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Are perceived soundscapes within urban parks restorative?

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The perceived quality of urban park soundscapes is starting to be explored, and attention restoration research has shown which environments are generally restorative. Yet the effect of perceived soundscapes on individuals' restorative experiences is hardly known. Natural environments, in general, provide restoration for people, including recovery from attentional fatigue and enabling reflection. Therefore the visually 'natural' environment of urban parks provides a useful setting to explore the role of varying soundscapes in restoration. Four hundred park users within Sheffield, UK, were surveyed as they left two urban parks. Data were collected on aspects of their park visit, along with measures of their current perceived restoration. Participants' perceived soundscapes were described by the amount of time they heard certain sound types in the park, and the volume at which they heard them. Sound levels [LAeq, dB(A)] within the parks were also monitored on a number of days to provide contextual information. Results of the study will be discussed along with the importance of soundscape quality and individuals' restorative experiences in helping to provide a productive and positive quality of urban life.

1 Introduction

Perceivers of sounds have often only been considered in terms of how the physical aspects of a sound (sound level, spectral and temporal characteristics) may be affecting their experience of a place, in terms of how much it annoys them. More recently though researchers have been recognising how the everyday perceiver experiences their surrounding soundscapes [1] (Soundscapes is used in this paper, to refer to what the individual hears within a certain place, where as the sonic environment is the combination of sounds that are physically present in a certain place). Additional emotions from hearing environmental sounds are now researched rather than just annoyance, such as 'acoustic comfort' [2], and a variety used in a soundscape quality tool [3]. The context of where the perceiver hears the sound, their attitudes towards the sound sources are also becoming recognised [1]. In general, the perceiver is now regarded as less of a passive object who is subjected to certain sounds, and more of an individual who interprets the soundscape that they hear in accordance to their own preferences, attitudes and the current situation. This paper seeks to add to this growing body of research by exploring the role that soundscapes play in an individual's experience of a certain place – an urban park. The focus is on the individual, what they heard, why they are there, what they did there and how they feel now they are leaving the place, rather than the physical acoustic aspects of the sonic environment. This approach will highlight the role the perceiver plays in the interpretation of a place's sonic environment, and the role this plays in having a restorative experience.

Attention Restoration Theory (ART) [4] refers to an individuals need to restore from 'directed attentional fatigue'. This can arise when an individual has been focusing on one specific task for a length of time, so they are now becoming tired, and are more likely to make mistakes as they have drained certain cognitive resources. Attention restoration contains two components, recovery and reflection [5]. Recovery involves resting the fatigued cognitions potentially by switching to involuntary attention, which involves undirected attention. Reflection allows the individual to think over any issues or problems, from a different approach. Together positive benefits have been shown to arise from restorative experiences, both in terms of economics [6], physical and mental health [7]. Therefore restorative experiences are important contributors to achieving a good quality of life.

Natural environments in general provide more of a restorative experience than built up urban environments [8]. Views of nature alone have also been shown to provide positive health benefits [7] and cognitive benefits in terms of effective functioning and attention [9]. If these benefits can be gained from visual aspects alone, what part does soundscapes therefore play in providing a restorative experience? Most ART research has been carried out by contrasting images of green vegetation versus grey buildings, with very few studies incorporating any acoustics. Yet if participants are shown images of a natural environment and then presented with its real audio clip, consisting of motorway traffic sounds from behind the hill, the individuals' preference rating for the place decreases [10]. In such situations it is expected that the restorative experience will also decrease.

This paper is focusing on urban parks, as they provide the visual aspects of a natural environment, yet the sonic environment may additionally consist of sounds from the surrounding built environment. Hearing 'urban' sounds while in the visually 'natural' environment of an urban park is not necessarily incongruent with the users' expectations, but it is not known if this would affect the individual's restorative experience. Research into urban park soundscapes has shown how park users' perception of the soundscapes can vary throughout different sections of a large park [11]. A comparison of park users perceptions of the soundscape quality in urban and suburban parks concluded that its traffic noise exposure needed to be below 50 dB(A) for people to perceive a good soundscape quality [12]. The current paper adds to this growing body of research by starting to explore the specific role of perceived soundscapes in providing a restorative experience within urban parks.

