Are urban park soundscapes restorative or annoying?

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Summary

Urban parks play an important role in creating healthy and sustainable cities for urban dwellers. They provide opportunities to interact with nature and visually the perceiver can feel like they are immersed in a different world to the city. Therefore, urban parks can be restorative environments allowing people to recover from any directed attentional fatigue. Opportunities to restore are important for people to avoid prolonged fatigue, stress, and potentially, symptoms of burnout. However, acoustically, urban parks can also be filled with the sounds from the surrounding city which may be less restorative than natural sounds. Using a virtual reality laboratory, this study assesses the perceived restorativeness and noise annoyance of two urban park soundscapes. Eighty-three participants viewed a video whereby 'they' walked along a street and into an urban park. They rested there for a few minutes before walking back out of the park. This video was either accompanied by no sound, or one of two created soundscapes containing natural sounds and traffic. Participants evaluated their experience in terms of the perceived restorativeness of the environment/soundscape and where appropriate, noise annoyance. This paper will discuss the outcome of these results and the relationship between the two concepts of restoration and annoyance.

PACS no. 43.66, 43.50

1. Introduction

Noise is unwanted sound and there has been much research showing the negative health effects of noise [1]. The positive health impact of wanted sounds however is comparatively underexplored. One project entitled the 'Positive Soundscapes Project' took a technical and artistic approach to explore people's perception of sounds in urban environments [2]. But this did not directly explore any health benefits. Another project explored positive health benefits of urban park soundscape by assessing their restorative value [3]. This paper aims to build on these two contrasting approaches of studying negative *or* positive health effects by examining both the annoyance *and* restorativeness of urban park soundscapes.

The negative impact of noise annoyance on health, including stress has been examined for many years [4, 5]. In outdoor urban areas, including city parks in particular, noise annoyance has been explained in part by sound levels but also the types of sounds perceived.

Psychological restoration is important for people to avoid prolonged fatigue, stress, and potentially symptoms of burnout. Visually, urban parks can be restorative environments allowing people to recover from mental fatigue [6]. However, acoustically, urban parks can be filled with sounds from the surrounding city, such as traffic, as well as

natural sounds of birds. The sound level may also vary, thus sound levels and perceived sound sources may affect the restorativeness of a soundscape. By creating urban park soundscapes with different sound levels and sound sources quantities, the relationship between annoyance and restoration can be explored.

2. Aim

The aim of this study was to examine the relationship between the restorativeness and annoyance of urban park soundscapes. The objective was to examine differences in the perceived restorativeness and annoyance of soundscapes experienced in a virtual reality laboratory.

3. Method

This study used an independent samples design to avoid participant strain as each condition took 10 minutes. There were three conditions which varied in terms of the audio stimuli presented, no sound condition, quiet sound condition and loud sound condition (see section 3.3).

3.1. Participants

In total, 83 people participated in the study. The median age of participants was 22 years and 72% were female. All participants, except for six, were first year landscape architect or landscape engineer students. Nineteen participants completed the no sound condition, 32 participants completed the quiet sound condition, and 32 participants completed the loud sound condition.

3.2. Setting

The experiment was conducted in a virtual reality laboratory at the Norwegian University of Life Sciences. This consisted of 29 seats, in three rows on different levels, facing a 180 degree curved screen. Computer images were projected onto the central portion of the screen. The lights were dimmed, so that most light came from the visual stimuli on the screen, but bright enough for participants to complete questionnaires. The room is sealed and has some acoustic dampening, so few external sounds are audible. Above the screen were three speakers (left, centre, and right) which played the audio stimuli.

3.3. Stimuli

The visual stimuli was a 9 minute continuous film of a virtual pocket park environment from the perspective of a person walking along or sitting down within this environment. To begin with the visuals simulate the viewer walking up a side road, passing parked cars, and a bus stop. They then turn into an adjacent urban park which they survey before sitting down on a bench in one side of the park. The visuals then remain with this inward perspective of the park for several minutes, whilst birds fly overhead and a couple of people talking are visible in the far distance (Figure 1). Next, the viewer stands up and walks out of the park to another adjacent side road (Figure 2) before turning back around to view inside the park again.

