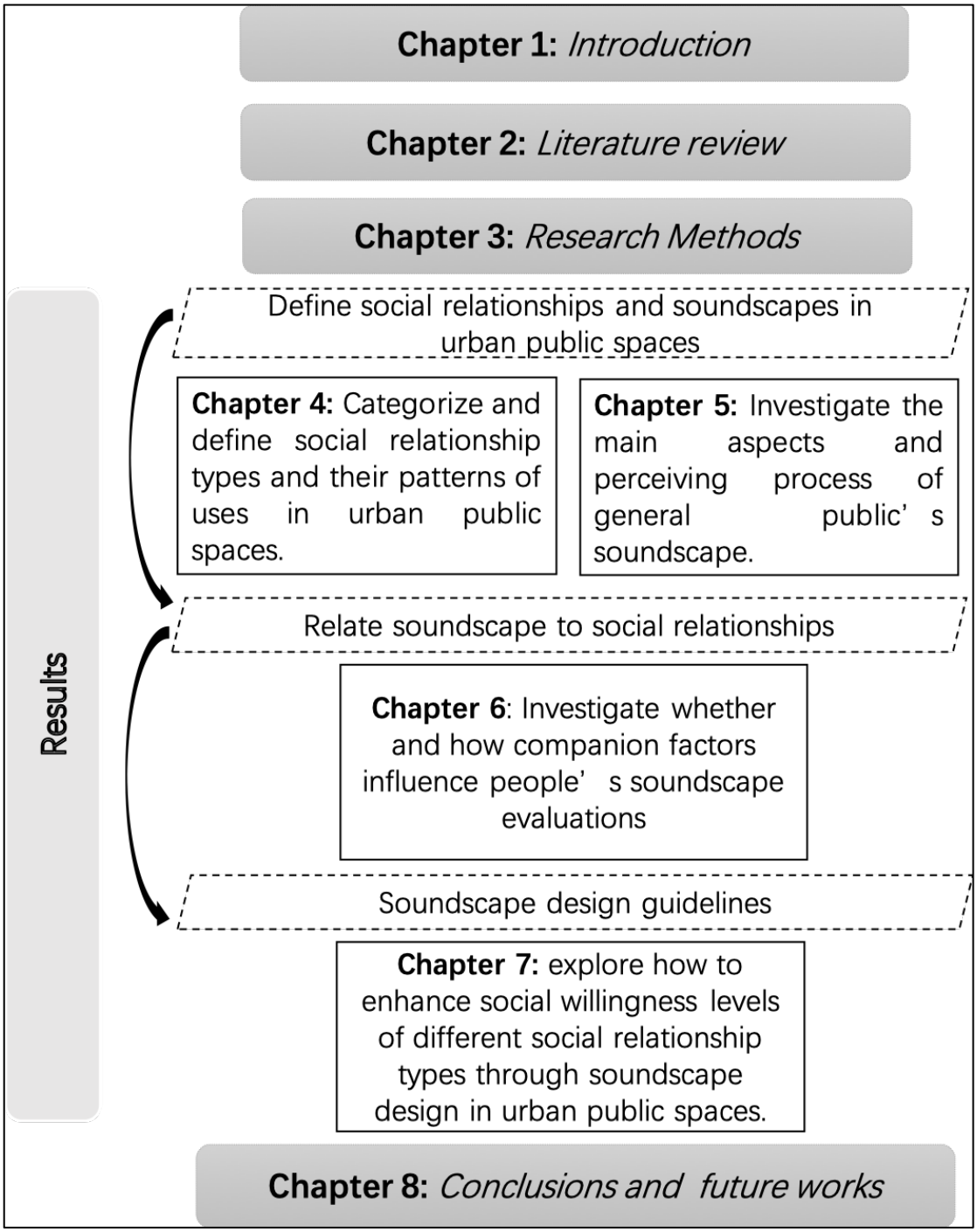


Figure 1.1 Overall thesis framework

Chapter 2:

Literature Review

2. Literature review

2.1 Introduction

As defined in the previous chapter, the focus of this thesis is how factors of social relationships influence human acoustic perceptions in urban public spaces. The research question addressed in this study is belong to a broader question- the mechanism between people and physical environment. In terms of the attributes of people, it has been demonstrated that social, demographic and behavioural factors influence environmental perceptions and evaluations (Chen& Ng, 2012). In terms of physical environment, thermal, wind, visual, acoustic and olfactive aspects were all included in the environmental perceptions. To focus on social relationships and soundscape, this chapter reviews the previous studies about the relationship between socio-demographic factors and soundscape perceptions as well as associated environmental factors, such as visual aspect. Two aspects will be addressed in this chapter: one is to understand the social relationship categories in the social context of urban public spaces; the other one is to review soundscape in relation to other environmental factors and their impact on social interactions and human perceptions.

In summary, first discussed are social relationships in public spaces, with consideration to the categorisation of social relationships and patterns of use. This is followed by review of previous studies investigating how environmental factors affect human perceptions. The third part is a discussion of soundscape researches in urban public spaces sphere, sound categorization method, measurement, and the influential factors. The final part reviews the design guidelines raised in soundscape field and how sounds can enhance sociability in urban public spaces.

2.2 Analysing social relationships in urban public spaces

Social relationships, defined as ‘the sum of the social interactions between people over time’ (August& Rook, 2013), are the entry point of this research. Various kinds of people in different social relationship groups can be seen on the square. Urban public spaces have long been recognized as promoting social interactions (Gehl, 1987; Carmona, Heath, Oc& Tiesdell, 2010).

In terms of the companion factors, on the one hand, companionships influence people's psychological states to make them prefer particular physical environments. Solitude is considered as a major attribute of wilderness experiences, while accompanied is associated to urban context (Staats& Hartig, 2004; Hammitt, 1982). On the other hand, social relationship types determine what activity people join in in the urban public spaces, so as to influence their requirements for physical environment (Whyte, 1980). It is worth emphasizing how social relationships influence people using urban public space. Social behaviours represent how people interact with the physical environment (Baker& Crompton, 2000). The behaviours of use of different social relationship groups can explain their preferences for certain physical environment. Thus, in section 2.2.1 is reviewed the social context of urban public space to explore the definition of social relationships types. Section 2.2.2 then extends this by reviewing social behaviours in relation to social relationships and other demographical factors.

2.2.1 Social context of urban public spaces

2.2.1.1 Definition of urban public spaces

'Urban public space' is defined as 'an area or piece of land legally designed for public use', which includes various urban places, such as public roads, public squares, parks and beaches (McGraw-Hill Dictionary, 2003). The word 'public' is the key to understand urban public space. The word 'public' is defined as 'people in general, rather than being limited to a particular group of people' (Oxford dictionary, 2020). 'Public' in the urban public space is referred to the 'authorities' provided by the public to make this place open or available to the public (Manipour, 1999). Open and accessible to the public is the prerequisite for 'urban public space'. And only when the place is available to everyone, the function of public space can be worked. Gehl (2013) emphasized more on whether the space is functioned as 'public space'. He concluded that urban public spaces should have 'public life' happening and he further pointed out that public space should be understood in the broadest sense- streets, alleys, buildings, squares, bollards can all be considered as 'public space' because public life often happen between buildings, or to and from schools. Only if public life

happens, those places can be considered as the public space. Lynch (1981) also defined the public space as an activity focus and a meeting place.

There are various types of urban public spaces. Marcus and Francis (1990) categorized five kinds of public spaces based on architectural forms and functions: street plaza, corporate foyer, urban oasis, transit foyer and grand public place (Table 2.1). Green spaces, like parks, usually are mixed up with public spaces. Marcus and Francis (1990) excluded parks from their classification because parks are not open with full time and some of them are privately owned. Also, they mentioned that urban public spaces have harder surface than green areas in the architectural form. As shown in the table below, they describe each category of urban public space with architectural features and functions in relation to the particular users and their behaviour of uses. Among five types of public spaces, it can be seen that grand public place attract the most varied users and can accommodate a wide range of activities. In other words, grand public place may be the most appropriate venues for behavioural observation research and environmental perception research, when aiming to reach various kinds of users.

From a much broader sense of public space, the term 'semi-public space' was introduced to describe places between private and public, such as building façade, entrance, and ground floors managed by building managers (PPS, 2008; Whyte, 1980). Those places can function as an attractive and secure buffer zone between private and public. Whyte (1980, p99) praised these places as 'the most felicitous, leftovers, odds and ends that by accident work well for city people'. Those places are generally small in size and don't take up much urban spaces, yet they are practical and offer great convenience to the users. For example, the bus stops in cities are often amiable and attractive to be involved in many activities other than people waiting for the bus. People are willing to stay around those small places and they may even feel better about the city for knowledge of them. HKPSI (2011) also mentioned the 'semi-public spaces' (or 'pseudo-public space') as the place appears to be public spaces. But they consider those places have the key elements of public space stripped away. Although, those places take on the responsibilities of social interactions, they cannot be 'real' public spaces. Because they do not contain the essence of 'public' and may even imply restricted entry. For example, a shopping mall's façade cannot be regarded as 'public' since the

doorkeeper have the right to deny entry. Although in many circumstances public spaces are in fact recreational spaces that encourage social interactions, there are often interchangeably used, but they are not conceptually synonyms. After all, the concept of 'semi-public space' confirms the importance of public life for public spaces. Even though some of those places are not 'public spaces' in architectural forms, they function as public spaces. The idea of semi-public space also reflects the importance that many researchers attach to the 'social life' on the definition of urban public space. 'Public life' is not only the function of the public space, but also the requirement for becoming a real public space.

Table 2.1 Categories of urban public spaces by Marcus and Francis (1990)

Type	Design	Features	Function	Users
Street Plaza	As a widening of the sidewalk or an extension of it under an arcade; Adjacent to the side walk and connected to the street;	Seating edge, widening sidewalk, bus-waiting place	Brief periods of sitting, waiting, and watching	Used more by men than by women
Corporate Foyer	Part of a new, high-rise building complex.	Decorative porch, impressive forecourt, stage set; to discourage use	provide an elegant entry and image for its corporate sponsor	Passers-by, people who work near by
Urban Oasis	Have a garden or park image; heavily planted; set apart from the noise and activity of the city;	Outdoor lunch plaza; garden oasis; roof garden	Popular for the lunchtime eating, reading, socializing	Attract more women than men or, at least, equal proportions of each
Transit Foyer	Created for easy access in and out of heavily used public transit terminals	Subway entry place; bus terminal;	Usually is meant to use for passing through, but sometimes activities happen	Street entertainers, vendors, and people watchers

Grand Public place	Come closest to our image of the old-world town square or piazza; big and flexible enough to 'host' crowds; considered as the 'heart' of the city	City plaza; city square;	Can host large amount of people and big events, like annual Christmas three may be erected there; foreigner visiting	Tend to attract users from a greater distance and in greater variety (by age, gender, ethnicity) than other plazas; lunch crowds, outdoor cafes; pass through; occasional concerts, art shows, exhibits, and rallies.

2.2.1.2 Urban public spaces as the social occasions

With urbanization, more people congregated to live in cities and citizens are forced to adapt to a society of strangers. Simmel (1903) suggested that residents of large cities come across numerous people every day, but they cannot engage in with everyone. In other words, people in cities are becoming emotionally detached. It was believed that personal relationships and social interactions are the important predicators of subjective well-being (Dolan et al., 2008; Mouratidis, 2018). Dolan et al. (2008) pointed out that marriage or intimate relationships and relationships with family and friends are termed as personal relationships, which are related to the subjective well-being. Balducci and Checchi (2009) suggested that friends and neighbours play a catalytic role in subjective well-being. Except intimate personal relationship, Healthy place report (2016) pointed out that social interactions among people can offer significant benefits to mental wellbeing and the feeling of safety. Mouratidis's (2018) summarized several indicators for predicting satisfy personal relationship: marital status, number of close relationships, frequency of meeting friends and relative, support received from the close relationships, and opportunities for social contact. In short, existing personal relationships as well as interactions with strangers can both be helpful for mental health.

Urban public space was considered as an architecture form for social interactions to generate and to deal with the problem of 'stranger society' (Fischer, 1982; Milgram, 1970; Gifford, 2007). Goffman (1963) consider public spaces as the place for 'social occasions'. In his theory, occasion, situation and encounters were categorized as the rules of social gathering. Occasion is the socially constructed border which defines how people perceive and act. People usually behave according to

their previous experiences or observations. Occasion represent the social- cultural background and norms of participants. The 'situation' is the manifestation of the 'occasion'. It also represents the potential of communication between people. Based on different situations, people would know how to behave within in the frame of occasion. An 'encounter' is the very essential part of social interaction, which indicates two or more people currently present in front of each other, focusing on a shared object. Although occasion and situation define the formal code, every encounter may have its own identity, such as two friends meet and talk about something in their own ways. When apply the theory of Goffman in public spaces, the physical form of public spaces provides people with social situations where encounters are able to happen. And Goffman's theory also pointed out that social interactions in public space has its own set of norms, people should behave accordingly.

While social interactions do not always happen along with the urban public spaces. There were also many unsuccessful public spaces exist because of following reasons: 'lack of seats; lack of gathering points; inaccessibility; dysfunctional features; poor surroundings (Hine, 2013)'. These shortcomings lead to the unpleasant physical environment, which is the fundamental reason for hindering social interactions to happen (Gehl, 1987). Rutledge (1981) pointed out that the lack of observations of human behaviours leads to those unsuccessful designs. He suggested summarising the patterns of use of people from behavioural observations, putting design at the service of people rather than satisfying the aesthetics of the designer himself. Some researcher pointed out the effect from physical environment and urban forms. Gehl (1987) believes that social life only happens in public space when the spaces are qualified in the environmental conditions. Whyte (1980) summarized that a square need to have sun, wind, trees and water to satisfy social activities. Mouratidis (2018) suggested that residents live in compact-city have more close relationship because they socialize more frequently and they receive more emotional and functional support compared with residents from low-density suburbs. Compact urban forms also give higher access to the 'third place', which refers to places like café, restaurants, parks, public libraries and other urban public spaces.

Some non-profit organizations which focus on the enhancing urban communities have put massive effort on promoting the sociability of urban public spaces in order to benefit city dwellers,

such as PPS (Project for Public Spaces) and HKPSI (Hong Kong Public Space Initiative). By evaluating thousands of urban public spaces around the world, PPS (2009) and HKPSI (2011) both raised several indicators to evaluate sociable levels, they displayed them in a graphic model as shown in the Figure 2.1. PPS is a non- profit organization focusing on creating sustain public space and strong communities. They believed that those successful public spaces share the following four qualities: they are accessible; people are engaged in activities there; the space is comfortable and has a good image; and it is a sociable place. The ring outside the four main criteria are a number of intuitive or qualitative aspects by which to judge a place; the next outer ring shows the quantitative aspects that can be measured by statistics or research. Sociability is emphasized as one of the most important features for a successful urban public space. It was considered as a difficult quality for a place to reach and once a place is qualified with sociability, it will bring with a strong sense of attachment to people's community and city (PPS, 2009). To evaluate the sociability of a place, PPS (2009) proposed some simple questions to ask users:

1) Is this a place where you would choose to meet your friends? Are others meeting friends here or running into them?

2) Are people in groups? Are they talking with one another?

3) Do people seem to know each other by face or by name?

4) Do people bring their friends and relatives to see the place or do they point to one of its features with pride?

5) Are people smiling? Do people make eye contact with each other?

6) Do people use the place regularly and by choice?

7) Does a mix of ages and ethics groups that generally reflect the community at large?

8) Do people tend to pick up litter when they see it?

These questions represent four latitudes of sociability: first, whether the place is suitable for intimate relationships groups to have activities; second, whether it promotes friendly relationships

between strangers; third, whether people are emotionally attached to the place; fourth, whether the place is completely open to different types of people. Through these questions, it seems that social context of urban public space involves multiple levels of relationship intensity. Public spaces are required to satisfy those various kinds of social relationships.

HKPSI is a charitable non-profit organization founded in 2011, Hong Kong. HKPSI (2011) believed that 'public space' is the stage for public life, where one can interact with each other, regardless of people they know or they don't know. Their model is quite similar with PPS's (Figure 2.1). Sociability, public utilization, environmental facilities and accessibility correspond to PPS's sociability, uses& activities and access& linkage. While in HKPSI's pyramids, sociability is believed to be based on the accessibility of the place and equipped with proper environmental conditions and facilities and public utilizations. In other words, to achieve sociability needs a step-by- step process from the basis to the top.

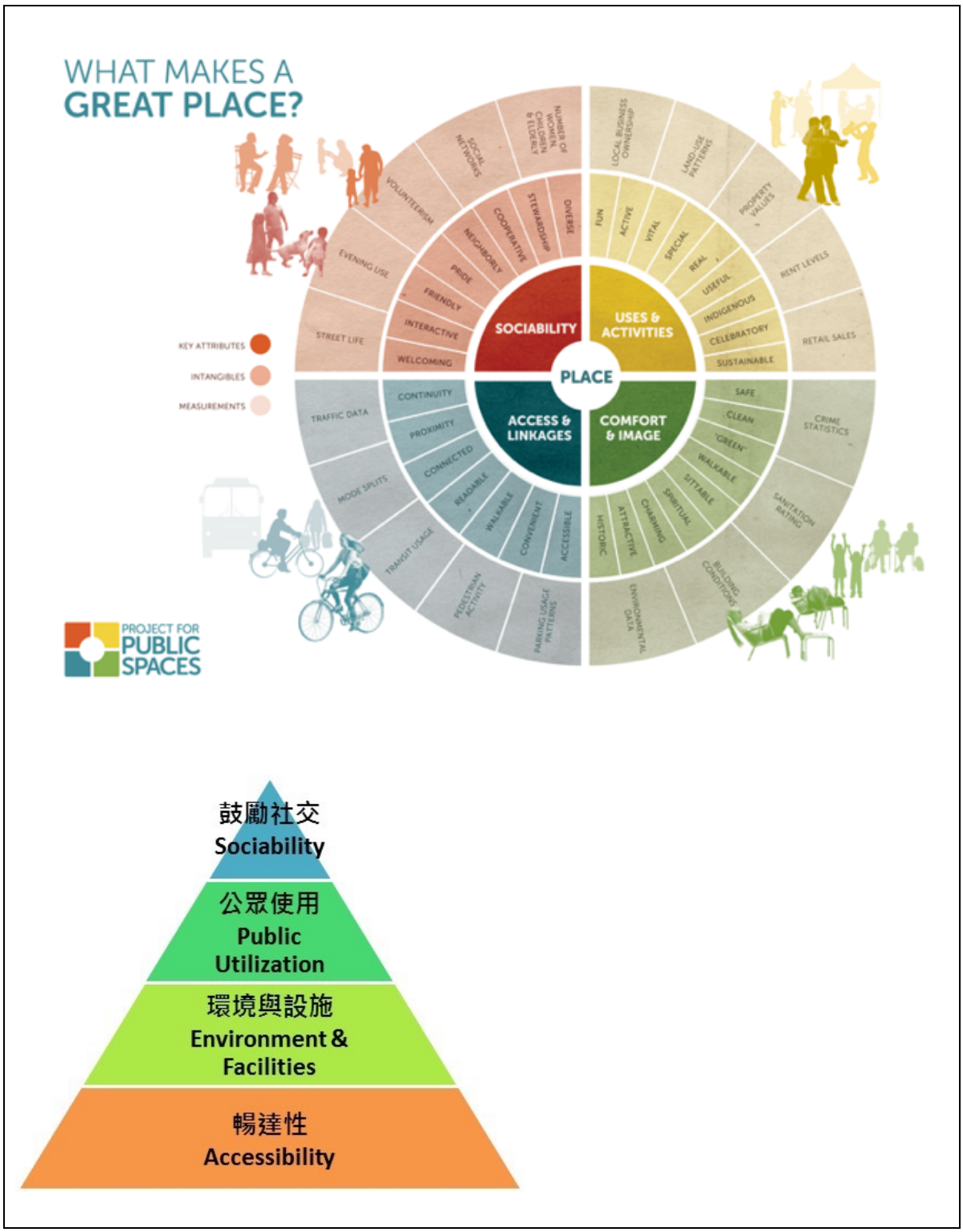


Figure 2.1 Models of what makes a successful public space by PPS and HKPSI. Above: ring model of PPS (2009), Below: Pyramid model of HKPSI (2011)

2.2.1.3 Social relationships defined in urban public spaces

Public spaces are considered as the social spaces where people can have social activities with people from various kind of social relationships. To clarify those relationships, Gehl (1987) categorized them by relationship intensity: from 'very simple and noncommittal contacts to complex and emotionally involved connections', named as passive contacts ('see and hear' contacts), chance contacts, acquaintances, friends and close friendships (P15). Further, Gehl (1987) believed that even those seemingly insignificant 'see and hear contacts' are highly possible working as prerequisites for more intensive contact forms. He used 'civic mixing' to refer to the situation that occurs on a spectrum from aloneness to close friendships. 'Civic mixing' includes three period: passive contact, chance contact, familiar stranger (Figure 2.2). Passive contact is referred to the situation whenever someone is in the presence of others. Chance contact means strangers interact with each other by accident, such as someone picks up the scarf you dropped, or asks you for the time. Familiar strangers are similar to the word 'acquaintance' who you are familiar with but you can hardly speak out his/her name. Gehl introduced the concept of social mixing in order to emphasize the importance of public spaces for the creations of new social interactions. Public spaces accommodate different groups of people mixing together, which have considerably benefit on the economic and social tolerance and empathy sphere. It was also believed that contact with homosexual people and people from different races can give positive influence on people's attitudes (Brown, K.T., 2003; Herek, G.M., 1996). And there is a relationship between socioeconomically integrated neighbourhoods and positive social outcomes (Chetty, R., 2014, 2015).

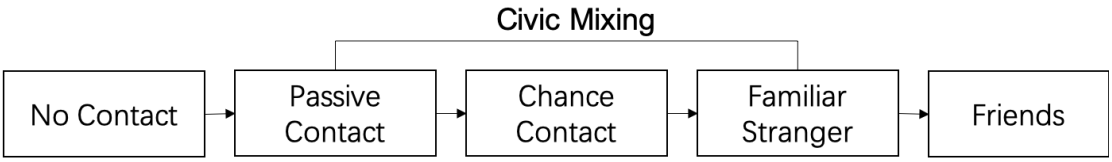


Figure 2.2 The various social relationships in urban public space and 'civic mixing' progress (Gehl, 1987)

The relationship of 'familiar stranger' was emphasized by Paulos and Goodman (2004) to be the key for making real interactions. The familiar stranger is referred to the situation that people observe each other many times but never go into any interaction. They gave an example on such relationship that a person sees the other person on the subway every morning but he doesn't know anything about that person. Paulos and Goodman (2004) believed that people are very likely to establish direct interactions with familiar strangers because of their shared knowledge and place. Thus, they suggested to apply some wireless devices to connect those people in order to light the sociability of the public spaces.

Hall (1992) categorized social relationship by social distance. Social distance measurement was based on the zoologist's research on animal's living habit and behaviours. Hall (1992) introduced Hediger's classification of birds' flight distance: critical distance, personal distance and social distance to measure social distance. Because it is both birds' and human's nature to exhibit territoriality, by which they can use sense to distinguish between one space or distance and another. Based on observation and interviews with various participants from the United States, he introduced the distance measurement into analysing the relationships among people and termed four levels of relationship intensity: 1) Intimate distance (0 to 45cm): feelings of tenderness, comfort, love and strong anger;2) Personal distance (0.45 to 1.30m): conversation between close friends and family;3) Social distance (1.30 to 3.75m): ordinary conversation among friends, acquaintances, neighbours, co-workers…;4) Public distance (greater than 3.75m): informal situations.

Distance can determine what people see and hear, which further give influences on people's social activities. People can behave differently under different social distance. Hall (1992) explained how sensory apparatus work and how people behave in these four distance ranges. In the sphere of intimate distance, sight, olfaction, heat, sound and the breath can all be felt from the other person. Intimate distance involves physical contact: pelvis, thighs, and head can be touched and arms can encircle. Personal distance is described as a small protective sphere or bubble between people. At

this distance, one can 'hold or grasp' the other, which means that each participant can touch the other with one's extremities. In social distance range, there is a 'limit of domination' between people. Nobody will touch or expect to touch the other unless there is some special effort. This index also gives evidence for measure social relationships in public spaces. In the end, Hall pointed out that the four -level distance measurement are based on Americans lifestyle and culture customs, which is by no means to be universal. He mentioned possible differences might appear when applying them into different social context.

Inspired by Hall, Gehl (1987) considered that a knowledge of the apparatus senses is necessary for understanding the communication among people. The most important senses that in connection with human contacts are concluded as: 1. The distance receptors: eyes, ears, nose; 2. The immediate receptors: skin, membranes, muscles. The interplay between the intensity and distance of sensual impressions is widely used in human communication: 1. Intense emotional contacts: 0~0.5 meters (0 to 2 ft); 2. Less intense contacts: 0.5~ 7 meters (2 to 20 ft). Fotios, Yang and Uttley (2015) considered the relationship between social distance and sight, and from the results of eye tracking data suggested to use an interpersonal distance of 15m to better analysing people's behaviours in dark conditions.

Apart from the distance measurement, Whyte in his street life project (1974) mentioned that kissing, smiling, touching and eye contact are the best signs to evaluate the close relationship. Project for Public space (2018) summarized five actions that happen between close groups: 1) Display of affection: kissing, hugging, holding hands, an arm around shoulder, or a selfie; 2) Sharing: sharing is a sign of intimacy and trust; 3) Touching: for example, a polite touch on the shoulder, a kiss on the cheek, or a grazing of elbows; 4) Proximity: the close distance between people; 5) Smile and eye contact.

Followed the Hall's (1966) distance theory mentioned before, the idea of proxemics was put forward in communication studies indicating 'a form of nonverbal communication or body language in which messages are conveyed from one person to another by changing the space that separates them during a conversation'(Oxford dictionary, 2011). Proxemics is one of the five non- verbal communication theories, the others being semiotics (sign language), kinesics (body language),

haptics (touch) and chronemics (time). Proxemics, as mentioned before, was shown by physical distance in the beginning, from intimate, personal, social to public distance.

While, recently, digital proxemics were raised to deal with the social relationships of the digital era. Digital technology is now shaping our personal bodily movement, our interpersonal negotiation of social space, and our navigation of public spaces and places (McArthur, 2016). For example, studies showed that people naturally appeal to media in which proximity can be accurately simulated in the virtual world. The greater the perceived proximity, the more successful and effective the technology becomes (Marquardt& Greenberg, 2015). Media audiences might perceive an on-air personality as a friend over time, and develop a parasocial relationship without personal meeting in the reality (Horton& Wohl, 1956). In this way, the spatial 'distance' among people was needed to be re-defined in the virtual reality. The new emerging communication forms were needed to be reconstructed in this theory, for example, people can easily relate net friend to real geographical location through the application of Pokemon Go (Rosenqvist et al., 2018). Ubicomp interaction design emerged to explore how the knowledge of proxemic relationships between the entities in ubicomp ecologies (people, devices, objects) can be exploited in interaction design. For example, when our living space was full of digital devices, our mobile phones, digital whiteboards, tablets can be connected and be ready for information sharing and exchange. Subsequently, all these devices can serve as the platforms of virtual human interactions (Weiser, 1991). Soundscape can also be designed as the socially interactive platform, for example, previous projects tried to display the large-scale light and music interventions on architectures in the cities (Hespanhol et al., 2014), or set up sound- related interactive installations in the public spaces (Eng et al., 2003), or construct the sound maps letting people from different areas to communicate through sharing sound recordings (the application 'soundscape' in apple store，the project of Harbin sound mapping), further to enable people to have social interactions.

2.2.2 Patterns of use in relation to social relationships

2.2.2.1 Analysing patterns of use in urban public spaces

In urban public space field, behavioural observation is the most frequently used method. With the aid of observation, patterns of use of different type of people can be figured out. Patterns of use bridge people and physical environment. Behaviours of different groups can offer the information about what physical environment provide for users' activities, and what people require from the environment (Golicnik Marusic, 2015).

Through behavioural observation, Gehl (1987) and Whyte's (1980) found that activities usually happen in the 'edge places'. The edge effect is a phenomenon that people tend to stay at the edges of a public space. 'Edge effect' is firstly put forward by sociology Derk de Jonge (1967) who studied the popular areas for stays in Dutch recreational areas. 'Edge places' in public space are summarized as: 1) half shade: colonnades, awnings, sunshades along the facade, niches in the facades, recessed entrances, porches, verandas and plantings in the front yards, etc; 2) in recesses: on corners, in gateways, near columns, trees, street lamps, or comparable physical supports, Bollards, etc. (Gehl, 1987). These edge places are usually located in the periphery areas of the public spaces where people can lean on. Such places provide the support for users' back on the one hand, and they can surveil the activities of others in the central square from a distance (Whyte, 1980). It offers the opportunities for people to regulate their engagement level and type with strangers (Stevens, 2007).

Although people usually intend to seek protection and control the exposure to the outside stimuli in the edge, sometimes unexpected interactions may happen. Triangulation is used to describe the process by which some external stimulus can provide links between stranger people and make them start to talk with each other (Whyte, 1988). Those kinds of conversation are unplanned, informal and non-instrumental and they often just happen in the edges of public spaces (Stevens, 2007). Whyte (1980) summarized some other regular patterns of users' distribution besides triangulation: self-congestion and amphitheatre effect. Self- congestion means that people like to do various activities in the crowd and in the mainstream. Amphitheatre effect refers to the

phenomenon that people tend to show much more interest in the surround audiences than the show itself.

Zeisel (1984) list six elements of analysing patterns of use: who, doing what, with whom, relationships, context and setting. Patterns of use cannot be analysed in isolation, they should be put into the context of the connection with the user and the sites. 'Doing what' refers to the actions people are doing, which is similar to 'activities'. The description of the action depends on the observer's judgement which is more from subjective side. Based on different levels of research questions, the descriptions also have different levels of details as shown in Table 2.2 He used the action of 'shopping' as an example, behaviours descriptions change from general one to detailed one according to the different research questions. When the description become more detailed, the relationship between actions and physical settings is emphasized. Zeisel (1984) believed that physical environment can encourage or constrain particular behaviours, and he relates behaviours to the 'settings'. Objects in the environment can imply obvious choices for use and can also support other kinds of uses created from users' imagination. Except the physical objects, the environmental conditions, such as loudness, light intensity, and air flow can also directly affect using behaviours through hearing, seeing and smelling.

Table 2.2 Designing questions for pattern of uses from general to detail (Zeisel, 1984)

	Pattern of uses	Design Question
General Description	'Shopping' as opposed to 'hanging around'	In a shopping-centre plan, how many places are needed for people to hang around, and how can they be designed to augment rather interfere with shopping?
	Shoppers browsing as opposed to buying something	How should items be displayed so that browsers and buyers can see them but buyers have greater access to them?
	Where and how often shoppers stop in supermarket aisles	How can flooring materials, lighting, and aisle length be designed for maximum convenience to customers, maximum exposure of sales items, and minimum maintenance?
	How high patrons will reach and how low they will stoop	What shelf design and what product placement (what size container on what shelf) will ensure that customers have the easier time reaching items?
	Where customers' eye focus while moving down an aisle	Where should standard signs be placed to convey the most information, and where ought sale signs be located to catch customers' glances?
Detailed Description		

Gehl also related the activities with the 'settings' of the place, which is mostly referred to the micro environment conditions. Gehl (1987) summarizes three types of activities happening in public spaces: necessary activity, optional activity and social activity. Necessary activities are usually compulsory, like going to school or to work, waiting for a bus. Most of these kinds of activities are related to walking. Optional activities usually happen if time and place make it possible. Activities like taking a walk to get refreshed or sitting and having a sunbathing are included as optional activities. Optional activities require a much higher level of exterior conditions than necessary activities. Providing with proper environmental conditions, the latter two types can happen.

2.2.2.2 Categorizing patterns of use in relation to social context

Previous studies categorized behaviours of use according to various social background of people, such as gender, age, race and group size (alone, in couples, or in groups) (Nasar and Yurdakul, 1990). People from different gender, age and group size are found to behave differently in terms of staying location, using preferences and using time.

In terms of the age factor, Holland et al (2007) summarized how users from different age groups behave in public spaces through a one-year long research project in the town of Aylesbury in South East England. They combine group discussion, street survey with non-participant observation. As a result, they categorized three age groups with their patterns of use: 1) Infants and younger children: unaccompanied primary school-aged or younger children are rarely seen in the public space. Very young children are never observed unaccompanied. Their companions are usually carers, family groups, or groups from local nurseries and playgroups of older children and adults. 2) Older children and young people: older children (aged around 11-15 years) and young people (aged around 16-19 years) often gather in large groups regardless of time and locations, especially out of school hours and during holidays. Young people's gathering is thought as source of bad behaviour and petty crime, such as skateboarding activity, use of bandstands, gatherings in the shopping centre. 3) Older people: older people are quite sensitive to the presence of others. They tend to be absent from areas with older children and young adults with fear of young people's bad behaviours. They mostly avoid night time venture and show up before 10 a.m. alone or in couples or pairs, occasionally stopping to talk to other people. Older people are rarely seen in large groups, but at weekends, they may show up in multi-age groups. Their observations identified not only the varied activities, but also the varied group size people from different age join in. Gehl (1987) also emphasized the group size as well as time period of use of people from different age. He found that people walking in the afternoon usually join in a small number of participants having children and elderly people. In the later afternoon, middle-aged adults withdraw from the bustle walk through the public space. Young people wander around after the mid evening.

Gender was also emphasized in patterns of use of urban public spaces. Women were found to be more sensitive about the 'environmental negatives', such as pollution, noise, dirt, excessive

concrete, etc (Mozingo, 1989). They also were found to be sensitive about potential danger- they cared more about surrounding people and preferred secluded places, for example, the inner side of benches and rear part of the square in order to avoid displaying to the public (Whyte, 1980; Marcus& Francis, 1998). Men, on the contrary, they preferred the front locations, such as standing near the gate as guardians and the outer side of benches. They cared less about the surrounding, and they are open to interactions and interruptions. In short, women seek the feeling of comfort, safe, relief, control and relaxation; men seek for publicness, sociability and involvement (Marcus& Francis, 1998).

Women's patterns of use and their occupancies in urban public spaces are not only a reflection of the characteristics of female population, but are in fact the expressions of the social environment. The bias against women being seen along in public spaces still prevails. Gender issue is stressed in cultural geography, which refers to space is socially constructed as an actor perform (Mowl&Towner, 1995). Public space is constructed as men theorized space from the premise of the male norm. Scraton and Watson (1998) focused on women's leisure lives in the context of gender issue with the aim to explore theoretical ideas about space and the consumption of place and the mechanism among gender, class, 'race' and age. Through two case studies of Leeds women from young to old, they found that public area was perceived in terms of safety and the potential threat of male violence instead of leisure. Before going to public areas, many women would plan or 'map' their routes in order to avoid danger. This kind of concerns are found to be varied by their age. For old women, they talk more about a fear of mugging and attack; Younger women fear more about the sexual attack. They also point out the differences among women groups in terms of leisure constraints concerning about women's identity, like age, class and race. Public leisure spaces in the city are gendered, racialized, sexualized and constrained concerning with individual's access to financial resources. Thus, on one hand, when analysing women's need for leisure in the context of public space, empirical research methods are needed to recognize the difference identities between women. On another hand, attention should be paid on the exploration of socially constructed public space where leisure activity takes place.

Social relationships are also considered as an influential factor of using behaviours. In the work of Marcus and Francis (1998), they suggest to design different sitting place for single users and group users as they tend to use the place in different ways. Single users seem to prefer more secluded seats in order to avoid intrusion. For alone users: 1. Steps, ledges, or straight benches which permitting natural spacing between people; 2. A circular bench around a planter can bring people together and promote seclusion. For group users: 1. wide, backless benches; benches forming right angles at corners; 2. benches curving inward. Bild et al., (2018) drew the distributions of alone and accompanied users and found that: accompanied users usually dominant across spaces, face the water while sitting on grass, and occupy larger grass field in the sunny days; solitary users mostly sitting on the benches and faced the water from a larger distance. Half of them occupy the open fields and the other half rest on the seating amenities closer to the path in the shades. Although, social relationships are seldomly addressed in relation to the patterns of use in urban public spaces. They are actually closely related to the other social demographical factors. Such as the frequently mentioned 'young gang' (Holland et al., 2007), this term includes both the age information as well as the relationship types. In fact, the fundamental thing that determined their behaviours in the public spaces is their relationship. If they are not in relation of 'young gang', they would just be a normal group of young people. In other words, analysing the social relationship of groups can offer great help in understanding human behaviours in urban public spaces. That is also the reason that this study put emphasis on social relationships.

On top of the patterns of uses of people in urban public spaces, it is necessary to figure out what determine and regulate people's behaviours. According to the man-environment interaction theory raised by Rapoport (1976), before the actions of 'use', people need to perceive and understand the physical environment. Thus, the following section reviewed the mechanism between man and environment.

2.3 Environmental factors affecting human perceptions

Human perceptions towards environment are constructed by various aspects of the physical world such as environmental, physiological and social/ behavioural factors (Chen& NG, 2012). Among these factors, environmental factor is an important issue as it determines the quality of spaces. For urban public spaces, because they are mostly unshaded outdoor spaces, the comfort level of 'microclimate' is often stressed as the primary factor in attracting people to use them (Jacobs & Appleyard, 1987). The term 'Microclimate' is used to describe the environment of urban public spaces within the range of people's perceptions (Katzschner, 2006). The 'climate' is referred to the long-term behaviour of the surroundings in a selected region. While a 'microclimate' is referred to a local atmospheric region where the climate differs from the encircling area (Raghed et al, 2016). The comfort of microclimate involves multiple aspects of the environmental factors that people can feel and experience, such as, wind comfort, visual comfort, acoustic comfort, olfactive comfort, thermal comfort (Reiter& Herde, 2003). In the following sections, how the various environmental factors influencing human behaviours and perceptions were thoroughly reviewed, especially for acoustic factor.

2.3.1 Human perceptions and physical environment

2.3.1.1 Human- environment relationships

Previous studies show there has been wide discussion of how people perceive the physical environment (Schweiker, 2020). Environmental perception was defined as '*awareness of, or feeling about, the environment, and as the act of apprehending the environment by senses'* (Zube, 1999). Ittelson (1973) stressed the transactional process between the person and the environment and viewed the environmental perceptions as a multi- dimensional phenomenon. According to Ittelson (1973) there are three natures of perceiving process: first, it is not directly controlled by the stimulus; second, it is linked to and indistinguishable from other aspects of psychological functioning; and third, it is relevant and appropriate to specific environmental contexts. Tuan

(1977) defined that perceptions is both the response of the senses to external stimuli and purposefully activity in which certain phenomena are clearly registered while others recede in the shade or are blocked out. His definition stressed the human agency which can block some senses and leave others. The perceptions we perceive usually have value, either for biological survival, or for providing certain satisfactions that are rooted in culture. He considered that perception is usually mixed with the concept of 'attitude' and 'world view'. In his point of view, 'attitude' is primarily a cultural stance, which is formed of a long succession of perceptions and is more stable than perception; world view is conceptualized experience which is constructed by personal and social aspects.