2 Method

Two urban parks within Sheffield were chosen as case studies. One was a Botanical Garden that covered 6.93 hectares, while the other was called Weston Park, and covered 4.82 hectares. Both parks were located under a mile from the city centre and were located next to Universities, hospitals, schools, and residential housing. Both were flanked by busy roads down one side of the park. They had similar ratios of natural to artificial covering (80:20), and singing bird species (6 and 5 different types). The Botanical Gardens had a higher percentage of amenity planting, while Weston Park had a higher percentage of amenity turf, but they had a similar amount of tree canopy and water areas [13]. During the study Weston Park was

currently undergoing its own restoration project, which meant there were a number of workers and large mechanical equipment and vehicles in the park during the week. The Botanical Gardens also had their own park vehicles that were driven throughout the park along with the use of large lawn mowers.

2.1 Sound pressure levels

In July and August 2007, the sound levels in 8 or 9 locations throughout the two parks were monitored for 7 days (4 days in Weston Park), between 10am and 7pm. Due to limited resources, the sound level was manually noted every 10 seconds in one location, for 5 minutes, before moving to the next location in the park and repeating this process there. This process took around an hour, and was then carried out again one hour later; five hours of sound level was monitored each day. Sound pressure levels [dB(A)] were measured on a Tenma 72-860 sound level meter which was attached to a camera stand, making the microphone 130cm high. Results were averaged for each hour in each location to provide an average weekday and weekend hourly sound level measurement for each location.

2.2 Procedure and sample

Throughout July to early September 2007, and between the hours of 10am until 7pm, the researcher stood at the various exits within the two parks. Every park user leaving the park was approached and asked if they could help with a questionnaire about their experience of the park. The response rate was 49:51, and the questionnaire lasted between 5 and 20 minutes. In each park 200 participants answered the questionnaire with 63% of those being questioned on a weekday. Five participants responses were removed due to missing data (n=395). Sound pressure levels were also periodically measured throughout the day, along with noting the location and time of day the participant was questioned. Responses to any open ended questions were content analysed to form categories, and the data was recoded as dichotomous variables as to whether the individual had mentioned that category (variable) or not. The coding was carried out by two people and appropriate inter-rater reliabilities were achieved ($.9< \kappa <.92$).

2.3 Perceived soundscapes

Participants were presented with a list of seven types of sounds, each with some examples; *Background City (e.g. background traffic)*, *Happy People sounds*, *Sounds from the Surrounding Buildings (e.g. construction work)*, *Natural sounds*, *Object sounds due to people in the park*, *Individual Vehicle or Aircraft sounds*, *Sad and Angry People sounds*. These had been developed from urban park users' classification of urban park sounds [14]. Next to each sound type was a line marked from 0% (didn't hear), to 50% (half of the time) to 100% (all of the time). Participants were asked to '*make a mark on the line which represents how much of the time you heard these types of sounds today*' while in the park. Then for each sound type they had heard they were asked to rate the '*average volume'* they had heard the sound type, on a 7 point semantic differential scale ranging from *quiet*(1) to *loud*(7).

A sound predominance value was generated by multiplying the two scores of each sound type together. For example if a participant perceived hearing the Background City for 70% of their duration in the park, at a perceived volume level of 3, the predominance value for the sound type would be 210. Sound predominance values ranged from 0 to 700.

Two singular 7 point semantic differential scale items were used to assess how expected the sounds were that the participants heard and how aware they thought they were of the sounds in the park; '*The sounds I heard today in the park were expected/ unexpected*' and '*I was aware of the sounds around me a little/ a lot*'.

Participants sensitivity to noise was also measured by three items on 7 point semantic differential scales, '*Noises get on my nerves and get me irritated none of the time/ all the time*', '*I'm good at concentrating no matter what is going on around me*', (*disagree* to *agree* -reverse coded) and '*I am sensitive to noise*' (*disagree* to *agree*). These were based on Weinstein's Noise Sensitivity Scale [15] and these three items provided a fairly reliable scale (α=.6).

