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Producing a scale to measure the restorativeness of urban park soundscapes

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ABSTRACT

Attention Restoration is an important component for the enhancement of people's well being. Natural environments tend to provide a more restorative experience than urban environments, thus it is important for urban residents and workers to have access to natural elements. Urban parks offer a visual respite from the built environment, yet part of the soundscape will still be associated with 'urban' elements. A Perceived Restorativeness Soundscape Scale has been developed which is able to differentiate between broadly different types of soundscapes (urban, urban parks, and rural). This tool has also been effective at differentiating between the restorativeness of different types of urban park soundscapes. The development and testing of this tool will be reviewed, before discussing planned work to improve the tool and compare the restorativeness of urban park soundscapes in Montreal, Canada, with those of Sheffield, U.K.

1. INTRODUCTION

Psychological restoration is an important component for the enhancement of people's well being, When individuals are attentionally fatigued they are likely to make more errors, have reduced productivity levels and incur stress[1,2], resulting in time off work owing to poor health. Attention Restoration Theory (ART[1,2]) lists four components as important in producing restorative environments: Fascination (use of involuntary, effortless, attention), Being-Away (a physical or cognitive relocation of ones self from everyday activities), Compatibility (a match between the individual's desired activity/behaviour and the environment) and Extent (the scope and connectedness of the environment). In general, natural environments have higher levels of each of the four ART components than urban environments[2,3]. Urban parks contain many natural elements, implying they are also likely to have higher levels of ART components than the urban

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environment. Urban parks therefore provide the opportunity of a restorative environment for people living and working in cities. Although much research has shown the restorative importance of natural environments compared to urban environments, little research has noted the potential effect of soundscapes enhancement or detraction of a restorative experience. To aid future assessments of soundscapes contribution to individuals' restorative experiences, this paper outlines a series of studies designed to develop a scale to measure the perceived restorativeness of soundscapes.

2. STUDY ONE

The first study aimed to develop a Perceived Restorativeness Soundscape Scale capable of differentiating between types of environments' soundscapes (e.g. urban, urban park and rural). Existing perceived restorativeness scales conducted *in situ* measure the restorativeness of the environment in general[3], thereby ratings are potentially made in reference to people's visual and acoustic perception of the environment. Therefore, similar contrasting levels of perceived restorativeness for urban (low) and rural (high) environments are expected for a Perceived Restorativeness Soundscape Scale (PRSS); an urban soundscape is perceived as less restorative than an urban park soundscape, which is perceived as less restorative than a rural soundscape. The success of the PRSS in producing these contrasting results was tested under experimental conditions.

A. Method

A number of videos were made of walks taken through different types of environments during dry sunny lunchtimes in spring, using a mini DV camcorder (Panasonic, NV-DS28) with an external 90 degree configuration XY stereo microphone (Røde, NT4) and windshield. From these, three 2.5 minute, continuous streaming video recordings were chosen for each environment and edited to create audio-visual recordings and separate identical audio recordings[4]. These were of walks through an urban (Sheffield, UK, city centre), urban park (Sheffield, UK, Endcliffe park) and rural (area in the Peak District National Park, UK) environment. An example image from each environments walked route is presented in Figure 1.

The recording of the urban soundscape consisted of a general hum of constant indistinguishable sounds, vehicle related sounds (engines, horns, mechanical braking), snippets of people's conversations, people walking (footsteps), construction work (banging and drilling) and one brief moment in time of relative calmness, owing to wind on the microphone. The urban park soundscape consisted of a general hum of moving water from the stream, other natural sounds (gushing waterfall, birds twittering, ducks quacking), some construction work (banging from nearby site), and quiet snippets of people's conversations. The whole soundscape was generally quieter than the soundscape in the urban video. The rural soundscape consisted of a general indistinguishable quiet background level, natural sounds (birds twittering in the trees, some wind, running water from a stream), the researcher's footsteps (in the soggy grass underfoot, in the leaves and on rocks), a passer by saying hello and a gatepost being shut. The soundscape seemed fairly quiet, but with the sound of the ever present nearby stream, it was at a similar sound level to the urban park soundscape.