A two- way process between people and environment was introduced by Carmona et al (2010), people create and modify spaces while at the same time being influenced in various ways by those spaces. The physical environment is believed to influence the patterns of human behaviours and further on social life through the design process. Social behaviours in physical environment can be:

1) Constituted through space- where site characteristics influence settlement form;

2) Constrained by space- where the physical environment facilitates or obstructs human activity;

3) Mediated by space- where the friction-of- distance facilitates. Or inhibits, the development of various social practices.

In this way, Carmona et al (2010) stressed the role of human agency and introduced the concept of environmental possibilism. Rather than physical environment determines human behaviours, environmental possibilism believes urban design can act as a means of manipulating the probabilities for certain actions or behaviours occurring. Physical environment provides various probabilities, and people choose among them. In a given physical setting some choices are more likely than others- which is referred to how design can change people's behaviours. What people actually do is defined as the 'resultant' or 'effective' environment. Designers create potential environments, people create effective environments.

Rapoport (1976) raised the 'image' theory to explain how people perceive physical world. He defined 'image' as '*an internalized representation which is individual's mental representation of*

the parts of external reality know to him/her via any kind of experiences (including indirect experiences).'In this sense, two levels of components are involved in the term of 'image': a) value images; 2) factual and knowledge images. Value image includes how people rate the world on the scale of better or worse. While factual and knowledge image seems more like the accumulation of experiences. Rapoport quoted Boulding (1956) to emphasize that all behaviours are depended on the 'image'. Real world is firstly filtered by cultural image and then personal image, in the end to form the perceived world. Built environment is based on 'images', as values are embodied in images and they help simplify and complexity of the world. Based on the two components of the image theory, he further combined Boulding's ten dimensions of the image and summarized three structured image components:

1) Ideals and preferences, affective ranking of values: including the value image and affectional image of the Boulding's theory. These two aspects play an important role in evaluation and preferences.

2) Factual knowledge and how this related grouping and arrangement of elements: including the spatial image, temporal image, relational image and personal image of the Boulding's theory. The first three is referred to space, time and relation which are the major aspects of urban organization and behaviours. The fourth is referred to how people themselves and how they structure the society. These four images construct the cognition level of how people perceive the environment

3) Grouping and similarity in terms of structure, properties and components: including the conscious, subconscious and unconscious image, certainty or uncertainty image, reality- unreality image and public- private image. The first image influences the strength of holding an image on the assumption that subconscious and unconscious images are more emotional and be more resistant to change. Certainty and reality are referred to how people take actions based on the confidence about the images and about the consequences of decisions occurred in the real world. Public and private image are focused on the importance of considering different scale of images when doing architecture designing. Images in this aspect step into the stage of categorizing, clustering and linking components.

2.3.1.2 Factors influence the human environmental perceptions

Multiple factors influence the construction of image and further influence the perceptions and evaluations of built environment. Rapoport's image theory (1982) emphasized the cultural factors because images are more than individual, they can be shared among a group of people, which is referred to the public and private image. Public images are understood and acknowledged by people under the same culture, which affect the way they organize their ideals, fashion, and the likes. Public images also lead to specific ways of coping with the environment, such as architectural design. The social organization and the chosen environment help with the transmitting and developing particular images. In this way, particular public images are consolidated in people's mind.

To further explain cultural factors influencing human perceptions, Rapoport (1982) put forward the theory of 'decode' to further explain the cultural factors influencing perception of the built environment. Environment is a form of 'nonverbal communication' where users have the means to decode these meanings. The environment will not communicate if the code is not shared or understood by its users. Eisler et al. (2003) put forward the similar theory that culture has their particular sets of rules, which are learned and shared by members of the same culture. They further acknowledge that identity and nationality can give impacts on users' perceptions and experiences of the place just as important as environment's objective physical attributes. Rapoport (1982) considered culture as the deepest embedded factor and it gives impacts through subculture, values, images, lifestyle and activities. Activities are thought to be the most useful entry point to relate built environment and culture. By comparing activities, researchers can identify the differences between lifestyles, values, worldviews and culture.

Research of the thermal environment suggested that psychological and cultural factors like thermal history and memory and expectations should be involved in to combine with the physiological approach (Nikolopoulou et al., 2001). Knez and Thorsson (2008) suggested that the cultural and psychological factor can influence people's attitude towards thermal conditions in parks. They conducted the research in Sweden and Japan about the influence of culture on people's thermal, emotional and perceptual assessment within the physiological equivalent temperature (PET) comfortable interval of 18-23°C. By contrast, Japanese people evaluated the weather as warmer and

less good for outdoor activities than did Swedes for similar thermal conditions. There is an interesting discrepancy between Japanese participants' positive place- related assessments and their less positive individual feelings. They attribute this to the Japanese culture's admiration for the personal attribute of modesty. They conclude that Japanese tend to impose avoidance of intense personal- related judgements and try to stick with the neutral assessment. While, Swedes kept consistency in their judgements and assessed the site more with their emotional feelings. All in all, researchers suggest that thermal, emotional and perceptual assessments of a site should be involved in a multi- disciplinary field with the psychological and cultural process.

Chen and Ng (2012) put forward a general framework for assessing outdoor thermal comfort (Figure 2.3). They summarized recent research on the behavioural aspects of outdoor thermal comfort and find out that the thorough microclimatic analysis and thermal comfort assessments have only been involved in the last decade because of the development of techniques in the field of urban climatology and biometeorology. They complete with the framework for analysing outdoor thermal comfort to deal with the multiple layers of this concern. Similar to Nikolopoulou's (2006) suggestion of combining physiological approach with psychological and cultural factors, they concluded four levels to learn outdoor thermal comfort in terms of behavioural aspects: physical, physiological, psychological, and social/ behavioural (Fig 2.3). Although this framework is intended for thermal research, it is functional for studying other environmental factor in the outdoor spaces.

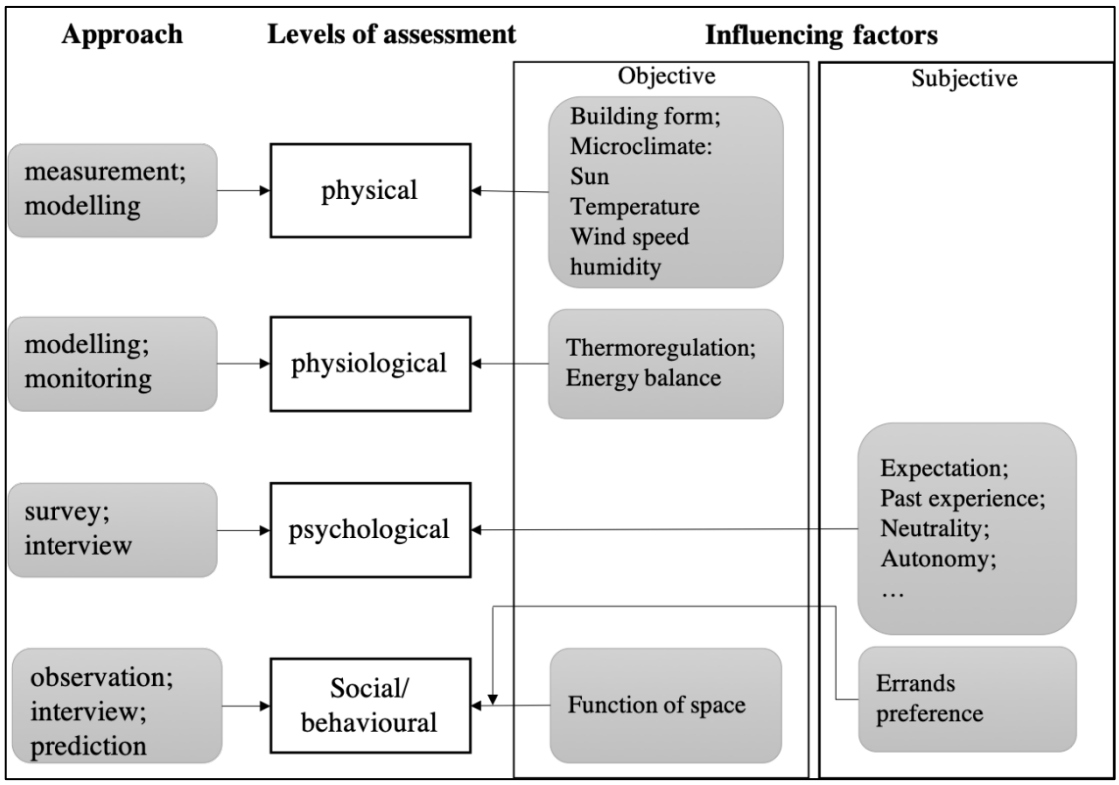


Figure 2.3 A framework for outdoor thermal comfort assessment based on behavioural aspect (Chen& Ng, 2012)

2.3.2 Various environmental factors in urban public spaces

2.3.2.1 Physical environment in relation to human perceptions

In the understanding of environmental determinism, the physical environment has a determining influence on human behaviours (Carmona et al., 2010). The quality of the physical environment is stressed as one of the core factors for evaluating the comfort level of public spaces. A study based in Norway showed that a suitable microclimatic design could extend the time people spend in outside public spaces by almost six weeks (Reiter& Herde, 2003; Culjat& Erskine, 1998). The microclimatic design includes several principles, such as wind protection, orientation for sun, prevention of shadowing, etc. (Culjat& Erskine, 1998; Zrudlo, 1988). Gehl (1987) also attributed the various activities happening in the square to the microclimate conditions. Activities like optional activity and social activity only happen when the environment is appropriate. And because people

perceive the physical environment through their sensory apparatus, environmental factors are believed to be highly linked to the comfort of a place.

Hall (1992) compared the relationships between humans and environment to animals in the nature in order to explain how humans perceive the physical environment by the information received through all kinds of sensory apparatus. He categorised human sensory apparatus as: 1. The distance receptors- the eyes, the ears, and the nose; and 2. The immediate receptors- sensations received from the skin, membranes, and muscles. And these sensory apparatuses mentioned are related with the microclimate conditions, such as eyes correspond to the visual comfort. Hall gave various examples illustrating how human's sensory system make the influence on people's experiences in the space. He also pointed out that space perception is not only a matter of what can be perceived but what can be screened out. He related sounds to the visual and pointed out the effect of incongruity between visual and auditory space. Black (1950) demonstrated that the size and reverberation time of a room affects reading rates. People were found to read more slowly in larger rooms where the reverberation time is shorter than in smaller rooms (Hall, 1992:44). The feeling of 'small' or ample also comes from sensory apparatus, which is based on human's kinaesthetic feeling, such as not 'bumping into things'. The sense of 'spaciousness' is experienced on whether or not you can walk around. As a result, Hall emphasized the importance of design kinaesthetic space because users' actions somehow are determined by their physiologically using experiences in a given space. Thus, environmental factors are stressed based on the feedback of human sensory apparatus, such as the smell of the nose.

Gibson (1979) suggested five sensory systems: the visual system, the auditory system, the taste- smell system, the basic- orienting system, and the haptic system. Similar to Hall, Gibson's sensory theory also comes from the observations from animals and environment. Touch, smell and taste are believed to give the 'near-space' information, which is the space immediately around the person's body. In contrast, visual and auditory systems receive information over a greater range, which is called 'far-space'. In the animal world, visual information is projected to the eyes by the flux of daylight illumination; acoustic information is transmitted to the ears by sound signals. Sound is an excellent channel for communication, such as danger signals by cries, calls, growls and grunts.

These phenomena also reflect in the city environment: images and sounds in the public spaces can offer great amount of information to guide people's behaviours. Thus, theories in this filed often suggest that design progress should respond to human's sensory system to give back and positive information to satisfy users.

In the context of urban public spaces, thermal, acoustic and olfactory factors were frequently analysed in the literature. Thermal satisfaction and the mechanical strength were considered as two main microclimatic elements for outdoor comfort, because they highly related to human activities and can be greatly enhanced by planning and designing (Nikolopoulou, 2011). Katzschner (2006) pointed out that appropriate thermal conditions can lead to high intensity of human activities. In terms of the appropriate thermal conditions, they further pointed out that thermal conditions can be required differently depending on activities people involved in. The smell aspect in urban public spaces often involve a number of negative odours, including odours with pollution, such as factory exhaust, car exhaust, or unpleasant odours, such as smoke and perfume mixes (Ba et al., 2020). The smell of smoking in public spaces was addressed as the negative smell in relation to public health (Kaufman et, al., 2010). Other smells like coffee, spices, vegetables, freshly plucked fowl, clean laundry were believed to evoke the feeling of life when experienced in public spaces (Hall, 1992). Olfactory factor was still required further investigation considering its complexities. A standard perceptual model is needed for analysing 'smellscape' (Xiao, Tait& Kang, 2018). Acoustic comfort was emphasized in urban public spaces context because the great concerns about urban noise (Brown, 2011). Previous studies have made lots of efforts on analysing and modifying urban noise and some researchers have also been turning to pay attention to sound perceptions and preferences (Aletta et al., 2016). Sound perception was emphasized because although noise can give negative impact on people's physiology and psychology aspects, soundscape evaluations is quite complex. Some negative sounds are considered as meaningful and can provide information to people (Aletta, Kang& Axelsson, 2016). Therefore, researches on soundscape evaluations is important for the design of sound environment in urban public spaces. At the same time, the other environmental factors, like olfactory, thermal and visual aspects and the interrelationships among these factors also should be considered when carrying out soundscape researches in urban public spaces.

2.3.2.2 The relationship among acoustic, visual and olfactory factors

Among those environmental factors related to sensory apparatus, acoustic and visual are widely recognized as two interacted factors. There are mainly two kinds of interrelationships: One is that sounds can deliver complementary information to visual scenes; the other is visual aspect can influence the auditory experiences. Acoustic information usually gives appropriate accompany to the visual scene. The information delivered by sounds enhance the visual evaluation and even the whole environment. Carles et al. (1999) showed a rank of preferences running from natural to man-made sounds, with the nuance of a potential alert or alarm-raising component of the sound. It is suggested that there are two main functions of sound in the landscape, which provide information in addition to visual data. One function is related to the interpretation of the sound identified, such as water, birdsong, voices and cars, and the other is related to the abstract structure of sound information. The first function is identified by how human sounds (voices, footsteps and conversations, etc.) fit in relative to natural sounds (highly rated) and technological sounds (widely rejected). When human sounds were understood as an element of communication, they add to an appreciation of humanized spaces. While, in certain places with a distinct environmental identity, any acoustic disturbance can lead to a rapid deterioration in quality. Natural sounds, meanwhile, may improve the quality of built-up environments to a certain extent. Many natural sounds (especially the water sound) are proved to enhance both the images of natural environment and of urban spaces. For the second function is closely related to its physical structure with the ability to produce alarm or alert. And further, the relationship between a sound's alert- raising capacity and their setting in which it appears has an important impact on its interpretation. In this way, visual and acoustic information can reinforce or interfere with each other. The sense of coherence or congruence between visual and acoustic information is associated to aesthetic preferences which has been analysed in classic studies.

On the contrary, visual information can also contribute to the soundscape evaluation. In an experiment carried out in an anechoic chamber in which stimuli were electronically generated, Parlitz and Colonius (1993) confirmed the significant influence of visual parameters in the appraisal and perception of sound. They concluded that different sensory stimuli, auditory and visual,

converge in 'multi-sensorial' neurones which govern functions like spatial ability and orientation. Viollon and Lavandier (1997) found that visual conditions modify the auditory perception of subjects to a significant degree.

Sounds should be appropriately combined with the visual scenes. As in the research of Carles et al. (1992), who found that '*a general factor of congruence may be evoked to explain most of the observed interactions'*. Appraisal of a sound depended largely on the extent to which it matched with the setting in which it occurred (e.g. natural sounds in a natural setting). When sounds are not appropriate to the context in which they are perceived and do not provide readable information on the same (traffic circulation in a natural landscape) they are perceived as 'noise' and negatively rated. Research focused on tranquillity has also found that the combination of the maximum sound pressure level and the percentage of visual natural features present at a place determine the feeling of tranquillity (Pheasant et al., 2008).

Olfactory factor was found to have associations with sounds during the sensory walk research, when participants reported the traffic noise along with the fumes' smell from the cars. The mixed traffic smell and sounds of taxis, cars and buses were even considered as a distinctive characteristic of urban public environment (Zardini, 2005). Bruce et al (2019) pointed out that smells and sounds were linked to place expectation. They summarized the patterns of smell and sounds in English cities, which suggested the urban public spaces usually have a combination of people, perfume, food and traffic smells with talking, shouting, footsteps, traffic, loud music sounds.

2.3.3 Behavioural and emotional influences from physical environment

2.3.3.1 Social behaviours influenced by physical environment

Gehl (1987) suggested that human behaviours are constrained by physical environment because of human's physical abilities. In the above sections, physical environment is believed to be perceived through sensory apparatus from eyes, noses, ears to skin, membranes, muscles, etc. Based on this understanding, it was suggested by Gehl (1987) that physical environment of urban public spaces should correspond to the limit of human physical abilities. Gehl tried to control those sensory

apparatus within particular distances, such as he defined the smell apparatus only working within the distance of 2-3 meters to catch the normally strong odours; ears can hardly hear other people clearly at distances beyond 35 meters; people can see and perceive others at distance from 0.5 to 1 kilometre and recognize human individuals at about 100 meters. To stimulate more activities in urban spaces, the scale and layout of city can be rather important. Gehl (1987) pointed out that the usual radius of action for most people on foot is limited to 400 to 500 meters per excursion. The possibilities for seeing other people and events are limited to a distance of between 20 and 100 meters. These two limits are closely related to the activities of people in urban spaces. Setting the dimensions of streets and squares in relation to the limit of human abilities and range of senses can work efficiently for stimulating activities and improve the using experiences.

In line with the understanding of 'resultant' environment, frequent uses of a place is believed to be resulted from pleasant and comfortable environmental conditions. Experiments were conducted to analyse the relationship between the physical conditions and the uses of public spaces. It was concluded that the environment conditions can affect the staying time, numbers and activity types of public space users (Bild et al., 2018). In poor quality public spaces, only necessary activities will happen, while when higher quality conditions provided, a wide range of optional activities will tend to occur (Gehl, 1987). Similarly, an experiment of how thermal comfort affect the public space use conducted by Nikolopoulou et al (2011) found that better microclimatic conditions can raise the numbers of users in public spaces. Thermal conditions also are proved to directly affect the activity types. Social activities, cultural activities and breaks require for much warmer conditions than other strenuous activities (Katzschner, 2006).

Besides the using time and users' number, people's feelings of comfort also partly come from the level of physical comfort. Feeling of comfort is more about the subjective evaluation which is based on a combination of people's physical, physiological, psychological, sociological and cultural factors (Reiter& Herde, 2003; Katzschner, 2002). Olgyay (1963) put forward a Bioclimatic Chart based on outdoor studies to explain outdoor thermal comfort. In his chart, he not only concern about the thermal factor, but also include other parameters to evaluate comfort, such as air temperature, wind speed, radiation and humidity. He emphasized how these parameters relate to each other's and

how some factors can be compensated for by the variation of another. In other words, when some places cannot satisfy users by particular aspects, they can try to enhance other environmental factors to make compensations. Whyte (1980) also pointed out that environmental factors are entangled with each other. When the weather is considerably cold, people in the urban squares tend to seek places in the sun. When the weather has turned into warm enough, occupancies would not be highly related to the sun.

Gehl (1987) pointed out the scale of physical environment can give influences on social behaviours and relationship intensity. Distance theory indicates that small scale of places can encourage social interactions as the intensity of experience is increased with reduced size. In small scale environment, all kinds of sensory apparatus can work to discern both the whole and the details, which is the best experience ever. Environments built in small scale, such as narrow streets and small buildings, provide a feeling of intimate, warm and personal. In contrast, large spaces such as wide streets and tall buildings leave a feeling of cold and impersonal. Furthermore, where the space is too narrow such as in elevators, ordinary conversation and social interactions cannot be produced.

As sociability is considered as an important function of urban public spaces, it is proved that pleasant physical environment can encourage people to make more social interactions. The research conducted on smell proved that people waited in the room with scented condition showed more social interaction behaviours than did the participants that waited in the unscented one (Zemke& Shoemaker, 2007). In other words, this research proved that the factor of smell in the environment has an influence on people's social interactions. Designers may have the ability to enhance sociability by improving the ambient scent.

2.3.2.2 Emotion response to the built environment

Emotion takes an important part in experiencing and perceiving the built environment. Neuroscience studies have found that people usually experience emotions before they are consciously aware of them. This result reveal that the emotion responses towards built environment take place by a complex process involving multiple steps. Rapoport (1976) concluded that man-environment interaction involves three areas- knowing something, feeling something about it, then

doing something about it. He then put forward three stage of process in line with Boulding's (1956) theory to give further explanation:

1) Cognitive: involving perceiving, knowing and thinking, the basic process whereby the individual knows his environment;

2) Affective: involving feelings and emotions about this environment, motivations, desires and values (embodied in images);

3) Conative: involving acting, doing, striving and thus having an effect on the environment in response to (1) and (2).

These three stages depicture the primary components of the 'image', which is the classic theory raised by Rapoport. As described above, conative respond to the influences from both cognitions and emotions. Affective and cognitive are both mental responses to the environmental stimuli, which build a dynamic and interactive system. For cognition, Rapoport (1976) differentiate it with perception and preference: perception is how information is gathered and obtained; cognition is how it is organized; preference is how it is ranked and evaluate. Perception is more from emotion aspect as it is considered as more sensory, more related to direct experience, involves the individual in the specific environment. Cognition as defined by Schreuder et al (2016) is believed to base on the emotional experience and perceptions and reach the conscious stage, which explain the way of 'organize'. For the relationship between these two components, there exist argument about whether cognitive or affective give more important influence and what is the hierarchy of three components in the whole process.

Schreuder et al (2016) put forward a conceptual multisensory response model which describes different levels in processing stimuli and their link to relevant outcomes: emotion, cognition, behaviour and decision making. In this model, named the SOR model, the environmental stimuli (S) evokes an emotional response in individuals (O), and following with potentially elicitation on either approach or avoidance behaviour (R). Two influential models emerged based on this model, which are different in the how emotions make the mediating affect during the SOR process. In the first model, emotions are believed to have a mediating effect on the appraisal process (cognitions) and behaviours toward the perceived environment or product. While, in the second model, emotion has

a mediating effect on the relation between appraisal and behaviour. They define emotion as a short-term state which is directly related to the environmental stimuli. Both consciously and unconsciously state (response) are included. Based on these two aspects, from the external perspective, people can perceive a painting or environment with emotional content and consider it as an emotional scene even if they do not actually experience any emotions. From the internal assessment perspective, people can have an emotional experience when looking at a scene.

Before actions are taken, people usually experience the cognition and emotion stage. In the model of Rapoport (1976), actions are located in the stage three which are affected by emotion and cognition. In the model of Schreuder et al (2016), emotion is emphasized as the mediating rule which can either influence both on cognition process and behaviours or influence the relationship between cognition and behaviours. According to the EIC model from Lerner et al (2015), emotion is emphasized as the dominant driver in most of meaningful decision-makings of one's life. Emotions in this model work from two aspect: the first one emphasised that people make decisions depended on predicting one's emotion response to that outcome. These predicted emotions enter as rational inputs and influence the making decision process. In this hypothesis, emotion has not been produced or felt, it is predicted and it influence the decision. Emotions in the second kind are felt at the same time of making decision which is considered as completely outside the scope of rational choice models. Emotion directly give influence on the cognition and further affect the decision-making. Also, emotion can indirectly influence decision making by changing predicted utility for possible outcomes.

There are generally two opposite emotional responses, negative and positive. Negative emotional responses are referred to such as fear for the potential of conflict and harm triggered by urban stressors. Positive emotions are referred to such as enjoyment and excitement. Moscoso et al (2018) suggest five kinds of emotional states both from negative and positive aspect: happiness, sadness, tranquillity, fear and irritation. These five categories were considered to influence human life and universal human responses. Fear emotion is frequently referred in the context of public spaces, the feature of social and environmental qualities of outdoor spaces also create the convenience for unsafe conditions, especially for women (Jorgensen et al., 2013). As discussed in

Chapter 1, women are found to be more afraid and sensitive to the potentially crime and harassment in the urban public spaces. And dark public spaces usually are considered as unsafe places.

Environmental factors closely related to human sensory apparatus are proved to evoke diverse psychological responses. Smells are believed to evoke much deeper memories than either vision or sound and help people locate themselves in the environment. Some smell even gives the space with the atmosphere of life and soul, like the smell of coffee, spices, vegetables, freshly plucked fowl, clean laundry, give positive influences on the emotions (Hall, 1966). Sounds evoke emotions has also been analysed in the previous studies. Sounds are considered as one of important aspects of psychology that can influence decision making (Clore, 2012). Sound types are related to emotion responses in the study of Moscoso et al (2018), natural sounds were associated with positive emotions, whereas mechanical and industrial sounds are linked to negative emotions. Different from other sound types, natural sounds are considered as valuable resources that have abundant meanings in non-urban environments and benefit human wellbeing. In another study, researchers aim to understand and define the emotional dimensions of a soundscape, and two independent emotional dimensions of a soundscape was defined as ‘calmness’ and ‘vibrancy’.

By analysing how environment evokes emotional responses in individuals lead the way to understand how people interact with the built environment. This understanding can allow planners, architects, engineers and designers to better understand the link between human and environment and make better decisions about built environment design, further achieve positive results from users’ feedback. While previous studies on emotional responses from acoustic environment is still limited and the mechanism between them are still not clear. Sound, as one of the environmental factors also can construct human perceptions towards physical world. Next stage of literature review is required to broaden the knowledge of perceived acoustic environment.

2.4 Soundscape in urban public spaces

It has been increasingly acknowledged by landscape architects and urban planners that acoustic factors contribute significantly to the perception of urban public spaces (Sun et al., 2019). The

concept of ‘soundscape’ emerged to pay more attention on the perceptual aspect of acoustic environment in analogy to ‘(visual) landscape’ (Cain et al., 2013). There is no single agreed definition of soundscape, Payne et al (2009) defined ‘soundscape’ as: soundscapes are the totality of all sounds within a location with an emphasis in the relationship between individual’s or society’s perception of, understanding of and interaction with the sonic environment. Recently, International Organization for Standardization (2014) defined soundscape as: ‘[the] acoustic environment as perceived or experienced and/or understood by a person or people, in context’. Both definitions emphasize how listeners perceive and understand sounds in different context of environment.

Because soundscape focuses on both the perceptual and the physical aspect of sounds, measuring it is quite complex. Previous works focused on the physical aspects of sounds, such as sound vibrations (Genuit, 2006), loudness (Lavandier, 2006) and noise annoyance levels (Payne, 2013; Alves et al., 2015). Others emphasized the importance of measuring perceptual aspect of sounds and break down soundscape into several key components or investigate the perceiving process of sounds (Davies et al., 2013; Schulte-Fortkamp& Fiebig, 2006). Later, researchers put forward ‘soundscape descriptors’ to deal with them soundscape. Soundscape descriptors are emphasized as productive measurements for soundscape perceptions (Aletta et al., 2016). Various sets of soundscape descriptors were summarized through different methods in the previous works. While it still lacks uniformed systems for defining and categorizing soundscape descriptors to tackle with diverse sound context.

Thus, the following sections review previous work about the measurements of soundscape and the factors that influence soundscape evaluation.

2.4.1 Categorizing sound sources in urban public spaces

The way in which people categorize different sounds is the fundamental basis of the soundscape perceptions. Sound sources are defined as the physical entities that make up the sound environment (Davies et al., 2013). Kull (2006) considered that a soundscape is an entire acoustic environment resulting from natural (non- anthropogenic) and man-made (anthropogenic) sound sources. The

non- anthropogenic sounds include the weather, animals, natural physical/mechanical, vegetation, and the terrain. Anthropogenic sound elements include mobile sources, stationary sources, structures/materials, noise controls, and barriers. Nature and man-made represent two extremes of sound sources, which facilitate people to differentiate sound types. Besides these two categories, other works classified sounds into three categories: 'natural', 'human' and 'mechanical' (Payne et al., 2009) or four categories: natural sounds, human sounds, mechanical sounds and instrumental sounds (Yu& Kang, 2010). Liu and Kang (2014) classified five major categories: human, mechanical, traffic, geophysical and biological sound. They put 'voice & instrument' and 'social/ communal' into the category of 'mechanical sound'. Traffic sound was categorized as an independent category as they want to emphasize it in urban context.

Rather than define a soundscape according sound types, other researchers have focused on the categorization method that people use. Maffiolo et al (1999) found two generic categorization types based on non- expert listeners' point of view: 'event sequences', where individual sounds can be distinguished from the whole soundscape; and 'amorphous sequences', where individual sounds are not easily distinguished. Similarly, Raimbault (2006) summarized two modes of sound categorization methods, 'descriptive listening' mode and 'holistic hearing' mode. In the 'descriptive listening' mode, people can identify individual source or event. While in the 'holistic hearing' mode, people perceive the sounds as a whole. Kuwano (2003) also found that listeners usually have a 'overall impression' over sounds. According to their research, the prominent sounds may contribute more greatly to determining the overall impression than less prominent sounds. It is not always the loudest sound become the prominent sound. The serial order of presentations of sounds in the memory is also important. In other words, both the loudness of the sound and the content of the sound have a role to play in influencing the overall impression. In Vanderveer (1979)'s research, they found two methods for sorting sounds: one is acoustical similarity (or temporal patterning in particular), which means people tended to categorize sounds with similar patterns together, such as sounds of 'pin box', 'sawing', 'filing' shared similar sound patterns; the other is relatedness of source events (or meaning), which means sounds were caused by similar events, like 'drop pen', 'drop can' and 'drop wood'. Davies et al (2013) reviewed the previous studies and summarized that

people perceive the soundscape on basis of the categorization of sounds, the prominence of the sounds, and the comparison of ratio of different sound types.

Researchers categorized sounds into different types by various methods: there is no one agreed method for sound categorization. Some researchers suggested that sound categorizations can be influenced by listeners background (Woodcock et al., 2017). 'Expert' and 'non- expert' listeners were found to categorize sounds differently in Lemaitre et al (2010)'s research. Based on Vanderveer (1979)'s 'acoustical similarity' and 'relatedness of source events' method, they found that experts tended to use acoustical similarities more often than non- experts. Non- experts mostly used the similarity of the cause of the sounds. In the research of Raimbault (2005), they applied linguistic analysis and found that planners used a much more technical vocabulary and generic expressions when describing soundscapes than city-users. The sounds categorizations used by planners and city-users are not the same (Figure 2.4), it can be seen that planners tended to refer more to an object-centred concern than to a human-centred one. Planners were also more worried about noise complaints and noise management, than to ambient quality that could enhance users' experiences. Users, on the opposite, were more concerned with their own psychological and physical experience.

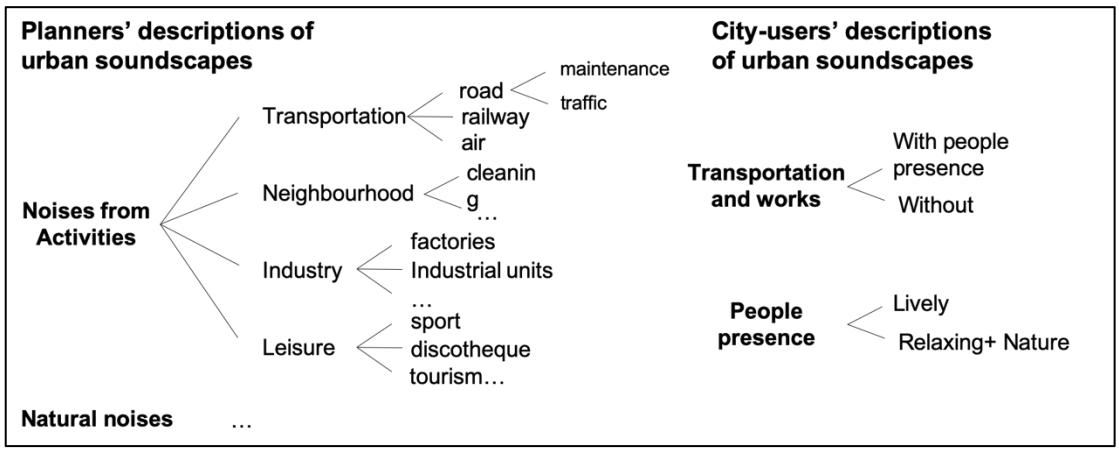


Figure 2.4 Comparison between planners' and city- users' verbal descriptions of urban soundscapes (Raimbault, 2005)

Brown et al (2011) pointed out three problems in categorizing sounds: first, background sounds and foreground sounds are not clearly clarified. In some researchers, sound sources were just listed together without showing how they are delivered. Second, the categorizations of sound types were not uniformed, such as the differences between complex multiple objects and simple objects. This problem is due to the human values which are intertwined into the presence and nature of sound sources. Thus, the affiliated relationship should be clear. Third, the sound context should also be taken into considerations. Brown et al (2011) summarized a taxonomy of the acoustic environment for soundscape (Figure 2.5) to categorize sounds according to the where they come from and how they are generated. There are mainly two kinds of sound sources: sounds generated by human activity/ facility and sound not generated by human activity. Under the category of sound generated by human activity/ facility, they decompose five types of sources: motorized transport, human movement, electro-mechanical, voice& instrument, and social/ communal. Sounds not generated by human activity include domesticated animals and nature sounds. Although Brown et al (2011)'s taxonomy map almost includes all types of sounds of urban soundscape, it should be noted that common people may not able to distinguish between these sounds.

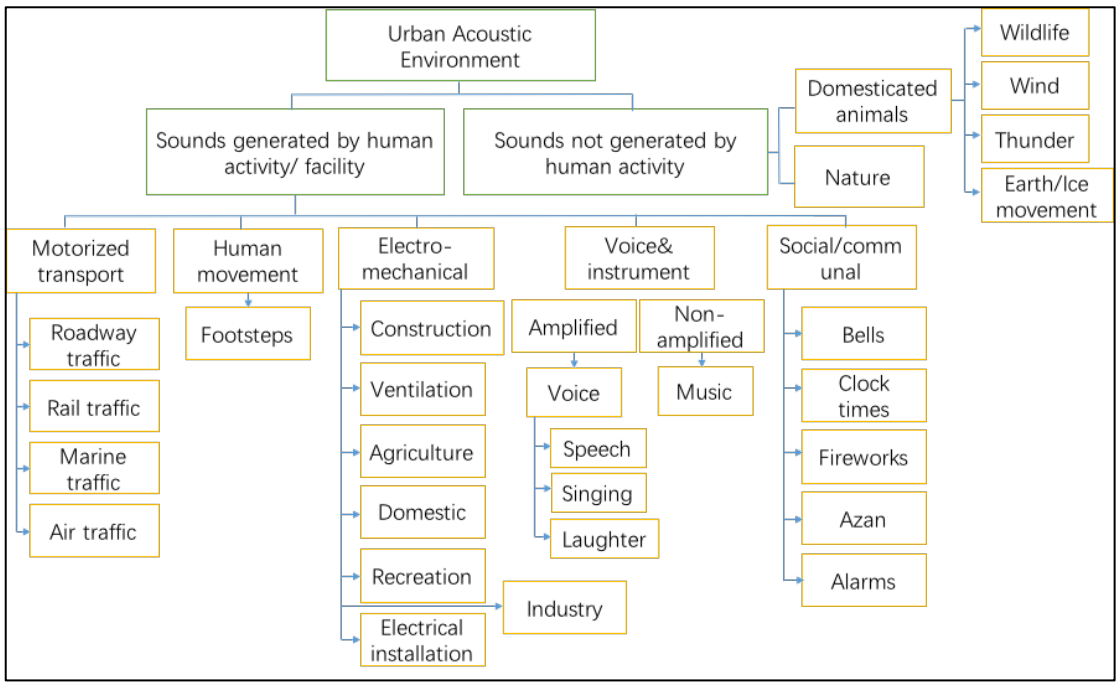


Figure 2.5 The taxonomy of the acoustic environment for soundscape (Brown et al., 2011)

Recently, based on the previous studies, Sun et al (2019) proposed a hierarchical classification to be used for labelling audio-visual collections or as a first mapping of the city as shown in Figure 2.6. Their classification does not focus on specific sound sources, but rather on the variability among the sound features in a holistic context. According to the Figure 2.6, backgrounded and foregrounded sounds were classified at the first stage. In the second stage, people could differentiate disruptive or supportive sounds. These two indicators are referred to whether the sound environment can support or interrupt their activities in the place. A disruptive sound environment can lead to annoyance. The final stage is referred to the emotional results from sound experiences by two arousal dimensions- calming (reducing arousal) and stimulating (increasing arousal). Their classification has more emphasis on the sonic environment itself and reduce the impact due to the differences in perceptions among people.

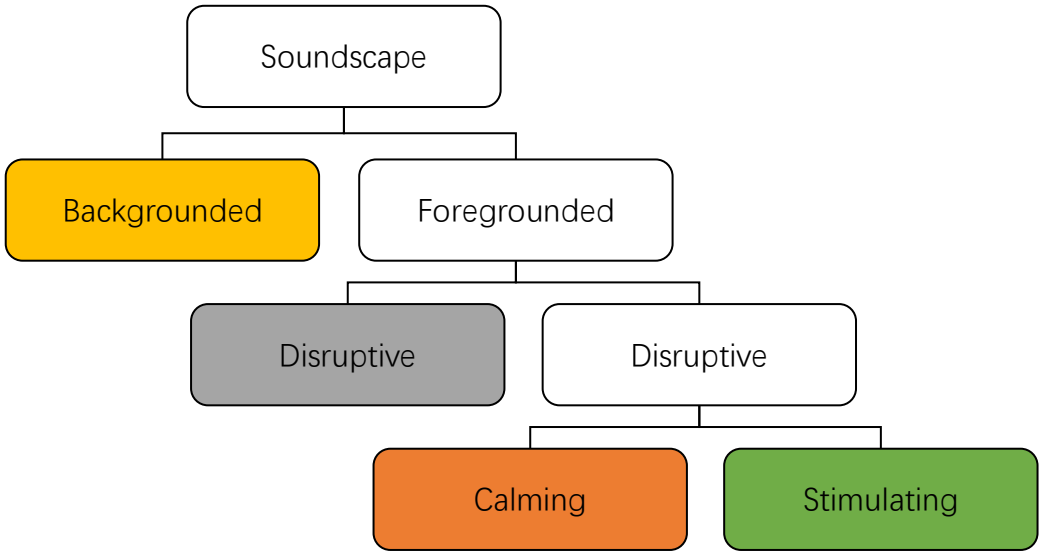


Figure 2.6 The hierarchical classification of urban soundscapes (Sun et al., 2019)

2.4.2 Perceptual structures of soundscape

Previous studies about soundscape perceptions usually break down soundscape into several key components to analyse sound perceptions (Davies et al., 2009; Raimbault& Dubios, 2005). Axelsson et al (2010) raised the two-dimensional coordinates- pleasantness and eventfulness. Through principle components analysis, 116 attributes were divided into three zones, which are named as pleasantness (50%), eventfulness (18%) and familiarity (6%). Pleasantness and eventfulness organize the soundscape attributes in a circular pattern. Pleasantness is summarized from uncomfortable, comfortable, appealing, disagreeable, inviting, etc. Eventfulness is explained by eventful, lively, uneventful, full of life, mobile, etc. These two- dimensional coordinates also respond to the findings of Russell and Snodgrass (1987): environmental appraisal would be represented by the two components- Exciting and Calming. The key components of soundscape raised by Kang and Zhang (2010), relaxation, communication, spatiality and dynamics, also include meaning of pleasantness and eventfulness. Under each category, Kang and Zhang (2010) applied a pair of indicators containing both positive and negative aspects. Relaxation includes indicators of comfort- discomfort, quiet- noisy, like- dislike, etc. Dynamics includes hard- soft and fast- slow sounds. Spatiality indicates the relationship between sounds and spaces, which involves indicators like varied-simple, echoed-deadly and far-close. Communication is referred to the sound experiences social-unsocial, meaningful- meaningless, calming-agitating, and smooth- rough. Kang and Zhang (2010) pointed out that these four elements cover the main facets of acoustic design for urban public space: function (relaxation and communication), space, and time. The functional facet indicates that people perceive sounds through their requirements for activities (for relaxation or conversation) (Marquis-Favre, Premat& Aubre´e 2005; Payne& Guastavino, 2013). The latter two facets indicate that people can perceive the physical attribute of sounds in context (Raimbault et al., 2003; Herranz-Pascual et al., 2010). Each element has several indicators with two extremes, such as comfort- discomfort, quiet–noisy, pleasant–unpleasant under the element of relaxation. In their research, they also revealed the different understandings of soundscape between the general public and designers. Designers showed stronger preferences to natural sounds and their evaluation is also more diverse. Herranz- Pascual et al (2010) applied environmental perception theories to analyse

soundscape, and they suggested sound perceptions are determined by person (community), activity and place, and the interactions between person and place. For each person, sound perceptions consist of emotion (feelings), cognition (thoughts) and knowledge (meaning). While how these aspects work and what is the relationship among these three aspects lacks further illustrations.