Figure 1. Participants experiencing the virtual urban park; the scene as they complete the PRS & PRSS.

Figure 2. Participants experiencing the virtual urban park; the scene after walking out of the park.

There were three audio stimuli conditions. The first condition was the reference, and included no sound stimuli. The second condition was the ‘quiet condition’. This consisted of sounds of occasional seagulls and a few passing cars and a bus. For the majority of the time, the sound level ranged between 38 to 45dB(A), although there were three louder peaks above this, one reaching 62dB(A).

The third condition was the 'loud condition'. This consisted of sounds of many seagulls and a constant stream of passing traffic. For the majority of the time, the sound level ranged between 44 and 53dB(A), although there were two louder peaks above 53, one reaching 58dB(A).

3.4. Measures

A number of measures were taken, percieved restorativeness, percieved soundscape restorativeness, and noise annoyance.

3.4.1. Perceived restorativeness

Thirteen items from an established Perceived Restorativeness Scale (PRS) [7] were used to measure how much people thought they could restore whilst in the park. Six items assessed the component Fascination (e.g. *This place is fascinating*), six items assessed the component Being-Away (e.g. *This place gives a refuge from unwanted distractions*), and one item assessed the component Extent – Scope (*This places has the quality of being a whole world in itself*).

All the items were measured on an 11 point scale scale from *Do not agree at all* (1) to *Completely agree* (11).

3.4.2. Perceived soundscape restorativeness

Three items from a tested Perceived Restorativeness Soundscape Scale (PRSS) [3] were used to measure how much people thought they could restore whilst hearing the soundscape in the park. These items measured the same Fascination, Being-Away and Scope components as the PRS and were similarly worded (e.g. *This soundscape is fascinating*).

All the items were measured on an 11 point scale scale from *Do not agree at all* (1) to *Completely agree* (11).

3.4.3. Noise annoyance

The standardized noise annoyance question [8] was used to measure how much people thought they were annoyed by the soundscape in the park. This item was also measured on an 11 point scale scale from *Not at all annoyed* (1) to *Extremely annoyed* (11).

3.5. Procedure

Participants were informed that this was a study about how they experienced the park. Consent forms were completed whilst in the virtual laboratory. The visual film then commenced with either the no sound, quiet, or loud sound condition. At the point when the film was showing the perspective as if the viewer was sat in the park, the participants could complete Part 1 of the questionnaire. This consisted of the PRS items, the PRSS items, and the noise annoyance item. When the film reached the point where the viewer was stood by the road looking back into the park, Parts 2 and 3 were completed. These consisted of the IPQ items, sound spatial quality items, and participant demographics. For those in the no sound condition (and some of the loud sound condition), they did not have the PRSS items or the sound spatial quality items.

Practically all participants had completed the questionnaire by the time the film finished. They were then debriefed and thanked for their time. The whole process took around 20 minutes.

3.6. Analysis

Analysis for items that assess experience of the environment in general (PRS and IPQ) is calculated from all participant data (n=83). Analysis for items that assess experience of the soundscape in particular (PRSS and sound spatial quality) is calculated from participant data from the quiet (n=32) and loud (n=20) sound condition.

4. Results

The PRS items formed a reliable scale (α=.91) as did the PRSS items (α=.84). The PRSS items did not form a reliable scale if the noise annoyance item was included (α=.56). This suggests that the brief PRSS is measuring something different to the standardized noise annoyance item. Furthermore there was no correlation between the brief PRSS and noise annoyance r=-.17, p=.11, thus confirming the lack of a systematic relationship between these two measuring tools.

Perceived Restorativeness varied slightly across the different conditions. The no sound condition had the highest perceived restorativeness ($\bar{x}$= 6.39) followed by the loud sound condition ($\bar{x}$=5.70) and then the quiet sound condition ($\bar{x}$=5.94). However a one way ANOVA with a quadratic function, showed these were not significant differences F(82,1)=1.44, p=.23.