2.4 Perceived restoration

Participants perceived restoration were evaluated by 8 items on which they rated how much they had been able to do them on a 7 point semantic differential scale from disagree to agree. These items were based upon those used by Staats, Kieviet and Hartig [16]. There were four items for recovery which were 'r*enew your energy*', '*regain the ability to concentrate*', '*reduce any tension*' and '*become your self again*', and four reflection items, '*ponder over your daily experiences*', '*think about your relationships with others*', '*think about important issues*' and '*see things in a new perspective*'. The item 'become your self again' was later excluded due to the large amount of missing data. Together, the remaining seven items created a reliable scale for attention restoration (α=.76).

Participants were also asked about other aspects of their park experience; *whether they were with anyone*, *what activities they did there*, and *how long they spent in the park*. Along with noting the participants' *gender*, other questions about themselves were also asked; their *age* (*<17*, *18-24*, *25-34*, *35-44*, *45-54*, *55-64*, *>65*), *how often they visit the park* (*4 plus days a week*, *2-3 days a week*, *weekly*, *fortnightly*, *monthly*, *rarely*), their *reason for coming to the park*, how much they consider themselves a *country or urban type of person* on a 7 point semantic differential scale (based on Knez [17]), and if they had any *hearing problems*. Some of the reasons why they visited the park and the activities they did when they were there had moderate correlations ($r \approx .4$). To avoid multicollinearity these were combined to form separate factors, which were each fairly reliable scales (α<.6).

3 Results

The participants aged from 15 years old to at least 76 years old, with an average age of 35 to 44 years old. There was practically a 50:50 split of female and male participants. There were no significant differences between the two

parks in terms of participants age or gender (χ^2=11.05, 1.31, p>.05 respectively. Participants however were more likely to be by themselves in Weston Park than in Botanical Gardens (χ^2=6.09, p<.05). Participants also significantly varied in how long they had been within the parks (χ^2=43.08, p<.001); people stayed longer in Botanical Gardens than in Weston Park, in particular when staying there for over an hour. In contrast more people only briefly stayed in Weston Park, (under 10 minutes) compared to those in the Botanical Gardens.

3.1 Sound pressure levels

The average sound pressure levels heard throughout the parks were slightly quieter in Botanical Gardens [50.2 dB(A), ranging from 42.2 to 60 dB(A)] than they were in Weston Park [53.1 dB(A), ranging from 47.2 to 63.9 dB(A)]. Sound levels varied more across locations within the Botanical Gardens [average 13.8 dB(A) difference] than due to time or a weekday/weekend [average 4.9 dB(A) change]. A similar result occurred within Weston Park, but to a lesser extent, with an average 11.3 dB(A) difference across locations and an average 7 dB(A) change due to time or week/end. This was due to two locations having large differences across the week and weekend, most likely due to the presence of construction work in Weston Park in the week. On average the noisiest location for each park was at the exit adjacent to the busiest road. The average quietest location wasn't in the middle of each park, as may have been expected, but were to one side in the more secluded, less frequently used areas.

3.2 Perceived sound types, volumes and sound predominance.

The Background City, Happy People, Surrounding Buildings and Construction work, Natural, Individual vehicle/Aircraft, and Objects in the park sounds, were heard by participants between 0 to 100% of the time. Sad and Angry People sounds were never heard more than half of the time spent in the park. Participants also ranged in perceiving the volume of the seven sound types from quiet (1) to loud (7). Good correlations existed between the amount of time a participant heard a sound type and its perceived volume (.26 < r < .65). In general the longer the time period a sound type was heard for, the louder the perceived sound type. Most people heard Natural sounds (n=370) and Happy people sounds (n=369), and they were heard on average for 70 and 60% of the time of the participants' visit. Background City sounds were heard by 310 participants, although they were only heard on average for 30% of the time. The other sound types were heard by fewer people and for 30% or less of the participants' duration in the park. The mean perceived volume of the sound types was at a quiet to medium sound level (3 - 4).

The most predominant sound types (percentage of time it was perceived as being heard for, multiplied by its perceived volume) in the two parks, as perceived by the park users, were Natural and Happy People sounds (median value 200 - 270). In Weston Park the Background City sounds were also fairly predominant, (120), in contrast to the Botanical Gardens (20), due to them never reaching a high predominance level in the latter (maximum = 480, compared to 700). All the other sound types had a median predominance value of 0, due to the large number of people who didn't hear them. Object sounds though had a low median predominance value (20) in the Botanical Gardens.