'Appropriateness' was considered as another important components of soundscape. Aletta et al (2016) reviewed previous studies about soundscape perceptions and summarized eight major components of soundscape evaluations as: noise annoyance, pleasantness, quietness or tranquillity, music-likeness, perceived affective quality, restorativeness, soundscape quality and appropriateness. Among these categories, Aletta et al (2016) considered appropriateness as the 'third dimension' apart from pleasantness and eventfulness. Appropriateness is also mentioned in the studies of Bild et al (2018) as the 'expectations for soundscape'. People may feel 'inappropriate' when soundscape does not meet their expectations. Davies et al (2013) found that when people were asked to design a soundscape in a laboratory environment, those designed soundscapes were based more on people's expectations of typical urban soundscapes than on their own preferences for sounds. Appropriateness indicates how people believe in social norms and how social norms influence soundscape perceptions and evaluations.

Sounds are received through a process, from perceiving to experiencing to understanding (Dubios et al., 2006). Previous studies have summarized dimensions of soundscape, and the relationships among those dimensions represent the process of soundscape perception. Liu and Kang (2016) generated five dimensions for how people understand sounds from past to future in the urban context. These five dimensions capture people's understanding and psychological needs of the urban soundscape: soundscape definition, soundscape memory, soundscape sentiment, soundscape expectation, and soundscape aesthetics. Soundscape definition is a concept for the development of understanding, and can be broken down into soundscape memory, sentiment, and expectation. These three parts, respectively, lead to the accumulations of soundscape aesthetics from the past, present, and future. These dimensions represent the process of sound perceptions from past to future but do not address each individual's perceiving process. The research of Davies et al. (2013) suggested that a cognition process influenced how participants perceive sounds, such as

understanding the meaning of a soundscape and its components and distinguishing whether a soundscape supports one's behaviours. Three concepts comprise the perceiving process: sound sources, sound descriptors, and soundscape descriptors. Sound sources are physical entities, sound descriptors are descriptions of sounds, and soundscape descriptors refer to the totality of what is heard. People tended to focus on sound sources, which are in the 'foreground', compared to the soundscape descriptors in the 'background', whereas sound descriptors are in the middle. The sequence from the sound source to the sound descriptor to the soundscape descriptor represents a cognitive hierarchy from shallow to deep. However, the perceiving process of soundscape was still vague in their study.

Other studies reach the exact process of sound perceiving by focusing on how sounds are transferred into sound perceptions. Schulte-Fortkamp& Fiebig (2006) summarised five processes of people perceiving sounds in a parallel sequence: the acoustics of the sound(scape), the initial perception, a negotiation process internal to the listener, psychological reactions, and behavioural responses. The ISO's (2014) perceptual structure of soundscape explained how physical sounds were perceived and understood by people from acoustic environment through auditory sensation and interpretation of auditory sensation to response and outcome. It was believed that people could consciously or unconsciously process the auditory signal into useful information that would lead to the understanding of the understanding of soundscape. After this interpretation, the perceived sounds then bring with them responses and outcomes. Responses include short-term reaction, emotions, and behaviours. Outcomes include attitudes, beliefs, judgements, habits, and users' experiences (e.g. activities, actions, and mental states). This 'translation' process was summarised by Kang et al (2016) as the acoustic environment leading to human perception and then to human response/reactions. Both of the two perceiving process focused on the 'translation' from physical sounds to perceived sounds, the different perceptual stages in the perceiving process were not emphasised.

Soundscape descriptors and indicators were introduced as the measurement method for soundscape perceptions. Soundscape descriptor are measures of how people perceive the acoustic environment; soundscape indicators are measures of predicting the value of a soundscape

descriptors (Aletta et al., 2016). Descriptors are usually descriptive words or phrases to describe sound perceptions, while indicators are usually numerical terms. For example, Pheasant et al (2008) raised a descriptor- 'Tranquillity Rating' and they introduced to use sound levels and the percentage of natural features in a scene as indicators of 'Tranquillity Rating'. Further, Davies et al (2013) differentiated soundscape descriptors and sound descriptors: sound descriptors are descriptions of sounds including nouns, adjectives or phrases; soundscape descriptors are referred to the totality of what is heard. In other words, sound descriptors describe the features of sound sources. Their relationships were represented in the Figure 2.7. Davies et al (2013) proposed four soundscape descriptors: cacophony, hubbub, constant, and temporal. Soundscape descriptors summarize various sound descriptors into one word, for example, under the category of 'cacophony', there are crinkling, barking, roar, etc. Outside the four soundscape descriptors, there are soundscape indicators, which are the measurements of each descriptor. These four soundscape descriptors represent two axes: a cacophony- hubbub axis, and a constant- temporal axis. Cacophony and hubbub refer to the numbers of different sounds making up the soundscape and the levels of dissonance or discord perceived by the listener within the mix. Constant and temporal relate to the time of sounds, whether it keeps dull for a long time or changes quickly from time to time.

In terms of selecting appropriate descriptors, Aletta et al (2016) suggested descriptors to meet several requirements: 1. Provide measurement of how people perceive, experience or understand the sound environment; 2. Numerical, if used for modelling; 3. Either refer to a singular underlying dimension of soundscape (e.g. pleasantness) or to soundscape holistically (e.g. soundscape quality).

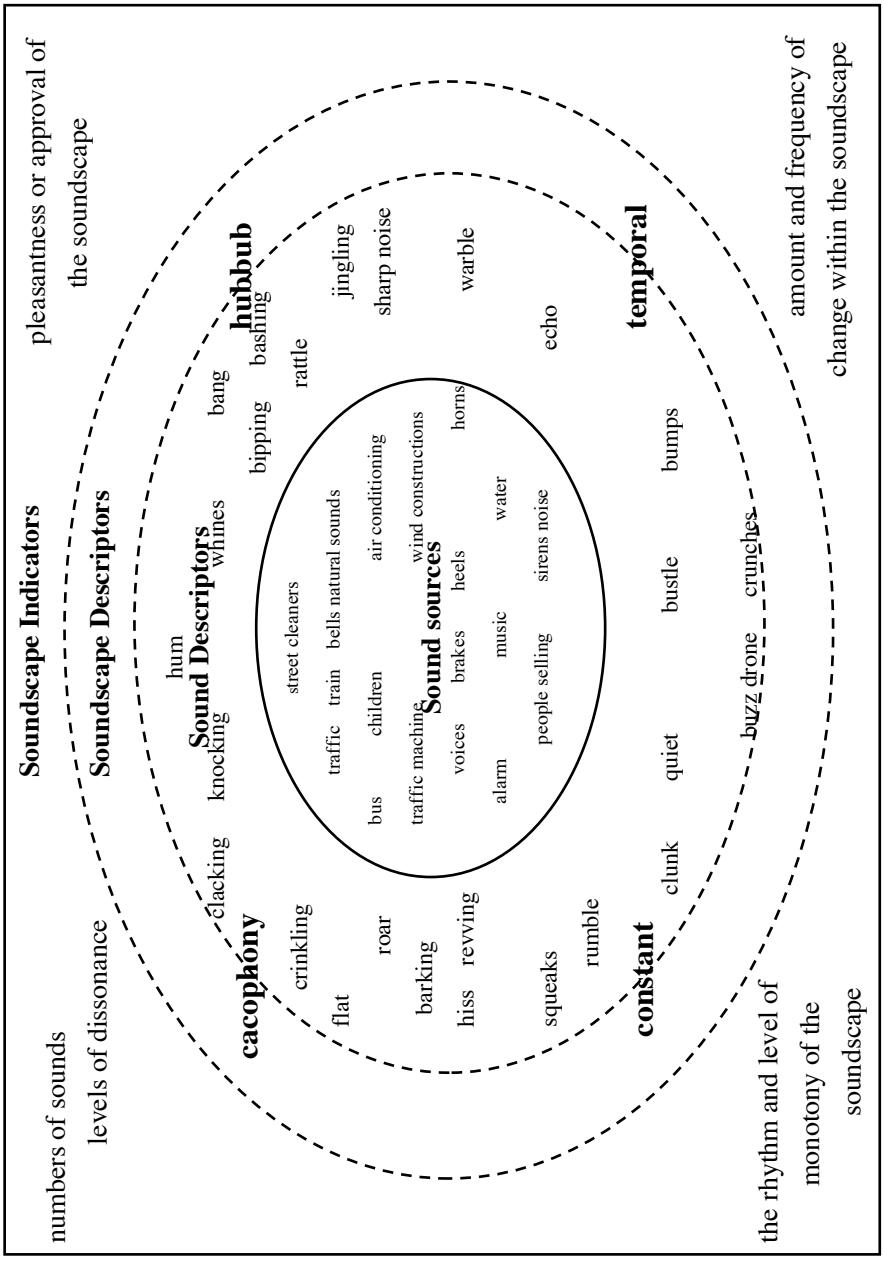


Figure 2.7 The relationship among soundscape indicators, soundscape descriptors and sound descriptors

2.4.3 Factors influence soundscape evaluations in urban public spaces

2.4.3.1 Soundscape evaluations in urban public spaces

Environmental evaluation or environmental assessment, is the process of assessing, or measuring, the change or consequences to environmental factors (Jain et al., 2012). Rapoport (1976) compared environmental evaluation to perception and cognition and emphasized the necessity of clarifying these terms. Environmental perception is referred to the direct sensory experience of the physical environment for those who are in it at a given time. It can also describe the meaning of environmental evaluation, i.e., the perception of environmental quality, and hence preference, migration (choice), behaviour, and decisions. Rapoport adopted the parallel term of environmental evaluation and preference as alternatives. Environmental cognition is used to describe the way in which people understand, structure and learn the environment and use mental maps to negotiate it. Perception is the process about how information is gathered and obtained; cognition is referred to how information is organized; preference is focused on how those are ranked and evaluated. Rapoport considered these three processes as three parts of a continuum.

Analysing every single sound source is the initial step of the soundscape evaluations in the urban public spaces. To evaluate sound sources, Schafer (1977) pointed out three typical sound types, keynotes, foreground sound and sound marks. Keynotes are origin from music, which identifies the fundamental tonality of a composition. Foreground sounds are referred to attention attracted sounds. Sound marks are those featured sounds which are acknowledged by a community and its visitors, similar to the meaning of ‘landmarks’. It seems that Schafer (1977) gave more emphasis on the typical and featured sounds, while, it is necessary to concern about both foreground and background sounds. Davies et al (2013) found that people usually tended to categories sounds into foreground and background. When the foreground sound required more attention allocation, by being loud, they tended to evaluate soundscape as negative. Sounds that blend together were evaluated as harmonious or positive. During the process of sound source identification, numerous sound sources can hinder the identification, people then perceive soundscape as a whole. Thus, two kinds of sound category are introduced to identify different way of processing in listening: ‘descriptive listening’ and ‘holistic listening’. ‘Descriptive listening’ is focused on identification of

acoustic sources or events. While, 'holistic hearing' is referred to perceive soundscape as a whole without semantic processing, in which no specific event can be isolated (Raimbault, 2006; Raimbault, Bérengier& Dubois, 2003).

Zhang and Kang (2007) suggested to consider the complexity of soundscape concerning interactions between plenty of sound sources and acoustic factors and other factors. They put forward four elements to analysing soundscape evaluation: sound, space, people, and interactions between acoustic and other physical or environmental factors. Sound is referred to the sound sources in the site. Space is about the place where sounds are delivered. People is referred to how social and demographic factors of listeners may influence the evaluations. Other interactions are referred to how soundscape evaluations can be influenced by other environmental factors, such as temperature or visual aspects.

Bild et al (2018) adopted three criteria to analyse soundscape evaluations from the aspect of whether soundscape benefit people's activities: disruption, stimulation and suitability. Disruption is referred to whether performances of users' activities are disrupted by what they heard; stimulation indicates whether the performance of users' activities are stimulated by what they heard; suitability is similar to the descriptor of 'appropriateness' (mentioned in 2.4.1), which is referred to whether the soundscape is suitable for users' activities.

In 2008, ISO working group ISO/TC 43/SC (International Organization for Standardization, 2014) summarized the whole process of the soundscape perceptions and evaluations. As shown in Figure 2.8, seven concepts were included as the processes of perceiving or experiencing the acoustic environment and the relationship among those concepts were also summarized: context, sound sources, acoustic environment, auditory sensation, interpretation of auditory sensation, responses and outcomes. These concepts work in the sequences to explain how people receive and understand soundscape: *sound sources* make up the acoustic environment, people perceive the soundscape through the process of *auditory sensation*, *interpretation of auditory sensation* help with the understanding, so as to produce the *responses* and *outcomes*. Evaluations happen in the stage of response and outcomes: *response* is referred to the short-term reaction and emotions; while, *outcome* indicates long-term consequence, including attitudes, beliefs, judgements, habits, visitors/ user experience, and etc. Response and outcome are both the result of evaluation, but they are varied in the time phase.

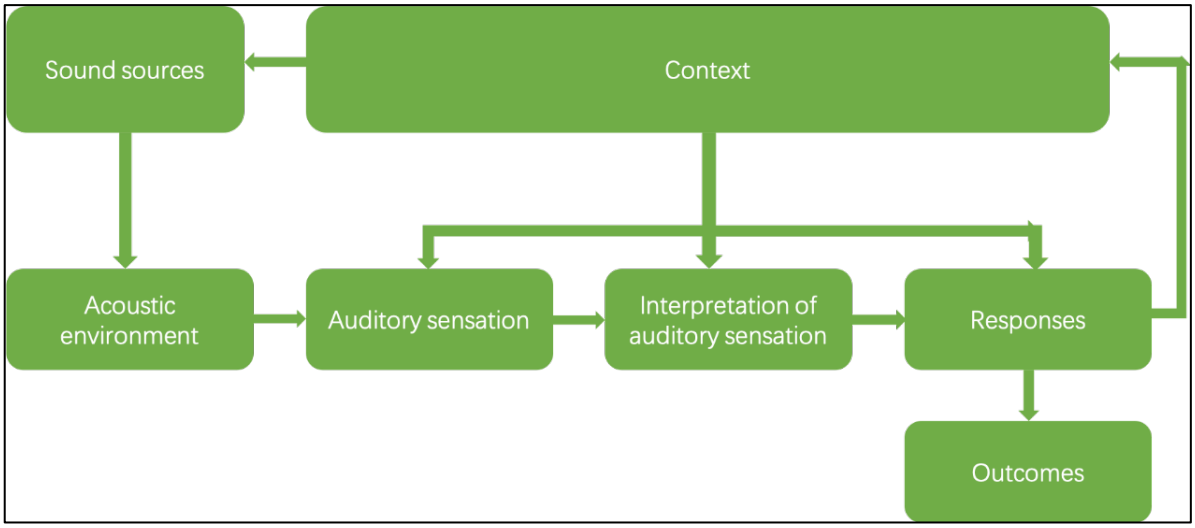


Figure 2.8 Framework of perceptual construct of soundscape (International Organization for Standardization, 2014)

2.4.3.2 Influential factors of soundscape evaluations

Various influential factors from both physical and social aspects may give impacts on the results of evaluations. Physical factors are referred to the attributes of the space and micro or macro environment. Physical factors, or named as environmental factors, are referred to the factors like weather, season, time of day, lighting, odour and visual factors (Yu& Kang, 2010; International Organization for Standardization, 2014). Social factors include demographic information (age, gender, occupation, education), physiological aspects (hearing ability and other sensational abilities), experiences (reason to the site, frequency of coming to the site, memories of the site, expectations of the site) and cultural background (Yu& Kang, 2010; Davis et al., 2013; Liu& Kang, 2016).

The International Organization for Standardization (2014) applied 'context' to refer to the influential factors of soundscape. Context includes the interrelationships between people and activity and place, in space and time. According to International Organization for Standardization (2014)'s frameworks for soundscape, context influences soundscape through the auditory sensation, the interpretation of auditory sensation, and the responses to the acoustic environment. Auditory

sensation is influenced by meteorological conditions (seasons) and people's hearing ability; cultural and psychological factors can affect the interpretation of auditory sensation with the attitudes to the sound sources and to the producer of the sound (how people define and understand the sound sources based on their own social and cultural background), experiences and expectations (including cultural background, intentions or reason for being at a place), and other factors (visual impression and odour); factors that influence the responses to the soundscape are introduced as: physical attributes of the place (time of the day, lighting and weather), emotional state, psychological and physiological resources to deal with the situation, perceived ability to control one's exposure to sounds, as well as personal activities and those of others. In short, influential factors are believed to give impacts on the different stages of people perceiving and understanding soundscape process. It explains the mechanism of how varied influential factors make people evaluate soundscape differently.

It has been widely recognized that soundscape is interacted with visual factors in the sphere of environmental perceptions and evaluations (Brown et al., 2011). Based on the subjective evaluations data of various physical indices in 14 urban public spaces in Europe, factor analysis showed that visual and auditory aspects are always in the same factor, covering 17-19% of the total variance (Kang, 2019). These two factors interact and work with each other as aesthetic comfort factor. When the sounds are related to the scenes, people have a sense of involvement and comfort (Yang& Kang, 2005). Also, Viollon et al (2002) found that visual conditions modify auditory perceptions to a significant degree. In their research, participants were asked to rate eight urban sound environments with sound recordings when they were associated with five visual settings (four colour slides varying in degree of urbanization and a control condition with no slide). Two sound scales, unpleasant- pleasant and stressful- relaxing were used for the evaluation. The results suggested that urban visual settings can bring with more negative sound ratings than nature settings. In short, visual aspect may give contributions to the acoustic evaluation in particular ways (Carles et al., 1999).

In terms of the factors from social aspects, it is found that social/ demographical, behavioural and psychological should be taken into considerations in soundscape evaluations. In the study of Yu and Kang (2010), they collected recordings from nineteen case studies and analysed the soundscape preferences with 3-point scale: -1: favourable, 0: neither favourable nor annoying,

and 1: annoying. Influential factors from social/demographic (age, gender, occupation, education level, residence status and home sound environment), physical (season, time of day), behavioural (frequency of coming to the site, reason for coming to the site), psychological (site preference) aspects were analysed in the research. In terms of social/demographical factors, they suggested that age and education level are two factors that generally influence the sound preference outstandingly. With increasing age or education level, people would prefer natural sounds and are more annoyed by mechanical sounds. Other demographic factors like gender, occupation and residence status were proved to have no significant influence on sound preferences. Physical, behavioural, and psychological factors also had insignificant influence on the sound preference. They further pointed out that there are some correlations between social/demographical and physical/behavioural/psychological factors. The frequency of coming to the site and the site preference are highly related to social/demographical factors.

Age variance have been frequently stressed in the field of soundscape evaluations. In the research of Yang and Kang (2005), differences about age groups were shown in two aspects: 1. Acoustic comfort levels: teenagers evaluated with the lowest comfort levels while older people (above 55) evaluated with the highest comfort level; 2. Sound preferences: older people seemed to prefer natural and/or culturally approved sound elements while young people (10-17) appreciate high arousal sounds in the public space. They also tested other demographic factors and found that there was no significant difference between males and females. In the research of Yang and Kang (2005) found that people prefer sounds relating to nature, culture or human activities with an increase age. On the contrary, younger people are more found of music and mechanical sounds. With an increase in age, people tend to prefer quieter and natural sounds environment. Differences in gender was also found to be less significant. While there are still some variances: women are more favourable to emotional effect sounds, such as church bells, water, street music performance, and children's shouting. This difference was believed to be attributed to female having a higher arousal level than males.

Many studies have found that people had different soundscape preferences led by their varied cultural backgrounds. For example, that water sounds preferences differ from people from Sheffield (UK) and Sesto San Giovanni (Brazil) was one of the examples. In Sheffield, 75-84% of interviewees evaluated water sounds as 'favourite' but only 28% less in Sesto San Giovanni (Yang&

Kang, 2003). Researchers have found cultural differences on the concept of noisiness through the semantic differential analysis in Japan, Germany, USA and China (Kuwano et al., 2003). Japanese and Chinese judged loudness as 'neutral' while others evaluated as 'negative'.

Social relationships are also emphasized by Bild et al (2018) in relation to soundscape evaluations. In their study, levels of social interactions were believed to be interacted with the performed activity. People involved in social activities were defined as 'socially interactive respondents'. Solitary and socially interactive respondents are supposed to evaluate soundscape differently in relation to what they were doing. In order to analyse soundscape evaluation, they introduced three aspects of evaluation criteria: disruption, stimulation and overall suitability. Results were analysed from both quantitative and qualitative data. Quantitative results turned out that solitary and socially interactive users tended to have different degree of satisfaction towards the three evaluation criteria. Solitary users seemed to be more sensitive to the soundscape, a larger share of them evaluated the soundscape as having very high levels of disruption than socially interactive users and larger share of them evaluated the soundscape as having very low or low level of stimulation. And for suitability, a smaller share of solitary respondents evaluated their soundscape as highly or very highly suitability than accompanied users.

Results from qualitative data showed that both solitary and socially interactive users considered sounds of others in the space as disrupted; Solitary respondents cited more holistic reasons for their disturbance (e.g. 'city sounds', 'all sounds'. 'racket'). For stimulation, socially interactive respondents list more aspects of their auditory experiences and more holistic-cosiness than alone. Solitary users focused on how what they heard stimulated *hypothetical conversation* or *doing what they wanted*, while socially interactive users emphasized on the presence of others for cosiness and cheerfulness. Similar to the quantitative results, most solitary users felt their expectations are not fully met, as they are more likely to expect *quietness*. Socially interactive placed *crowdedness* first. More socially respondents mentioned that they expected the presence of others.

2.5 Soundscape design in urban public spaces

Following the concept of 'soundscape', soundscape design is referred to the methods that regulate or manage sounds to better satisfy human activities. The goal of soundscape design was suggested as, on the one hand, to minimise negative sounds and, on the other hand, to preserve the sounds that people enjoy and that bring a positive impact (Sasaki, 1993). Previous works have investigated soundscape design guidelines and various detailed design examples as reviewed in the following sections.

2.5.1 Design soundscape through acoustic affordance

Based on the previous studies, soundscape has been classified into three components, each of which is belong to separately discipline: 1) physical characteristics of sounds in the field of acoustics; 2) the perceived sounds in the field of psychology- or psychoacoustics; 3) the cognitive and emotional variables of sounds in the field of semiotics, semantics and aesthetics (Bild et al., 2018; Aletta et al., 2016; Moscoso et al., 2018). In this way, the acoustic environment gives influences on human from varied aspects. Previous studies have focused on how acoustic environment offer the potentials for human activities because activities can be greatly influenced by soundscape (Marquis- Favre et al., 2005; Payne& Guastavino, 2013; Nielbo, 2015).

Environmental affordance is defined by Gibson (1979) as the quality of an object or an environment that supports the performance of an activity. It is viewed from what and how physical environment offers people or animals. In sound research field, 'acoustic affordances' was raised to indicate whether and to what extent the soundscape provides the actionable properties for an object (Andringa et al., 2013). Turvey (1992) concluded that an affordance is an invariant combination of properties of substance and substance taken with reference to an animal to afford actions like grasping, upright posture, catching, and so on. Affordance theory was introduced to HCI (human-centred informatics) by Norman in late 1980s as: 'an affordance is a relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used' (Norman, 1988). Human centred informatics (HCI) is the intersection of the cultural, the social, the cognitive and the aesthetic with computing and information

technology (Schneiderman, 1987). When applying affordance theory into HCI design, Norman (2013) differentiated signifier from affordance indicating any perceivable indicator that communicates appropriate behaviour of a person. Signifiers are signs and signals that specify how people can discover the possibilities of the physical world (Interaction Design Foundation, 2000). In the context of acoustic affordances in urban public spaces, particular sounds may act as the signifiers for social activities, such as human sound and event sounds, they may provide the signs for engaging in social activities. In Liu& Kang (2016)'s research, they found that human sounds had the key influences on perceived sound levels and the strongest relationships with the physical and psychoacoustic parameters. Jo & Jeon (2020) pointed out that the most important factor that determines the comfort of the park soundscape is the presence of people itself. Human sounds can decrease the perceived tranquillity or peacefulness while increase the experience of the soundscape dynamics. Event sounds, on the other hand, can attract passers-by to stop and even join in the activity (Meng& Kang, 2016), which provide the opportunity for 'triangulation'. 'Triangulation' refers to the process by which some external stimulus (such as event sounds) can provide links between people who are strangers and make them start talking to each other.

Acoustic affordance as one of the properties were believed to provide a description of the environment that was directly relevant to behaviours. Andringa et al (2013) suggested that environment with high complexity can provide discoverable affordances to enhance knowledge and skills through typically playful interaction. On the contrary, boring environment are devoid of stimuli, or the stimuli are either too ordered to maintain interest or too complex to determine constituting structure. They further raised the 'complexity of the acoustic environment' (Figure 2.9) and involved 16 words derived from the New Oxford Dictionary to interpret the complexity.

High complexity Forced search for best behavioural option **Chaotic:** in a state of complete confusion and disorder **Mobile:** able to move or be moved freely or easily **Disharmonious:** lack of harmony or agreement **Obtrusive:** noticeable or prominent in an unwelcome or intrusive way	**High on affordances** Enjoying opportunities **Exciting:** causing intense and eager enjoyment, interest, or approval to do or to have something **Joyful:** feeling, expressing, or causing great pleasure and happiness **Living:** have an exciting or fulfilling life **Lively:** (of a place) full of activity and excitement, (of mental activities) intellectually stimulating or perceptive
Low on affordances Searching for affordances **Monotonous:** dull, tedious, and repetitious; lacking in variety and interest **Without atmosphere:** a place or situation without a pervading tone or mood **Empty:** containing nothing; not filled or occupied **Lifeless:** lacking vigour, vitality, or excitement	**Low complexity** Freedom of mind-states **Calm:** the absence of violent or confrontational activity within a place or group **Unobtrusive:** not conspicuous or attracting attention **Tranquil:** free from disturbance Harmonious: forming a pleasing or consistent whole.

Figure 2.9 Dictionary descriptions of words commonly used in appraising sonic environments (Andringa et al., 2013)

Ipsen's (2002) theoretical model- the theory of acoustic complexity, or termed as sonic diversity, also summarised the relationship between low and high complexity. This model illustrates the relationship between complexity and human curiosity in a non-liner, hump-backed curve as shown in Figure 2.10. With the increase of the complexity of information, the curiosity of human would increase. While if the complexity is too high and 'unreadable', people would tend to react

with annoyance. There is an intermediate level of complexity, between these two extremes, which generates a high positive motivation and this applies to any form of information, including acoustic perception. However, individual variations sometimes influence whether people feel attractive or unattractive towards the same level of complexity of a situation. The factor of familiarity with a situation, the level of complexity of the information and the adaptability of an individua can all influence the responses to the acoustic information. Designers are able to both enhance and reduce the complexity of sounds through soundscape design to please those who enjoy the complexity and who do not find the high complexity of sounds as attractive.

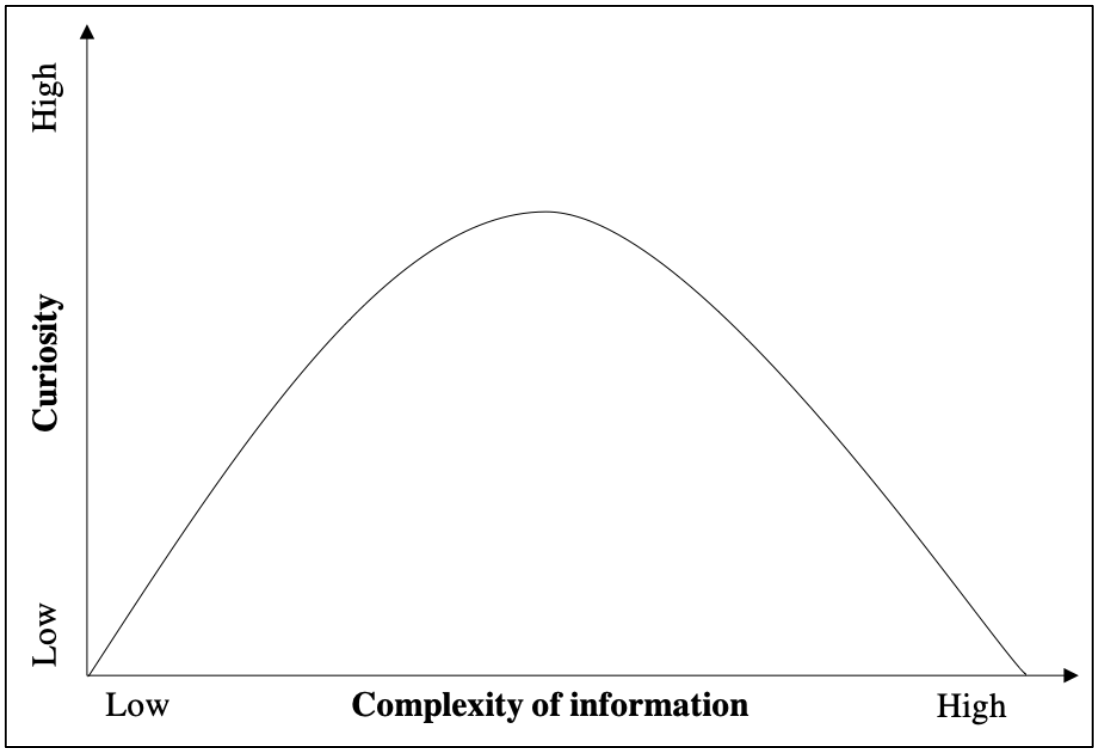


Figure 2.10 Complexity of information and curiosity (Ipsen, 2002)

Further, Elmqvist (2013) suggested the creation of zones and refuges to better satisfy people who seek for the complexity and who do not find the high complexity of sounds as attractive. Common practices of masking in soundscape design is to use natural sound sources in urban planning, such as water and vegetation. Green walls can reduce up to 40 dB of outdoor noise and vibration. For the future soundscape design, Elmqvist (2013) suggested to move forward to two

aspects: on the small neighbourhood scale, innovation design and materials are needed, such as green spaces, green walls, water walls and other unrecognized ecosystem services; on the larger scale as district of city scale, designers could work on the composition of urban soundscapes- e.g. 'the dual soundscape', including zoning areas with 'silent parts' intermixed with more 'noisy parts' and designing individual acoustic profiles for specific zones in a city.

Following the idea of acoustic affordance, the term of 'social willingness' was raised to evaluate the willingness levels of social interactions. Similar to Bild's (2018) soundscape affordance evaluations, social willingness level includes the two levels of evaluation criteria, one is suitability, the other is stimulation. The concept of 'social willingness' may presuppose that everyone would have the will to socialise, but this is not necessarily the case. There exists neurodivergent people who thinks differently from the way of the majority (or termed as the neurotypical) expect (Singer, 1999). Some of those neurodivergent people may not have the same feeling for social interactions as the neurotypical people. For example. Autism people has traditionally been defined by core deficits in social interactions and communication (American Psychiatric Association, 2013). Also, there exists mismatch of the social interaction styles between the nonautistic people and autistic people (Davis& Cromption, 2021). The 'I- thou relationship' discussed by Buber (1923) and Levinas (1969) pointed out how people communicate and live with other people. Buber considered the preservation of otherness to be the most fundamental feature of dialogue. A 'true dialogue' between people is featured by 'true appreciation', which not only displayed by conversations but also an exchange of glances and other non- linguistic forms (Meindl, León& Zahavi, 2020). Buber (1923) believed that the more people interact and know more about each other, the more they will get closed. While Levinas (1969) believed that there is an unbridgeable difference between people, rather than integrating and uniting. He raised the concept of 'neighbour' indicating people are always aware of others intensively, but they are separated from each other. Sennett (2017) applied the concept of 'neighbour' to the urban context to point out that cities should allow strangers to remain stranger, which was the concept of 'open city'. People can remain apart, and yet mutually aware and interactive. Social willingness levels, as one of the soundscape evaluation indicators, may have different values for the varied groups of people. For the soundscape of urban public space, researchers may need to think whether a more sociable soundscape better. Perhaps future studies would need to use other indicators to evaluate soundscape for a wider range of people.

2.5.2 Soundscape design practice in urban public spaces

Truax (1999) described two approaches for acoustic environment design: one is the traditional, objective, energy- based model (environmental noise management); the other is the subjective, listener- centred model (soundscape approach). The former model suggests to manage sounds as a waste- a waste to be reduced and managed. Previous soundscape design mentioned various ways of sound level reduction, such as sound masking through water fountains or planting trees (Licitra, Brusci& Cobianchi 2010; Hellstro¨m, 2012; Asdrubali et al., 2014). While reduction of noise does not always deliver the required improvements in quality of urban public spaces (Aletta et al., 2016). Thus, the soundscape approach views the sounds as 'resources'. Studies in this field focus mainly on perceived sounds and sound preferences. In this field, Kang (2019) proposed a strategy for soundscape design including four aspects: (1) sources - characteristics of each sound source; (2) space - acoustic effects of the space; (3) people – social/demographic aspect of the users as well as their activities and behaviours; and (4) environment - other aspects of the physical environmental conditions. There are various sub- categories under these four main aspects as shown in the Figure 2.11. This framework pay attention to the various aspects of sounds as well as the elements that were entangled with sounds.

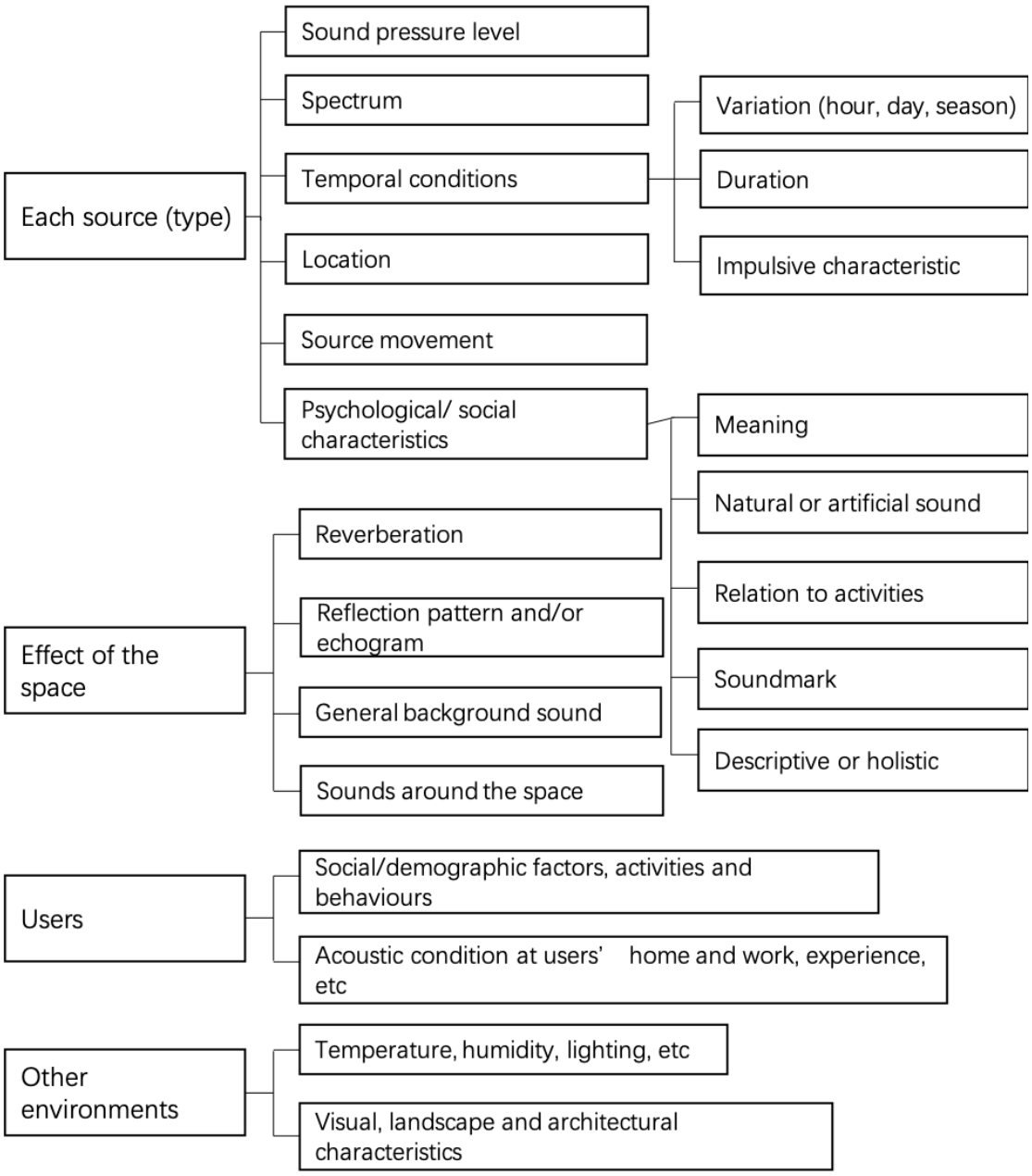


Figure 2.11 A framework for soundscape description in urban open public spaces (Kang, 2019)

Distance between people is considered as the entry point for soundscape design in urban public space, which was stressed by Hall (1966) and Gehl (1987). Distance can influence the information received from smell, seeing as well as hearing. The activity of communication is highly depended on the distance between people to ensure the seeing and hearing ability. According to Gehl (1987), normal social interactions requires distances below 7 meters to hear effectively and distance below 20 to 25 meters to perceive the feelings and moods of others in visual. Distance is

believed to be able to regulate the social relationship intensity and to control the beginning and end of each conversations. Gehl (1987) summarized how distance between people indicate their relationship intensity: common communications usually happen within 1 to 3 meters and more intense relationships can happen even shorter than 1 meter; conversations among intense relationships usually take place between 0 to 1/2 meter, where all the senses can work together and where all details can be clearly perceived. As a result, Gehl (1987) suggested that multiple ranges of distance are required in the urban public spaces to satisfy various social relationships.