The three videos were presented to a convenience sample of 1st year Town and Planning, and 1st and 2nd year Architecture students at the University of Manchester, UK. In total, 123 participants took part in the experiment, aged between 17 and 25 years ($\bar{x}$=19 years), where 52%

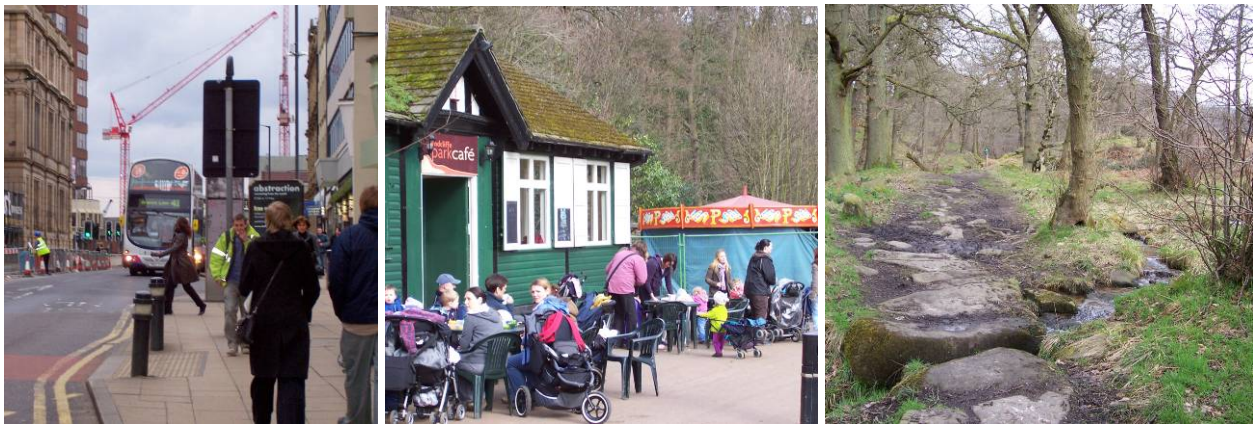

Figure 1: Example images from the urban (left), urban park (centre) and rural (right) environments' videos.

were female. The videos were presented on two different audio-visual reproduction systems, due to students' availability. One condition involved a 28" colour television with additional Yamaha Powered multimedia speakers (model YST-MS28), including 2 satellite speakers and a subwoofer, producing a 25 watt output. Condition 2 and 3 had its own integral audio-visual reproduction system, consisting of a large projection screen (2.5m x2.5m) and two Ohm public address speakers in the top left and right hand corner of the theatre. The presentation order of the videos varied across the three groups to control for order effects.

Participants were asked, "*to imagine yourself in each of these environments. Imagine you are the person who is walking through and experiencing the environment. In particular I would like you to* ***listen*** *to the sounds around you*". When the audio-visual playback had finished, the identical audio recording was played while participants rated the soundscape using the Perceived Restorativeness Soundscape Scale and sound quality items described below. The procedure was repeated two more times for the other two environments.

Nineteen items from perceived restorativeness scales of environments in general[5,6] were adapted to be sound specific. Five items were for the ART component Fascination (e.g. *My attention is drawn to many of the interesting sounds here***),** three for Being-Away-To (e.g. *This is a different sonic environment to what I usually hear*), three for Being-Away-From (e.g. *This sonic environment is a refuge from unwanted distractions*), four for Compatibility (e.g. *These sounds relate to activities I like to do*) and four for Extent (three for Coherence, e.g. *All the sounds merge to form a coherent sonic environment*, one for Scope, e.g. *The sonic environment suggests the size of this place is limitless*). Items were measured on a seven point scale in response to '*how much do you agree with the statement…?' not at all* (0), *very little* (1), *a little* (2), *somewhat* (3), *a fair bit* (4), *very much* (5), *completely* (6). These were recoded in analysis to range from 1= low restorativeness to 7 = high restorativeness.

Owing to participants listening to the audio recordings under different experimental conditions, participants rated the sound quality of the presented audio recordings to ensure this did not influence results. Sound quality was measured by presence (*the audio clip produced a sense of realism; that of being 'inside' the place rather than 'outside' of it*), envelopment (*the sounds seemingly wrapped around me, rather than coming from one location*) and depth (*the array of sounds seemed to be coming from many different distances from me*). All items were rated using the same seven point scale of *not at all* (0) to *completely* (6) agreeing with the statement. Items were inspired by existing items and discussions used for testing spatial qualities of audio reproduction systems[7,8].

B. Results

Three MANOVAs (Multivariate Analysis of Variance) were conducted, one for each environment, assessing if participants' perceived sound quality items varied depending on their experimental condition. The perceived sound quality of the urban, urban park and rural audio recordings did not significantly differ across experimental conditions (Wilks' λ=.90, .98 and .96, $p>.05$, respectively). Generally, participants' perceived sound quality of the urban, urban park and rural audio recordings was very good ($\bar{x}$=4.86, σ=1.33; $\bar{x}$=4.81, σ=1.11; median=5, respectively).