3.3 Perceived attention restoration

On average participants only perceived themselves as being slightly restored when leaving the park (mean = 4.48). There was no significant difference between the perceived level of attention restoration for participants in Botanical Gardens and those in Weston Park, t (388) = -.42, p>.05.

A factorial analysis of variance, calculating only the main effects of each independent variable was used to assess which factors were significant in explaining the participants perceived levels of restoration. Firstly all the contextual factors (*Park*, *Time questioned*, *Weekday or weekend*), personal aspects [*Gender*, *Age*, *Country/Urban person*, *how often they visit*, *how familiar they are with the park,* Reasons for coming (*relax and take a break*, *socialise*, *indirect route*, *to do some form of cognitive activity*, *due to the weather or the sounds*, as they *made a positive comment about the park*)], their experience [*With Anyone*, *how Long they were there*, Activities carried out (*relaxed*, *interacted with nature*, *socialised including looking after children*, *some form of cognitive activity*)] and the created Activity/Reason factors (*Be in the Park and be Active*, *See the Park*, *have Food and/or Drink*) were entered. The factors that had the most insignificant loading on the dependant variable, perceived restoration, was removed. This process was continually repeated until only significant variables remained, (Gender was kept in at the end even though it was insignificant as removing it, greatly reduced the explained variance). Results indicated that making a positive comment about the park, wanting to carry out some form of cognitive activity (two reasons for coming to the park) interacting with nature while in the park (an activity), having planned to and/or actually having food and/or drink in the park, the frequency they visit the park, and their gender significantly explains 10% of the variance in participants' perceived restoration levels, with small to medium effect sizes (.14< eta<.25). [The ANOVA table can not be reproduced here unfortunately due to space, but is fairly similar to that of Table 1].

The factorial ANOVA and the process carried out above was repeated again, this time with the inclusion of the four additional items about the perception of sounds; their *awareness level*, the *expectation level of hearing those sounds*, their *noise sensitivity level*, and if they have any *hearing problems*. The same five variables as in the prior ANOVA remained significant, (Positive Comment, to do a Cognitive Activity, Interacting with Nature, having Food/Drink, Frequency of Visiting), along with the inclusion of Gender, as well as the participants Awareness level of the soundscape and if they had any Hearing problems. Together these explained, 15% of the variance with very small to medium effect sizes (.09<eta<.23, see Table 1). Each variable besides from hearing problems had a positive relationship with the perceived levels of restoration; participants who had gone to the park for those reasons or carried out those activities, frequently visited an urban park, reported higher perceived levels of awareness of the soundscape and had no hearing problems, the higher their perceived level of restoration.

Personal and Park Experience Variables		df	F	Significance	Partial Eta Squared
	Corrected Model	18	4.288	0.000**	0.196
	Intercept	1	411.109	0.000**	0.565
Reason they came to the park	Positive Comment made about the park	1	9.691	0.002**	0.030
	To do some type of cognitive activity, e.g. reading	1	4.645	0.032*	0.014
Activity they did	Interacted with nature	1	10.388	0.001**	0.032
Reason/Activity	Planned to and/or had food and/or drink	2	3.762	0.024*	0.023
Person	Frequency they visit urban parks	5	3.670	0.003**	0.055
	Gender	1	2.506	0.114	0.008
Sound related	Perceived level of Awareness of the sounds	6	3.081	0.006**	0.055
	Any Hearing Problems	1	8.746	0.003**	0.027
	Error	316			

Table 1. Factorial analysis of variance for a participants' perceived restorative level as a function of their personal and park experience variables. *= p<.05 **=p<.01

4 Discussion

Urban park users' soundscape perception has a significant role, in their restorative experience of an urban park. These results should be taken tentatively though due to some problems described further below. However they provide a good starting point and raise further questions about perceived soundscapes.