Fountains is a common sound masking facility in urban public spaces. Water sounds can produce white sound and has the function of masking the honks and bangs from the streets. Whyte (1980) pointed out that their functions are more than just masking noise. It also contributes to the privacy of conversations. When people talking near the water, others will not hear your words because of the masking function. Multiple kinds of water elements are referred as waterfalls, water walls, rapids, sluiceways, tranquil pools, water tunnels, meandering brooks, fountains of all kinds. Also, water elements in urban public square provide an opportunity for people to interact with physical environment. To look and feel it make the time in square more interesting. People, especially children, always want to feel the water, they stick their hands in it, or splash water by toes or feet.

Meng and Kang (2016) found that sound-related activities in the urban public spaces can influence human behaviours, such as music related activities (various kinds of dancing and exercises accompanied with music) and human sound related activities (Whip Whipping, Roller Skidding and Playing Cards). They found that music- related activities can cause 5.1- 21.5% of passers- by to stop and watch the activity, it also gives little influences on the number of persons who performed exercises. The activities with music caused the pedestrians to focus much more than activities without music or music without activities. Similarly, Gehl (1987) and Whyte (1980) has pointed out that people can be attracted by the events happening in the public square. Music- related activities are more able to be noticed as they can increase the sound level from 10.8 to 16 dBA, while human sound related activities only increase the sound level from 9.6 to 12.8 dBA. Bigger groups of human sound related activities attract more attentions. In other words, the soundscape design in the square is not only about noise masking, but also about how the sound stimulate people to enter the square.

When people are attracted to enter the square, the possibilities for social interactions increase with the 'triangulation effect' (mentioned in 2.2.2.1).

Other sound design practices involve various kinds of sound art installations, such as using a programmed playback material adapting the content and sound levels at pre- determined time periods (Lavia et al., 2012; Lavia et al., 2016). The projects carried out by Architettura Sonora employed a database of site-specific and original soundtracks composed by a sound artist through multichannel audio amplifiers (Cobianchi& Brusci, 2010; Lictira et al., 2010). Cobianchi et al (2021) pointed out the importance of implementing more compositional and art intervention approaches and summarized the guideline for creating liveable soundscape: analysing objective and subjective data regarding the casual links between the quality of the soundscape and people's subjective responses. Soundscape design in urban public spaces is still in the experimental stage. Previous mentioned sound art interventions and installations may limited to superficial engagement in the urban soundscape qualities (Arkette, 2004), rather than an overall soundscape design. The major difficulty of applying soundscape theory to architectural design is suggested to be the reliance on visual modes of communication and dissemination within the field of design (Fowler, 2013; Schafer, 1992). Also, the management of soundscapes is different from managing noise levels, as the latter usually do not involve other physical aspects of the sound, or non- physical aspects relating to human representations and responses to these physical aspects (Dubios, 2003; Schulte- Fortkamp, 2002). Noise control merely focuses on lowering the sound levels and removing the negative aspects of sounds. While soundscape design should consider both the positive and the negative aspects of sounds, the quality and meaning of sounds, because of the complexities of sound perceptions. Some unsuccessful soundscape designs were identified as those that relied upon reducing sound levels, or only used noise parameters, or applied the concept of noise control to design soundscapes (Payne et al., 2009). It is important to incorporate all aspects of the soundscape concept into soundscape design (Kang, 2007).

When designing soundscape in urban public spaces, the accessibility should be carefully considered because of the nature of urban public spaces. The definition of public spaces emphasizes that they are publicly accessible places, free of charge. 'Accessibility' is defined as 'the freedom or ability of people to achieve their basic needs in order to sustain their quality of life'(Lau& Chiu, 2003). Accessibility in urban public space is referred not only the physically enter the space, but

also the inclusiveness and publicness for people from different types and degrees of disability (Meciejko& Czajka, 2020; Gehl, 2014). Accessibility is required as the prerequisite for a successful urban public space (PPS, 2008). Talen (2000) suggested that accessibility levels can be measured as an indication of the degree of public space dispersion. A good residential area should be equipped with well- dispersed public spaces, not aggregated at the periphery (Calthorpe, 1993). To evaluate the accessibility levels of urban public spaces, Whyte (2000) recommended to judge a place by its connections to its surroundings, both visual and physical. A successful public space is easy to get to and get through; it is visible both from a distance and up close. But for some visually impaired people, having an entrance easily to be 'seen' is not enough. Because sound usually carry a great amount of geographical information, especially for blindness and low-vision people. Soundscape, in this aspect, can do a lot to improve the accessibility level of urban public spaces. For example, the project of 'Microsoft Soundscape' developed an app by delivering a 3-D soundscape of navigation information through headphones to help people find out their ways. With the spatial sense of soundscape, 3-D soundscape broadcast geographical information in time, and alerts users with a higher pitched sounds when they approach the entrances to their destinations. Those changes in sounds can bring with the spatial perceptions and allow users to build a mental maps in mind.

In addition, the development of technology recently can enable various levels of reality simulations, including the soundscape of urban public spaces, which can enhance the accessibility of urban public spaces. In the primary stage, researchers using 2D pictures or 360° pictures accompanied with soundscape to simulate a particular setting, which is called 'remote soundscape assessment'. For example, Oberman et al (2020) designed an auralization room for 'virtual soundwalks' using ambisonic audio (through loudspeakers) and 360° pictures on a screen in three cities with typical sound features. Arup's SoundLab (Forsyth, 2018) designed an anechoic room where ambisonic audio is delivered by 12 speakers surrounding the listeners. In the recent studies, VR (virtual reality) and AR(augmented reality) extended the limited effect of pictures, enabling the spatial perceptions for sounds. Such as the experiment conducted by Kern and Ellermeier (2020), they recruited 36 participants to wear noise- cancelling headphones and to take a stroll in a VR park while walking on a treadmill in the real world. Other studies used only mobile phones and VR glasses have been shown to enable the simulation of soundscapes at low cost as well (Miller, 2013; Lugten et al., 2018). Although, in VR and AR settings, researchers have found that the soundscape

simulations are still somewhat distant from the real soundscape, this distance is shrinking rapidly with the development of technology.

2.6 Summary

This chapter reviews theories on the man- environment interactions and focuses on one of the environmental factors, the acoustic environment, reviewing the structure of soundscape and how various factors influence soundscape evaluations, and its interactions with human activities. Based on the previous works, this work was conducted to investigate four aims, described below, with each aim explored in a separate study. The aims of each study were exploratory and were not designed to test specific hypotheses.

Firstly, in urban public spaces, people involved in different relationship groups tended to have varied social activities types, which makes them have varied requirements for soundscape, as reviewed above. It is important to define the social relationship types and to summarize their patterns of use in urban public spaces to better understand their soundscape preferences. In terms of patterns of use, previous studies analysed patterns of use through activity types and their occupancies in the site. Thus, the *first aim* was to explore the patterns of use in relation to social relationship types in urban public spaces.

To understand the soundscape perceptions, studies about man -environment interactions and environmental perceptions were reviewed. Physical environment was perceived through a process with several aspects. While, previous studies about sound perceptions focused on breaking down several key elements of soundscape, the perceiving process of soundscape of urban public space context is still vague. Also, perceiving sounds is highly dependent on the context of listeners and place. How the general urban public space users perceive soundscape requires elaborate investigations. Thus, the *second aim was* to explore how the general public perceive the soundscape of an urban public spaces.

Provided with the perceptual nature of soundscape, present studies have focused on the various factors affecting soundscape evaluations, with the influence of demographic background factors being the most discussed. Social relationships, as one of the demographic factors, have received little attention in the previous works. Bild et al (2018)'s research mentioned the influence

from companion status- whether people are accompanied or not, while the level of social relationship intensity was not included. Thus, the *third aim* of this study was to explore how companion status (solo users or groups of users) and relationship intensity (partner/spouse; family; friends ranked from close to distant) influences soundscape evaluations in urban public spaces.

Lastly, social activities (hearing and talking) in urban public spaces are highly dependent on the quality of acoustic environment, so that the promoting sociability through soundscape design has become a direction. Previous studies focused on noise reduction methods to enhance the affordance for social activities, and explore sound stimulus to foster the complexity of soundscape. Human and event sounds were found to enhance social willingness in urban public spaces. While, concerning the varied soundscape requirements of different social relationship groups, it lacks targeted soundscape design guidelines for different social relationship groups in urban public spaces. To fill this research gap, the *fourth aim* was to explore how soundscape design (human and event sounds) influence social willingness levels of varied relationship groups in urban public spaces.

Chapter 3:

Overall Research Methods

3. Overall research method

3.1 Introduction

The literature review (chapter 2) resulted in four aims being established. Those aims will be tested by exploratory research methods consist of four separate studies, reported in chapters 4 to 7. Exploratory research is defined as a research used to investigate a problem which is not clearly defined in the past (Saunders et al., 2012). Exploratory research aims at connecting concepts as to unveil the 'whys' of potential cause/ effect relationships. In comparison, hypothesis testing research is where the researchers have considerably enough idea about the topic. For example, the researcher has a theory (or several theories), and the aim is to test whether the theory supported by the facts (Butleret al., 1993). While, as reviewed in Chapter 2, previous works about social relationships and soundscape were quite limited. Thus, this study has to apply exploratory research method to discover the relationship between them so as to build a theory upon them.

This chapter first provides a review of the standard methods used in soundscape field. Following is an overview of the methods that used in this research and explains why those methods were chosen and how these studies interact with each other. The precise method and analysis procedures of each study is reported in Chapters 4 to 7.

3.2 Standard methods in soundscape field

In the research field of soundscape, it was suggested to apply a combination of quantitatively and qualitatively methods to explore the soundscape because of its subjective nature (ISO/ DIS 12913-2, 2017). It was summarized there are mainly four methods for collecting data of soundscape: soundwalks, laboratory experiments, narrative interviews and behavioural observations. To conduct these studies, five data collection tools were widely used: questionnaire, semantic scales, interview protocols, physiological measurements, and observation protocols (Aletta et al., 2016). Particular methods should be chosen according to the acoustic environment types. When the researchers aim to collect the instant acoustic experiences in the site, behavioural observation and soundwalks are

suitable for this situation. If researchers aim to rule out interference factors and reproduce the soundscape in the lab, laboratory experiments are involved with scale questionnaires. Narrative interviews are conducted when recalled memories are targeted (Aletta et al., 2016; Kang et al., 2017). The corresponding relationships among methods, tools and objectives were illustrated in Figure 3.1.

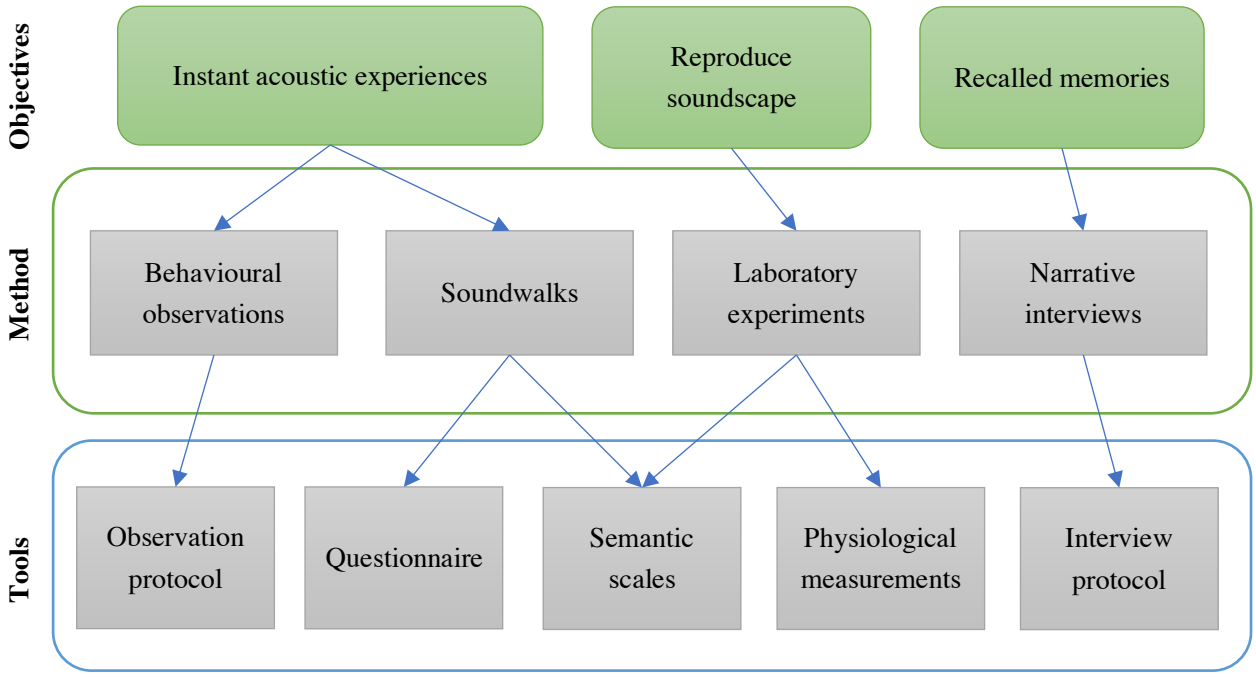


Figure 3.1 Typical methods and corresponding tools and objectives. Adapted from (Aletta., 2016; Kang et al., 2017)

Soundwalk method is an empirical method for identifying a soundscape and its components as well as to explore areas of human response to an acoustic environment (ISO/TS 12913-2, 2018). It is a common method for the evaluation of soundscapes (Jeon, Hong, & Lee, 2013). In soundwalks, participants are led with researchers to walk in silence to listen to the sounds along the route. Except narrative interviews, some of soundwalks also involve interviews. After the walk, participants are either be asked to fill in a questionnaire or be interviewed. Soundwalk has been used in the soundscape field for a long time, there was no criteria for recruiting participants in the previous studies. While in recent years, sound experts, urban planners and non-experts were all included in

soundwalks to achieve a more comprehensive soundscape understandings (Axelsson et al., 2014; Hong, Lee& Leon, 2010; Semidor, 2006).

Both targeted on instant acoustic experiences, behavioural observations happened with participants unaware of the study aims. It was defined as the systematic recording of behaviours by an external observer (Haynes& O'Brien, 2000). Non- participatory observations were firstly applied to capture and assess human behaviours on music intervention researches by Lavia et al (2012) and Witchel et al (2014). They conducted a series of researches in outdoor acoustic environment with or without music intervention and recorded participants' behaviours during the intervention. Behavioural analysis was applied on the videos. Behavioural mapping was usually involved to aid with the systematic recording to record people's behaviours in real spatial settings (Goličnik Marušić, 2015). In Bild et al (2018)'s research, they applied observations and behavioural mapping to analyse users' soundscape evaluations in relation to their activities in a spatial and behavioural context. They drew a total of 665 distinct data point on site maps with their companion information- individual in blue and accompanied users in red to analyse people's occupancies in the site.

Laboratory experiment is used to stimulate or reproduce acoustic environment in indoor lab. Usually in a laboratory experiment, participants will listen to binaural recordings reproduced by headphones and then they will give responds to a semantic questionnaire (Aletta et al., 2016). Semantic questionnaire is made up of a finite number of categories of soundscape evaluations with rating scales. A five- point ordinal- category scale is suggested by ISO/TS 12913-2 (2018). The distance between the categories are supposed to be equidistant and the categories are thought to represent equal sections leading to interval scaled data (ISO/ TS 12913-3, 2019). Because this method is often criticised for failing to reproduce the real environment, recent studies involve alternative technologies, like auralization models (Vorländer, 2008) and immerse virtual reality (G.Echevarria Sanchez et al., 2015; Sun et al., 2019).

Narrative interviews are also frequently used in the soundscape studies to collect the rich and initial data from participants. Interviews are especially useful when researchers had limited knowledge about the research topic. Compared with quantitative research method, it was considered that narrative interviews and other qualitative methods can offer in-depth information of human experiences and perceptive knowledge of soundscape (Flick et al., 2004; Aletta et al., 2016). Previous studies adopted qualitative interviews to identify attributes of soundscape (Axelsson et al.,

2010; Davies et al., 2013). Those soundscape attributes then was developed to be indicators of soundscape evaluations. Liu and Kang (2016) conducted interviewed 53 participants in Sheffield and collected abundant information of subjective soundscape understandings. They adopted Grounded Theory to analyse the data and generated the five categories of soundscape understanding. Studies mentioned above all focused on the fields where researchers had limited knowledge, and the results derived from them can be used as the basis for next stage's research.

3.3 Overall strategy

To analyse soundscape, this study applied a combination of quantitatively and qualitatively methods as suggested by Aletta (2016). Research of this study followed an inductive research approach, which starts with the observations of the phenomenon and theories are proposed towards the end of the research process as a result of observations (Goddard& Melville, 2004). Figure 3.2 shows the structure of the methods used in the four studies and their relationships between each other.

According to Figure 3.2, study 1 and 2 define social relationships and soundscapes in context of urban public spaces. Study 1 aims to explore the patterns of use in relation to social relationship types in urban public spaces. With the observation method of study 1 collecting patterns of use and demographic background of different social relationship types, the categorization method of social relationship types, how they behave and where they occupy can be figured out. Study 2 aims to explore how the general public perceive the soundscape of an urban public spaces with the aid of interview method and Grounded Theory approach. Based on the results from study 1 and study 2, study 3 adopted questionnaire method and statistics analysis to investigate how people involved in varied social relationships evaluate the various aspects of soundscape. Through on study 3, which aspect of soundscape is influenced by social relationships can be figured out. The followed study 4 then explore the soundscape design to enhance the sociability of different social relationship types with experimental survey and observation method. In the end, the whole study bring with two outcomes: the structure of soundscape and sociable soundscape guidelines which can be used in the future studies.

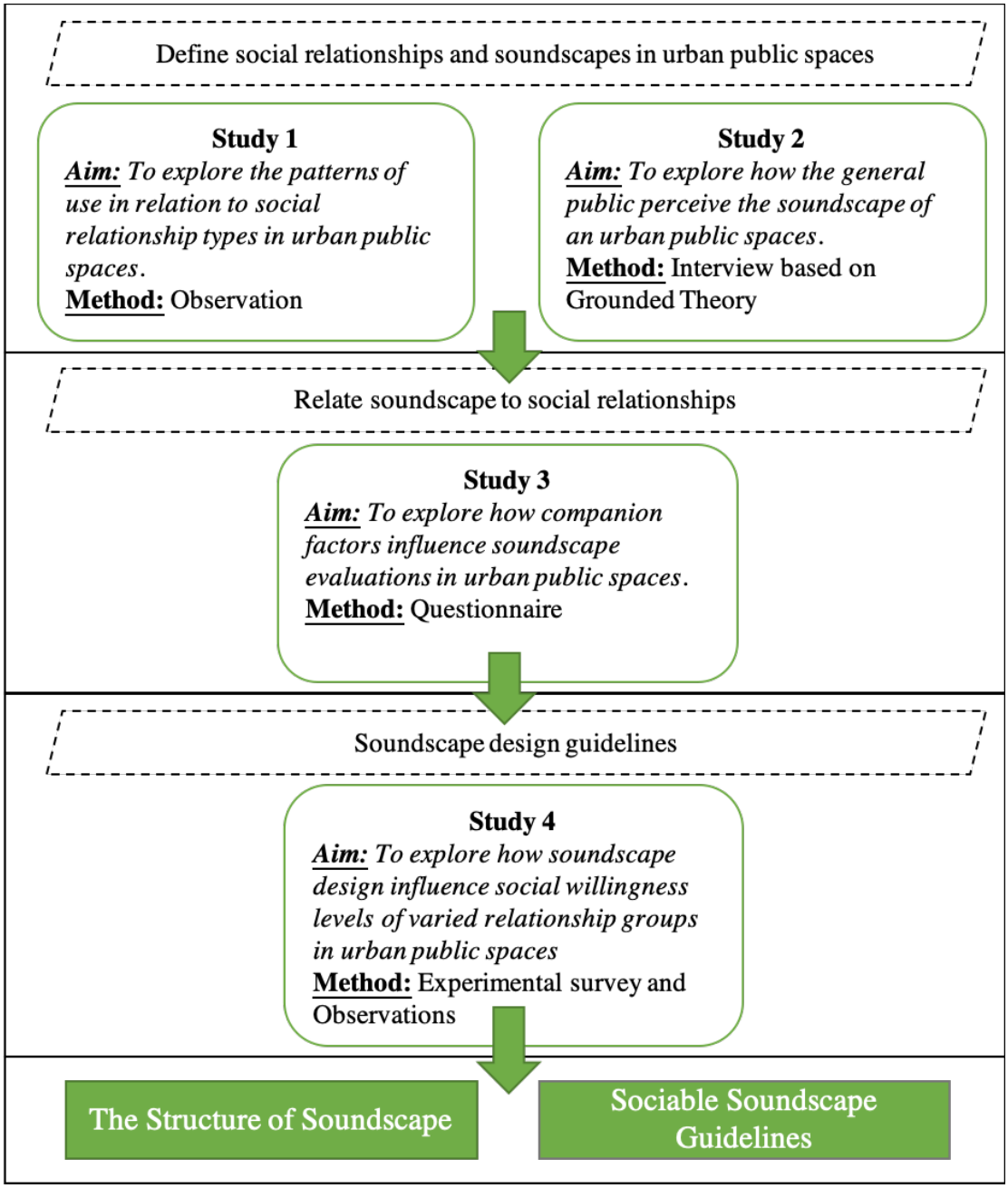


Figure 3.2 The structure of methods used in the research

3.3.1 Study1: Observation method

To define the patterns of use of different social relationships, data of their activities and occupancies in urban public spaces were required. The observation method has been used widely by researchers in architecture and landscaping public space studies since 1960s (Lipovská & Štěpánková, 2013).

Whyte (1980) adopted observation method with time- lapse photography to analyse human behaviours, which is a recognized approach for analysing the relations between people and public spaces. Gehl (1987) and the Project for Public Spaces (1981) applied similar methods to commercial streets and neighbourhood public spaces. The method is relatively cost-effective and time-effective, and it consistently yields useful data on actual uses of designed places (Cooper & Francis, 1998). Observation method used in this study followed Ittelson (1970)'s five steps process:

1. A graphic rendering of the area(s) observed
2. A clear definition of the human behaviours observed, counted, described or diagrammed
3. A schedule of repeated times during which the observations and recordings occur
4. A systematic procedure of observing
5. A coding and counting system that minimizes the effort needed to record observations

Along with the process recommended by Ittelson (1970), Gehl &Svarre (2013) advised observing the space through note taking, documenting, photographing, and videotaping.

To collect the data of occupancies, behavioural mapping was applied. Behavioural mapping was used to record users' activities and spatial occupancies. Behavioural maps can include all of a site's information on one map and link users' behaviours to their spatial settings. To create a behavioural map, an accurate scale of the site, clearly defined types of activities and details about behaviours to be observed should be pre-determined (Goličnik Marusic & Marusic, 2012). Different from the ethnographical observations, behavioural observations adopted in this research were conducted through behavioural mapping with the aim to figure out the patterns of use (activities and occupancies) (Goličnik Marušić, 2015). Data obtained from the behavioural mapping can be both qualitative and quantitative according to the research aims. In most cases, results of behavioural mapping were presented in descriptive statistics, such as number and percentage of observations at certain location in tables, charts, or figures (Ng, 2015). The aim of this study needed to use quantitative method to figure out the relationship between users' characteristics and their patterns of use.

Thus, the observation in this study was carried out with the behavioural mapping to record demographic information of users (gender, age and group size), users' activities, spatial occupancies

in comparison with time, weather, season, site location and. Because people's relationships can hardly tell from direct observations, social relationships were clarified by the distance among user to users within a group. As distance was proved to reflect the social relationship intensity (Hall, 1992). In the analysis stage, three measurements were involved to deal with pattern of use: frequency analyses were adopted with the quantitative data from gender, age and group size; activities were sorted and analysed by clustering method in Matlab; occupancies were recorded and transformed into digital map to better compare the variations. Through this stage, social relationships were clarified and how they influence the activity types and occupancies were summarized. More details about study 1 was shown in Chapter 4.

3.3.2 Study 2: Interview method

Study 2 is an interview research based on Grounded Theory approach, because in-depth interviews are the core method of collecting data in the Grounded Theory process. The present studies widely used the grounded theory (GT) approach to generate categories for structuring soundscapes in urban public spaces. This method is believed to be useful for generating inductive theories from systematically collected data in terms of the psychological aspect (Glaser & Strauss, 1968; Strauss & Corbin, 1998). As the emphasis of the soundscape concept is on people's subjective understandings, the GT approach has been gradually accepted and applied in soundscape research in various contexts (Liu & Kang, 2016; ISO/TS 12913-3, 2019). Researchers have adopted the GT approach in both indoor and outdoor spaces to investigate sound perceptions, such as in open-plan offices and traditional Chinese buildings (Acun & Yilmazer, 2018; Yilmazer & Acun, 2018; Zhu et al., 2020). Through this method, both the dimensions of soundscapes and the relationships among those dimensions can be identified based on the knowledge of users of general public spaces.

The interview was conducted in two sites each in different countries, China and UK considering cultural factors. Participants selected in study 2 also involved varied social relationships- alone, friend, family and partner/spouse. Two phases of interviews occurred, first phase interviewed 5 in Guanqian, China; in the second phase, another 13 individuals were interviewed at Peace Garden, Sheffield, the United Kingdom until no new content emerged.

Interview questions included background information, overall impressions about sounds, and subjective evaluations of sounds. Coding was adopted to extract massive data into several main categories and figure out their relationship following the GT approach. Detailed methods and data analysis were illustrated in Chapter 5.

3.3.3 Study 3: Questionnaire method

Provided with the social relationship types summarized from study 1 and the core categories of soundscape from the study 2, study 3 explored the mechanism between social relationship types and soundscape evaluations. Questionnaire method is suitable for study 3 because questionnaire consists of a series of questions with the purpose of gathering abundant information from respondents (Ketchen et al., 2007). It provides a relatively cheap, quick and efficient way of obtaining information from a large sample of people. Only when a large number of urban public space users were investigated, can the influences of social relationships on the soundscape evaluations be analysed. Also, questionnaire can include questions about various aspects of soundscape. The questions of the questionnaire followed the previous soundscape questionnaire design, which involves seven-point scales to mark people's sound perceptions (ISO/ PRF TS 12913-2, 2018).

Thus, 184 questionnaires were distributed by paper in Sheffield, UK and 120 in Suzhou, China. Distributions took place during April and May 2017 in Sheffield, June and July 2017 in Suzhou. Questionnaire questions involved various aspects of soundscape, including sound sources, sound features, sound preferences and sound psychological reactions. Detailed information about study 3 were presented in Chapter 6.

3.3.4 Study 4: Experimental survey and observations

In study 4, with the aim to analyse how acoustic environment influences social willingness levels of different social relationship groups, two influential factors were defined: one is the human sound, the other is the event sound. Experimental survey was adopted to analyse human sound, observation method was applied to analyse event sound. Experimental survey is research conducted with a

scientific approach under highly controlled conditions. In soundscape field, sound experiment can deepen basic knowledge and assist in detailed analyses of specific phenomena related to soundscape. It is suggested to ensure a proper duration of sounds presented in laboratory studies, which are long enough to immerse a participant sufficiently into the acoustic situation (ISO/TS 12913-3, 2019). Thus, using experimental survey method, human sounds can be designed at foreground, background or can be eliminated. Then people listen to the different sound types and evaluate them, so that researcher can compare their evaluations towards different sound types through statistics analysis.

Social willingness levels were analysed based on 'affordance theory', which was raised by Gibson (1979) to indicate to what the environment offers the animal, what it provides or furnishes, either for good or ill. In the acoustic research field, 'acoustic affordances' was raised to indicate whether and to what extent the soundscape provides the actionable properties for an object (Andringa et al., 2013; Nielbo et al., 2013). Bild et al., (2018) then applied affordance theory to soundscape sphere and suggested to evaluate how sounds support people's activities from three aspects: disruption, stimulation and suitability. Disruption is referred to whether the activities are disrupted by what they heard; stimulation represent whether soundscape stimulate people's social activities; suitability means the soundscape is suitable for carrying out people's activities. These three dimensions were believed to constitute the soundscape affordances in urban public spaces. In terms of stimulations, it was suggested to differentiate the 'affiliation behaviours' and 'social interactions' (Marie, Zemke& Shoemaker, 2007; Fish, Karabenick& Heath, 1978). Affiliation is the primary level of social interaction, which indicates people's desires to affiliate with others (Carmona, Heath& Tiesdell, 2010; Lerner et al., 2015). Eye contact (looking in the direction of other people), body orientation (increasing facing other people), gestures (mirroring or parallel behaviours), facial expressions (smile) and body distance (closing distance) were included in their research to identify the affiliation behaviours. Social interaction is defined as the actual interaction between two or more people, including talking, closing distance and physical contact. Similarly, in Gaby and Zayas (2017)'s smellscape research also defined two levels of stimulations. They analysed the level of 'liking' by asking three questions: how likely would you be to have a conversation with [this person]? If you had to sit next to this person every day, it would be…? How friendly was this person's smell? Question 1 identified the willingness for actual social interactions, and the rest two questions identified the affiliations. Thus, in this study, social willingness was evaluated by suitability and

stimulations. Suitability stands for whether the soundscape is suitable for social activities; stimulation is referred to whether the soundscape can foster social interactions. Under the category of stimulations, people's willingness for affiliation and actual social interactions were both evaluated.

Based on present method, in the behavioural observation phase, researcher observed sites with eventful and uneventful soundscape and recorded the behaviours representing suitability and stimulations: 1). suitability: focused time (time of focusing on their activities), social behaviour times (including eye contact, laugh, hug, touch, kisses); 2). stimulations: contacts with strangers' times (including looking at strangers, eye contact, smile, small talk). These recorded data were analysed through frequency analyses. Further details of study 4 were described in Chapter 7.

Chapter 4:

(Study 1) An investigation of patterns of use in relation to social relationship types in urban public spaces

4. (Study 1) An investigation of patterns of use in relation to social relationship types in urban public spaces

4.1 Introduction

Previous works have observed and summarized social relationships by relationship intensity (Hall, 1992; Gehl, 1987), but their categorization method was quite vague without demographic information of each type, such as gender, age, and group size. Staats and Hartig (2004) mentioned the different individuals' environmental experiences between single and accompanied people in urban public spaces, which addressed the possible influences from social relationship types on environmental behaviours. While, only single and accompanied was mentioned, they did not include different social relationship types. There is a lack of systematic analysis of the ways that people feel and behave in public spaces when accompanied by various types of companions.

Patterns of use are referred to the ways that people use a space, which usually comprises activity and spatial occupancy (Goličnik & Thompson, 2010). Activities in public spaces usually were identified from users' behaviours, such as walking, sitting, standing and so on (Marcus & Francis, 1998). Occupancies were found to be vary among groups. Whyte (1980) pointed out that people tend to prefer occupying the peripheries over central areas of public squares, which De Jonge (1967, p. 10–11) presented as the 'edge effect'.

Thus, based on the previous studies, this study analysed patterns of use in urban public spaces based on social relationship types by observing people at four public spaces in China and the UK. Two types of social relationships were considered, one is companion status (single or accompanied), the other is relationship intensity. Cross-national sites were selected to introduce cultural differences and to collect more abundant data. Using data on the sites and cultural/demographic factors, social relationship types were identified, compared, and analysed in terms of activities and spatial occupancy. Those results were used to categorize the patterns of use of the public spaces by social relationship types.

4.2 Methods

4.2.1 Observation process

Since the 1960s, the observation method has been used widely by researchers in architecture and landscaping public space studies (Lipovská & Štěpánková, 2013). Researchers use the observation method to assess and map activity in the setting of plazas, parks, and many other kinds of public spaces (Francis, 1984). Previous observation practice found that patterns of use strongly related to the time of day, weather, and season (Gehl & Svarre, 2013; Goličnik Marusic & Marusic, 2012). Thus, this study's observations were designed to cover various times of day, various weather conditions, and at least two seasons. A pilot study identified an observation span that was appropriate for observing and recording. Observations were photographed and videotaped to verify the recorded visual observations.

Behavioural mapping was used to record users' activities and spatial occupancies. To create an accurate site map for this study, accurate locations of spatial characteristics, such as benches and trees, were needed to determine the users' spatial occupancies. Labelling activity types depends on the observers' opinions, which are more or less subjective (Zeisel, 1984). To avoid variations across observers recording user activities, this study defined activities to include every specific human action, such as users simultaneously engaged in two activities or users stopping one activity and starting another. All of these activities should be recorded during the observation time. For optimal efficiency, users' activities were directly recorded onto the behavioural map using symbols accurately drawn on the map at the locations of the activities.

The current study identified types of social relationship by distance following Gehl's (1987) application of Hall's (1992) social distance theory. Hall (1992) suggested four types based on distance: (1) intimate (zero to 45 cm), observed as expressions of tenderness, comfort, love or strong anger; (2) personal (46 cm to 1.30 m), observed as conversations between close friends or family; (3) social (1.31 m to 3.75 m), observed as ordinary conversations with friends, acquaintances and so on; and (4) public (> 3.75 m), observed as informal situations. 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. They also elucidated the relationship types, pointing out that the type could be determined by sight, sound, touch and smell. For example, the intimate level/distance might involve the individuals' physical contact (pelvis, thigh, or head; Hall, 1992, p. 117). The use of a distance measure widens the observational sphere of social relations. Therefore, this study identified the intensity of social relationships according to Hall's distance measurements. A further category was formed based on the intensity level.

4.2.2 Site selection

Four public squares in two cities (Sheffield UK, Suzhou, China) were selected as study sites because they experienced a variety of users in numerous types of social relationships daily. The city public square is a type of the grand public place in Marcus and Francis' (1998) five-category typology of urban public spaces: street plaza, corporate foyer, urban oasis, transit foyer, and grand public place. The city public square is defined in this study as a centrally located and often historical place where major thoroughfares intersect.

The study sites were popular places with facilities fully occupied during weekend days, and they all had geographical advantages and symbolic histories. Figure 4.1 summarises the sites' characteristics. The Peace Garden (Sheffield) had a large grass lawn and dramatic fountain. Barkers Pool (Sheffield) was located between City Hall and John Lewis (a large department store), and it served as a pathway in the central city. Central Park Square (Suzhou), built to commemorate the industrial park symbolizing cooperation between China and Singapore, faced Xingming Street, which is one of the city's main streets. Although it occupied a massive space, it had little green area and no seating. Guanqian Square was the smallest of the four sites, and it was inside Guanqian's commercial zone, which is a famous business area for residents and visitors. It had a large area of trees, several flowerbeds, and many benches for users to sit and rest. A broken fountain was in the centre of the square for many years.

Peace Garden, Sheffield

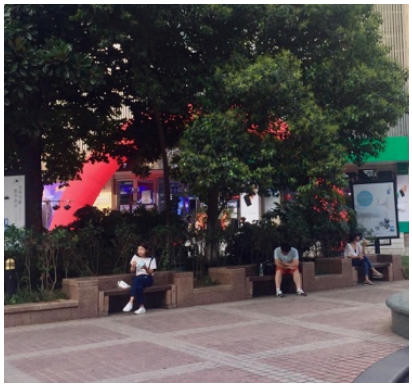
Historic square able to host large numbers of people and major events; large green areas and a beautiful fountain; many comfortable seats

Barker's Pool, Sheffield

Memorial square with large areas of hard surfaces; the steps in front of the City Hall served as seating; two small fountains

Central Park, Suzhou

Memorial plaza with hard surfaces; green areas are somewhat small; no seating provided; very large fountain.



Guanqian Square, Suzhou

Historic square with a large amount of greenery; many seats; surrounded by a commercial district

Figure 4.1. Descriptions of the four study sites (sources: authors)

4.2.3 Data collection

The data were collected in April to May 2017 (Sheffield) and July to August 2017 (China). Observations were conducted throughout the week and under various weather conditions (sunny, windy, cloudy, and so on). Observations occurred four times of day (9 AM to noon), (12:01 PM to 2 PM), (2:01 PM to 5 PM) and (6 PM to 10 PM). Ten observations lasting 20 to 40 minutes each were made at each study site. The researcher checked the weather forecast and visited the sites when the weather conditions were good to ensure that the observations could be carried out efficiently. Site maps were prepared before the observations were made. The maps used different symbols to represent men and women, respectively. The locations of the groups and individuals were recorded on the site maps. Group members were assigned identification numbers, and data on age and activities were linked to the identification numbers. Some commonly observed activities are drawn using symbols combined with the gender symbols to increase efficiency. Age groups were categorized through observations as children, youths, adults and elders. Short-term activities in the space, such as walking through it without stopping, were not included because the study's focus was on people who interacted in the spaces long enough to experience the environment.

The social relationship types were determined using Hall's (1992) distances. Whereas Hall (1992) covered relationships ranging from intimates to strangers, this study assumed that all the users were at least acquainted with the people they interacted with and stranger interactions were dropped from the analysis. The distance measurement was intended to apply to the distance between two people, but groups comprised more than two individuals. Therefore, the distances of groups of three or more people were determined by computing the average distance within the groups. All distances were visually approximated.

Although more than one person usually performs the observations (e.g., Gehl& Svarre, 2013; Whyte, 1980) with researchers using the same observational methods, this study's observations were made by one researcher. One reason for this was that, unlike studies that aim to understand an entire public space, the observations were simple and focused. Second, this study did not require a

significant amount of subjectivity. Identifying gender, activities and distances were recorded as facts, and age was assessed in predetermined ranges based on common sense.

4.2.4 Data Analysis

The analysis included 801 observations of 1,664 users. 367 people were alone when observed, with 145 in Suzhou and 222 in Sheffield. In 439 observations, people were in groups which account for 1297 users, with 485 in Suzhou, 812 in Sheffield. Additional information such as unexpected events were recorded to inform city comparisons. Age, gender and group size were quantitative values, and activities were recorded as descriptive terms, such as sitting, eating, or talking. Spatial occupancy was recorded on the maps using the symbols described above. Data on every observation were first manually mapped on observation sheets and then input into Microsoft Excel, Matlaband Photoshop for further analysis, as follows.

1. Frequency analyses were performed on users' personal characteristics to summarize and compare by gender, age, and group size (Excel).
2. Activities were categorized by the clustering method (Matlab).
3. Spatial occupancy data were transformed into a digital map to analyse variation (Photoshop).

Group activities recorded through observations were complex because group members tended to simultaneously be engaged in several activities, such as standing, talking, and using a mobile phone, or sitting, eating, and talking. Therefore, the clustering method was used to identify patterns of group activities. The first step was manual semantic categorizing to improve the precision of the clusters. Then, 23 different activities were identified: sitting, talking, playing, standing, eating, drinking, contacting others using a phone, laying, smoking, playing with a phone, picnicking, touching others, drawing, looking around, kissing, hugging, photographing with a mobile phone, waiting, listening to music, reading, dancing and exercising. In the second step, some of these activities were merged together to simplify the data, such as combining photographing with a mobile phone, playing with a phone and contacting others with a phone into one activity named 'using a mobile phone'. Ten activities remained, as shown in Table 4.2.

