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URBAN PARK SOUNDSCAPES AND THEIR PERCEIVED RESTORATIVENESS

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1 INTRODUCTION

Individual sounds and soundscapes can influence individuals[1], their place evaluations[2] and potentially their psychological restoration[3]. As urban park soundscapes can vary greatly, ranging from quiet, serene oases to noisy city spaces, it is important to understand how they are perceived and evaluated, as they could influence people's experience and evaluation of the park in general. This paper studies the different types of soundscapes that are perceived in urban parks and examines if these soundscapes vary in their perceived restorativeness.

Soundscapes can be described via a number of different methods, including measured acoustic and psychoacoustic parameters, or a professional's description of the foreground and background sounds. However, because of the different ways in which people listen (e.g. different 'listening types'[4]), individual perceivers can notice different sounds and experience a different soundscape than one depicted by others. It is therefore important to identify the soundscape that is perceived by the individual who makes the soundscape evaluation. Methods for identifying people's perception of the soundscape include asking them to freely recall sounds[5], or rate how often they heard a number of presented sound types[6]. Similarities in perceived soundscapes can be identified through free sorts of recorded soundscapes and examining the acoustic properties and sound sources of the subsequent categorisations[7,8]. A combination of these methods was proposed to identify different categories of urban park soundscapes for this study.

Individual differences in the perception of urban park soundscapes could vary for personal or contextual reasons. Different urban parks will have different, albeit potentially similar, soundscapes providing variation in the categorisation and evaluation of urban park soundscapes. For example, the evaluation of the soundscape at numerous sites in a very large urban park (52.4ha) varied[9]. Temporal alterations in the soundscape will also exist because of changes in human behaviour patterns, such as traffic rush hours and families visiting at the weekend. Therefore, the perception of soundscapes throughout the week and weekend may also vary, resulting in different soundscape types.

Personal variations in the perceived soundscape may arise because of differences in individuals' listening mode, as they carry out different activities in a place[4,10]. Depending on an individual's activity and related listening mode, individuals' level of awareness of the soundscape is likely to vary. Additionally, individuals' sensitivity to noise is often considered in soundscape studies[11] as a potential factor influencing the perception and evaluation of different sounds and its sound level. Noise sensitivity and awareness of the soundscape could be related, as an individual with high noise sensitivity would be expected to have a higher awareness level of the soundscape.

Soundscapes have recently been evaluated by urban park users in terms of its perceived restorativeness[12]. The Perceived Restorativeness Soundscape Scale (PRSS) is a measure of the individual's perception of the soundscape's potential to enable psychological restoration, based on general measures of the perceived restorativeness of an environment[13,14]. The individual rates the soundscape in terms of how fascinating and coherent it is, it's scope, its compatibility with the

individuals needs and behaviours, and how much it provides a feeling of being-away from other soundscapes. The higher the perceived restorativeness, the higher the soundscape potential in enabling psychological restoration, which has cognitive and physical benefits, such as reduced stress levels[15].

Soundscapes from urban and rural environments vary in their perceived restorativeness as do soundscapes from two different urban parks[12]. The perceived restorativeness ratings of soundscapes within the two urban parks also varied[12]. Potentially, different types of soundscapes were perceived within each of the parks, with each type of soundscape having a different perceived restorativeness rating. This study therefore aims to clarify if different types of urban park soundscapes have different perceived restorativeness ratings. First, the types of urban park soundscapes perceived by urban park users within two urban parks in Sheffield, UK will be determined. Contextual (park, day) and personal factors (awareness, noise sensitivity) that could influence the perception of the soundscape will be incorporated. Secondly, the identified soundscape types will be evaluated, using the Perceived Restorativeness Soundscape Scale, to assess if different urban park soundscapes vary in their perceived restorativeness.

2 METHOD

Two urban parks within Sheffield, UK were chosen as case studies to explore varied soundscapes within one place type. The two city parks, Weston Park (4.82ha) and Botanical Gardens (6.93ha), were located under a mile from each other and less than 1.5 miles from the city centre. Both parks are adjacent to busy artery roads, although Weston Park was flanked on two opposing sides by heavily trafficked road, while Botanical Gardens was only bordered on one side. Additionally, Weston Park had construction work occurring in the park during weekdays as part of its own renovation project.

Urban park users leaving the two parks were asked to participate in the study. Four hundred participants completed a questionnaire *in situ* during July to September 2007, between 10am and 7pm. There were 200 participants from each park, with the questionnaire lasting between 5 and 20 minutes. Five participant's responses were removed from further analysis due to missing data. The final sample consisted of 44% female, 42% male, 14% groups of mixed gender, with a median age of 35-44 years, with 63% of the questionnaires conducted during a weekday.