A series of analyses were conducted to assess the relationship between the PRSS items and theoretical FACE components, and determine the most appropriate factor structure for the developed PRSS items. The series of analyses replicated the procedure used for developing a perceived restorativeness scale[6] and relates to general scale development processes[9]. First, individual items' ability in measuring only one FACE component was evaluated by inspecting preliminary Principal Axis Analysis' factor loadings (PAA). Five items were removed from further analysis due to joint high or low loadings. Second, the remaining PRSS items in measuring their a-priori FACE components all produced a reliable scale for each environment (Cronbach's $\alpha>.7$, or mean inter item correlation $.2<\bar{x}_r<.4$), except for the three items measuring the Extent of the urban soundscape. Third, a two factor structure was determined to be the most appropriate solution to represent variability in the data's correlations, as determined by a Principal Components Analysis (PCA) and Monte Carlo PCA for parallel analysis[10]. Finally, a PAA with a forced two factor solution was conducted for each environment. This resulted in a General Factor consisting of ten items (five Fascination, two Being-Away-From, two Compatibility and two Extent-Scope) and a Being-Away-To and Coherence Factor consisting of four items (two Being-Away-To and two Coherence). These Factors were reliable scales for all three environments (Cronbach's $\alpha>.7$, or mean inter item correlation $.2<\bar{x}_r<.4$).

Factor scores for each environment were calculated by averaging the item within each Factor, for each participant. Mean PRSS scores for both the General Factor (1) and the Being-Away-To and Coherence Factor (2) show that urban environments were perceived as less restorative than urban park environments, which were less restorative than rural environments (Table 1). Being-Away and Coherence Factor scores were higher than General Factor scores. Standard deviations were small for each environment and Factor; Factor 1 σ=.97, .92, 1.13, Factor 2 σ=.74, .88, .93 for urban, urban park, and rural respectively.

Table 1: Mean Perceived Restorativeness Soundscape Scale Factor 1 and 2 scores for each environment type, (7=low restorativeness, 1=high restorativeness).

Environment Type	Factor 1	Factor 2
Urban	4.86	5.18
Urban Park	4.39	4.66
Rural	3.13	4.19

C. Discussion

The Perceived Restorativeness Soundscape Scale produced similar results to perceived restorativeness scales designed for environments in general[3,6], thus partially validating the scale. Only a two factor solution was produced, differing to the five factor solutions produced by a general perceived restorativeness scale[6], which has a factor per FACE component. However,

this was the first development process of the PRSS and two factor solutions were also produced in the early development stages of a perceived restorativeness scale[3]. The two PRSS Factors produced reliable scales, as did the a-priori subscale items for each FACE component. This suggests the soundscape adapted items were successfully measuring the same FACE components as their original items for the perceived restorativeness of the environment in general.

As predicted, the urban soundscape was perceived as less restorative than the urban park soundscape, which was perceived as less restorative than the rural soundscape. These PRSS results satisfy concurrent validity as they are similar to perceived restorativeness scale results of the environment in general, albeit cautiously, as no direct comparison between scores on the two scales were made. The PRSS successfully discriminated between different environment types including significant differences for the urban park soundscape compared to the urban and rural soundscape. Overall, the developed scale was successful in measuring FACE components within different environments' soundscapes, thus differentiating between the perceived restorativeness of soundscapes in urban, urban park and rural environments in the expected manner.

3. STUDY TWO

The success of the developed PRSS in differentiating between urban and rural soundscapes in study one, meant the scale's ability to differentiate between the perceived restorativeness of different soundscapes within one environment type (urban parks) could be tested. Additionally, a comparative test of soundscapes within one environment type enables further development of the PRSS and determining its success when used *in situ*, with non-students. Therefore, a case study of the perceived restorativeness of soundscapes within urban parks was conducted.

A. Method

Summer visitors leaving two urban parks within Sheffield, UK, named Weston Park and Botanical Gardens were asked to participate in the *in situ* questionnaire study. In total, 194 people participated, 61% on a weekday, aged between 15 and at least 76 years old (median=35 to 44 years), 47% female, with 49% from Weston Park. Both parks are located less than 1.5 miles from the city centre, are 0.7 miles apart from each other and have residential housing, hospitals and Universities nearby. Weston Park is flanked on two sides by busy roads, with heavy bus and car usage, while Botanical Gardens only has a busy road along one side of the park. During the study, Weston Park was undergoing a redevelopment project, which meant there were a number of workers, large mechanical equipment, and vehicles in the park during the week. In Botanical Gardens, park vehicles were often driven around, as well as the occasional tractor driven lawn mower. Throughout the smaller Weston Park (4.82 ha) the average sound level measured during the study was 53.1 dB(A), ranging from 46.5 to 67.2 dB(A), (σ=4.42). On average the larger Botanical Gardens (6.93 ha) was quieter, with an average measured sound level of 50.4 dB(A), ranging from 41.6 to 66.2 dB(A), (σ=5.36)[11].