Table 4.2. The observed frequency of simplified activity types from sematic categorizations

Simplified activity types	Frequency
Sitting	324
Standing	111
Laying	13
Using a mobile phone (photographing with mobile phone, playing with phone, contact others with phone)	89
Relaxing (reading, drawing, smoking, looking around, listening to music, eating and drinking)	118
Talking	310
Physical intimacy (kissing, touching others, hugging)	13
Playing	92
Waiting	19
Exercising (dancing, exercising)	9

In the third step, the clustering method categorized activity patterns using Matlab based on the simplified data. The clustering was intended to reveal patterns of activity clusters based on K-means. In the Matlab program, cases were sorted into 3, 4, or 5 clusters based on their similarities. The clearest clustering was of five cluster types. Table 4.3 shows the cluster types, the numbers of cases in each of them, and their primary features. The clusters were defined by their features; for example, Cluster 1 is featured by the activity of 'relaxing', most sets of which were 'sitting/standing and relaxing'.

Table 4.3. The five cluster types with featured activity types generated from the clustering method, using simplified activity data

Cluster type	Number of cases	Main features
1	114	Relaxing
2	208	Talking, sitting
3	14	Playing
4	52	Using a mobile phone
5	51	Standing
Total	439	

Spatial occupancy was analysed by estimating the distance between a user and the centre of the public space. This determined where the users were placing themselves in the space and defined those placements according to the edge effect. To evaluate the edge effect, each map was divided into three regions from the centre to the periphery. The numbers of users in the three regions were counted, and those quantities were used to create line graphs to analyse the numbers of users from the centre to the fringe of each map.

4.3 Results

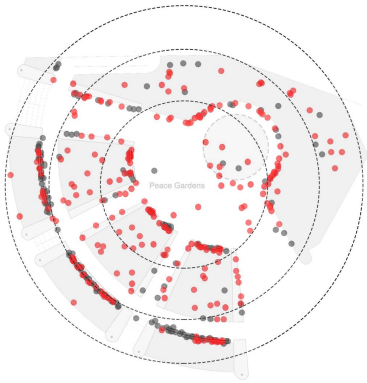
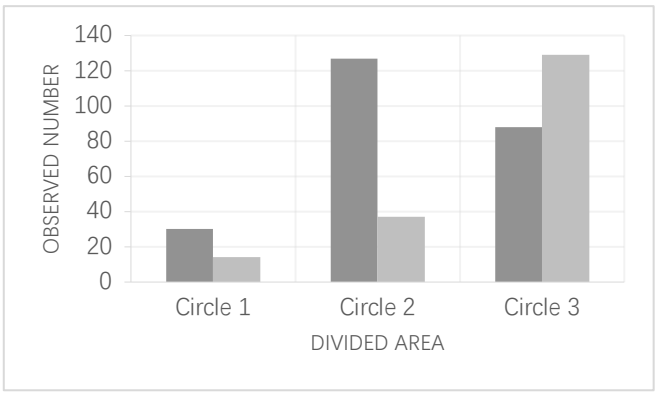
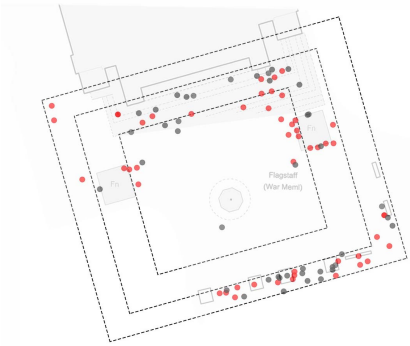
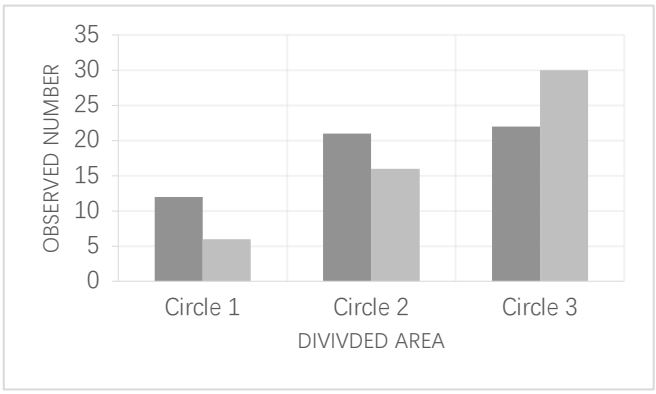
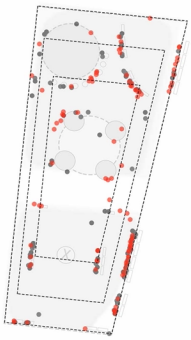
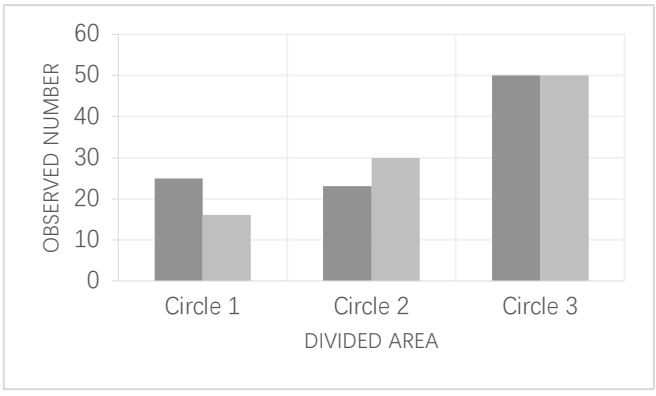
4.3.1 Patterns of use between single and accompanied users

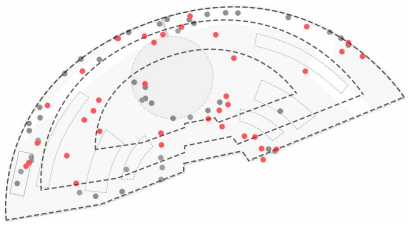
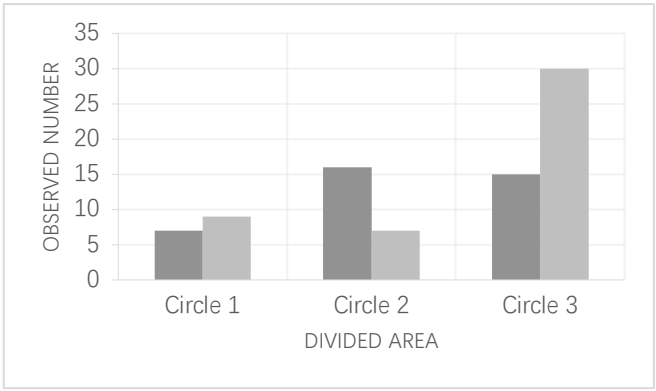
One focus of this study was the differences and similarities between single and accompanied users regarding the characteristics of their patterns of use. The comparison found that the gender composition was different in the two groups, women were more likely than men to be in groups (accompanied), with 40% versus 34%. There were almost half as many unaccompanied women as there were men (9% versus 17%). The activities of single and accompanied users were quite different from each other regarding type and composition. Unaccompanied users were mostly

engaged in one or simultaneously in two activities, whereas group users tended to engage in more than two activities at the same time. The unaccompanied users participated in 13 types of activity: waiting, photographing, looking around, using a mobile phone, exercising, smoking, relaxing, standing, playing, sitting, eating, sleeping, or drinking. The most common activities were using a mobile phone (52.5%) and waiting (13.3%). Group users engaged in relatively more types of activity as described above in Table 4.2, and 23 different activities remained after the sorting process. The group activities included interactions with other group members, such as talking and playing. The most common group activities were sitting (29.5%) and talking (28.2%).

The spatial occupancies of single users conformed to the edge effect, but that was not the case regarding accompanied users. Table 4.4 shows the spatial occupancy locations of single and accompanied users symbolized by black and red dots on the maps of the four study sites. Each site map shows the three regions from the centre to the periphery. The numbers of users in each region of each map were counted, and a bar chart was created for each site (shown next to each map). The four bar charts show that the numbers of single users increased from the inner to the outer regions, and the numbers of accompanied users did not seem to have an edge effect pattern. Most of the accompanied users seemed to be in the middle regions.

Table 4.4. Spatial occupancy of the users observed at the four public spaces. Legend: Red = Accompanied users; black = Single users; Four bar charts show how single and accompanied users distribute from the inner circle to the outer. Legend: Dark grey= accompanied; light grey= single)

	Distribution map	Distribution chats
Peace Garden		
Barker's Pool		
Guanqian Square		

Central Park Square		

4.3.2 Patterns of use by defined relationships groups

In the analysis, three types of relationship were categorized using the distance between individuals (intimate, personal, and social) and named 'Intimate Pair', 'Intimate Group' and 'Social Group'. In the four study sites, the three groups accounted for 29%, 30%, and 41% of the total, respectively. The data revealed that intimate distances only occurred for Intimate Pairs. The distances between individuals increased as group size increased. That finding supports Hall's (1992, p. 117) theory that describes intimate distance as 'love-making, wrestling, comforting, or protecting', which are unlikely to occur among more than two people.

The differences in patterns of use among the three relationship types were determined by examining the personal data collected during the observations. The majority of the Intimate Pairs were identified as lovers because about 69% of them comprised a man and a woman. The majority of the Intimate Groups included three or more people and the ages varied, which identified them as family-like or families. About 77% of the Social Groups comprised two people who maintained social distance from each other, and it was concluded that they might have been friends. Table 4.5 summarizes the three types of groups.

Table 4.5. Three types of relationship based on relationship intensity measured by physical distances between individuals

Relationship intensity distance	Group size	Assumed relationship
Intimate	Two individuals	Intimate Pair (e.g., partners, close friends or family members)
Personal	Three or more individuals	Intimate Group (e.g., family members or friends)
Social	Two or more individuals	Social Group (e.g., friends, acquaintances, neighbours or colleagues)

The analysis found that the three relationship types engaged in different activities and spatial occupancies. Table 4.3 above lists the five cluster types with their characteristics: relaxing, talking/sitting, playing, using a mobile phone, and standing. Table 4.6 illustrates the similarities and differences among the three types by comparing their activities using the five activity clusters. The Intimate Pairs mostly were using mobile phones (43.1%), the Intimate Groups were mostly talking/sitting (32.5%), and the Social Groups were mostly relaxing (48.2%) and playing (43.0%). The three types of groups were generally the same regarding standing. It was unexpected that the closest group, 'intimate pairs', mostly joined in the activity of 'using a mobile phone', as this activity seems to have no interaction involved. It should be noted that the pairs always used one phone together, to watch short videos or read the news together, for example. They would be close enough so that they could read from the small screen together. Most people now own their own phone, and they store private information on their phone, and in most cases, people do not use their phones with other people. On this basis, using a mobile phone with another person may indicate that they have an intensely close relationship. It could also indicate that mobile phones are used more as entertainment devices than just for voice communication. Subsequently, activities in public spaces continuously change with the development of technology.

Table 4.6. Activities of the three relationship groups. (The most frequent activity of each relationship group is marked in grey)

	Relaxing	Talking Sitting	Playing	Using a mobile phone	Standing
Intimate pair (%)	26.4	27.7	28.5	43.1	32.0
Intimate group (%)	26.4	32.5	28.5	27.5	30.0
Social group (%)	48.2	39.8	43.0	29.4	38.0
Total (%)	100.0	100.0	100.0	100.0	100.0

Regarding the spatial occupancy of the three types of relationship, occupancy patterns differed according to the three regions on the maps. Figure 4.3 illustrates that information in the bar chart. Intimate Pairs and Social Groups seemed similar because they tended to occupy the middle and edge regions more than the central regions, which was particularly obvious regarding Social Groups. This trend is also illustrated on the distribution map (Figure 4.2), and the blue and yellow dots represent the intimate pairs and social groups. They rarely show up in the inner circles but are spread evenly in the middle and outer circles, especially for the yellow dots. On the other hand, Intimate Groups were most likely to occupy the central regions, followed by the middle regions, and they were least likely to occupy the edge regions.

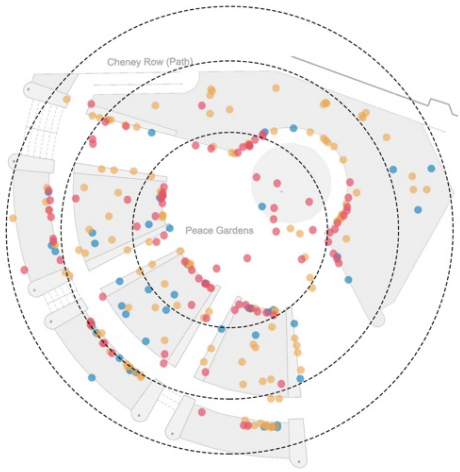
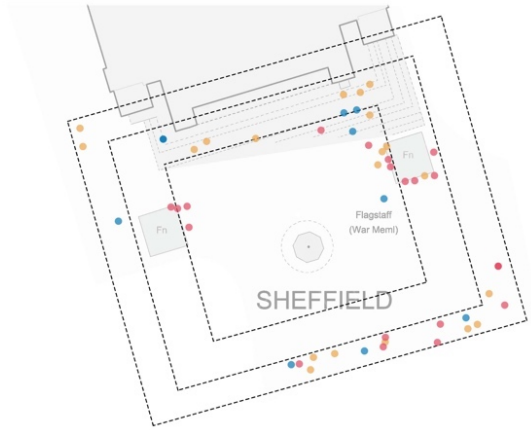
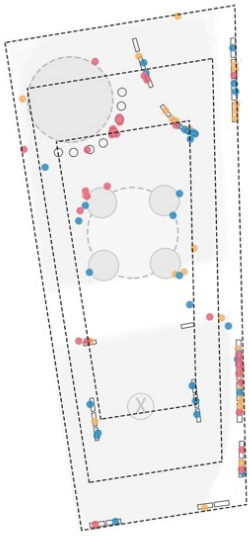
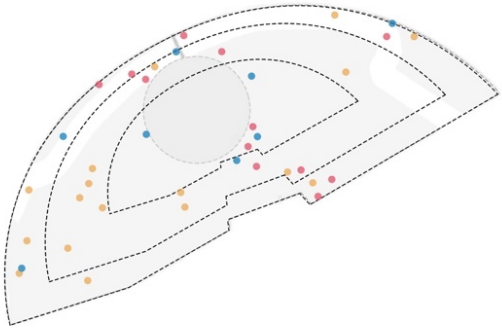
Peace Garden	Barker's Pool
	
Guanqian Square	Central Park Square
	

Figure 4.2. Distribution of the three relationship types in four sites. Legend: Blue = Intimate Pairs, Red = Intimate Group, Yellow= Social Group

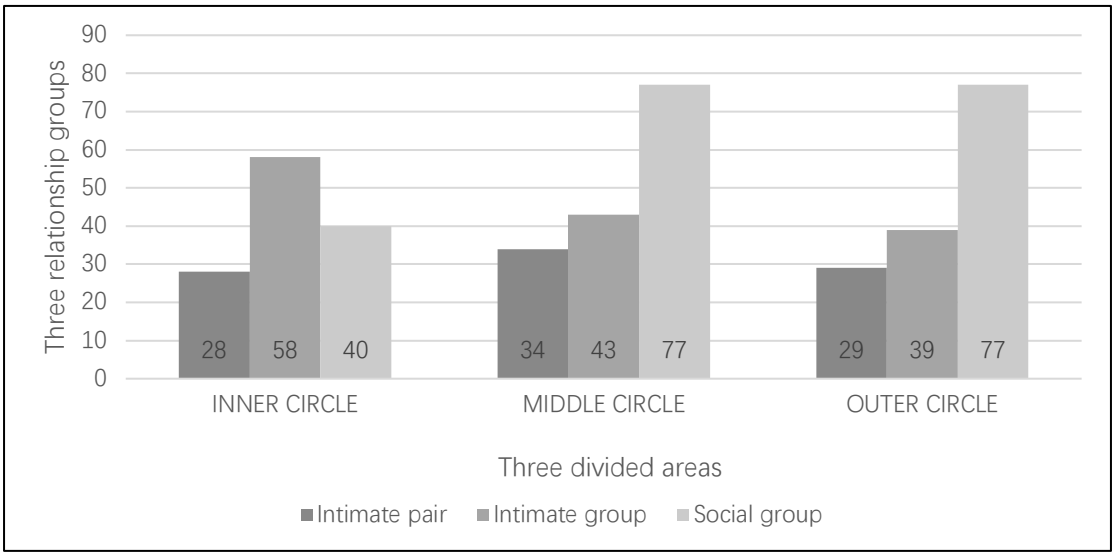


Figure 4.3. Spatial occupancy of the three relationship group types based on the mapped spatial regions

To further illustrate spatial occupancy, the relationship types were investigated relative to the features of the public squares. The frequencies of the users' closeness to certain features were ascertained (Figure 4.4), which provides a clear understanding of the different spatial occupancies of the relationship types. Intimate Pairs were more likely than the other two types to be near trees, followed by Social Groups. Intimate Groups were more likely than the other two types to be near benches and a fountain, which were comfortable and playful areas. The Social Groups were more likely than the other groups to occupy lawns and steps, which are casual and open areas.

Spatial occupancies of the three relationship groups correspond with the results of the three circles' distribution as illustrated in Figure 4.4. Trees, steps, and lawn, which were mostly occupied by intimate pairs and social groups, are all situated in the middle and edge of the public square. In contrast, intimate groups were not recorded near steps or trees and were rarely recorded on the lawn, which confirms the findings of the low frequency of the intimate groups occupying the middle and edge of different places. More of the intimate groups remained around the fountain. The fountains were located in the centres of the which confirms the findings of the high likelihood of intimate groups occupying the central regions of the public spaces.

Spatial occupancies are related to the groups' activities and their social relationship. Intimate groups' high occupancies of the benches support their favourite activity—sitting and talking. Steps and lawns are suitable for relaxing casually, which explains why the social group mostly remained in these two places, and their high frequency of relaxing. Steps and lawns provide a free range of spaces for sitting and standing, and people have the flexibility of adjusting their distances to other people in those areas. This may be the reason why social groups are willing to remain there. In particular, when they are made up of more than two people, and they do not want to be too close to each other, they need areas like these. However, these three areas are all not proper sitting places as they can be dirty or wet some of the time. This may explain why intimate groups mostly used benches and had low frequencies of using steps and lawns. Because many intimate groups are made up of older people and children, who are more sensitive to which facilities they use in consideration of their health and safety (Holland et al., 2007). And for intimate pairs, trees may offer more privacy and can be quieter.

Figure 4.4. Likelihood of using features of the public spaces by relationship groups. Legend: + = low frequency, ++ = moderate frequency, +++ = high frequency (photo credit: authors)

4.3.4 Effects of the sites and cultural factors

Chi-squared for contingency was used to analyse the site effects by comparing the users by gender, age and group size. Then, the differences among the four study sites were compared for consistency in these factors. The statistical value was compared to the critical value: fx = Chiinv (probability, the degree of freedom). Before performing the Chi-square test on group size, three unusually large groups were omitted (50, 58, and 15 people) from the Central Park Square data. Extremely large groups used the public space for square dancing between 7 PM to 9:30 PM every day. The statistical values on age, size, and gender were 59.559, 37.903 and 1.146, respectively, but only the age difference was statistically significant (59.559 > 26.217). The large statistics were at Central Park Square (40.430), which was a significantly different age composition about four times as large as the other three places. According to Figure 4.5, Central Park Square had a much larger share of elders (24%) and a much smaller share of young adults (2%) than the other public spaces. The high proportion of elders relates to their overrepresentation in the dance group. Although big dancing groups are tested and omitted from the data, some small dance groups made up of 3 or 4 older dancers remain. When the small dance groups were omitted from the data, the age compositions across the places were not significantly different.

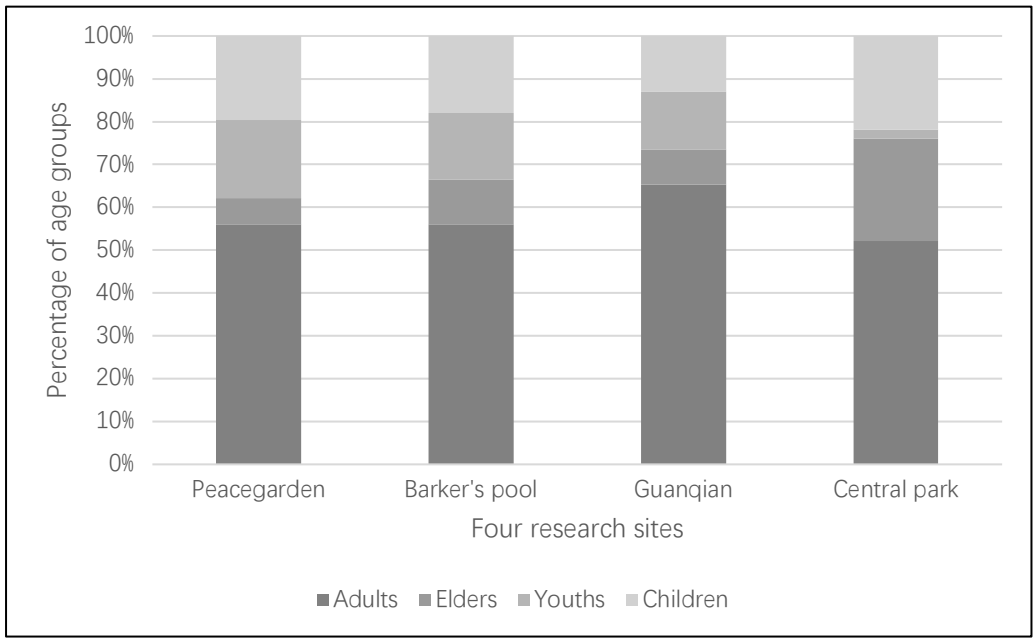


Figure 4.5. Age composition of the users observed at the study sites

The exceptional data at Central Park Square suggest cultural differences between China and the UK. Dance groups typically are observed in Chinese public spaces. Most of the dancers are middle-aged or older adults who seem well organized and consistent in their behaviours, and, during this study's observations, they even came to dance one day when it was lightly raining. Square dancing is a popular activity in China that is attracting millions of retired people. The participants are referred to as 'dancing grannies' by English news media (BBC News China, 2013), which suggests their age and gender. However, the dance group at Central Park Square was not only these 'grannies', and there seemed to be a balance of men and women participants. It may because different types of dancing are involved in. There are various types of dancing performing in Chinese squares, such as folk dancing, zombie dancing (Meng & Kang, 2016). Unlike the random street performances observed at the Sheffield public squares, Chinese people regularly participated in those activities to enhance their health and enrich their lives. During the dancing, a large area of the space was occupied, and loud dance music was played, which seemed to negatively affect other users because they started to leave the place when the dancers came. To avoid noise, earphones have been gradually used to replace the speakers to deliver music (Zhou, 2014). Consequently, the dance group not only influenced the differences in age and group size, but it also influenced the normal uses of the space.

Cultural factors also influenced the amounts of time spent in the places and the activity types at Sheffield and Suzhou. According to the observation memo, users at the Suzhou places were more likely to use the public spaces at night. No users were observed in the Sheffield squares after dark (after 7:00 P.M. in April; after 8:00 p.m. in May.), whereas, in Suzhou, the numbers of users increased after 6:00 PM. Then, the Suzhou users gradually left from about 9:00 PM until about 11:30 PM. Except for the big amount of dancing people, many Suzhou users engaged in the evening activity of 'taking a walk after dinner'. Walking after dinner is considered a healthy exercise in China as evidenced by the maxim, 'people who walk after dinner can live up to 99 years'. Peopled walked to the square to relax and then they returned home. The Sheffield users' activities were often observed as highly related to weather conditions because the number of users in the public spaces

increased to nearly twice when the weather was pleasant. Users went there to rest on the grass and sunbathe or to picnic and enjoy the balmy weather. When the duration of sunshine becomes longer in summer, the street fairs are a common sight in these two squares. Great amount of people show up in the street fair to celebrate the summer. And those fairs are recognized as a common cultural currency and asset in the UK (Walker, 2015).

In sum, the sites were not obviously different regarding the personal characteristics of the users, but the cultural differences related to the Chinese dance group greatly influenced age and group size distributions in the public space where they occurred because the group was very large. When the dance group was not included in the statistical test, age, gender and group size were consistent across the study sites.

4.4 Summary

In summary, the comparison of single to accompanied users found that the single users engaged in different types of activities and had different patterns of spatial occupancy than the group users. Women were more likely than men to be in groups than alone, indicating a gender difference in the public spaces. Compared to single users, group users tended to participate in multiple activities simultaneously, and their activities involved more interactions with other people. In terms of spatial occupancy, the single users confirmed the edge effect, but the group users were generally evenly distributed throughout the spaces.

Three types of group users were identified (Intimate Pair, Intimate Group and Social Group), and their patterns of use appeared to be different. Intimate Pairs were most likely to be using a mobile phone, Intimate Groups were most likely to be talking/sitting, and Social Groups were mostly playing and relaxing. Regarding these groups' spatial occupancies: (1) Intimate Pairs were more in the middles and edges than the central regions and they were more likely than the other types to use the areas under trees; (2) Intimate Groups were evenly distributed from the outer to the central regions and were more likely than the other types to use benches and fountains; and (3) Social Groups were highly unlikely to be in the central regions and they were more likely than the other types to use lawns and steps.

At the end, the analysis found that there were no site differences with respect to the users' personal characteristics when the data were adjusted by omitting the large, unusual dance group from the data on one site. This dance group was a cultural factor at Central Park Square reflecting a common activity in China that influenced the age and group size distributions and negatively influenced the normal use at that study site. Cultural factors also influenced timing and activity types, with Suzhou users at the public spaces more likely to use the spaces at night than during daytime and Sheffield users more likely to use the spaces on sunny rather than less pleasant days.

Chapter 5:

(Study 2) An exploration of a perceptual structure of soundscape in urban public spaces based on Grounded Theory

5. (Study 2) An exploration of a perceptual structure of soundscape in urban public spaces based on Grounded Theory

5.1 Introduction

Previous studies about soundscape structures usually focus on a particular aspect of soundscapes, breaking the concept down into several key components (Aletta et al., 2016; Davies et al., 2009; Raimbault & Dubios, 2005). Classifying sound sources is considered as the first step in structuring sound perceptions (Brown et al., 2001; Woodcock et al., 2017). During the process of sound source identification, two strategies for listening were introduced: 'descriptive listening' and 'holistic listening' (Raimbault et al., 2003; Raimbault, 2006). In terms of the aspect of perceived affective quality, a two-dimensional coordinate was introduced, that is, pleasantness-eventfulness (Axelsson et al., 2010), and calmness-vibrancy (Cain et al., 2013). Herranz-Pascual et al. (2010) applied environmental perception theories to analyse soundscapes, suggesting that, for each person, sound perceptions consist of emotion (feelings), cognition (thoughts), and knowledge (meaning). However, how these aspects work and the relationships among them are not clearly understood.

Others emphasized that sounds are received through a process, from perceiving to experiencing to understanding (Dubios et al., 2006). They raised several perceiving process models to describe how people understand sounds, such as Liu and Kang (2016)'s five dimensions of soundscape, Davies et al. (2013)'s cognition process and ISO's (2014) conceptual framework of soundscape. However, in these studies, perceiving processes focused on the translation from physical sounds to perceived sounds; the different perceptual stages in the perceiving process were not emphasised.

To fulfil the gaps, this study aimed to explore further the mechanism of how sound is perceived by general users of urban public spaces. Two research questions were posed: 1) What are the aspects of soundscapes in urban public spaces from the perspective of their users? 2) How do these aspects form the process of perceiving soundscapes? By investigating these two issues, a perceptual structure of soundscapes in urban public spaces can be obtained.

5.2 Methods

5.2.1 Research design and process

In the GT approach, in-depth interviews are the core method of collecting data. To obtain abundant data, participant selection should be based on the ability to contribute to the understanding of the research problem. Therefore, in this study, we employed convenience sampling; every user in the two urban public spaces in question was asked whether they were willing to be interviewed. Usually, those willing to be interviewed had some free time and planned to stay in the square for an extended period of time. This was exactly the kind of person required for this study, because only those who had spent some time in the square would have insight into the sounds of the site. Before the interview, the researcher had a small talk with potential participants to inform them of the research aims and objectives. Because the research requires participants to have normal hearing abilities to be able to express opinions on soundscape. The researcher identified participants' hearing abilities through self-assessment during this conversation- by observing whether the subjects could hear the researcher's words and give feedback without much effort.

There were two interview phases, both of which were approved by the ethics committee from the University of Sheffield. The first was a pilot study involving 5 participants in Guanqian Square, Suzhou, China during January to February, 2018. It was found that the sound perceptions described by the interviewees were highly dependent on the sound sources of the site. Thus, in the second phase, another 13 individuals were interviewed at Peace Garden, Sheffield, the United Kingdom until information from the interview become repetitive, which means everything the new interviewee told the researcher had been told by the previous interviewees. This phenomenon was defined as the 'data saturation' in Grounded Theory, which marks the end of the interview (Glaser& Strauss, 1967; Dobbins et al., 2018). The second phase of interview occurred during June, 2018. The sample size was eventually similar to the previous grounded theory research, which were around 13- 15 (Zhu et al., 2020; Yilmazer& Acun, 2018). Figure 5.1 shows the general appearance of the two sites. Each interview involved unstructured, open-ended questions and lasted for about 15–30 minutes, depending on the length of the interviewee's responses. During the interviews, data were recorded and initially analysed, and when no new content emerged, interviews ended. Among

the 18 interviewees, there was a balanced gender distribution with 3 men and 2 women in Guanqian Square, 5 men and 8 women in Peace Garden. A variety of age groups was covered as shown in Table 5.1: young participants were between 18 and 24, adults were between 25 and 49, and older participants were between 60 and 70.

(1)

(2)

Figure 5.1 Pictures of the two sites in which study 2 was conducted, (1) Guanqian Square, Suzhou, China, (2) Peace Garden, Sheffield, UK

Table 5.1 Age compositions of interviewees in Peace Garden and Guanqian

	Peace Garden	Guanqian
Young	5	1
Adult	6	3
Older	2	1

5.2.2 Interview questions

The interview consisted of three parts (Table 5.2). The first part concerned the interviewees' background information: age, gender, occupation, companion information, and activities in which they participated at the sites. The second part concerned what they heard and their descriptions of

those sounds. This allowed the researcher to observe the process of participants perceiving and understanding sounds. The third part concerned subjective understandings, asking participants about their feelings and preferences for sounds in order to dig deeper into sound perceptions.

Table 5.2 Interview questions and question aims

Category	Question details	Question aims
Background information	Age and occupation through questions, gender through observation	Demographic background
	Whom have you come with today? With whom do you generally go to a public space?	Companion types
	Why have you come to this place? What are you doing here? Do you often come here for this activity?	Activity types
Descriptions of sounds	What are the physical environmental factors you care most about an urban public space? How would you describe the preferred environment in a public space? Why?	Overall impressions about sounds as part of environmental factors in general
	Do you pay attention to sounds? How do you think of sounds compared to other factors?	
	What sounds do you hear in this place? How do you think of these sounds? How would you describe them?	Overall impressions about sounds at the site
Subjective understandings	What do you feel about those sounds? What sounds do you like or dislike? Do you feel the soundscape in the square hinders/stimulates your activity?	Subjective evaluations of current soundscape
	Describe your preferred soundscape in urban public spaces? Or describe a place you have been to that had a great soundscape? What have you heard in this public space that you have liked? What kind of improvements would you like to see in the square soundscape?	Experiences about public space soundscapes

5.2.3 Data analysis

The primary method of data analysis in the GT approach is multiple category coding (Böhm, 2004), with the successive use of open, axial, and selective coding. In more detail, the analysis followed these steps:

Sorting memos: Collecting interview contents according to the questions and sorting them into key phrases.

Labelling: Browsing through the sorted text to identify and merge repeated words and meanings, followed by summing up the merged meanings in short sentences.

Conceptualising data: Comparing different phrases and relationships to summarise the concepts at different levels. Followed by asking questions about those differences and make linkages between them.

Generating main categories: Summarising similar concepts into categories based on the linkages between them and comparing the effectiveness of several classifications based on different criteria.

Generating sub-categories: Identifying the multi-dimensional properties and characteristics of one main category of the soundscape.

Relationships among categories: Comparing the main categories to determine the hierarchical order in the way people perceive sounds, and how they interact with each other.

Establishing the theory: Clarifying the perceptual structure of soundscapes.

Table 5.3 shows a part of the analysis process from sorting memos to generating main categories and sub-categories based on the GT approach. Some of the answers regarding background information and sound descriptions are shown in Table 5.3. Open coding occurred during the process of sorting memos and labelling to break down and examine raw data. Raw data were labelled as a1, a2, a3… These raw data were then conceptualised and cut down from 176 to 155 items as labelled aa1, aa2, aa3... Axial coding, conducted simultaneously, allowed the classification of unstructured data into concepts and categories; in this way, 55 categories labelled as A1, A2, A3…were produced. In order to identify the main categories, the interrelationships among categorised data were analysed through selective coding. For example, A1, A4, A6, and A8 were found to express background reasons for people's soundscape judgment. Thus, they were grouped under the main category of AA4. The main categories identified four aspects of sound perceptions. After this, the relationships among these categories were considered to form the perception process and build the relationship structure of soundscapes.

Table 5.3 Coding analysis of grounded theory: open, axial, and selective coding

Sorting Memos →	Labelling →	Conceptualising Data →	Categorising Data →	Categories	Sub-Categories
('Why have you come to this place? What are you doing here? Do you often come here for this activity?')	a1.Location affects whether people come here	aa1. The weather is the reason people come to the public space; sound is the second priority. (a9, a13, a16, a75, a36)	A1. A comfortable environment is a more important reason for coming to public spaces than sounds. (aa1, aa12)	AA1.Sound classifications	AA1. Sound classification:
'I use it as a base when I've been working, and then relax out in the square...'	a2. Many people come here because of the square's central location	aa2. Centrality is the main feature of public spaces. Numerous people come to the public space. (a1, a2)	A2. People love to see other people and hear others' conversations. This makes them feel happy and enjoy the space.	AA2.Sound features	- By sound type
'Maybe because it is like the main spot in the city, like, everybody comes here together.'	a3.People like to see other people	aa3. People love to see and hear other people in public places. (a3, a91, a98)	Talking sounds are a main feature of public spaces. (aa3, aa48, aa54)	AA3. Psychological reactions to sounds	-By attentiveness
'It's very central, we just get off the train and a little walk ...usually we come here to take a rest on the way to the bank or shopping...very convenient....'	a4. People usually take children to the fountain	aa4. Children like playing in the fountains. Families always take their children to the fountains. (a4, a5, a6)	A3. Hearing others' conversations is awkward. People don't want to hear others playing music on their phones. (aa91, aa98)	AA4.Sound preferences	-By sound meaning
'I just like looking around...looking at people'.	a5. The fountain makes people feel relaxed	aa5. Open space and nature are preferred. (a6, a7, a39)	A4. Public spaces are centrally located and have various modes of transportation. Some people do not go there on purpose. They just go past it or rest there. (aa2, aa21, aa26, aa61)		AA2. Sound features:
'I think a nice urban space has a great number of people; you can see people doing things...it's nice to look at'.	a6. Open spaces, greenery, and fountains are important for public spaces	aa6. Safety issues are a concern in public spaces. Unsafe sounds, such as traffic, put people on alert. (a14, a35)	A5. Annoying surrounding sounds will damage the quality of public spaces. The quality of the surroundings can affect the impression of public spaces. (aa10, aa20, aa65)		-Diversity and integrality
'Playing with water, which children like'.	a7. People prefer things involving nature	…	A6. Fountain play an important role in public spaces. Children love to play with water. (aa4)		-Particularity and stereotypicality
'I would love to...fountain...and something to do with nature...like water, green, somewhere like here.... Very relaxing, and the kids are having fun around the fountains'.	a8. Public spaces exist for relaxation		…		AA3. Psychological reactions to sound:
('What are the physical environmental factors you care most about in a public square? How would you describe the preferred environment in a public space? Why?')	a9. Weather is considered the most important environmental factor for going to the square				-Instant reactions
…	…				-Prolonged reactions
					-Responses and strategies
					AA4. Sound preferences:
					-By descriptive words
					-By describing images
Initial Data	176 items	105 items	55 items		

5.3 Results

5.3.1 Sound classifications

With various sounds in the environment, categorising them was the first thing that came to mind when participants were asked to describe them. People tended to recognise sounds within a category, rather than individually. Three kinds of categorising methods emerged: 1) categorising sounds by sound attributes, 2) categorising sounds in the order in which they were noticed, and 3) categorising sounds by the information they conveyed.

5.3.1.1 By sound type

Categorising sounds by type was based on people's common sense and life experiences. Nature was the most frequently mentioned; this included 'sounds of trees, birds, water, and wind' (a29). In contrast to natural sounds, participants categorised the sounds of music and bells as 'artificial sounds' (a85). 'People sounds' were also mentioned. This included talking, children's laughing and screaming, and footsteps (a48, a77). The rest were categorised into the group of '*common sounds in the city*', termed 'city sounds', like traffic noise, wind between skyscrapers sounds, and store music (a25, a90, a94, a40). In short, there were four types of sounds: 1) human sounds: talking, laughing and screaming, and footsteps, 2) natural sounds: trees, birds, water, and wind, 3) instrumental sounds: music and bells, and 4) city sounds: traffic noise, wind from the urban canyon effect, and store music. This classification method represents a basic understanding of sound attributes.

5.3.1.2 By attentiveness

As public squares are usually located in the city centre, various kinds of sounds from the city make up a complex acoustic environment. Kaya and Elhilali (2017) referred to this situation as the 'cocktail party problem' to stress the challenge of holding listeners' attention despite numerous prominent distractors. In such an environment, the cognitive process enables people to navigate their surroundings and differentiate between salient and background sounds. The participants in this study also distinguished sounds in terms of foreground and background. The sound of water was mentioned mostly as a foreground sound, and some participants considered it to be so loud as to

mask background sounds (a87). Background sound included faraway sounds, such as the sounds from surrounding shops and amusement facilities (a65, a20). It seems that participants generally distinguished between foreground and background sounds based on volume.

Some participants mentioned that background sound had both a negative and a positive influence on the whole sound environment. Background sound could be annoying when it disturbed the overall soundscape, for example, '*I don't like too much noise. I don't feel good when I hear those sounds from the amusement park nearby*'; '*surrounding sounds can affect the impression of public spaces*'; and '*shops (sounds) around are annoying, because they are all the same across the world*' (a10, a20, a65). Although the background sounds mentioned were quite far away from the square, they were required to fit in the overall soundscape of the square to create a satisfactory sound level. The positive influence included: '*Water from the surroundings echoes with the water sounds here, which makes a connection*' (a16). Compared to the negative effect, when the surrounding sounds were positive and in harmony with the foreground sounds, they were considered to have a positive effect.

5.3.1.3 By sound meaning

The various pieces of information contained in sounds were used as a classification method, because sound is a medium for conveying information. As information tends to be time-sensitive, information-related sounds were categorised into two types: 1) current information, where listeners could learn about events and situations that were happening at the moment, for example, clock bells providing information about the time (a101) and 2) past information, or sounds associated with memories. For example, water sounds in the Peace Garden reminded a participant of the memory of travelling to Chatsworth, where similar water sounds were heard (a19). Store music was also believed to trigger memories because of some old songs that were played in shops (a20).

In short, classification is fundamental to how people understand sounds. Compared to the classification methods used in previous research, the one used in the present study did not involve delving deep into the physical attributes of sounds, such as strength and fluctuation (Kang & Zhang, 2010). The three kinds of categorising methods summarised in this study reflect the fact that people tended to classify sounds only by content and volume.