Participants were presented with visual analogue scales, which were annotated with the values 0 and 100 percent at the two ends of the line and 50 percent in the middle. They were asked to make a mark on the line to represent how much of the time they had heard each of seven presented sound types while they had been in the park, on that specific occasion. The seven types of sounds were 'Natural, 'Happy People', 'Sad and Angry People', 'Object sounds due to People in the park', 'Surrounding Building sounds including Construction Work', 'Individual Vehicles or Aircrafts', 'Background City including Background Traffic'. These seven sound types were developed from a prior study of laypeople's conceptualization of urban park sounds[16]. Participants were then asked to rate the average volume of each of the perceived sound types on a seven point semantic scale from *quiet* (1) to *loud* (7). A sound predominance value was generated by multiplying the perceived sound type duration and volume. This generated a sound predominance scale with values from 0 to 700 for each sound type.

Half the participants (n=200; 47% female, median age=35-44 years) were also required to answer the Perceived Restorativeness Soundscape Scale[12]. This involved fourteen statements (adapted from general environment measures[13,14]) about the sounds and soundscape of the urban park, such as '*The sonic environment was a refuge from unwanted distractions*' and '*All the sounds I heard belonged to this type of urban park*'. Participants had to rate their level of agreement on a 7 point scale with each statement ranging from *not at all* agreeing (0) through to *completely* agreeing (6).

All participants were also requested to self-rate their awareness of the soundscape on a 7 point semantic scale '*I was aware of the sounds around me… a little* (1), to *a lot* (6). Their noise

sensitivity was also assessed using three items adapted from Weinstein's Noise Sensitivity Scale[17]. These were '*noises get on my nerves and get me irritated... none of the time* (1) to *all the time* (7)', '*I am sensitive to noise... disagree* (1) to *agree* (7)', and '*I'm good at concentrating no matter what is going on around me... disagree* (1) to *agree* (7)'. The latter item was reverse coded, and together, the three items reliably measured noise sensitivity (Cronbach's α=.61, $\bar{x}r$=.33).

3 RESULTS

A K-means cluster analysis of participants' perceived predominance values of the seven urban park sound types was conducted to determine the number of types of soundscapes perceived by the urban park visitors. A five cluster solution was the most appropriate, identifying five different types of perceived soundscapes that varied in the predominance value of each of the sound types. The predominance value of each sound type, at the central point of each cluster represents the typical participants' predominance value for that cluster (see Table 1). In the statistical analysis, each participant became associated with a soundscape type, as their predominance values were closest to the central values of that cluster than to any of the other four central cluster values. This means, each participant's perception of the soundscape did not match the exact predominance values of their associated soundscape type, but will closely relate to its subsequent description, which are described in Table 2. The majority of participants perceived soundscapes that were characterized by Natural and Happy People sounds, although some of these participants (those who perceived Soundscape Type 2) perceived these sound types more predominantly than others (those who perceived Soundscape Type 1).

Table 1: Five soundscape types and their central sound predominance value for each sound type.

Sound Type	**Soundscape type and predominance values**				
	1	**2**	**3**	**4**	**5**
Natural	143	436	323	149	178
Happy People	158	338	417	104	210
Background City/ Traffic	66	56	348	266	522
People's Objects in the Park	38	133	38	18	147
Buildings/ Construction work	13	25	36	421	54
Individual Traffic/ Aircrafts	19	49	31	79	283
Sad/ Angry People	8	11	8	5	20

Table 2: Description of the different soundscapes perceived by urban park visitors.

Soundscape Type	**Sound types and their predominance level**	**n**
1	Weak Natural and Happy People sounds	181
2	Strong Natural sounds with Happy People and weak People's Object sounds	124
3	Strong Happy People sounds with Background City/Traffic and Natural sounds	36
4	Strong Buildings/Construction work sounds with Background City/Traffic, and weak Natural and Happy People sounds	24
5	Strong Background City/Traffic sounds and a cacophonic[a] soundscape	21

[a] The term cacophonic is used here without any negative connotations, to reflect the diverse range of perceived sound types of a moderate predominance level. Unfortunately, no similar meaning neutral term was known.

The perception of the different types of soundscapes significantly differed depending on which park the participant had visited (χ^2=48.68, p<.001). Table 3 shows that participants within Botanical Gardens were more likely to have perceived a soundscape predominated strongly by Natural sounds (Soundscape Type 2) than those in Weston Park. Conversely, those in Weston Park were more likely to have perceived a soundscape that consisted of predominant Background City/Traffic and/or sounds from surrounding Buildings and Construction Work (Soundscape Type 3, 4 and 5).