Perceived Restorativeness of the Soundscape hardly varied across the two sound conditions. The quiet sound condition had a very slightly higher perceived soundscape restorativeness ($\bar{x}$=5.99) compared to the loud sound condition ($\bar{x}$=5.77). A one way ANOVA confirmed these were not significant differences F(51,1)=.12, p=.74.

Noise annoyance of the two sound conditions varied as the quiet sound condition was rated less annoying ($\overline{x}$=3.41) than the loud sound condition ($\overline{x}$=5.95). The quiet sound condition was significantly less annoying than the loud sound condition $F(51,1)=14.29$, $p<.001$.

5. Discussion

The virtual environment film of walking into an urban park, sitting there for a few minutes, before walking out of the park was considered moderate in its perceived restorativeness. This perceived restorativeness rating was regardless of the soundscape condition (none, quiet, or louder). Additionally the perceived restorativeness of the soundscape was considered moderate regardless of if they heard the quieter less busy soundscape than the louder, busier, soundscape. However, the quieter soundscape was less annoying ('slightly annoying') compared to the moderately annoying, louder, busier, soundscape. Simply put, perceived restorativeness and noise annoyance did not have a linear relationship.

Despite previous research showing that urban park soundscapes can vary in perceived restorativeness [9] and can impact on peoples' perceived restoration [10], this research did not support this relationship. There are a number of reasons for these potential differences.

Firstly, the two sound stimuli used in this experiment were fairly similar, varying only in the quantity of birds and traffic sound sources and sound level. This contrasts to the real world studies were a complex multitude of sound sources were rated in terms of perceived restorativeness [9]. The dissimilarity between the sound stimuli may therefore have been too subtle to have an effect on perceived restorativeness which may need larger soundscape variations to have an impact on the perceiver.

Secondly, attitudes towards these sound sources and therefore the soundscape would not have varied greatly as the same sound sources were present in the two soundscape stimuli. Attitudes towards sound sources may affect restoration as attitudes towards sound sources affect noise annoyance [11]. Therefore, the conceptualization of sound sources rather than just the perception of sound sources may have an important role in perceived restorativeness.

Noise annoyance however, unlike perceived restorativeness, was shown to vary between these two sound stimuli. Noise annoyance in urban areas is also related to sound levels [12] and this could also explain the 'louder' sound stimuli being rated as more annoying. Thus, it is unclear whether the attitudes towards the more 'sqwarky' birds and 'stream of traffic' in the 'louder' sound stimuli caused the increased noise annoyance or if it was the louder sound level.

Thirdly, this research was conducted in a virtual environment, whilst others have examined soundscapes and restoration in the real world [10], or examining restoration [13] or urban parks [14] in relation to one set of sensory stimuli only. Virtual laboratory environments are often evaluated in terms of the feelings of 'presence' that they provide [15]. This helps show how immersed in the virtual world the participants felt, with greater presence likely to provide similar responses to those in real world environments. Similarly, the spatial audio reproduction is important for recreating soundscapes that are considered similar to real world soundscapes [16]. Comparing evaluations of presence and spatial quality of the sound stimuli in each of the experimental conditions may determine if participants were perceiving, and therefore responding, to the stimuli in a similar manner as they would in a real world pocket park. By ensuring the virtual laboratory feels 'real', results will be more generalizable to real world experiences and may therefore produce perceived soundscape restorativeness results similar to those found in non-virtual reality studies.

6. Conclusion

Whilst noise annoyance can increase with louder soundscapes containing more of the same sound source and of a reduced quality, perceived restorativeness does not necessarily decrease. Designing soundscapes to be less annoying and therefore reducing the negative impact on an individual's health and quality of life does not mean that the soundscape will in turn become restorative and improve the individual's health. The lowering of sound levels, the improvement of sources' sound quality and quantity will not necessarily have a positive impact on an individual. Designing soundscapes is a more complex process which involves a consideration of the intended aim and desirable effect on people's quality of life, be that the removal of negative emotions or the creation of positive experiences. If virtual reality laboratories are to be used as a tool to aid designing soundscapes and general environment experiences, then feelings of presence need to be assessed to ensure results are generalizable to real world experiences.

Acknowledgement

This project was supported by a Visiting Scholarship funding from the Norwegian University of Life Sciences.

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