5.3.2 Sound features

Faced with multiple sound sources in the square, participants tended to think of the relationship between individual sounds and the overall sound environment. They concluded that there are two kinds of relationships: the ones between diversity and integrity and between particularity and stereotypes. The first one refers to people's recognition of the coexistence of multiple sounds and the requirement for those sounds to be harmoniously combined into an integral whole; the other indicates that people had a requirement for the particularity of a sound to identify the square, but they did not want this particularity to exceed their general understanding of the soundscape of the square. Both relationships show how people thought logically and critically about the characteristics of the square's soundscape.

5.3.2.1 Diversity and integrality

A wide range of sounds was recognised as a positive feature of the square's soundscape: '*listening to various kinds of sounds is the reason I come to the public space*' (a56); '*…in the public space you can hear various kinds of sounds…they are all good…*' (a43). In addition to the diversity embodied by multiple sound types, variations in the tone and volume of the same sound can also bring diversity. Fountains were mentioned as showing this kind of diversity, as the changing water flow can bring with various changing sounds (a78). Sound tone was mentioned with reference to bird sounds, as some birds can make changeable sounds (a51). People even thought that the more varied the sound, the better, as demonstrated in the statement: '*if you can only hear one kind of sound, you will not feel good…more is better*' (a56).

Although many people viewed diversity as positive, others felt that too many kinds of sounds can confuse listeners. Some people said that they disliked hearing too many sounds at a time because it felt noisy. They mentioned that no more than three kinds of sounds are acceptable (a64, a96). Others disagreed and accepted various types of sounds as long as they '*mix well together*' and '*mix in a natural way*' (a28, a57). Thus, they stressed 'integrality': '*just everything in the place, not a certain sound; I like them…all of them together…they just depict the public space*' (a60, a43). As a holistic soundscape, the critical issue is whether sounds blend harmoniously or mix naturally (a28, a57). For the sake of this wholeness, particularly 'harsh' sounds, such as sudden sounds (alarm,

brake) and high-volume sounds (loud music, traffic) (a19, a86), were considered to require improvement.

5.3.2.2 Particularity and stereotypes

People desired that the square soundscape be unique, but at the same time, they required it to conform to the stereotypical attributes of a square. One of them did not like store music because it was too popular to be featureless (a20). The sound of water was praised as it represented Sheffield's character. There were several other fountains and streams in the surroundings to echo the square's fountains. The ubiquitous water sounds were believed make the city more memorable (a16, a18, a19).

On the contrary, participants had limited imagination regarding what constitutes a general square soundscape. They displayed a similar, uniform understanding of the square soundscape. According to a75 and a42: '*Sound types in this public space are all basic sounds, very common; fountain, children, talking are ordinary sounds in the public space*'. Other environmental factors are included in the 'stereotype' of the public space soundscape: mild temperature, mild sound level, and good sanitation (a41). Interviewees mentioned that they wanted the other environmental factors to match the sound environment. In return, they did not ask for a perfect sound environment. Instead, they considered commonness to be even better (a50). As a result, some unusual sounds were considered unacceptable, such as loud music: '*I don't like loud music, not here. If I wanted to listen to loud music, I would go to a pub*' (a86). Loud music was recognised as a sound only found in pubs, and therefore inappropriate in the square. It indicated that people also have a stereotype of pubs. People might wish each place to perform its functions and to have its standards. To sum up, stereotypes and particularity are not contradictory: what people want is the particularity within their square stereotype.

5.3.3 Psychological reactions to sounds

Sounds can bring about psychological reactions, and participants tended to describe the soundscape by describing the feelings that sounds triggered. A soundscape was found to bring about two kinds of subjective reactions: 1) instant and transient and 2) relatively stable and prolonged. In response

to sound-induced subjective reactions, especially negative ones, participants adopted strategies of tolerance, avoidance, and complaint.

5.3.3.1. Instant reactions

Instant psychological reactions were found to be triggered by particular sounds in the square: 1) happy/depressed: speaking, birds' singing, children screaming (a3, a48, a77), skyscraper effect sound, wind (a40); 2) awkward: others' conversation, music on others' phones (a91, a98); 3) relaxed, calming, peaceful: waterfall, fountain, sounds representing nature (a80, a13, a55, a22); 4) unsafe, worrying: car brake, bus (a24, a99); 5) energetic, exciting, lively, vivid: dancing music, children playing and screaming (a38, a30); and 6) sociable: festival music (a14). In addition to the particular sound source, the visual aspect was tightly combined with sounds. It was often the combination of sound and image that triggered a particular feeling. For example, participants mentioned 'looking at children screaming and running...that makes me happy' (a77). Children's screams as they played, combined with their happy expressions, conveyed that children were enjoying the moment. Perhaps the interviewee would not have had a happy feeling if he had heard only screams.

5.3.3.2 Prolonged reactions

Prolonged psychological reactions are relatively stable compared to instant reactions. For example, people mentioned 'just being in this square makes you feel tranquil' (a13). Unlike the instant relaxing feeling caused by a particular sound, the feeling of tranquillity is not changed by other factors. Anxiety was also frequently mentioned. A feeling of anxiety was related to urban life. As public squares are mostly located in city centres, people mentioned that they felt depressed when facing all the high-rise buildings (a34). Also, people were always exposed to urban noise in the squares, such as sounds related to traffic and construction. These noises led to a state of anxiety (a90). Some people mentioned that they constantly felt anxious in the squares. By contrast, the sounds of nature eased anxiety. People mentioned that they came to the squares to experience nature and forget the high-pressure urban life (a29, a47, a80, a83).

5.3.3.3 Responses and strategies

Psychological reactions were found to influence both mental and physical aspects. Calm sounds made people think: 'rainy sounds are thoughtful. Rainy days are good for thinking; Fountain sounds

are like those you hear on the beach…those sounds make you think' (a49). Happiness, on the contrary, was associated with physiologically perceived warmth (a66). Similarly, a calm and tranquil feeling brought about by the sound of water was believed to reduce the temperature and '*make you feel cool inside*' (a22). Positive feelings were found to provide restoration and benefit mental health. For example, a peaceful and calm mental state relieved stress; one participant mentioned that he came to the square regularly to listen to water sounds, which could '*relieve him from work*' (a69). Another participant considered the public space the '*buffer area in the city to take people away from the traffic noise*'; without it, city dwellers would be 'depressed' (a25). It seemed that the soundscape of a pleasant public space acted as a remedy for city dwellers. The consequences of negative feelings were more far-reaching and severe, with potential long-term negative effects on psychological and physical aspects. Anxiety aroused by traffic noise made people physically uncomfortable: '*Those cars are too noisy. I don't feel good when hearing those sounds*' (a52). The sounds of loud laughter and shouting from groups of teenagers cast a long psychological shadow over one of the participants, who said she would '*always stay away from any teenager in the square*' (a32).

Three strategies for coping with negative emotions were summarised from the interviews: tolerance, avoidance, and complaint. Tolerance was adopted when people felt that they could not change the situation, and they finally accepted it. Such strategies were often adopted in response to traffic noise, which people considered unavoidable in cities (a94, a76, a93). When people felt that they could not cope with unwanted sounds, they would choose avoidance. Some of them considered it a way to control the situation as they thought they had the option to leave. As long as they could leave the place at any time, they felt everything was under control, and they would not feel stressed about the unwanted sounds anymore (a39, a92). Others chose to complain about negative sound experiences, and they gave suggestions in an attempt to improve the future sound environment. Suggestions included: '*public spaces should be designed to screen annoying sounds like the noise of cars*' (a55); and '*public spaces should be as big as possible to avoid the loudness*' (a31, a63). In short, these three strategies cover people's psychological adaptation. When people meet with sound satisfactions, they tended to solve problems at the psychological level.

5.3.4 Sound preferences

Sound preferences appear to go deeper than the aspects mentioned above. This is because people cannot judge sounds and tell their preferences until they have a general understanding of sounds. People were found to express their sound preferences in two ways: through adjectives or descriptive phrases and through 'image' description, expressing sound preferences by narrating an event in the square in which sounds appeared as a part of the 'image'.

5.3.4.1 By descriptive words

People sometimes use phrases or adjectives that directly point to the preferred sound source or preferred feelings brought about by sounds. While people used positive descriptive words to describe their favourite sounds, they also used negative words to describe what they disliked. 'Preferred' or 'annoying' is an essential measurement by which people understand and evaluate sounds. It was also found that sound preferences contained judgment about their preferences for the three aspects mentioned above: sound sources, features, and psychological reactions. As shown in Table 5.4, descriptive words were categorised according to the three aspects and were both positive and negative. Generally, positive sound sources, features, and psychological reactions were preferred. Human and nature sounds were mostly preferred: children playing (a77), talking (a3, a48), birds singing (a51, a53), fountain (a11), water (a83), and music (a69). People described their preferred sound sources as beautiful (a72), natural (a29), and quiet (a104). Most of the annoying sounds were under the categories of city and human sounds, described as noisy/loud and artificial, including traffic/cars (a99, a24, a52), vendor sounds (a26), shop music (a20), square dancing music (a102), loud talking (a63), and children screaming (a42). Although most people disliked hearing loud sounds, some could accept a reasonable level of loudness in the square, considering the context (a44). Some people even expressed a preference for loudness, considering it an indicator of eventfulness (a76). In the context of conveying information, people tended to prefer meaningful sounds (a18).

Preferences about soundscape features were: 'various' (a56, a57) and 'harmonious/united' (a28) in the aspect of diversity and integrality and 'distinctive' (a20), 'typical' (54), and 'appropriate'

(a86) for particularity and stereotypes. The preferred psychological reactions were mostly those associated with positive emotional feelings, such as happiness and relaxation.

Table 5.4 Descriptive words for preferred and annoyed sounds in urban public spaces

	Preferred	**Annoying**
Sound classifications	Quiet	Noisy/loud
	Meaningful	Meaningless
	Memorable	Forgettable
	Natural	Artificial
	Beautiful	Tuneless
Sound features	Varied	Monotonous
	Harmonious/united	Conflict
	Distinctive	Ordinary
	Typical	Unusual
	Appropriate	Inappropriate
Psychological reactions to sounds	Happy	Depressed
	Relaxing/relieving	Stressful
	Tranquil/calm/peaceful	Exciting
	Eventful/energetic/lively/vivid	Dull
	Warm	Cold
	Thoughtful	Shallow
	Safe	Unsafe
	Comfortable	Awkward
	Unconcerned	Worried
	Calm	Irritated
	Fearless	Fear
	Polite	Offensive

5.3.4.2 By describing an 'image'

When people felt that it was challenging to describe preferred sounds, they described an 'image', including information such as 'who', 'where', and 'doing what'. Various pieces of socio-demographic information were included in these 'images', such as occupation, age, gender, and social relationships. Social relationships were dominant, as activities were centred around them. People's activities were found to correspond to their social relationships. Categorised by social relationships, three types of 'images' emerged: those pertaining to friends, family, and couples. People mentioned an ideal 'friend image' with an eventful soundscape: '*when last summer, they had a festival here…and I was with my friends. We were just enjoying the festival performance…everything was nice and pleasant, and we had ice cream*' (a14); and '*sleeping on the grass during a music festival in the square when accompanied by friends*' (a97). The 'family image' involved a soundscape that was '*relaxing, peaceful…we are looking at children having fun around the fountains without hearing those traffic noises*' (a4); and '*I don't like events that have the sound of music. I like natural sounds*' (a85). The 'couples' image' were generally concerned with quietness and a private sound environment; they desired not to be overheard or to hear others' conversations: '*we want to be in a quiet environment where we can only hear each other and not hear other people talking or playing music on their phones*' (a91, a13, a98). In these images, sound preferences also included judgments of the above three categories, such as relaxing (psychological reactions), nature sounds (sound classification), and hearing sounds not belonging to the square (stereotype).

Socio-demographic information is usually considered to influence people's sound preferences (Yu & Kang, 2010). In the 'image', socio- demographic information provided the background as to how those activities occurred. To some extent, it explains why demographic information influences sound preferences. According to the content of the 'image' illustrated above, it was found that people's social attributes determined what kind of activities they participated in. Especially for social relationships, there was a strong connection between relationship type and activity type. Apart from personal preferences, people preferred sounds that supported and stimulated their activities. In short, social attributes influence people's sound preferences through the sound requirements for their activities.

5.3.5 A perceptual structure of soundscape: the process of perceiving sounds

5.3.5.1 Perceiving process based on four aspects of sound perception

Based on the four aspects summarised above, a progressive relationship explains the perceiving process. This process, illustrated in Figure 5.2, has three levels: classification, appraisal, and judgment. When sounds reach people's ears, they express what they hear through classification. This step is the starting point from physical sounds to the sphere of perception, and it provides the basis for sound features and psychological reactions. Based on the classifications, people appraise sounds through two methods: one is a rational and functional appraisal, which evaluates the features of sounds, and the relationships between the single sound and the overall sound environment; the other is from the emotional aspect, emphasising the feelings and emotions triggered by sounds. In this study, the two appraisal methods emerged at the same time. Some participants only appraised sounds from one perspective, while others appraised them from both perspectives. At the final level, sound preferences reach the value judgment level, with the preferred-annoyed criteria to judge the previous three aspects. It is considered the end of the sound perception process because it enters the outcome sphere. Thus, a progressive process of sound perceptions was derived: classification-appraisal (sound features and psychological reactions)-judgment (sound preferences).

5.3.5.2 The perceptual structure of soundscape

The perceptual structure of soundscapes includes perception aspects and perceiving process. According to Figure 5.2, four aspects make up the perceived sphere of sounds: sound classifications, features, psychological reactions, and preferences. The relationship between these aspects is that sound preferences encompass judgment regarding the other three aspects; sound classification is the foundation. Four aspects form the perceiving process, in a progressive order. The perceptual structure stresses two points about the soundscape: first is that there is a hierarchy in people's perceptions of sounds whereby the four aspects form three progressively more profound levels of sound perceptions; second is that sound preferences entail value judgment about the sound classification, features, and psychological reactions.

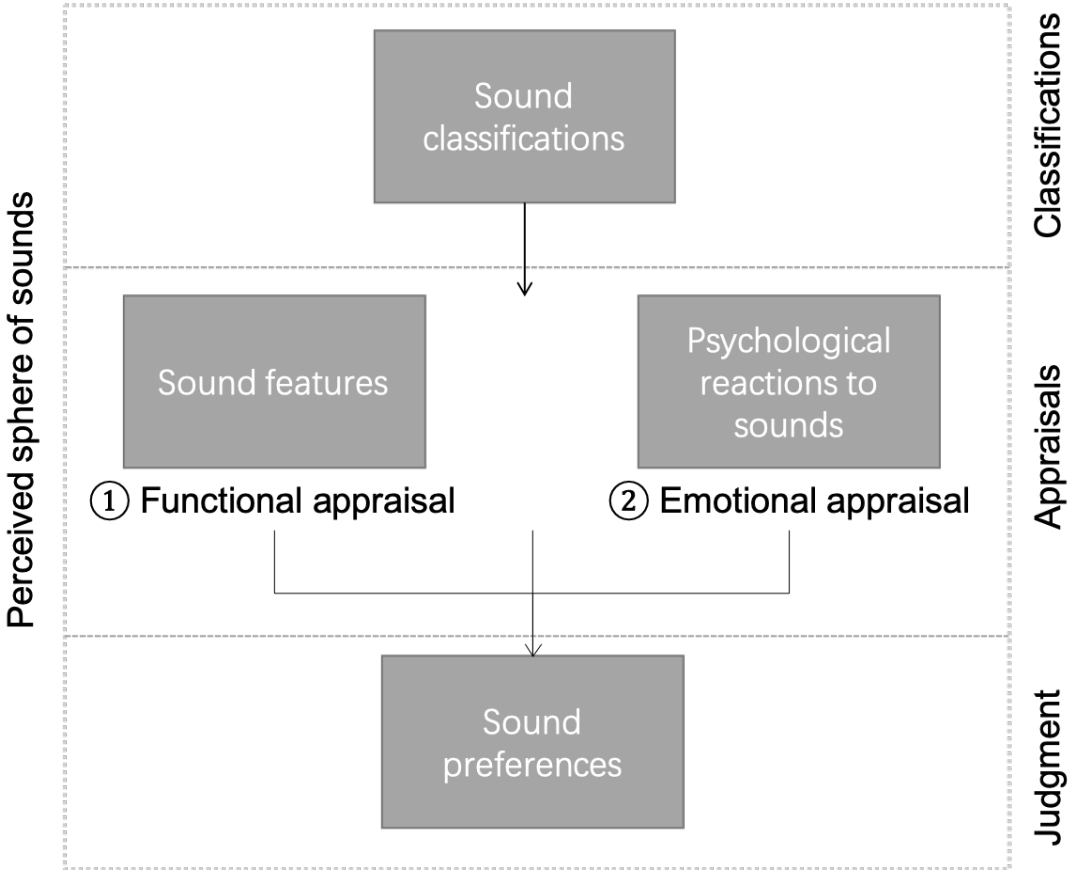


Figure 5. 2 Perceptual structure of soundscapes

5.4. Summary

This study aimed to explore the aspects of the perception process in order to build a perceptual structure of soundscapes for general users in urban public spaces. Based on the GT approach, four aspects were summarised: sound classification, features, psychological reactions, and preferences. (1) Sound classifications: the way people categorise sounds reflect the fundamental understanding of sounds. Ordinary listeners tended to categorise sounds by content and sound levels. (2) Sound features: people can think dialectically about the relationship between individual sound and the overall soundscape. (3) Psychological reactions to sounds: sounds trigger instant or prolonged psychological reactions, which can result in physical and psychological outcomes in listeners. To deal with the negative outcomes, people adopt the strategies of tolerance, avoidance, and complaint.

(4) Sound preferences: people were found to express preferred sounds by descriptive words and 'images'.

The four soundscape aspects form a progressive perception process with three levels: classification-sound appraisals (sound features and psychological reactions)-judgment (sound preferences). After the sound stimuli entered the perceived sphere, people received and understood sounds by classifying them. Subsequently, there were two routes of appraisal: one from the functional aspect to evaluate the characteristics of the sound environment; the other from the affective aspect to evaluate the feelings and emotions stimulated by sounds. In the end, sound preferences represented the most profound perceptions because they involve choice-making, which takes us into the outcomes sphere.

The perceptual structure includes the aspects and process of sound perceptions. Four soundscape aspects categorised by three levels of perceiving progress make up the perceived sphere of sounds. Sound classification represents a basic understanding of sounds. Appraisals involve functional and emotional evaluations of sounds, representing rational and emotional thinking. Sound preferences are based on judgment of the previous three aspects. The perceptual structure emphasises the progressive deeper levels of sound perceptions as well as the relationships among these four aspects.

Chapter 6:

(Study 3) An investigation of the influence of companion factors on soundscape evaluations in urban public spaces

6. (Study 3) An investigation of the influence of companion factors on soundscape evaluations in urban public spaces

6.1 Introduction

Previous studies have reviewed that 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& Kang, 2008; Calleri et al., 2016). It was summarized that different factors can exert influences at different stages of sound perception (ISO/ DIS 12913, 2014). Social relationship as one of the factors affecting interpretations of auditory sensations was rarely mentioned. Present studies pointed out that social relationships can influence soundscape evaluations through the social-interaction levels associated with their activities (Statts& Harti, 2004; Bild et al., 2018). While, their researches focused on the differences between single and accompanied listeners. 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.

Based on the results from study 1 and 2, two kinds of companion factors were included: one is companion status, the other is the social relationship intensity between companions. In terms of soundscape evaluations, this study involved four aspects of soundscape summarized in study 2- sound sources, features, psychological reactions and preferences. 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.

6.2 Method

6.2.1 Sampling and research sites

To collect users' soundscape evaluations, 184 questionnaires were distributed by paper in Peace Garden, Sheffield, UK and a further 120 in Guanqian Square, Suzhou, China, which were the same sites as study 5. 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. 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. When researcher entered the site, researcher asked every user in the site, starting from the right-hand side. Before participants answered the questionnaire, the researcher explained the research aims and objectives. For this study, it was required that participant have normal hearing, and this was judged by the researcher when talking with them. 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. Sound tests involved two objectives: one was to test the sound volumes of the site, the other was to test sound types, user types, activity types. Sound volumes were measured by a sound level meter (01 dB solo, Limonest, France). The researcher listened and wrote down sound types 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 were selected. 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& 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. These sound types were based on the classifications generated in Study 2.

6.2.2 Questionnaire design

The sound evaluation questionnaire included four sets of questions: (a) Sound sources: multiple-choice 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-choice 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 (Davies et al., 2013), 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- choice 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& Yang, 2016). In Peace Garden, water sound was considered as the sound mark (Yang& 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.

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 single, enjoying nature and passing by. Two categories of companion factors were studied: single 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 450 mm), observed as lovers; 2) personal (0.46 m to 1.30 m), observed as close friends or families; 3) social (1.31 m to 3.75 m), observed as friends, acquaintances and so on; 4) public (> 3.75 m), 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 single were classified as having no relationship intensity.

6.2.3 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. The inter-rater reliability among the subjects is 0.733 (Cronbach's alpha). Generally, an inter-rater reliability value of above 0.6 is acceptable, and 0.8 or greater is a very good level (Nunnally, 1978; Ursachi et al., 2015). 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 volumes 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 6.2, independent variables included social/demographic and behavioural factors: age (15–90), gender (male/female), group size (1 people, 2 people, 3 people…), companion factors (single 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 single, 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 6.2 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
Companion status	1-accompanied; 2-single
Site	1-Peace Garden; 2-Guanqian Square
Group	1, 2, 3…
Age	15–90
Gender	1-male; 2-female

6.3 Results

6.3.1 Soundscape evaluations concerning companion status

As shown in Tables 6. 3and 6. 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 6. 5, figures of Odds 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. Odds ratio indicates that accompanied people are 1.767 and 2.153 times more likely to notice speaking and children sounds than single 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 6.4. Comparing the means of single 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 single people, with the average figures being -2.18 to -1.78 and -1.56 to -1.09. For 'social-unsocial' sound, the means of single users' scores are significantly lower than those of accompanied participants.

Table 6.3 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 6.4 Correlation coefficient of sound features/ sound preferences in relation to relationship intensity, group size and age; mean differences between males andfemales, Peace Garden and Guanqian Square, single and accompanied; and chi-square of activity type (*p <0.05, **p < 0.01).

	Correlation coefficient (R)						
	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 preference							
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 6.5 Binary regression between noticing speaking sound/ children sound and companion status

	Noticing speaking sound			Noticing children sound		
	Regression coefficient (B)	Significance level (P)	Odds Ratio	Regression coefficient (B)	Significance level (P)	Odds Ratio
Companion status (single 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 single users had less preferences for those sounds. It was surprising to discover that accompanied people desired safer soundscapes than did people who were single. It may be because people who are more concerned about safety would not travel to a given location single. 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.

6.3.2 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. According to Table 6.3, 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. Odds Ratio in Table 6.6 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. Friends 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 6.4, 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 6.6 Binary regression analysis between social relationship intensity and noticing children's sounds, preferring human sounds and preferring sociable soundscape descriptors

	Odds Ratio	
	Noticing children sound	Preferring human sounds
Partner/spouse	2.357	2.357
Family	1.399	1.848
Friends	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.

6.3.3 Comparing companion factors with other demographic factors

Other independent variables analysed in Tables 6.3 and 6.4 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 6.3 and 6.4, 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 6.7), 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 Odds 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.

Table 6.7. Binary regression analysis of age and companion status concerning noticing speaking sounds. *p < 0.05, **p < 0.01

	Regression coefficient (B)	Significance level (P)	Odds Ratio
Age	-0.025	0.004	0.975
Companion status	-0.397	0.148	0.673

Another indicator to be noted was the preferences for 'social-unsocial' sound. According to Table 6.4, 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 6.8. 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 single people. At the same time, this factor has relatively little explanatory power. Although the low R^2 indicates a limited explanatory power, it is acceptable in a social science context. R^2 is adopted in various research disciplines, there is no standard guideline to determine the level of predictive acceptance (Henseler et al., 2009). R^2 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^2 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 6.4, 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 6.8. 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

6.4 Summary

In summary, 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 (single/accompanied) and relationship intensity (partner/spouse, family, friends). Both companion factors were found to influence socially interactive sounds, which consist of human activity 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.

Chapter 7:

(Study 4) Sociable soundscape interventions in relation to social relationship types in urban public spaces

7. (Study 4) Sociable soundscape interventions in relation to social relationship types in urban public spaces

7.1 Introduction

On the one hand, it has been found that physical environment of urban public spaces is required to provide qualified conditions for 'hearing' and 'talking' (Marquis-Favre et al., 2005; Payne & Guastavino, 2013). To enhance the acoustic environment, researchers suggested to regulated and enhance acoustic environment by designing sound compositions (Liu& Kang, 2016; Meng& Kang, 2016). Among various sound sources, human activity sounds were found to be related to sociable soundscape in study 3. Other studies also mentioned human sound and event sound influencing people's social willingness levels (Meng& Kang, 2016; Gehl, 1987; Whyte, 1988). On the other hand, social distance between people was another key issue addressed in relation to talking and hearing in urban public spaces (Sommer, 1962; Scheflen, 1972). When people are accompanied by intimate companions, they will reduce their distance (Hall, 1992). People involved in different social relationships also tended to require varied sound conditions (Gehl, 1987). While Gehl (1987) merely focused on the sound levels required by different social groups, how to enhance social willingness through multiple aspects of soundscape design is still unclear.

Thus, in this study, two featured sound sources, human sound and event sound, were considered as the key components of making up sociable soundscape. Three research objectives are raised: 1. To investigate and compare how human sounds can influence the social willingness of various social relationship groups, 2. To explore and compare how event sounds can influence the

social willingness of various social relationship groups, and 3. To explore the sociable soundscape guidelines for different social relationship groups.

7.2 Methods

7.2.1 Research design process

Based on affordance theory (Gibson, 1979; Bild et al., 2018; Marie, Zemke& Shoemaker, 2007; Fish, Karabenick& Heath, 1978), social willingness level was evaluated in this study using suitability and stimulation. Suitability represents whether a soundscape is suitable for social activities, and stimulation represents whether a soundscape can foster social interactions.

In terms of soundscape design, two influential factors were defined: human sound and event sound. As shown in Table 7.1, a combination of research methods including an experimental survey and behavioural observation were applied to address the research aim. Study 7.1 designed four types of soundscapes for people in different social relationship groups to listen and evaluate their levels of social willingness through questionnaires. Study 7.2 occurred in eventful soundscapes and uneventful soundscapes to observe how people in different social relationship groups behave.

Table 7.1. Summary of the experimental survey and behavioural observation

	Study 7.1: experimental survey	**Study 7.2: behavioural observation**
Research questions	How do *human sounds* influence soundscape evaluations and the social willingness levels of various social relationship groups?	How do *event sounds* influence soundscape evaluations and the social willingness levels of various social relationship groups?
Defined sound types	1) Foreground human sound type, 2) Background human sound type, 3) No human sound type, and 4) Conflict sound type	1) Eventful soundscape and 2) Uneventful soundscape
Defined social relationship types (relationship intensity)	Single, friends, family and partner/spouse	Intimate pairs, intimate groups, social groups and single (observed by distance)
Level of social willingness evaluation	1) Suitability: soundscape evaluations and level of willingness to meet friends at the site; and 2) Stimulations: level of curiosity, level of willingness to make eye contact, and level of willingness to engage in small talk.	1) Suitability: time focused, observed number of social behaviours; and 2) Stimulation: observed number of stimulation behaviours.

7.2.1.1 Study 7.1: experimental survey on human sounds

To analyse the influences of human sounds, four sound types were designed:

1) foreground human sound type: human sound as foreground sound, no special annoying sounds, and pleasant sound level;

2) background human sound type: human sound as background sound, no special annoying sound, no special annoying sounds, and pleasant sound level;

3) no human sound type: without human sound, no special annoying sounds, and pleasant sound level;

4) conflict sound type: unexpected and conflicting sounds and human sound in the background.

Human sounds were applied in the foreground and background because previous studies suggested that people usually categorize sounds into foreground and background in the first stage of sound perception (De Coensel et al., 2017; Sun et al., 2019). Sounds in the foreground can attract more attention from listeners. Sound type 4 was designed to be compared with sound types 1, 2 and 3. The soundscapes of the first three types are generally satisfactory and can support normal social activities in a square. The soundscape of type 4 is quite negative and is supposed to disrupt human activities. By comparing type 4 with the others, researchers can test whether people listened carefully to the sound and can test the suitability of the sound environment. The sound sources of the four sound clips were chosen from the recordings database of UCL IEDE Acoustics Group. Sound sources used in this study were originally recorded in various urban public spaces across the UK. Because these sound sources are real recorded sounds, they can give participants a realistic experience of an urban public space environment. Videos were all shot in the Peace Garden, Sheffield from May to June of 2019. The shooting angle, weather, and time of the day were controlled to make the images alike. The original sounds were substituted by designed sound sources. Revised sounds were ensured to correspond to the content of the videos in case participants felt confused.

Four sound clips were attached to the questionnaire with evaluation questions regarding people's sound perceptions and levels of social willingness. The questionnaire consists of three sections of questions: 1) soundscape evaluations using a series of 5-point rating scales including four aspects of the soundscape of peaceful-stressful, eventful-uneventful, safe-unsafe, and happy-unhappy; 2) social willingness evaluations using a series of five-point rating scales including suitability and stimulation; and 3) demographic information including social relationship types, age and gender. Social relationship types were ranked by relationship intensity as suggested by Gehl (1987). A five- point scale was suggested by ISO/ DIS 12913-2 (International Organization for Standardization, 2017). The four soundscape evaluations followed the suggestions of Kang& Zhang (2010), and they also correspond to the features of the four sound types.

In terms of social willingness evaluations, four questions were asked: 1) Meeting friends: Are you willing to meet friends in this place? 2) Level of curiosity: Are you curious about what other people are doing? 3) Eye contact: Are you willing to engage in eye contact with other people at this place? 4) Actual social interactions: Are you willing to engage in small talk with strangers at this place? In the questionnaire, soundscape evaluations and question 1 identified the level of suitability by asking whether this place was sufficiently pleasant to be a suitable place for social activities. The remaining questions 2, 3& 4 assess levels of stimulation including affiliation and actual social interactions. Questions 2 and 3 identified whether people had the tendency to approach strangers. Question 4 identified whether people were willing to have actual interactions with strangers.

The questionnaires were distributed in Peace Garden and its surrounding areas, including bus stations at the exit of the square, streets, and cafés (Figure 7.1) during June to July, 2019. The questionnaires were distributed in these places because the people who were located around Peace

Garden had a certain familiarity with the environment of Peace Garden. Before the participants answered the questionnaire, the researcher had a short talk with them to ask their relationship types and inform them of the research aims and objectives. Approximately 120 participants were recruited through systematic sampling. Among the 120 participants, each social relationship group contained 30 participants. Consent forms were obtained from the participants at this phase. Participants were required to have normal hearing abilities to fulfil the questionnaire. Their hearing abilities were identified by researcher through talking with them. The people who agreed to take part in the research were asked to watch four recorded videos on the phone and listened through earphones (Apple wired earphones). Four sound videos were randomly displayed on the phone through the Google Form applications, the questionnaires showed after each video finished. This research was approved by the ethics committee of the University of Sheffield. For people accompanied by others, if they wished, all of them were able to listen to the sounds using the earphone with the multi-headphone splitter so that they could discuss the questions with each other. Researcher disinfected the earphones with an alcohol pad after participants used. Participants were not allowed to use their own earphones to avoid auditory differences.

(1)

(2)

(3)

(4)

Figure 7.1. Site photos of questionnaire distribution for study 4: (1) Peace Garden; (2) Nearby shopping streets; (3) Nearby café; (4) Nearby bus station (photo credit: authors)

7.2.1.2 Study 7. 2: Behavioural observation on event sounds

The observations occurred during April to July, 2019 in two different public spaces in the UK: Peace Gardens in Sheffield and Trafalgar Square in London (as shown in Figure 7.2). Trafalgar Square

was added because it is located in central London with various types of performance and large events occurring there. The observations were approved by the ethics committee of the University of Sheffield. Because this study focused on the people involved in different social relationship groups, systematic sampling was adopted. In each observation, the researcher randomly observed 5 participants of each relationship group for 3~5 min. A total of 8 observations were conducted, and each urban public space was observed 4 times. Among the 4 observations in each site, two observations were in eventful soundscapes, and the other two were in uneventful soundscapes. Eventful soundscapes consist of high sound volumes of human sounds, music sounds. Uneventful soundscapes consist of low sound volumes of human sounds and natural sounds. A total of 160 groups of people were observed and recorded. The sound pressure level of each observation was measured by a sound level metre (01 dB solo, Limonest, France) with 75~78 dBA in an eventful soundscape and 63~65 dBA in an uneventful soundscape. Events were found to increase the sound pressure level by 12~13 dBA. In terms of the social relationship types, because the researcher cannot accurately determine people's exact social relationships, distance theory was applied to determine people's social relationships (similar to study 1 in Chapter 4). The social relationship types were defined as intimate pairs, intimate groups, social groups and single with the relationship intensity from high to low.

	**Peace Garden, Sheffield, UK** Located in the city centre and attracts various types of people including both local residents and travellers; large enough to be able to host seasonal big events; large green areas with multiple types of water elements, such as a fountain, waterfall and sewer.
	**Trafalgar Square, London, UK** World-famous tourist spot attracting travellers of different nationalities and ethnicities; located between several of London's famous attractions, large crowds often cross the square; large area of hard empty space and relatively few facilities for resting.

Figure 7.2. Descriptions of the two observation sites (photo credit: authors)

The researcher recorded three types of information during the observations: 1) levels of social willingness: (a). suitability: time focused (time focusing on their activities) and observed number of social behaviours (including eye contact, laughing, hugging, touching, and kissing), and (b). stimulation: observed number of stimulation behaviours (including looking at strangers, eye contact, smiling, and small talk); 2) location information: occupancy area and surrounding amenities (use

phrases such as central fountain area, middle lawn/tree/benches/steps area, marginal tree/benches/steps area, etc.); and 3) demographic information: social relationship types (intimate pairs, intimate groups, social groups and single), groups size, activities.

7.2.2 Data analysis

This study involved multiple types of analysis methods to assess the data. In the questionnaire stage of analysis (study 7.1), frequency analyses of the average scores of soundscape evaluations and the level of social willingness were performed in Excel to summarize and compare the different social relationship types. Statistical analysis was applied through IBM SPSS statistics (version. 25) to determine whether levels of social willingness were influenced by social relationship types and other demographical factors. In the observation stage of analysis (study 7.2), frequency analyses were adopted to compare the figures among the suitability and stimulation of the different relationship types under eventful/ uneventful soundscapes.

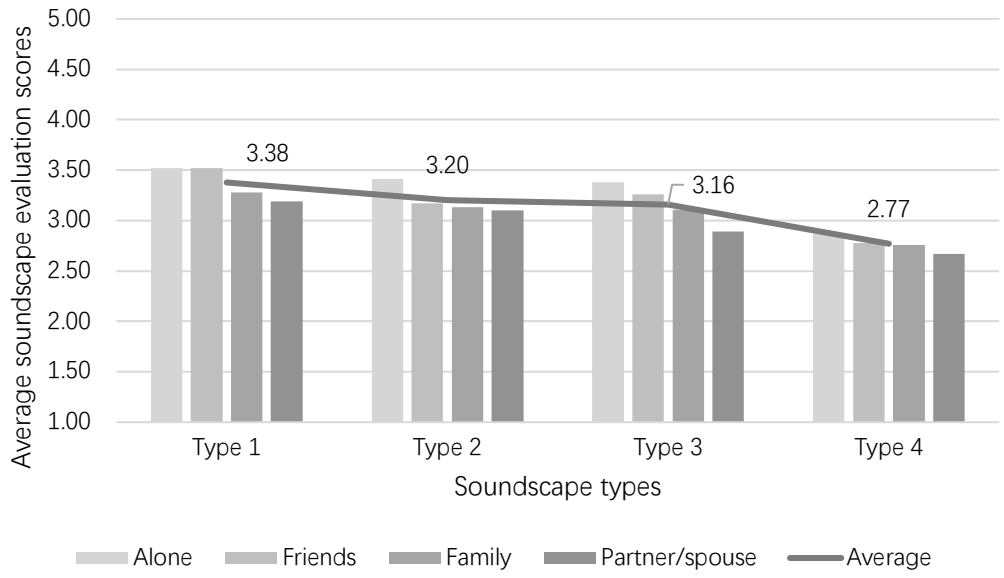
7.3. Results

7.3.1 Social willingness in soundscape with human sounds considering different social relationship types

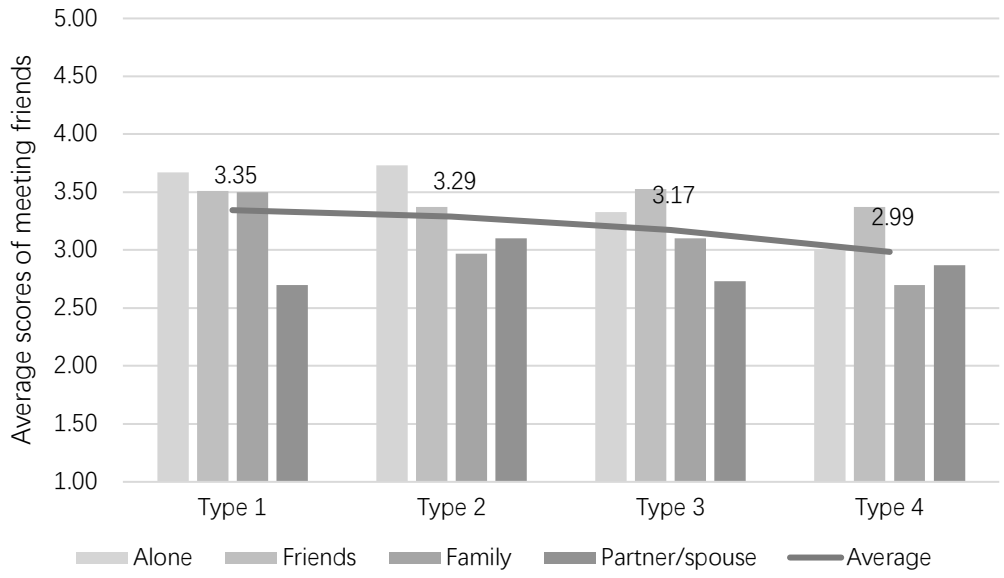
Figure 7.3(1) shows the average soundscape evaluations of the four defined social relationship types. It was found that from sound type1 to 4, the overall evaluation scores of the four relationship types all show a downward trend, with sound type 1 receiving the highest score and 4 receiving the lowest.

This result indicates that the four relationship types have the similar trend of judgements about these different sound types. Compared to sound types 1, 2 and 3, type 4 was found to receive a notably lower score. This finding corresponds well to the designed features of the four sound types, with types 1, 2 and 3 having pleasant soundscapes while type 4 has an unpleasant soundscape. Compared to sound types 2 and 3, sound type 1 receiving the highest score indicates the contribution of human sounds as the foreground sound to the soundscape evaluations. There was also an obvious trend that the soundscape evaluation scores decreased as the relationship intensity of the groups increased. This indicates that people involved in more intense social relationships tended to have more critical evaluations of soundscapes.