The perceived soundscape also significantly varied depending on the type of day the park was visited (χ^2=16.23, p<.01). In particular, soundscapes with a strong predominance of sounds from the surrounding Buildings and Construction Work (Soundscape Type 4) were more likely to be heard on a weekday than at the weekend (see Table 3). As expected, the contextual factors of which urban park the participant had visited and on what type of day, related to the perception of different types of urban park soundscapes.

Participants, on average, gave self-ratings of a medium level of awareness of the sounds while in the park ($\bar{x}$=4.16, σ=1.75). There were 141 participants with low awareness (1-3 rating), 83 with medium awareness (4) and 170 with a high awareness level (5-7). Table 3 shows that the soundscape type the participants perceived significantly varied with their soundscape awareness level (χ^2=60.81, p<.001). In particular, participants with a low level of awareness were more likely to report perceiving a soundscape with only low predominance levels of any sound types (Soundscape Type 1) and were less likely to report perceiving a soundscape with high predominance levels of Natural sounds (Soundscape Type 2). In contrast, those with a high level of awareness were more likely to report perceiving the more predominantly described soundscape (Soundscape Type 2) and less likely to report perceiving a weakly predominated soundscape (Soundscape Type 1).

Table 3: Significant differences on the perceived Soundscape Type and the park, type of day, soundscape awareness level and noise sensitivity level.

Variables		Count	Soundscape Type				
			1	2	3	4	5
Park	**Weston Park**	Observed	80.0	44.0	25.0	22.0	19.0
		Expected	89.1	61.0	17.7	11.8	10.3
	Botanical Gardens	Observed	101.0	80.0	11.0	2.0	2.0
		Expected	91.9	63.0	18.3	12.2	10.7
Type of Day	**Weekday**	Observed	111.0	68.0	26.0	23.0	12.0
		Expected	112.5	77.1	22.4	14.9	13.1
	Weekend	Observed	70.0	56.0	10.0	1.0	9.0
		Expected	68.5	46.9	13.6	9.1	7.9
Soundscape Awareness level	**Low**	Observed	92.0	17.0	16.0	4.0	10.0
		Expected	65.0	44.8	13.0	8.7	7.6
	Medium	Observed	35.0	24.0	7.0	6.0	6.0
		Expected	36.5	25.1	7.3	4.9	4.3
	High	Observed	52.0	83.0	13.0	14.0	5.0
		Expected	78.5	54.1	15.7	10.5	9.2
Noise Sensitivity level	**Low**	Observed	47.0	42.0	15.0	10.0	7.0
		Expected	56.9	38.7	11.3	7.5	6.6
	Medium	Observed	57.0	42.0	9.0	7.0	10.0
		Expected	58.8	39.9	11.7	7.8	6.8
	High	Observed	77.0	39.0	12.0	7.0	4.0
		Expected	65.3	44.4	13.0	8.7	7.6

There were 124 participants with low noise sensitivity levels, 127 with medium levels and 143 with high levels ($\bar{x}$=3.96, σ=1.36; levels calculated from mean ±½ standard deviation). A participant's level of noise sensitivity did not differ depending on the soundscape type, anymore than would be expected by chance (χ^2=11.20, p>.05; see Table 3). The personal factors of noise sensitivity and level of soundscape awareness therefore differed in their relationship with the perception of different types of urban park soundscapes. A low, insignificant correlation between soundscape awareness and noise sensitivity (r=.02, p>.05) also highlights the differences between these two variables.

Participants' ratings on the Perceived Restorativeness Soundscape Scale were analysed via a series of factor analyses, resulting in a one factor, nine item scale[12]. The remaining items in the scale consisted of four items to measure Fascination, two for Being-Away-From, one Compatibility, and two for Extent (one Coherence, one Scope). Participants PRSS scores were calculated from factor coefficients and subsequently grouped into three levels of perceived restorativeness, low, medium and high, based on the mean and ±½ standard deviation. There were 55 participants who rated their perceived soundscape as having low levels of perceived restorativeness, 71 who rated their perceived soundscape with medium levels and 68 participants who rated their perceived soundscape as having high levels of perceived restorativeness.