Among other questions about their experience in the park[11], participants answered the Perceived Restorativeness Soundscape Scale, consisting of the resultant fourteen items from study one. There were five items for Fascination, two for Being-Away-To, two for Being-Away-From, two for Compatibility and three for Extent (two Coherence, one Scope). These were rated on the seven point scale from *not at all* (0) to *completely* (6) agreeing with the statement. These were again recoded in analysis to range from 1= low restorativeness to 7 = high restorativeness.

B. Results

The same series of analysis used in study one was conducted to assess the relationship between the items and theoretical FACE components. This included determining the most appropriate factor structure for the developed PRSS items before testing its success in differentiating between urban park soundscapes. Five items were removed from further analysis due to joint high or low factor loadings on a preliminary PAA. The remaining PRSS items produced reliable, a-priori FACE component, scales. A one factor structure was determined to be the most appropriate solution to represent variability in the data's correlations, as determined by a PCA and Monte Carlo PCA for parallel analysis[10]. This contained the remaining nine items, consisting of four Fascination, two Being-Away-From, one Compatibility, and two Extent (one Coherence, one Scope). Together they formed a reliable PRSS Factor (Cronbach's α=.88). Individual participants' PRSS ratings for their perceived soundscape were calculated from the coefficients developed from the regression method from the forced one factor PAA solution. This meant the mean of all the scores is set at zero, converting the range of participants' Factor scores to -2 (very restorative) to 2.35 (not at all restorative).

An independent samples t-test compared the PRSS Factor scores for participants in Weston Park with those in Botanical Gardens and found significant differences ($t=4.47$, $df=181.482$, $p<.001$). The mean PRSS Factor score in Weston Park ($\bar{x}$=.29, σ=.99, range -2 to 2.35) significantly differed to Botanical Gardens' PRSS Factor score ($\bar{x}$=-.28, σ=.79, range -1.76 to 2.19); Weston Park's soundscapes were on average perceived as less restorative than Botanical Gardens' soundscapes. Weston Park's soundscapes were sometimes perceived as highly restorative and other times very low in restorativeness. In contrast, Botanical Gardens' soundscapes' restorativeness varied less and were frequently perceived as high in restorativeness.

C. Discussion

Within two urban parks varying in sound levels and perceived soundscapes[12], the developed Perceived Restorativeness Soundscape Scale was able to differentiate between the perceived restorativeness of their soundscapes. Therefore, study one and two results, showed the PRSS can differentiate between soundscapes' restorativeness, across different environment types and within different environment types. The scale is therefore sensitive enough to rate the quality of soundscapes (in terms of their perceived restorativeness) for one place compared to another, thereby suggesting which locations may need alterations to enhance the restorativeness of the soundscape.

The General Factor (all nine PRSS items) produced a reliable scale, supporting the theoretical relationship between the items as a scale for soundscapes' perceived restorativeness. In the second study, the PRSS only produced a one factor solution unlike the two factor solution produced in the first study. The reduced factor structure is owing to the reduced number of items in the final analysis, with only one remaining item from the Being-Away-To and Coherence Factor developed in study one. This unfortunately limits the scale's capabilities in determining individual theoretical aspects of Fascination, Being-Away, Compatibility and Extent's relationship with the soundscape and their involvement in producing a soundscape perceived as highly restorative.

4. FUTURE STUDIES

During the next year, further experiments are planned to improve and further develop the Perceived Restorativeness Soundscape Scale. This will include interviews to determine

participants' interpretation of individual items within the scale and adapting them accordingly to ensure they only relate to one theoretical FACE component. This should prevent high joint loadings in factor analyses and allow the development of further suitable PRSS items. An international comparative study will then be conducted, comparing the perceived restorativeness of soundscapes within urban parks in Montréal, Canada and Sheffield, UK, in part using the further developed PRSS, thus further testing its reliability and validity.

5. CONCLUSIONS

A Perceived Restorativeness Soundscape Scale has been developed. Its reliability and validity has been tested via comparisons with perceived restorativeness scales designed for measuring environments in general, rather than sounds specifically. The PRSS was able to differentiate between urban, urban park and rural soundscapes as well as between soundscapes in different urban parks. The further development and testing of the PRSS will increase its reliability and validity. The PRSS can then be used to identify the sounds and soundscapes contributing to a highly restorative experience within an environment. This has potential implications for planning sustainable city living.

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