Besides the soundscape evaluation, another indicator of the suitability of levels of social willingness is the evaluation of 'meeting friends'. According to Figure 7.3(2), a downward trend from sound type 1 to 4 was also shown, which indicates that the evaluations of 'meeting friends' correspond to the soundscape evaluations. According to Table 7.2, the level of willingness to meet friends in sound type 1 was significantly influenced by relationship intensity at the 0.01 level, and the levels in types 2 and 3 were significantly influenced by relationship intensity at the 0.05 level. However, relationship intensity was found to have no influence in sound type 4. The negative correlation coefficients suggest that people involved in closer groups tended to be less willing to engage in social activities in these three sound types. This finding corresponds to their soundscape evaluations, which show that closer groups tended to have more critical criteria for acoustic environment quality. No influence was found in sound type 4, which indicates that social relationships has no influences on the evaluations of 'meeting friends' in type 4. In other words, the decreasing trend of suitability evaluations was only significant in pleasant acoustic environments.



(1) Average soundscape evaluation scores in relation to social relationship types



(2) Average scores of meeting friends in relation to social relationship types

Figure 7.3. Average suitability evaluation scores of the four sound types in relation to relationship types (Type 1: foreground human sound type, Type 2: background human sound type, Type 3: no human sound type, and Type 4: conflict sound type)

In terms of the stimulations, Figure 7.4 shows the average scores of the three aspects of stimulation of the four sound types. The average stimulations scores (curiosity, eye contact, and actual social interactions) of each sound type were calculated as 2.69, 2.62, 2.55 and 2.68, respectively. Sound type 1 scored the highest average stimulation levels, and the aspect of small talk was evaluated extremely high. Notably, sound type 4, which was the least desirable of the soundscape environments, received a rather high average stimulation score. In contrast, the quiet environment without human voices received the lowest stimulation ratings. First, these results repeatedly emphasised the significant role of 'human sound' in stimulating social interactions. Second, these results indicate that unpleasant and conflicting soundscapes can also offer the effect of stimulation.

In terms of the stimulation of different social relationship groups, 'eye contact' and 'small talk' were found to be related to relationship intensity in sound type 3 (Table 7.2) at the 0.05 level. The negative correlation coefficients suggest that closer groups tended to evaluate lower levels of stimulation regarding 'eye contact' and 'small talk' with sound type 3. The age factor was also found to influence the evaluation of small talk for sound type 3 at the 0.05 level, and its positive correlation coefficients indicate that older people were more willing to engage in small talk with sound type 3. Compared to the other sound types, the results indicate that soundscapes without

human sounds have a significantly negative effect on the stimulation of closer groups. Furthermore, peaceful soundscapes without human sounds can stimulate older people to engage in small talk.

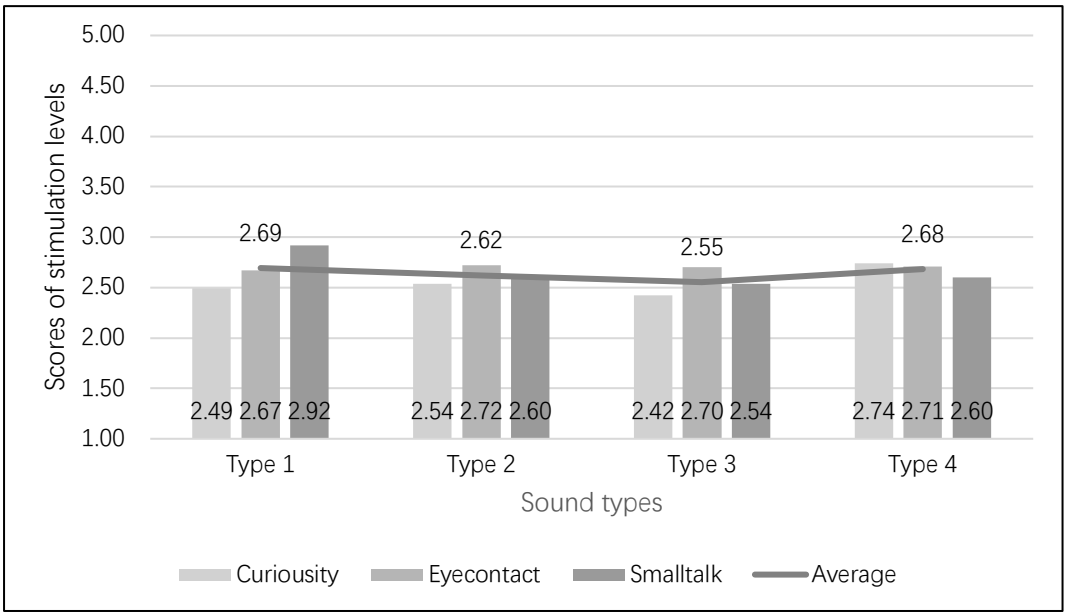


Figure 7.4. Average stimulation evaluation scores of the four sound types (Type 1: foreground human sound type, Type 2: background human sound type, Type 3: no human sound type, and Type 4: conflict sound type)

Table 7.2. Correlation analysis of social willingness levels in relation to social relationship intensity and age and the Whitney test between males and females. *p <0.05, and **p < 0.01 (two-tailed test of statistical significance).

		Relationship intensity	**Gender**	**Age**
Sound type 1	Meeting Friends	-0.247**	0.205	0.115
	Curiosity	0.084	0.159	-0.194*
	Eye Contact	-0.149	0.645	-0.294**

	Small Talk	-0.133	0.443	-0.132
Sound type 2	Meeting Friends	-0.210*	0.922	0.054
	Curiosity	0.052	0.467	-0.292**
	Eye Contact	0.047	0.068	-0.018
	Small Talk	-0.148	0.020*	0.114
Sound type 3	Meeting Friends	-0.192*	0.998	0.120
	Curiosity	0.164	0.088	-0.096
	Eye Contact	-0.233*	0.547	-0.018
	Small Talk	-0.206*	0.164	0.218*
Sound type 4	Meeting Friends	-0.089	0.721	0.008
	Curiosity	0.111	0.349	-0.053
	Eye Contact	-0.169	0.894	0.091
	Small Talk	-0.191*	0.335	0.094

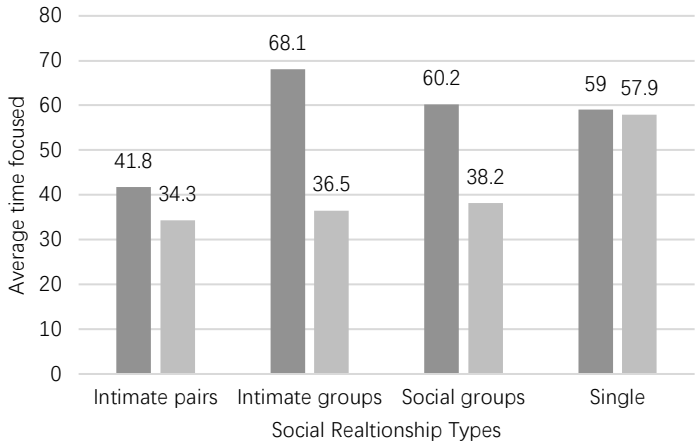
7.3.2 Social willingness in soundscape with event sounds considering different social relationship types

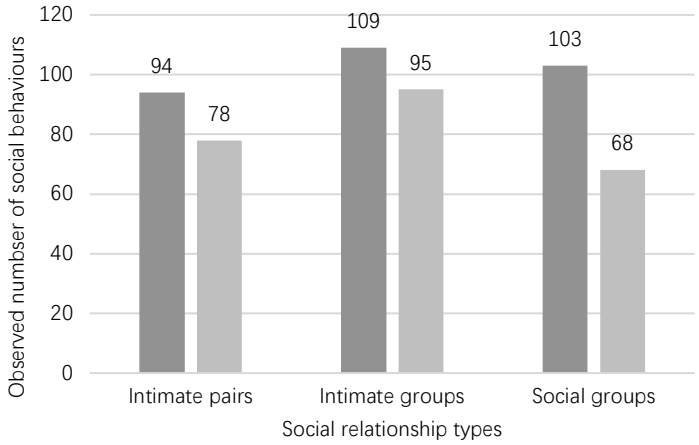
7.3.2.1 Suitability and stimulation analysis

Comparing eventful and uneventful soundscapes showed that event sounds had a significant stimulation effect while simultaneously reducing the suitability level. According to Figure 7.5, first, suitability was reduced because event sounds interfered with people's own activities at the site. Event sounds significantly shortened the time focused time and reduced the number of social behaviours. People focused on their activities for an average time of 57.3 s in uneventful soundscapes, and the time focused was reduced to 41.7 s in eventful soundscapes. Regarding number of social behaviours, there were 306 total activity behaviours in the uneventful soundscape,

and 241 were recorded in eventful soundscape. Second, stimulation behaviours were enhanced by event sounds. There were 224 total observed stimulation behaviours in eventful soundscapes, which was 62 more than that observed in uneventful soundscapes. In other words, within the same time scale, the large events in the square attracted people's attention, making them looking around; and these moves detracted them from their own activities.

Comparing the sociability of different social relationship types in eventful soundscapes to those in uneventful soundscapes, the extent of the decreased suitability and increased stimulations varied among the four relationship types, as shown in Figure 7.5. In terms of time focused, the time focused of intimate groups and social groups is significantly shortened by almost half (31.6 s and 22 s, respectively). However, intimate pairs' time focused was decreased by only 7.5 s. This suggests that intimate groups and social groups were more easily distracted by event sounds. The decrease in the time focused of intimate pairs is not significant, which suggests their lower interest in others' activities. For single people, event sounds had barely any influence on their time focused with only a 1.1 s difference. It was because they did not involve in any social activities and most of their activities were just 'looking around'. For people in groups, their own activities were distracted by the events; while for singles, they continued 'looking around'. In terms of social behaviours, all three accompanied groups recorded with fewer social behaviours in eventful soundscapes than in uneventful soundscapes. Among the groups, social groups were found to have the greatest reduction, with a reduction of 35 behaviours. In terms of the stimulation aspect, event sounds significantly enhanced the stimulation behaviours of the intimate groups, social groups and considerably enhanced the singles' stimulation behaviours. However, the enhancement was not significant in intimate pairs.


Average time focused
80
70
60
50
40
30
20
10
0
41.8
34.3
68.1
36.5
60.2
38.2
59
57.9
Intimate pairs
Intimate groups
Social groups
Single
Social Realtionship Types


Observed numbser of social behaviours
120
100
80
60
40
20
0
94
78
109
95
103
68
Intimate pairs
Intimate groups
Social groups
Social relationship types

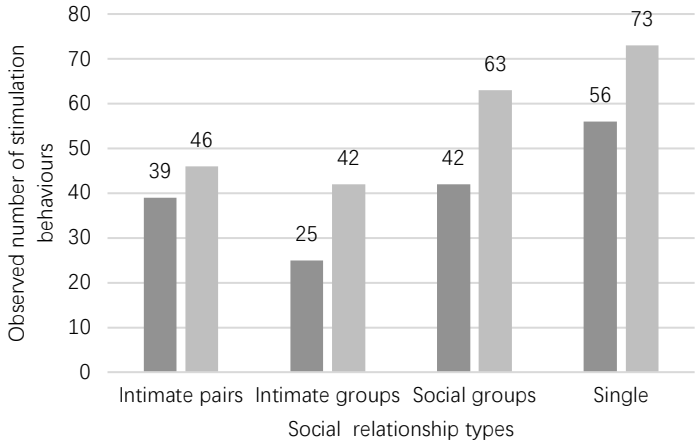

Observed number of stimulation behaviours
80
70
60
50
40
30
20
10
0
39
46
25
42
42
63
56
73
Intimate pairs
Intimate groups
Social groups
Single
Social relationship types

Figure 7.5. Average time focused, observed number of social behaviours and stimulation behaviours of the various social relationship types with/without event sounds (Dark grey= uneventful soundscape; Light grey= eventful soundscape)

7.3.2.2 Occupancy analysis

In general, according to the Table 7.3, the four relationship types were found to have different occupancy patterns at sites: intimate partners mostly occupied marginal areas, merely appearing in the central region; intimate groups were evenly distributed among central, middle and marginal places, with the fountain areas preferred most; social groups tended to occupy middle spacious areas such as middle edge places and lawns; and singles mostly occupied marginal areas. The presence or absence of event sounds did not produce a significant change in their occupancies. However, it should be noted that no one was observed occupying the marginal railings without events occurring. In contrast, when an event occurred, each group had extra two times of recorded marginal railings occupancies. Railings were built at both sites as the borders of the square. People who stayed at the railings were drawn from the streets by the event sounds inside the square. When people were curious about what was occurring inside the square, these railings provided opportunities for people to give a glance because of their lower height and the gaps between columns. This phenomenon suggests that event sounds travel a long distance and can attract pedestrians from a distance to the square, increasing the possibilities for social interactions.

The occupancies of different social relationship types were found to vary between eventful and uneventful soundscapes as shown in Table 7.3. In terms of intimate pairs, their occupancies were similar under the eventful and uneventful soundscapes with most of them occupying the marginal areas. This corresponds to their lower probabilities of disruption by events, as summarized in the previous section. For social groups and single users, when events occurred at the sites, none of the social groups or singles were found in the central areas. It seems that these two groups tended to avoid the central areas where activities occurred. In contrast, intimate groups have more people staying in the central place. In particular, they were quite obsessed with the central fountains. Generally, when a large event occurs in the centre of the square, it is reasonable to avoid the central area and find a place in another area to conduct the activities of their own groups. The fact that social groups did not avoid the central area indicates that the majority of these groups' activities revolved around the fountain of the central area.

Table 7.3. Observed number of times occupying facilities in relation to the different social relationship types with event sounds and without event sounds

	Intimate pairs	Intimate groups	Social groups	Single
Observations without event	marginal bench (10), middle edge place (4), marginal steps (4), and central bench (2)	central fountain (8), middle edge place (6), marginal bench (4), and central bench (2)	middle edge place (6), marginal bench (4), central bench (4), middle lawn (2), central fountain (2), and marginal steps (2)	marginal bench (12), middle edge place (4), central bench (2), and marginal steps (2)
Observations with event	marginal bench (6), middle edge place (6), marginal steps (4), marginal railing (2), and central bench (2)	central fountain (8), middle edge place (4), central bench (4), marginal bench (2), and marginal railing (2)	middle edge place (10), marginal bench (6), middle lawn (2), and marginal railing (2)	marginal bench (10), middle edge place (6), marginal railing (2), and marginal steps (2)

7.3.3. Sociable soundscape based on suitability and stimulations

Based on the results of this study, several sociable soundscape patterns can be summarized in relation to participants' social relationship types, as shown in Table 7.4. The four observed relationship types were ranked by the relationship intensity, from close to distant to no relationship. First, as the relationship intensity increased, people tended to evaluate soundscape suitability with lower score. This result reflects the fact that different relationship groups engage in various activities, so as to adopt different criteria for soundscape suitability. Because the activities of accompanied

people mostly involve talking and hearing, they demand an environment where people can at least hear each other. Single users' activities mostly do not involve social interactions. When the relationship intensity increases, the social interactions among groups deepens, which may lead them to be more concerned about the physical environment qualities. In other words, people required a higher quality soundscape for deeper social interactions to occur.

Second, human sound was found to have a greater stimulation effect on closer groups. Bild et al's (2018) research also found that a large proportion of socially interactive participants specifically mentioned that they expected the presence of others. The results of this research further suggest that others' talking sounds have greater influences on enhancing the social willingness of closer groups.

Third, hosting large events in urban public spaces can significantly enhance the sociability of intimate and social groups. However, no influence was found on intimate pairs. This may be highly related to different groups' activity types. Activities of intimate pairs require more privacy and quietness (mentioned in Chapter 4). Intimate pairs always occupying the marginal areas also supports this. In addition, because hosting large events usually requires large spaces, people were found to move away from the centre. Events also bring large amounts of noise that disrupt people's normal social activities. To what extent event sound interventions can enhance levels of social willingness still requires further investigation.

Table 7.4. Sociable soundscape patterns of various relationship types (the shaded colours represent the enhancement of the levels of social willingness)

	Intimate pairs	Intimate groups	Social groups	Singles
	Close →		*Distant* →	*none*
High quality				
Human sounds				
Event sounds				
Soundscape patterns	Pleasant and considerably hubbub	Eventful, pleasant and hubbub	Eventful and a little hubbub	Considerably eventful and a little hubbub

7.4 Summary

In summary, this study aims to explore the effects of human and event sound on levels of social willingness of different relationship types so as to summarize sociable soundscape guidelines. In terms of human sounds, it was found that human sound was the key to stimulation, and no human sound types significantly hindered stimulation levels; furthermore, soundscape quality corresponds to level of suitability, and better soundscape quality results in higher levels of suitability. Among the different relationship types, closer groups were more critical on soundscape suitability. Furthermore, human sounds have more significant influences on stimulating closer groups' social activities.

In terms of event sounds, event sounds can significantly enhance the stimulation of all types of social relationships while simultaneously hindering the level of suitability. The stimulation effects from event sounds work better on intimate groups and social groups while intimate pairs are less likely to be influenced by event sounds. Singles were found to be sensitive to the surroundings, and they can also be stimulated by event sounds. Events in urban public spaces can influence the occupancies of users, and more users were found to occupy the railings. For different relationship types, intimate pairs' occupancies were not influenced by event sounds; social groups and singles tended to avoid the central place where the event occurred; and more intimate groups were found to stay in the central areas, and fountains were their favourite.

In terms of the sociable soundscape for different social relationship types, a sociable soundscape that is pleasant and considerably hubbub is suggested for intimate pairs; one that is eventful, pleasant and hubbub is suggested for intimate groups; one that is eventful and little hubbub is suggested for social groups; and one that is considerably eventful and little hubbub is suggested for singles.

Chapter 8:

Discussion

8. Discussion

8.1 Patterns of use and cultural factors in urban public spaces

In study 1, behavioural observation was applied in four urban public spaces in Suzhou, China and Sheffield, UK. Through frequency analysis, patterns of use of accompanied and single users were figured out. The differences in the spatial occupancies between the single and accompanied users might be because single users tend to be more likely than accompanied users to engage in 'passive contact activities', meaning that they passively observe strangers (Gehl, 1987, p. 12–13) and desire relatively more privacy and protection. De Jonge (1967) suggested that edge spaces offer a sense of security because individuals or groups might find it easier there to stay away from other people and they provide opportunities to survey the area. Stevens (2007) proposed that inexperienced or shy people are often found on the periphery to avoid uncertain or unsafe situations. Edge places offer protection because users can maintain a comfortable distance from strangers. Thus, single users might be similar to people, Stevens (2007) mentioned, who desire protection and privacy because they are alone. In this study, unlike group users, who mostly were involved in interactive activities, single users were engaged in passive contact activities (Gehl, 1987), such as watching and listening, and the edge places were excellent locations for surveillance (Hall, 1992). When people are alone in a public space, the edges offer convenient locations for observing.

Based on the distance theory, three types of relationship groups with different relationship intensities were categorized in relation to their patterns of uses. To consider the reasons for the different patterns of use found among the relationship types, group size and age (which varied among the types) might have influenced their spatial occupancies and activities. For example, large

groups need relatively more room, and children and elders are relatively sensitive to temperature and sunlight. In addition, relationship intensity might motivate people's behaviours, such as Intimate Pairs' desires for privacy. Further, certain activities relate to relationship intensity because activity type relates to distance. For example, Intimate Pairs' uses of mobile phones created situations where heads, thighs, and other body parts physically touched. The distances between people in Intimate Groups were close enough for an individual to hold or grasp the other person, which correlates with their most frequent activity (close conversations). Social distance is the 'limit of domination' where no one touches or is touched by others. The Social Groups in this study preferred playing games, such as ball or card games, and relaxing, such as picnicking, reading, or drawing, which demonstrates this point because none of these activities involves physical touching.

Regarding the 'dancing group' in Central Park square, it was suggested to pay special attention when analysing Chinese public spaces. The large groups and massive noise they bring give negative effect not only on the other users but also on the surrounding residents. Although the modify method was starting to apply, which use earphone to deliver music to each dancer. The problem of occupying the spaces is still not solved. Chinese square dancing is a unique cultural phenomenon as its history demonstrates. Square dancing is believed to be a continuation of the 'Yangko dance', which is a form of traditional folk dance. Older people, especially those who grew up in Chinese villages, are more familiar with this kind of entertainment. When they were in their villages, they were not restricted by the performance location (Thepaper.cn, 2019), and contradictions gradually manifested during the course of urbanization. The function of public spaces is based on the awareness of and respect for other people's use of public spaces. The freedom to carry out the activities that one desires is a 'responsible freedom' with the recognition that a public

space is a shared space (Varna & Tiesdell, 2010; Carr, 1992). The desire for performing square dancing cannot be met in urban public spaces as it disturbs other users because the activity occupies a large area and generates a lot of noise. However, public spaces should be designed as 'containers' for human activities (Jacobs, 1961), and square dancers still have the rights to use the spaces. Perhaps there is an insufficient amount of tolerance for the plurality of values that leads to the contradictions between dancers and other users. Design has the responsibility of satisfying both the modern and the traditional in order to keep different people who live in the same space happy.

8.2 Comparing perceptual structure of soundscape to the previous models

Study 2 generated a four aspects of soundscape perceptual structure forming a three-stages of perceiving process based on the questionnaire and Grounded Theory approach. Although, there already exists several perceptual structures of soundscape, this structure has its originality in illustrating the general public's soundscape with associations with the environmental psychology studies.

8.2.1 Comparison with the previous environmental psychology studies

The perceptual structure generated in study 2 has many associations with previous research in the environmental psychology field. The process of perceiving sounds corresponds to Rapoport's (1982) process of how people perceive the physical environment, which consists of the cognitive, affective, and conative levels, that is, knowing something, feeling something, and then doing

something about it. The four aspects of the perceptual structure correspond to three levels: sound classifications and features represent how users receive and understand sounds at the cognitive level; psychological reactions are at the affective level, including feelings and emotions stimulated by the sound environment; preferences reach the level of judgment and choosing, which represent the conative level. Three levels of perceiving the physical environment are also seen in Boulding's (1956) 'image' theory. He referred to the image as one's subjective knowledge of the world, one's sense of being located in space and time, and in a web of human relations and emotions. People's behaviours are dependent on their images of the world. The 'image' comprises what one knows and thinks about an object (cognitive level), how one feels about it (affective level), and how one acts using this information (conative level). Image theory explains why people express sound preferences by describing an image: because this is a way of understanding the external world (Esser, 1976). Furthermore, image theory confirms that sound preferences are complex enough to contain all three levels of perception. In other words, it echoes the perceptual structure of this study, where sound preferences contain judgment of the previous three aspects.

Social relationships are the dominant aspect of the 'image' of sound because they influence people's sound preferences through the activities they engage in. The social relationship of the group corresponds to the types of activity they engage in. People tend to require the soundscape to suit and support their activities. This corresponds to Gibson's (1979) affordance theory, which referred to the quality of an object or an environment that supports the performance of an activity. Turvey (1992) concluded that an affordance is an invariant combination of properties of substance and surface taken with reference to an animal to afford actions like grasping, upright posture, catching, and so on. In this study, activities and social relationships were closely combined. Sound

requirements seemed to afford not only participants' activities but also their relationships. Further studies may be needed to enrich the meanings of affordance in this light.

8.2.2 Comparison with the previous soundscape structures

Liu and Kang (2016) and the ISO (2014) both summarised dimensions and structures of how people perceive sounds, as reviewed before. Compared to the structure reported by Liu and Kang (2016), two differences were found. First, the focuses of the two studies were different. Liu and Kang's (2016) study was grounded in the latitude of the whole city, examining psychological needs for urban soundscapes with a past-to-future developing soundscape trend. In their structure, the definition of soundscapes was broken down into soundscape memory, sentiment, and expectation, which symbolised, respectively, the past, present, and future perceptions of sounds. Soundscape aesthetics were developed over time. In comparison, this study focused on the aspects and process of the general public perceiving, understanding, and experiencing sounds based on the urban public space context. Secondly, the relationships among categories were different. The structure obtained by Liu and Kang (2016) summarised two directions of sound perception: one is the timeline of past, present, and future; the other is the consciousness's surface layer and deep layer. In this study, the focus was on the hierarchy of sound perceptions.

The ISO's (2014) structure has a similar progression order but is more general, including the whole process of the soundscape, from the acoustic environment and human perception to human response/reactions. Owing to the qualitative method used in this study, the focus was on the different levels of sound perception without the whole process of how people receive sounds. Compared with the ISO's structure, the perceptual structure in this study is more tailored to users of urban public

spaces who belong to the general public, and can be used as guidelines for urban public space soundscape evaluations.

8.3 Companion factors and socially interactive sounds in urban public spaces

Based on the quantitative analysis of study 3, 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& 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, socially interactive 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.

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& 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.

8.4 Theoretical basis for sociable soundscape design: suitability and stimulations

Study 4 analyses levels of social willingness through suitability and stimulations. These two indicators act as the starting point for guiding sociable soundscape design. It should be considered that suitability and stimulations have a conflicting relationship. If soundscape design emphasizes suitability with a peaceful soundscape, people will pay more attention to their own social activities and less to others; however, if the soundscape design encourages crowding and events, people will be more easily attracted by others while simultaneously being unable to conduct their own social activities because of the high sound level and the mess brought by the events. Especially for stimulating social interactions among strangers, peaceful sound type 3 without any human sounds had the lowest stimulation effect, even worse than conflicting, unpleasant sound type 4. This result suggests that peaceful and pleasant may not be the only objectives for designing a sociable soundscape. Instead, a pleasant soundscape with a degree of complexity is the key to stimulating social interactions. Previous studies have mentioned the complexity of the physical environment, and it was suggested that environments with high complexity can provide discoverable affordances to enhance knowledge and skills through typically playful interactions (Andringa et al., 2013; Herzog, 1992; Ipsen, 2001). Environments with high complexity were described as follows: chaotic, mobile, disharmonious and obstructive. In contrast, an environment with low complexity was described as calm, unobtrusive and tranquil (Andringa et al., 2013). In the soundscape field, Ipsen's (2002) theoretical model, the theory of acoustic complexity, termed sonic diversity, also summarised the relationship between low and high complexity. He explained the

relationship between human curiosity and soundscape complexity: as the complexity of information increases, the curiosity of humans increases. However, if the complexity is too high and 'unreadable', people tend to react with annoyance. Because curiosity is a part of social behaviours, this model can be applied to analyse sociable soundscape design. Based on Ipsen's (2002) theoretical model, the relationship between suitability and stimulations was mapped out in Figure 8.1, and each designed soundscape was located in this figure.

Figure 8.1 shows the possible sociability levels of each designed sound type. Suitability was valued more than stimulations because a qualified acoustic environment is the premise for social interactions (Gehl, 1987). If the soundscape cannot support people's social activities, they may not stay long, not to mention social interactions among strangers may not occur. Thus, sound type 3 was located within a fairly sociable soundscape range because it provided a rather high level of suitability. In terms of sound type 4, although it offered high stimulations, its soundscape was rather unpleasant for any social activities. In the real world, people may not even enter this environment because of the conflicting and noisy soundscape. In summation, a sociable soundscape should be based on high suitability levels plus appropriate stimulations that do not interfere with people's own social activities. In particular, the balance between suitability and simulation is more important for intimate and social groups than others because they are more easily attracted by events in urban public spaces.

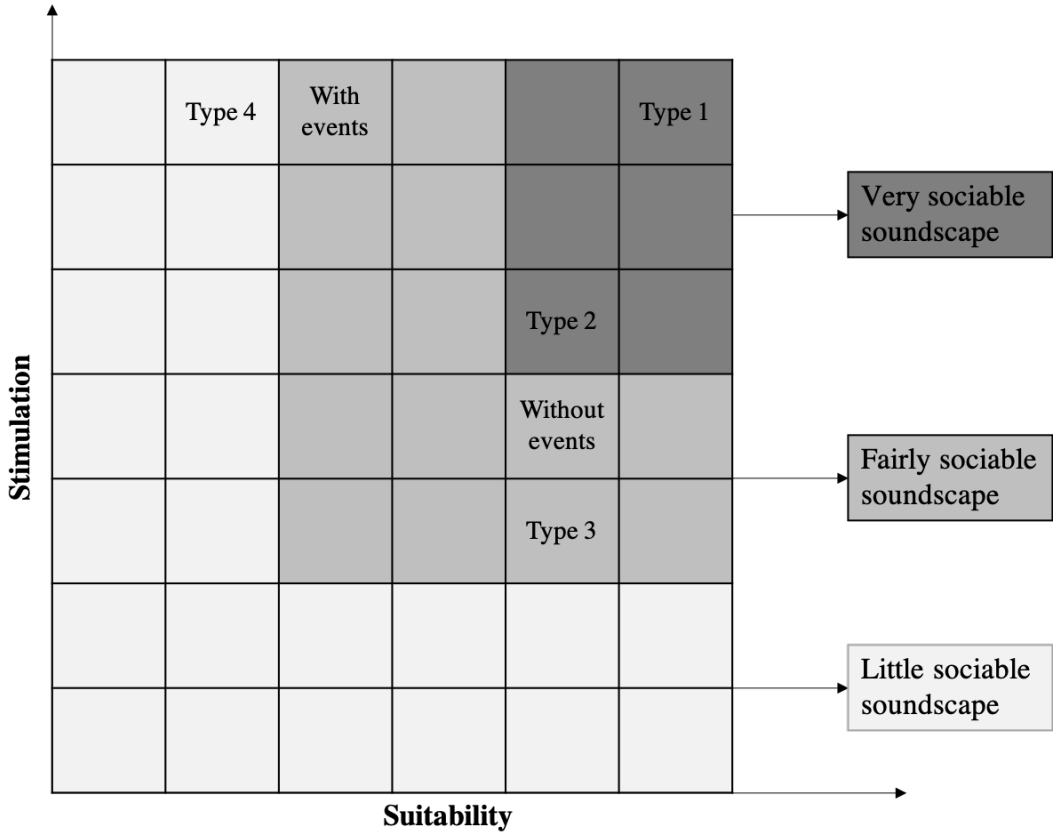


Figure 8.1 A possible structure of sociable soundscapes with the four sound types located in different sociable levels

8.5 Limitations and future works

In study 1, first, because of limited time and human resources, the observations covered just four sites in two seasons. Because patterns of use might vary throughout different cultural background and different seasons across the year, further cross- nation research over longer periods is suggested. Second, the spatial occupancies of users only focused on the divided areas (inner circle, middle circle, outer circle) to analyse the edge effect, which was limited. Because sites selected in this study

all have an iconic monument or facility in the central, which provide the opportunity to divide the areas into three circles from inner to outer. This dividing method would not make sense for other types of public spaces. Also, according to Gehl (1987), edge effect was unnecessarily happen in the peripheral areas, some facilities like colonnades, porches can provide similar functions. In the future research, more detailed spatial locations should be included to analyse edge effect. Third, frequencies were used to assess similarities and differences, which was inefficient for illustrating users' distributions within the public spaces, and GIS mapping of exact locations would provide precise results.

The limitation of study 2 was that the perceptual structure of soundscapes derived from this study may not be generalisable to other kinds of spaces. Also, this study focused on general public's sound perceptions, rather than urban planners, architects or sound experts. Previous studies have mentioned the huge differences of sound perceptions between general public and experts. Thus this perceptual structure may not be suitable for experts' sound perceptions. Further studies at other sites involving more kinds of participants are required to enrich this structure. Also, as this study was concerned with the overall process of how the general public with different social relationships perceives sounds, demographic, cultural, and site differences were not adequately explored. Two urban public spaces with cultural and site differences were intended to increase the sample's diversity so as to dig deep into the perceptual sound sphere, rather than for case comparisons. Future research must attempt to fill this gap. Also, in this study, people tended to describe soundscape of urban public spaces within an 'image', which address the importance of soundscape context. It seems those 'images' contain the activity types and social relationship types. It would be useful to further analyse how soundscape can support different 'image' types. For example, people can be

brought into sound lab to design their preferred soundscape into a ‘image’ of family bringing children to the square. In this way, how to satisfy people’s activities in urban public spaces can be figured out.

Because study 3 is an exploratory study, the results obtained are limited to the fact that companion factors positively influence people’s evaluations of socially interactive sounds. It seems that accompanied people tended to prefer socially interactive sounds and prefer social feelings brought by soundscape. But what is the exact compositions of socially interactive soundscape not clear. Further studies are required to analysed the composition and physical attributes of socially interactive sounds, for example, conducting a laboratory research with various kinds of simulated soundscape types. Hypotheses can be like children playing sounds as foreground sound will be evaluated with more social feelings than without. Results of this study showed people with more intense relationships tended to prefer socially interactive sounds, while this study did no go further to examine what causes this. Future study could focus on why people involved in more intimate relationship groups prefer socially interactive sounds. Perhaps it has associations with their activity types.

In the study 4, the sound interventions selected in study 4 were quite limited, only human and event sound interventions were included. The limitations were due to the complexities of designing sounds clips. In the experimental survey phase, human sounds were designed as foreground and background. Instead of designing different sound compositions manually, this study used sounds recorded from the realistic with the aim to make participants feel the real settings. This may bring with the disturbances from the sound sources, such as sound type 2 contains music sound, other sound types did not contain. While, if applying artificial sound clips to the recorded videos, it may

encounter the problem of 'uncanny valley' effect, where any introduced sounds have no corresponding sound source or event that can generate that sound, people may feel confusing and uncomfortable (Cobianchi et al., 2021). Future studies can further explore whether artificially produced sound clip give a different experience to participants compared to the real ones.

In the behavioural observation phase, due to the shortage of human resources, the number of observed users were limited. A great deal of time was spent on counting users' expressions and behaviours, which is relatively inefficient. Maybe in future studies, it is possible to involve face recognition and deep learning to calculate the relationships intensities and social willingness levels (if permitted by ethics), increasing the efficiency of behavioural observations. Such calculation method can also be used to measure the sociability levels of an urban public space with high efficiency. In addition, the researcher chose to observe the sites as events occurred to analyse eventful soundscape. This had the drawback that the events in the sites could not be controlled because the events were not exactly the same each time. Maybe involving XR (extend reality) and sensor technology to simulate eventful/ uneventful soundscape and bringing participants into sound lab to experience them can reduce this interference.

At last, based on the results of the four studies, a series of soundscape preferences of different relationship groups can be summarized. A possible future research can focus on designing micro-scale soundscape for different relationship groups in urban public spaces. Such as for single users, they tended to seek for quietness and avoid eventfulness. Researchers can create a quieter edge place in the site, then observing whether this design extend the length of single users' staying time. Ultimately, it is possible to create a guideline for design soundscape with diversities and

complexities in urban public spaces, which enables users to experience multiple kinds of soundscapes in one space.

Apart from solitary and accompanied people, those people who did not enter the site were not included. In the urban public spaces, some users may felt unsatisfied to the soundscape and they decided to leave the place or they chose not to enter the site. The researcher can hardly get access to this type of users because they were not in the site. In other words, there is a degree of error in the soundscape evaluations, as the selected participants were those who were willing to stay and hear the soundscape. This error also has relationships with the nature of urban public spaces- because of their openness, people can decide to stay or leave at any time. Researchers can hardly target urban public space users as they are often on the move or stay briefly. The physical environment conditions have a strong influence on their moves, including the soundscape factor. Although the researcher in this study chose the 'pleasant' environmental conditions to carry out the research, this criterion of 'pleasant' can be varied among different people. Generally, better environmental conditions will result in a significant increase in the number of users in the site. However, it was possible that some users who preferred a quieter environment would avoid crowd. In short, personal preference factors will have an impact on the soundscape evaluations in the outside sites.

On the other hand, this research only include people with normal hearing abilities. Because of the limitations of the researcher, this research was designed to focus on the normal hearing ability people. For people with hearing impairment, the sound they receive with hearing aids may differ from that received directly by the normal human ear (Lunner et al., 2009). Therefore a different

experiment may need to be designed to investigate. Among the ‘normal hearing ability people’, they may also be varied by the range of received sound frequency. But as this experiment only deals with the discrimination and perception of sound types and not too much with the physical properties of sound, the effect of this difference is relatively small.

In terms of the cultural differences mentioned in this study, because cross- cultural sites were selected in study1& 2& 3, significant variances brought by cultural differences were found in the analysis period. These variances repeatedly demonstrate the significant influences from cultural backgrounds on soundscape perceptions, which is reviewed in the literature review part. Cultural factors can shape our understandings to the physical world through the ‘decode’ process, which determines what we can hear and what we can feel (Rapoport, 1982). It was the fundamental issue when dealing with the field of environmental perceptions. While this study only superficially discussed the cultural differences, as the focus of this study is social relationship intensities. Similar to the cultural factor, the companion factor also significantly influence the sound perceptions. In the study 3, when the researcher controls the site factor, the influences from companion factors still present. Considering the cultural differences, future studies may concerned on how people with different cultural backgrounds show their proximity.

Urban public spaces were historically used as one of the spaces for the public affairs. But in modern times, with the establishment of the capitalist industrial production system, Marx (1927) and Simmel (1907) argued that people began to 'alienate'. Sennett (1977) added that there was a shift away from religious dispassion towards self-reflection. This shift weakened the inner life and corrupted the public spheres by an excessive focus on personal emotions and a lack of active

participation and rational expression in social affairs, which leads to what he saw as the 'fall of the public man'. With the development of commodity society, segmented goods further shaped the atomised social beings, making people to find their 'individuality' and their connections to society through purchases. Recently, the support of science and technology has made it even less necessary for people to enter physical spaces to consume and live; online platforms can solve almost everything about people's lives. Likewise, there is no need to go to a physical public space to deal with public affairs. The virtual public space is expanding, opinions and debates on public events are proliferating in the online space every day.

On the one hand, the 'invasion' of the cyberspace has been very evident even in our observations, many public space users seemed merely to come to the square playing their phones. Many users even used their phones with headphones, which meant they were isolated from the soundscape of the site. The advent of the mobile phone has therefore had a major impact on the previous social theory of urban public spaces. Previous research has suggested that other people's activities can attract users to stay longer and attract passers- by to enter the space (Whyte, 1980). But if people's attention is all on their phones, it's hard for them to get caught up by others' activities. Users who are attracted to mobile phones often need bigger external stimulations to get them out of their own little world to the outside world - for example, large events, high-decibel music, etc.

On the other hand, the mobile phone has also opened up a new direction for socialising- making net friends on virtual urban public spaces- a way that is particularly useful for niche interest groups to help them pinpoint their peers. Some of those online socialising can turn into offline friends, some others may stop at the internet. It is important to guide online socialising to offline,

because relationships on the internet can be fragile. Because of the anonymity of the internet, people don't always know the real identities of their online friends. And real social relationships tend to have a basis: people make friends with those who come from the same school, the same job, the same hometown, and these can serve as the basis for relationships that make it less easy to disconnect from each other. Real social relationships often involve an exchange of benefits, helping each other to find jobs, or helping with businesses, and in the exchange of these benefits the relationship is further strengthened (Granovetter, 1974). In Chinese society in particular, social relationships (or 'Guanxi') are the centre of the circle of people's lives (Bian, 2001; Fei, 1948). The concept of differential mode of association (Chaxugeju) raised by Fei pointed out that Chinese's networks usually start from their closet kinships to the other less close relationships. But this mode is observed in rural China rooted in Chinese Confucianism and kinship society, it has already been falling apart in recent year. Technology innovations usually bring with changes in society, including the way people make friends. It is still necessary to further explore the new mode of building networks in the internet era.