The level of the PRSS factor score significantly differed depending on the perceived soundscape type (χ^2=38.77, p<.000; see Table 4). In particular, participants who perceived the soundscape strongly predominated by Natural sounds (Soundscape Type 2) were more likely to rate it as high in perceived restorativeness and less likely to rate the soundscape as low in perceived restorativeness. In contrast, participants who perceived a soundscape strongly predominated by sounds from the surrounding Buildings and Construction work, as well as Background City/Traffic (Soundscape Type 4) were more likely to rate it as low in perceived restorativeness and less likely to rate the soundscape as high in perceived restorativeness. The perceived restorativeness of the other soundscapes perceived with quite predominant Background City and Traffic sounds (Soundscape Type 3 and 5) followed a similar pattern as Soundscape Type 4 but to a lesser extent. The perceived restorativeness level of the weakly predominated soundscape (Soundscape Type 1), however, did not vary from what would be expected by chance. The evaluation of the soundscape in terms of its perceived restorativeness as rated using the PRSS, was therefore related to the specific type of soundscape perceived; the PRSS significantly differentiated between the perceived restorativeness of different types of urban park soundscapes.

Table 4: Significant differences between the level of the perceived restorativeness of the soundscape and the depicted Soundscape Type.

Soundscape Type	**Count**	**Level of perceived restorativeness of the soundscape (from PRSS Factor score)**			**Total participants**
		Low	**Medium**	**High**	
1	Observed	22.0	36.0	30.0	88
	Expected	24.4	32.7	30.9	
2	Observed	4.0	22.0	29.0	55
	Expected	15.3	20.4	19.3	
3	Observed	8.0	5.0	5.0	18
	Expected	5.0	6.7	6.3	
4	Observed	12.0	3.0	1.0	16
	Expected	4.4	5.9	5.6	
5	Observed	7.0	5.0	2.0	14
	Expected	3.9	5.2	4.9	
Total participants		53	71	67	191

A series of independent *t*-tests were conducted to compare the two urban parks' mean PRSS factor scores for each soundscape type. The PRSS factor score for Soundscape Type 2, 3, 4 and 5 did not vary between parks [$t(53)=.80$, $p>.05$; $t(16)=.17$, $p>.05$; $t(14)=-1.15$, $p>.05$; $t(12)=1.08$, $p>.05$, respectively]; regardless of the park that Soundscape Type 2, 3, 4 and 5 were perceived in, its level of perceived restorativeness was the same. In contrast, the PRSS factor score for Soundscape Type 1 did significantly vary across the two parks [$t(56.27)=2.67$, $p<.01$]. For participants who perceived Soundscape Type 1 (weak predominant Natural and Happy People sounds), those in Weston Park rated it significantly lower in perceived restorativeness ($\bar{x}=.27$, $\sigma=.92$) than participants in Botanical Gardens ($\bar{x}=-.21$, $\sigma=.66$; values were reversed in analysis). Therefore, the stability of the PRSS ratings across the two parks varied, depending on the Soundscape Type being rated.

4 DISCUSSION

Within two urban parks in Sheffield, UK, park visitors' perception of the soundscape could be categorised into five different types of urban park soundscapes. The most frequently perceived soundscape types were those consisting of natural and happy people sounds. These soundscapes were more likely to have higher rating levels of perceived restorativeness. The soundscapes that consisted of predominant background city sounds including background traffic were only perceived by a quarter of the participants. This provides a positive reflection of two urban parks that are located by busy arterial roods and their importance in the provision of restorative environments.

All of the identified types of urban park soundscapes were perceived in both parks. These soundscape types could therefore also relate to the perception of soundscapes in other urban parks. Additional soundscape types will undoubtedly be identified with further studies, when the range of urban park types, locations and cultural settings are extended. Although there were similarities in the soundscape types across the two parks, as expected there were also differences, with visitors to Botanical Gardens perceiving more soundscapes that were strongly predominated by natural and happy people sounds. This is to be hoped for given its park type and fewer adjacent roads. Similarly, as to be expected, the sound of construction work was mostly heard in Weston Park, which was under renovation. Furthermore, the soundscape type strongly predominated by construction work sounds (type 4) was always (bar one time) heard during a weekday rather than at the weekend. These patterns of perception for the different soundscape types support the procedure used to identify urban park soundscape types as perceived by their visitors.

The differences in perceived soundscape types during the week and weekend also highlight the necessity in conducting soundscape surveys across a broad time spectrum. Temporal changes in the sonic environment will occur throughout the week and throughout the day, altering the perceived and evaluated soundscape. Additionally, as well as physical changes in the sonic environment, reasons that people visit an urban park are also likely to vary which in turn could affect their listening mode and subsequent perception of the soundscape. Therefore, as with recommendations for acoustic monitoring[19], a survey at different times, days and seasons is important to ensure the incorporation of the array of temporal elements in the sonic environment and the array of personal elements that can influence soundscape perception.