The two urban parks had fairly similar recorded sound levels, with Botanical Gardens being slightly quieter. Sound levels, were loudest at locations closest to the surrounding roads, but did not always decrease as distance into the park increased. This is likely due to the volume levels being generated by the other sound types within the urban parks, including Happy People sounds, and a few vehicles being used in the park itself. This hypothesis is supported by the higher perceived predominance value of the Background City and its traffic in Weston Park compared to in the Botanical Gardens, despite the little difference in their average measured sound levels. The participants also perceived the seven sound types at a variety of volume levels, highlighting, that Natural and Happy People sounds are not necessarily always quiet.

The publics own perceptions of sound levels have been shown to correlate well with measured sound levels [2]. This research showed another positive relationship between how long the sound type was heard for and the average volume it was perceived at. It is not known if the participants' perception of the sound types was accurate, or if they thought that because they had heard a particular sound type for the duration of their visit it was likely to be fairly loud. Natural sounds and Happy People sounds were heard on average for the longest time period suggesting they weren't masked out by the sounds from the surrounding buildings, traffic or aircraft (which actually flew over (quietly) nearly every 5 minutes in one location). Again it is unclear if the participants actually heard these sounds types for that length of time, or whether the expectation of hearing such sounds in urban parks influenced their responses to the questionnaire. In general these two parks, although being surrounded by busy roads and included park warden vehicles or construction machinery due to the park's renovation, were perceived as being predominated by Happy People sounds and Natural sounds.

Although a large number of variables were ascertained from the park users, only a few of these played a significant role in creating a restorative experience. Interestingly none of the contextual factors influenced their perceived restorative level, yet the frequency with which they visit urban parks significantly increased their restorative level. Either people who have discovered the restorative nature of parks frequently revisit them, or the frequent visitors have a different interaction with the place to infrequent visitors, or they report that their experience has been restorative to provide a valid worth for their frequent visits. The supporting literature on ART would suggest the latter reason would not be true, however the restorative measures used in this study are only the parks perceived restorative level and the actual attention restoration achieved from the visit is not know.

Once questions relating to the participants experience of the soundscape were included into the analysis five percent more of the variance in the perceived restorative level was explained. Participants who had hearing problems (e.g. tinnitus, needing hearing aids) had reported a lower restorative level than those without any problems. The significance of this variable alone suggests the importance that the perceived soundscape can have on providing a restorative experience. The significant predictor of the level of awareness the participants felt they had of the soundscape, also highlights the importance of the individual perceiver in the experience of the soundscape, rather than just the physical aspects that make up the sonic environment. Regardless of what wonderful sounds may be designed into or removed from the sonic environment, they may not have an effect on the laypersons experience of the place, if they are not aware, or paying attention to their surrounding soundscape. Of course, awareness level

probably only varies between individuals when the sound level is below a certain threshold as was the case with acoustic comfort, as it became related with sound levels over 70dB [2]; these two urban parks tended to be below 70dB(A).

Certain reasons for coming to the park and the activities carried out in the park were also significant in predicting the levels of perceived restoration achieved. This supports the literature [18] that the experience that is had in a place is just as important as the presence of certain physical aspects in making a place restorative to the individual. The activities that an individual carry out have also been shown to influence the perception of sounds and preference ratings towards them [19]. These relationships are most likely linked to the individuals perceived awareness level of the soundscape as well.

Caution should be taken with these results however, as due to the large number of variables that were included in the design, only main effects could be studied. This meant that potential interactions between the variables and indirect relationships some variables may have with perceived restoration levels can not be observed. This in part may explain the low level of variance that was actually explained. Also as there are some differences between the two parks especially in terms of the visual natural features, it may also be suitable to carry out analysis on the two parks data separately. This could potentially highlight the different important aspects of a place that provide its unique restorative experience, in two differently purpose-designed urban parks. The latter would help planners in arguing for a variety of different parks throughout a city, each providing different aspects, and potentially different soundscapes.

5 Conclusion

This study has shown the role that the perceived soundscape can play in providing a restorative experience within urban parks. In particular the individual as an active perceiver of the soundscape and their interaction with the place are important aspects when considering the sound quality of an environment and its affect it may have on providing a positive, restorative experience to aid urbanites quality of life.

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