This research took place before the first half of 2019 and the COVID- 19 pandemic occurred just a few months after the research ended. The results can be significantly different if the research is carried out during the pandemic. During the period of the new crown epidemic, the situation for urban public spaces has become more difficult, as the distancing rules has prevented many large events from taking place. Users of the squares also needed to keep a relatively long distance from each other, exacerbating the apathy between people. Worse still, because close contact can be virulent, in the long run, people will have negative feelings about 'getting close to strangers'. This

makes it even more difficult to promote social interaction through the development of neighbourhoods and urban public spaces. The images of urban public spaces are also likely to change from being a 'pleasant place to socialise' to a 'viral place'. While, at the same time, people are finding it less difficult than they thought to socialise and work via the internet without leaving home.

Is cyberspace a remedy in this matter? Firstly, will there ever be a true sense of 'public' in cyberspace? The cyberspace may seem to be public, but in fact it is a place bringing together people who hold the same views - people choose to 'customise' their content, focusing only on what they want to focus on and discussing only what they want to discuss. People drift away from those who have different opinions in cyberspace. Also, cyberspace has made it easier to regulate public opinions, with simple codes to filter content and keep the voices of some subgroups out of sight. In the long run, so-called public discussion will be self-defeating, and internet users will only see content and ideas that they want to be seen. Secondly, will people establish real social relationships in cyberspace? Because of the epidemic, many areas have adopted a policy of home isolation and people are completely deprived of the possibility of socialising in urban public spaces. This has led to the rapid development of software, such as Zoom, to make it possible to work and live without leaving home. On the one hand, as discussed above, whether online net friends in the ‘cyber public spaces’ can be a substitute for real world friends is debatable because of the inauthentic online identity. On the other hand, from the angle of environmental behaviours, social interactions involve the works of sensory apparatus- feeling others through sight, olfaction, heat, sound, etc. to get abundant information about other people (Hall, 1992). While these are impossible through internet.

Especially for the social interactions in urban public spaces, many users join in the so- called ‘passive contact’ (Gehl, 1987), people can get social experiences from hearing, seeing, smelling and etc. In other word, replacing real world social interactions by cyberspace can hardly be achieved at this stage.

Chapter 9:

Conclusion

9. Conclusion

9.1 Main findings

This research aims to explore the mechanism between social relationships and soundscape in the context of urban public spaces. Four studies were conducted in terms of the perceptual structure of soundscape and the behaviour patterns of different relationship groups, and ultimately to relate social relationships to soundscape design. As a result, how people from different relationship groups require for the soundscape were summarized, which give guidance for the future soundscape design in urban public spaces. Following sections reviewed the results generated from the four studies.

9.1.1 Patterns of use in relation to social relationship types in urban public spaces

Study 1(Chapter 4) categorized various social relationships types and explored their patterns of use in urban public spaces based on the observations in four public spaces of China and the UK. In terms of social relationship types, this study categorized two types of companion factors, one is companion status (single or accompanied), the other is the three types of social relationships based on relationship intensity as intimate pairs, intimate groups and social groups. Intimate pairs stayed within intimate distance and consist of two individuals, observed as partners, close friends or family members; Intimate groups stayed within personal distance, most of which were more than three individuals. They usually were family members or friends; Social groups were made up by two or more individuals observed within social distance. Most of them were friends, acquaintances, neighbours or colleagues.

In terms of patterns of use, different patterns of use were found between single and accompanied: women were more likely than men to be in groups than alone, indicating a gender difference in using the public spaces. Compared to single users, group users tended to participate in multiple activities simultaneously, and their activities involved more interactions with other people. In terms of spatial occupancy, single users mostly occupy edge places of the marginal areas, while group users were generally evenly distributed throughout the spaces.

In terms of the patterns of use of three relationship groups, intimate pairs were most likely to use mobile phones and use private spaces, intimate groups were most likely to be talking and sitting and to use park amenities, and social groups were most likely to be playing games and relaxing in spacious open areas. Regarding spatial occupancy, Intimate Pairs and Social Groups were most likely to use the middle and peripheral regions, and the Intimate Groups tended to be evenly distributed in the spaces. The differences found in the patterns of use of different social relationship types indicates those groups' varied demographical backgrounds (groups size, age) and relationship intensities.

Also, this study found that cross- nation sites bring with significant cultural differences to the research. The dancing groups in Chinese urban public spaces bring with the variances in groups size and activity types.

9.1.2 A perceptual structure of the general public's soundscape in urban public spaces

Study 2 (Chapter 5) conducted a qualitative research in two sites of China and the UK with the aim to explore a perceptual soundscape structure of the general public in urban public spaces. As a result, the aspects of soundscape structure and the relationship among these aspects were figured out.

Firstly, four perceptual aspects of sounds were identified: sound classifications, sound features, psychological reactions, and sound preferences. Sound classifications are referred to people's fundamental understanding of sounds, people tended to categorise sounds by content and sound levels; Sound features reflect the dialectical relationship between individual sound and the overall soundscape. Two pairs of sound features were found: diversity and integrality, particularity and stereotypes; psychological reactions indicate sounds trigger instant or prolonged psychological reactions, which can result in physical and psychological outcomes in listeners. To deal with the negative outcomes, people adopt the strategies of tolerance, avoidance, and complaint; Sound preferences are referred to how people evaluate soundscape. People were found to express preferred sounds by descriptive words and 'images. 'Image' preference indicates the approach towards perceiving the physical world. The dominant status of social relationships found in the 'image' reflects the social attributes of people in the square's activities. Social relationships influence sound preference through people's sound requirements for different activities.

Secondly, the relationships among these aspects represent a progressive perception process with three levels: classification-sound appraisals (sound features and psychological reactions)-judgment (sound preferences). When people receive sounds through ears, they tended to categorize those sounds. On the basis of sound classifications, people appraise sound through two routes: one

from the functional aspect to evaluate the characteristics of the sound environment (sound features); the other from the affective aspect to evaluate the feelings and emotions stimulated by sounds (psychological reactions). In the end, sound preferences represent judgment and evaluation phase. Sound preferences represented the most profound perceptions because they involve choice-making, which takes us into the outcomes sphere.

Thirdly, a perceptual soundscape structure was found includes the aspects and process of sound perceptions. Four soundscape aspects categorised by three levels of perceiving progress (classification- appraisals-judgment) make up the perceived sphere of sounds. Two point was stressed in the structure: first is that there is a hierarchy in people's perceptions of sounds whereby the four aspects form three progressively more profound levels of sound perceptions; second is that sound preferences entail value judgment about the sound classification, features, and psychological reactions.

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

Study 3 (Chapter 6) explored whether and to what extent companion factors, compared with other demographic factors, influence the various aspects of soundscape evaluation. Research was conducted through a questionnaire research took place in Sheffield, UK, and Suzhou, China with statistical analysis. Based on the results from study 1 and 2, study 3 included two types of companion factors: companion status (single/ accompanied) and relationship types by intensity (partner/spouse, family, friends and alone).

As a result, both companion factors were found to influence socially interactive sounds, which consist of human activities sounds. In terms of companion status, it was found that accompanied

people were more likely to notice speaking and children's sounds and prefer safe and social sound. In terms of relationship intensity, people with closer relationship intensities noticed children's sounds more and preferred social sound. And relationship intensity influenced the preferences for human sound type positively.

Other demographic information was also found to influence soundscape evaluations. Site and age factor turned out to have greater influences than other factors on preferring 'safe-unsafe' and noticing speaking sounds, respectively. When slit sites, it was found companion status and relationship intensity affected noticing children's sounds only in Peace Garden. Although group size, age factors, companion status, relationship intensity were all found to influence 'social-unsocial', companion status had the most significant influence on the preferences for social sound.

Results of this study pointed out the relationships between human activity sounds and sociable soundscape. Human sounds, especially sounds from others' activities, can contribute to the sociable soundscape and stimulate more interactions among people. While these stimulations may vary between single and accompanied people, which requires further investigations.

9.1.4 Sociable soundscape interventions in relation to social relationship types in urban public spaces

Study 4 (Chapter 7) focus on how to build the sociable soundscape guidelines for different social relationship groups. Two aspects of social willingness were analysed: one is suitability- whether the soundscape is suitable; the other one is stimulation- whether the soundscape stimulates social interactions. Previous study 3 pointed out the relationship between socially interactive sounds and sociable soundscape. Thus, two sound interventions were analysed: human sounds and event sounds

through experimental survey and behavioural observations, respectively. Experimental survey took place in Sheffield, UK and behavioural observations took place in Sheffield and London, UK.

In terms of human sound intervention, it was found that soundscape quality corresponds to the level of suitability, and closer groups were found to have more critical requirements for the acoustic environment. Soundscapes without human sounds have negative effects on stimulating social interactions, especially for closer groups.

In terms of event sound, for all relationship types, event sounds can significantly enhance the stimulation for social interactions while simultaneously hindering the level of suitability. The stimulation effect from event sounds worked better on intimate groups and social groups; furthermore, the level of suitability was reduced because their own activities were affected. Intimate pairs were found to be less likely to be disrupted by event sounds, and they focused more on their own social activities. Singles were found to be sensitive to their surroundings, and they can also be stimulated by event sounds.

Spatial occupancies from observation also reflect the stimulation effect of event sounds by attracting people from a distance to occupy the railings. Event sounds have various influences on the occupancies of different relationship types: intimate pairs' occupancies were not influenced by event sounds; social groups and singles tended to avoid central places when events occurred there; and more intimate groups were found to stay in the central areas, and fountains were their favourite. The changes in occupancies also reflect how event sounds can influence the levels of suitability and stimulation.

A sociable soundscape guideline was suggested to ensure a balance between soundscape suitability and stimulation. For different social relationship types, people with higher relationship

intensities require a more pleasant and hubbub soundscape. In particular, a sociable soundscape that is pleasant and considerably hubbub was suggested for intimate pairs; one that is eventful, pleasant and hubbub is suggested for intimate groups; one that is eventful and little hubbub is suggested for social groups; and one that is considerably eventful and little hubbub is suggested for singles.

9.2 Summary

All in all, this study revealed how people in different relationship groups behave and require for the acoustic environment in urban public spaces. First study defined a-three-types of social relationships in urban public spaces as: Intimate Pair, Intimate Group and Social Group. Their patterns of use were categorised based on their activity types and occupancies in the urban public spaces. Followed study 2 build a three-level process of perceptual structure of soundscape with four elements: sound classifications- sound appraisals (sound features and psychological reactions)- and judgment (sound preferences). By relating companion factors (single/ accompanied or relationship intensity) to soundscape evaluations in urban public spaces, study 3 found that accompanied people with more intense relationships tended to evaluate socially interactive sounds more positively in urban public spaces. Last study analysed the influences of human sound/ event sound interventions on enhancing sociability of urban public spaces. Both sound interventions were found to stimulate social willingness while event sounds negatively affect soundscape suitability. A balance between suitability and stimulation should be achieved to enhance sociability, especially for closer groups.

Results from study 1 provides a new understanding of the patterns of use in public spaces based on relationship intensity, which contributes to city planners' abilities to design sociability into

public spaces. The three types of relationship were theoretically based on Hall's (1992) and Gehl (1987)'s distance theory, but they have more comprehensive patterns summarizing the users' demographical information and activities. These patterns can be further adopted in future observation studies of urban public spaces to save researchers' time and human resources. The findings of study 1 point to the limitation of the edge effect, which was found for the single, but not the accompanied, users. This finding is a reference for the future design of diverse public spaces.

Study 2's results not only corresponds to but also expands on previous results on the perceived sounds sphere, especially contributing to the works related to ISO 12913. The four perceptual aspects summarised in the GT approach provide a comprehensive view of sound perceptions. These four aspects can be used as the guidance for designing soundscape evaluation questionnaires. Especially, the descriptive words generated in this study can be widely used to assess general public's sound perceptions. The three- level perception process offer the possibility of analysing soundscapes from different stages. In particular, more attention needs to be paid to the appraisal level, when people have not made a value judgment regarding the soundscape. Two methods of describing sound preferences found in this study, descriptive words and 'images', can expand the scope of future research on soundscape preferences. For example, in soundscape studies that aim to simulate the urban public space environment in laboratories, it may be possible to better recreate the scene by carrying out some activities. Social relationships emphasised the preference for 'image', and the influence of companionship should be explored in future experimental soundscape studies.

Study 3 highlights the soundscape preferences of both accompanied and solitary people, providing new entry points for future public square soundscape design and even architectural design. In this study, human activity sounds were closely related to building sociable soundscape, which

can be added as one of the indices to the assessment of successful public spaces. Also, the different attitudes towards human activity sounds of single and accompanied people indicates 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.

Study 4 emphasized the influences of soundscape design in promoting the sociability of different social relationship types in urban public spaces, which also followed the steps of ISO (International Organization for Standardization) guidance. It is expected that the findings of this study can broaden the future directions of the soundscape design of urban public spaces and help to better highlight the sociability of urban public spaces. Results from human and event sound factors laid the basis for designing a sociable soundscape- a balance between soundscape suitability and stimulation should be considered in design guidelines. Soundscapes with high suitability can support social activities within groups, but then people may not care about the outside world. Eventful soundscapes enhance the levels of sociability while simultaneously interrupting people's own activities. A sociable soundscape should be a pleasant acoustic environment with a degree of soundscape complexities. A qualified acoustic environment is the premise for social activities while a sound stimulus adds possibilities for social interactions. This guideline is particularly instructive for Chinese urban public space management, where always have large dancing groups accompanied with loud dancing music. When those stimulating events become the routine, the spaces for ordinary activities will be reduced to the point of disappearance. Thus, urban public spaces will lose its attributes of publicness and become a stage dedicated to dance. The suitability levels should be

emphasized through soundscape designs and urban governance in Chinese urban public spaces. This study also suggests applying different soundscape designs for various relationship types.

This research focused on the social aspect of how people perceive and understand soundscape, which highlight the limits of the previous soundscape studies. Previous studies have tended to consider participants as individuals, rarely placing them in groups for study. In contrast, this study consider the participants as socially constructed individuals and place them in social relationships and social scenarios, which has implications for the study of urban public space. This research also combine knowledge from other study fields to soundscape, such as environmental psychology, environmental behaviours and sociology. The edge effect, for example, is a concept that originally belongs to the concepts of space and distance, but when introduced to the soundscape, it reveals its connection to sound. Those at the periphery of the site are not only away from the crowds but also from the noisy sound sources, and the quiet and safety they sought are closely related.

In terms of the beneficial groups, firstly, this study benefits public space users, especially for those who want to involve in various social interactions in urban public spaces. Because hearing and talking can be significantly influenced by the soundscape, the conditions of urban public space soundscape usually were unpleasant. The sociable soundscape guidelines summarized in this study not only suggested a pleasant soundscape but also suggest to ensure the balance between suitability and stimulations. It can enhance the acoustic quality and satisfy diverse social activities. Secondly, this experiment is beneficial to those who have a diverse requirement for urban public space soundscape. Previous studies tended to view urban public space soundscape as a whole. This research found the differences of soundscape preferences among varied relationship groups, such as partners/ spouses may require a quieter soundscape with privacy. This research suggested to

create a variety of micro- soundscape types to meet the diverse needs and enhance people's soundscape experience in urban public spaces.

However, because this study included a limited choice of urban public spaces and cities, and social relationships were limited to relationship intensities. Results from this research may not be applicable to the other context. Also, observing people’s relationship and behaviours can be supported by the help of face recognition and deep learning to avoid the massive works and subjective errors. With the development of the sensor and XR (extend reality) technology, simulating various kinds of soundscapes in sound lab may be a more efficient way for analysing soundscapes.

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Appendix A: Publications

Journal papers in peer- reviewed journals

1. Cao, J., & Kang, J. (2021). The influence of companion factors on soundscape evaluations in urban public spaces, **Sustainable cities and society**, 69(March), 102860.
2. Cao, J., & Kang, J. (2019). *Social relationships and patterns of use in urban public spaces in China and the United Kingdom*, **Cities**, Volume 93, 2019, Pages 188-196, ISSN 0264-2751.
3. Cao, J., & Kang, J. Sociable soundscape design in relation to social relationship types in urban public spaces of the United Kingdom, **Cities** (to be submitted).
4. Cao, J., & Kang, J. A perceptual structure of general public's soundscape in urban public spaces based on grounded theory, **Environmental Impact Assessment Review** (to be submitted).

Appendix B: Statistical terms and tools applied in this research

Independent variable: (predictor): the variable that is changed or controlled in a scientific experiment to test the effects on the dependent variable.

Dependent variable (outcome variable)**:** the variable being tested and measured in a scientific experiment.

Categorical variable: A categorical variable (sometimes called a nominal variable) is one that has two or more categories, but there is no intrinsic ordering to the categories. For example, gender is a categorical variable having two categories (male and female) and there is no intrinsic ordering to the categories.

Ordinal variable: An ordinal variable is similar to a categorical variable. The difference between the two is that there is a clear ordering of the variables. For example, a variable of economic status has three categories (low, medium and high). In addition to being able to classify people into these three categories, you can order the categories as low, medium and high.

Null hypothesis (H_0): A hypothesis stating that there is no effect between two variables and the observation results are purely by chance. Researchers work to reject, nullify or disprove the null hypothesis.

Chi square test: it generally refers to Pearson's chi-square test of the independence of two categorical variables. Essentially it tests whether two categorical variables forming a contingency table are associated.

ANOVA (Analysis of Variance): ANOVA is an analysis tool used in statistics that splits an observed aggregate variability found inside a data set into two parts: systematic factors and random factors. The systematic factors have a statistical influence on the given data set, while the random factors do not.

Independent sample t-test: The independent-samples t-test compares the means between two unrelated groups on the same continuous, dependent variable.

K-means algorithm: Technique that aims at partitioning n observations into k clusters in which each observation belongs to the cluster with the nearest mean.

Pearson correlation (r): Measure of the linear correlation between two variables X and Y.

Linear regression: linear regression is a linear approach to modelling the relationship between a scalar response and one or more explanatory variables. The case of one explanatory variable is called simple linear regression; for more than one, the process is called multiple linear regression.

Logistic regression: Logistic regression is the appropriate regression analysis to conduct when the dependent variable is dichotomous (binary). Like all regression analyses, the logistic regression is a predictive analysis. Logistic regression is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables.

Reliability and Validity: Reliability and validity are concepts used to evaluate the quality of research. They indicate how well a method, technique or test measure something. Reliability is about the consistency of a measure, and validity is about the accuracy of a measure.

Appendix C: Questionnaire used in this research

Questionnaire used in Study 3

English version: 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**: _____

Chinese version: 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）

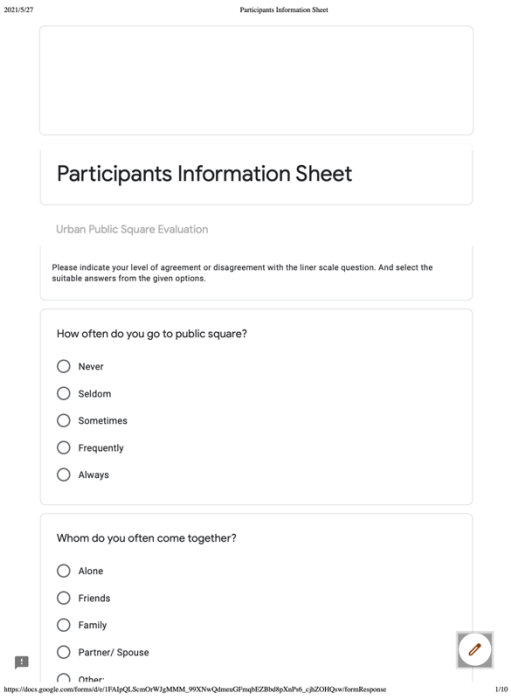
☐社交的　☐自然的　☐热闹的　☐安详的

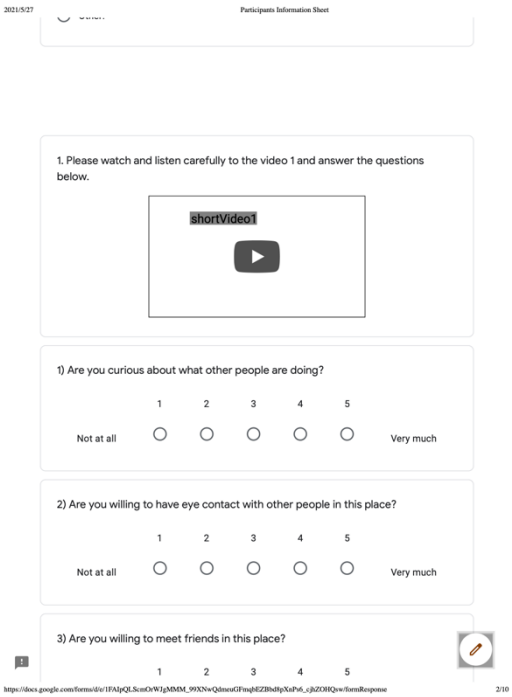
☐快乐的　☐温馨的　☐休闲的　☐优美的

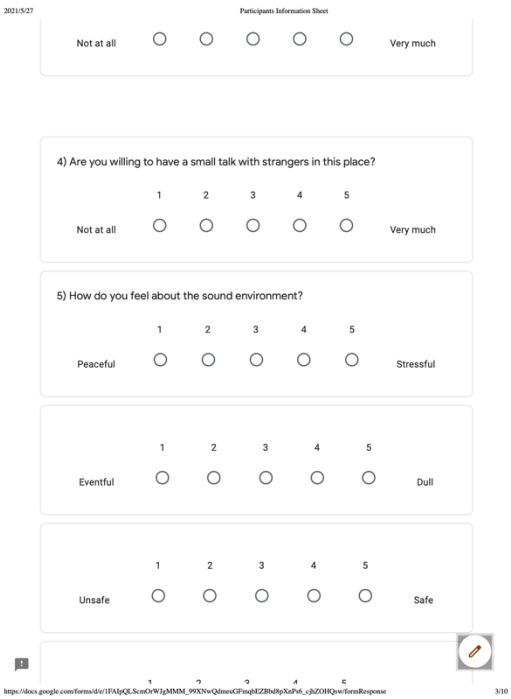
☐深邃的　☐温暖的　☐安全的　☐其他:_____

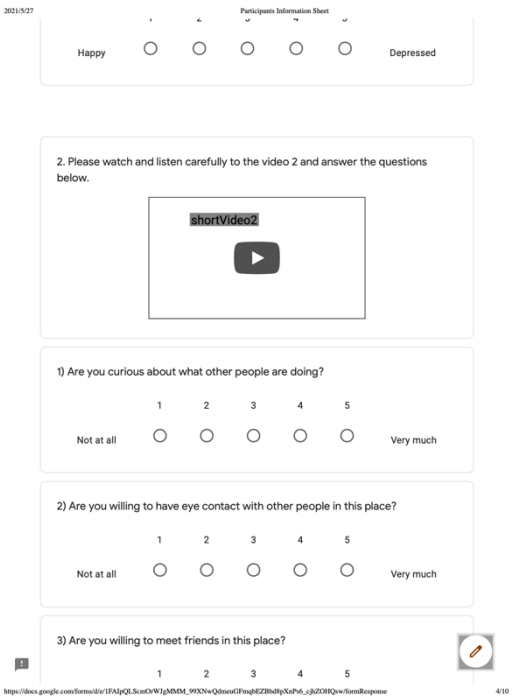
性别：_____ 年龄：_____

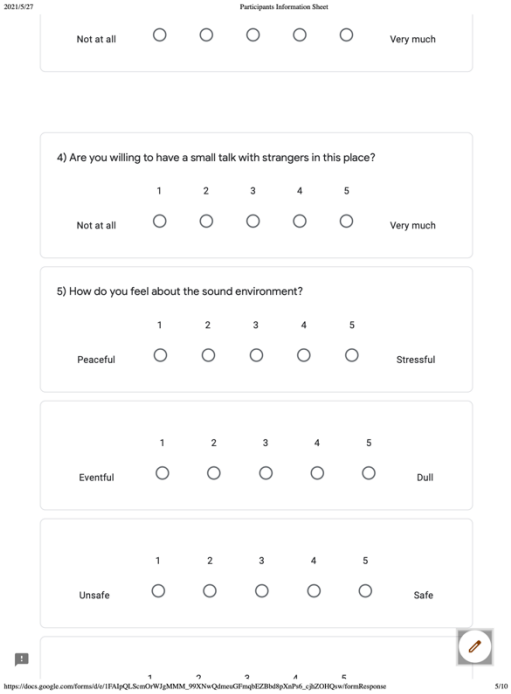
Questionnaire used in Study 4

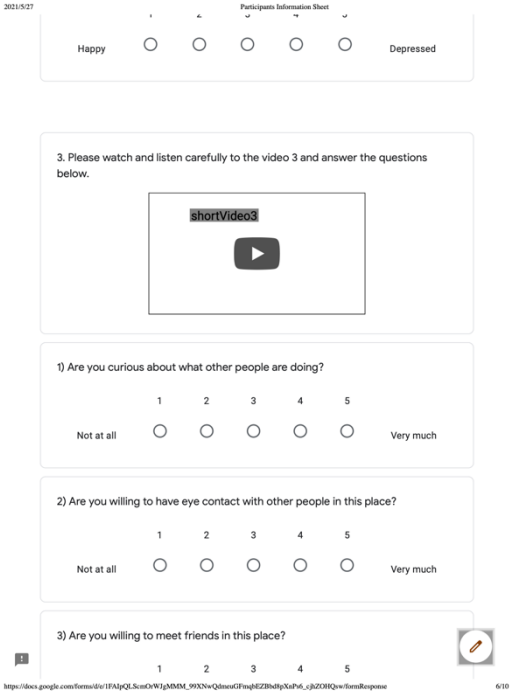


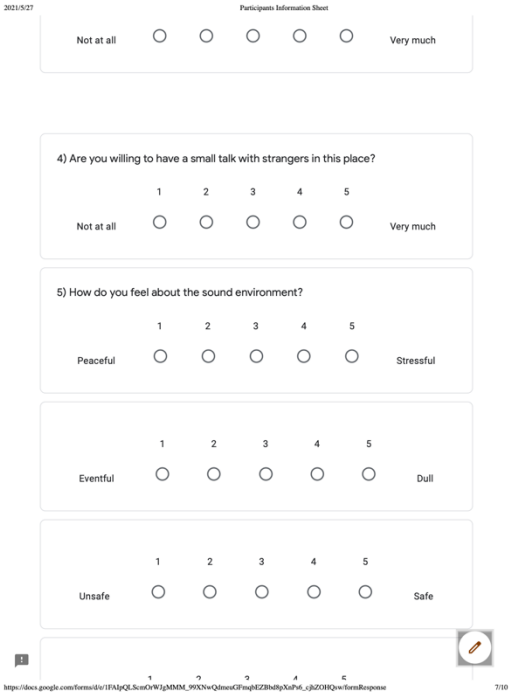


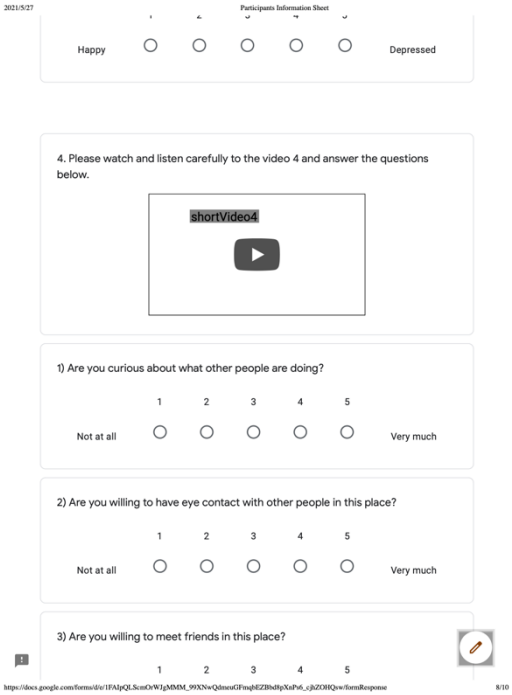


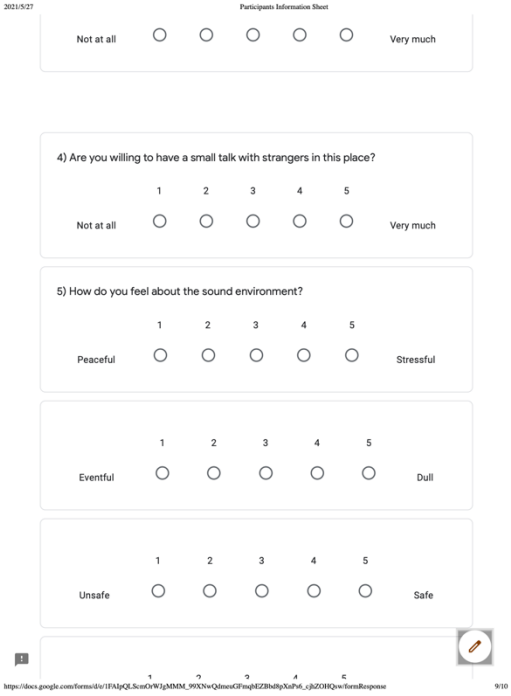



2021/5/27
Participants Information Sheet
Not at all
Very much
4) Are you willing to have a small talk with strangers in this place?
1 2 3 4 5
Not at all
Very much
5) How do you feel about the sound environment?
1 2 3 4 5
Peaceful
Stressful
1 2 3 4 5
Eventful
Dull
1 2 3 4 5
Unsafe
Safe
https://docs.google.com/forms/d/e/1FAIpQLScmOrWJgMMM_99XNwQdmeuGFmqbEZBbdBpXnPs6_cjhZOHQxw/formResponse
5/10


2021/5/27
Participants Information Sheet
Happy
Depressed
3. Please watch and listen carefully to the video 3 and answer the questions below.
shortVideo3
1) Are you curious about what other people are doing?
1 2 3 4 5
Not at all
Very much
2) Are you willing to have eye contact with other people in this place?
1 2 3 4 5
Not at all
Very much
3) Are you willing to meet friends in this place?
1 2 3 4 5
https://docs.google.com/forms/d/e/1FAIpQLScmOrWJgMMM_99XNwQdmeuGFmqbEZBbdBpXnPs6_cjhZOHQxw/formResponse
6/10


2021/5/27
Participants Information Sheet
Not at all
Very much
4) Are you willing to have a small talk with strangers in this place?
1 2 3 4 5
Not at all
Very much
5) How do you feel about the sound environment?
1 2 3 4 5
Peaceful
Stressful
1 2 3 4 5
Eventful
Dull
1 2 3 4 5
Unsafe
Safe
https://docs.google.com/forms/d/e/1FAIpQLScmOrWJgMMM_99XNwQdmeuGFmqbEZBbdBpXnPs6_cjhZOHQxw/formResponse
7/10


2021/5/27
Participants Information Sheet
Happy
Depressed
4. Please watch and listen carefully to the video 4 and answer the questions below.
shortVideo4
1) Are you curious about what other people are doing?
1 2 3 4 5
Not at all
Very much
2) Are you willing to have eye contact with other people in this place?
1 2 3 4 5
Not at all
Very much
3) Are you willing to meet friends in this place?
1 2 3 4 5
https://docs.google.com/forms/d/e/1FAIpQLScmOrWJgMMM_99XNwQdmeuGFmqbEZBbdBpXnPs6_cjhZOHQxw/formResponse
8/10


2021/5/27
Participants Information Sheet
Not at all
Very much
4) Are you willing to have a small talk with strangers in this place?
1 2 3 4 5
Not at all
Very much
5) How do you feel about the sound environment?
1 2 3 4 5
Peaceful
Stressful
1 2 3 4 5
Eventful
Dull
1 2 3 4 5
Unsafe
Safe
https://docs.google.com/forms/d/e/1FAIpQLScmOrWJgMMM_99XNwQdmeuGFmqbEZBbdBpXuPs6_cjhZOHQsw/formResponse
9/10


2021/5/27
Participants Information Sheet
Happy
Depressed
Age
< 19
20~34
35~49
50~64
> 65
Gender
Male
Female
Back
Next
Never submit passwords through Google Forms.
This content is neither created nor endorsed by Google. Report Abuse - Terms of Service - Privacy Policy
Google Forms
https://docs.google.com/forms/d/e/1FAIpQLScmOrWJgMMM_99XNwQdmeuGFmqbEZBbdBpXuPs6_cjhZOHQsw/formResponse
10/10

Appendix D: Behavioural maps used in this research

Behavioural maps used in Study 1

Observation in Barkers Pool

Date_____ Weather_____ Time_____

Group No.	Age (Child, young, adult, old)	Activities	Intimacy distance	Others
1				
2				
3				
4				
5				
6				
7				

Behavioural maps used in Study 4

Behavioural mapping

Background Information	Date_____ Weather: □ Sunny □ Windy □ Rainy □ Cloudy □ Foggy Sound level _____ Sound sources: _____
Intimate pairs	No. 1 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 2 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 3 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____.

	Stimulations: looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 4 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 5 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
Intimate groups	No. 1 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 2 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____.

	Stimulations: looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 3 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 4 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 5 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____, kissing_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
Social groups	No. 1 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.

	No. 2 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 3 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 4 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 5 *Location* _____ Group size_____ Activities _____ *Suitability:* Time focused_____; Eye contact times_____, laughing time_____, hugging_____, touching_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
Single	No. 1 *Location* _____ Activities _____ *Suitability:* Time focused_____, Eye contact times_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.

	No. 2 *Location* _____ Activities _____ *Suitability:* Time focused_____, Eye contact times_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 3 *Location* _____ Activities _____ *Suitability:* Time focused_____, Eye contact times_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 4 *Location* _____ Activities _____ *Suitability:* Time focused_____, Eye contact times_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.
	No. 5 *Location* _____ Activities _____ *Suitability:* Time focused_____, Eye contact times_____. *Stimulations:* looking at strangers_____, eye contact_____, smiling_____, small talk_____.

Appendix E: Ethics

Ethics approval letter for study 1

Downloaded: 28/05/2021
Approved: 05/05/2017

Jingwen Cao
Registration number: 160261071
School of Architecture
Programme: PhD Architecture

Dear Jingwen

PROJECT TITLE: Companion influence peoples environmental preferences in public space
APPLICATION: Reference Number 013707

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 05/05/2017 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 013707 (form submission date: 14/04/2017); (expected project end date: 14/05/2017).
- Participant information sheet 1029482 version 1 (10/04/2017).

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Your responsibilities in delivering this research project are set out at the end of this letter.

Yours sincerely

Cheryl Armitage
Ethics Administrator
School of Architecture

Please note the following responsibilities of the researcher in delivering the research project:

- The project must abide by the University's Research Ethics Policy: https://www.sheffield.ac.uk/rs/ethicsandintegrity/ethicspolicy/approval-procedure
- The project must abide by the University's Good Research & Innovation Practices Policy: https://www.sheffield.ac.uk/polopoly_fs/1.671066!/file/GRIPPolicy.pdf
- The researcher must inform their supervisor (in the case of a student) or Ethics Administrator (in the case of a member of staff) of any significant changes to the project or the approved documentation.
- The researcher must comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
- The researcher is responsible for effectively managing the data collected both during and after the end of the project in line with best practice, and any relevant legislative, regulatory or contractual requirements.

Ethics approval letter for study 2

Approved: 19/06/2017

Jingwen Cao
Registration number: 160261071
School of Architecture
Programme: PhD Architecture

Dear Jingwen

PROJECT TITLE: COMPANION INFLUENCE ON USER PREFERENCES OF URBAN PUBLIC SPACES
APPLICATION: Reference Number 014939

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 19/06/2017 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 014939 (form submission date: 06/06/2017); (expected project end date: 06/09/2017).
- Participant information sheet 1031797 version 1 (06/06/2017).
- Participant consent form 1031798 version 1 (06/06/2017).

The following optional amendments were suggested:

See comments regarding photography in public spaces and data storage.

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Your responsibilities in delivering this research project are set out at the end of this letter.

Yours sincerely

Chengzhi Peng
Ethics Administrator
School of Architecture

Please note the following responsibilities of the researcher in delivering the research project:

- The project must abide by the University's Research Ethics Policy: https://www.sheffield.ac.uk/rs/ethicsandintegrity/ethicspolicy/approval-procedure
- The project must abide by the University's Good Research & Innovation Practices Policy: https://www.sheffield.ac.uk/polopoly_fs/1.671066!/file/GRIPPolicy.pdf
- The researcher must inform their supervisor (in the case of a student) or Ethics Administrator (in the case of a member of staff) of any significant changes to the project or the approved documentation.
- The researcher must comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
- The researcher is responsible for effectively managing the data collected both during and after the end of the project in line with best practice, and any relevant legislative, regulatory or contractual requirements.

Ethics approval letter for study 3

Downloaded: 28/05/2021
Approved: 02/06/2018

Jingwen Cao
Registration number: 160261071
School of Architecture
Programme: Architecture

Dear Jingwen

PROJECT TITLE: Soundscape Evaluation and Social Relationships
APPLICATION: Reference Number 019886

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 02/06/2018 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 019886 (form submission date: 28/05/2018); (expected project end date: 28/06/2018).
- Participant information sheet 1044179 version 2 (28/05/2018).
- Participant information sheet 1045117 version 1 (28/05/2018).
- Participant consent form 1044180 version 2 (28/05/2018).
- Participant consent form 1045118 version 1 (28/05/2018).

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Your responsibilities in delivering this research project are set out at the end of this letter.

Yours sincerely

Chengzhi Peng
Ethics Administrator
School of Architecture

Please note the following responsibilities of the researcher in delivering the research project:

- The project must abide by the University's Research Ethics Policy: https://www.sheffield.ac.uk/rs/ethicsandintegrity/ethicspolicy/approval-procedure
- The project must abide by the University's Good Research & Innovation Practices Policy: https://www.sheffield.ac.uk/polopoly_fs/1.671066!/file/GRIPPolicy.pdf
- The researcher must inform their supervisor (in the case of a student) or Ethics Administrator (in the case of a member of staff) of any significant changes to the project or the approved documentation.
- The researcher must comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
- The researcher is responsible for effectively managing the data collected both during and after the end of the project in line with best practice, and any relevant legislative, regulatory or contractual requirements.

Ethics approval letter for study 4

Downloaded: 28/05/2021
Approved: 30/05/2019

Jingwen Cao
Registration number: 160261071
School of Architecture
Programme: Architecture

Dear Jingwen

PROJECT TITLE: Sociable soundscape evaluation
APPLICATION: Reference Number 026471

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 30/05/2019 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 026471 (form submission date: 09/05/2019); (expected project end date: 01/07/2019).
- Participant information sheet 1061659 version 1 (09/05/2019).
- Participant consent form 1061660 version 1 (09/05/2019).

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Your responsibilities in delivering this research project are set out at the end of this letter.

Yours sincerely

Chengzhi Peng
Ethics Administrator
School of Architecture

Please note the following responsibilities of the researcher in delivering the research project:

- The project must abide by the University's Research Ethics Policy: https://www.sheffield.ac.uk/rs/ethicsandintegrity/ethicspolicy/approval-procedure
- The project must abide by the University's Good Research & Innovation Practices Policy: https://www.sheffield.ac.uk/polopoly_fs/1.671066!/file/GRIPPolicy.pdf
- The researcher must inform their supervisor (in the case of a student) or Ethics Administrator (in the case of a member of staff) of any significant changes to the project or the approved documentation.
- The researcher must comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
- The researcher is responsible for effectively managing the data collected both during and after the end of the project in line with best practice, and any relevant legislative, regulatory or contractual requirements.