Participants' soundscape awareness level related to the perception of soundscape types predominated in natural and happy people sounds (type 1 and 2) and those strongly predominated by surrounding building and construction work sounds (type 4). Moreover, the self-reported level of awareness coincided with the separation between soundscape type 1 and 2, whose main differences were the perceived predominance level of the natural and happy people sounds; those more aware reported higher perceived predominance levels of natural and happy people sounds. This suggests that within urban parks (such as these) an awareness of the sounds and soundscape can be a positive attribute, as it is associated with perceiving sounds that are often rated pleasantly (e.g. natural sounds tend to be positively rated and preferred sounds[18]).

In contrast, noise sensitivity was not related to perceiving a particular soundscape type, nor was it related to soundscape awareness. This infers that noise sensitivity and soundscape awareness are

two different concepts, and that soundscape awareness may be an important measure to include in soundscape surveys. Moreover, noise sensitivity scales tend to have been used in indoor residential surveys[11,17] and may not be appropriate indicators for urban open space soundscapes. Instead, awareness of the soundscape may be a more appropriate indicator and could relate to people's listening states. Caution needs to be taken with the current results though, as awareness was only measured using one item.

The level of perceived restorativeness significantly differed with the type of perceived soundscape. In particular the soundscape type strongly predominated by natural and happy people sounds (Type 2) was more likely to be perceived as high in restorativeness, while the soundscape type strongly predominated by building and construction work sounds (Type 4) was more likely to be perceived as low in restorativeness. Although these two soundscapes were most likely to be perceived in different parks (Soundscape Type 2 in Botanical Gardens and Soundscape Type 4 in Weston Park), when the soundscape was perceived in the other park, it received a similar perceived restorativeness rating. This suggests other factors, such as variations in visual stimuli between the two parks, did not have a significant effect on the perceived restorativeness of these soundscapes. This helps support the content validity of the Perceived Restorativeness Soundscape Scale.

In contrast, the perceived restorativeness of the soundscape type which was only weakly predominated by natural and happy people sounds (Type 1) did vary in its ratings between the two parks; it was rated with a greater restorative potential in Botanical Gardens. This soundscape type was also more likely to be perceived by people who reported a low level of awareness of the soundscape. This could mean they then used other cues, such as the visual stimuli to help rate the restorativeness of the soundscape, resulting in the greener, more diverse and larger park (Botanical Gardens) gaining higher ratings. This is because visual stimuli, and the congruency between audio-visual stimuli, influences affective evaluations of sounds[20,21]. This effect of visual stimuli influencing auditory evaluations is likely to be enhanced when an individual feels less confident on their awareness of auditory stimuli, especially as the converse is true; sounds can play a larger role in perception when the visual information is inadequate[22]. The differences in soundscape awareness between soundscape type 1 and 2 would therefore explain why the perceived restorativeness ratings would vary between parks for one soundscape type but not the other similar soundscape.

Different categories of urban park soundscapes varied in perceived restorativeness within an urban park (one place type). This extends previous findings that the perceived restorativeness of soundscapes varies across urban parks, as well as across different environment types (e.g. urban, urban park, rural). As soundscapes can vary in their perceived restorativeness, then they have the potential to contribute or detract from an individual having a psychologically restorative experience. It is therefore important to consider the soundscape when designing places that can provide psychological restoration, such as urban parks. One aspect that can be considered is the layout and design of the park to help prevent the propagation of sounds from the surrounding urban environment. For example, many areas of the studied Botanical Gardens was shielded from direct traffic exposure due to its topography (slightly sunken park and a large berm on one side) and the propagation of traffic sounds was reduced by a pavilion parallel to the main road. In contrast, Weston Park only had a few trees parallel to its adjacent roads, which limited the acoustic and visual protection, and increased the likely perception of soundscape types with lower levels of restorative potential.

Overall, soundscapes should be considered in the development of urban parks to help provide a restorative environment. By enhancing the predominance level of natural sounds, people's awareness of these sounds and encouraging positive human activities (for 'happy people' sounds), the likelihood of the perception of a soundscape rated high in restorativeness increases. In turn, this will subsequently increase the chance of psychological restoration. However, it is also important to maintain an array of different soundscape types, for different types of urban parks, as psychological restoration is not what everyone seeks from an urban park. Moreover, other types of urban parks not included in this study, may have other types of soundscapes with higher (or lower) perceived restorativeness levels. Further research involving different types of urban parks would be able to extend the current findings.

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