Urban sound management often relies on a reduction in sound level to improve sound quality in urban spaces. Beside noise masking used in some indoor contexts, the role of added sound and particularly sound art in the public domain is less understood. Over the course of the summer and early fall of 2018, Montreal carried out a public space-making project in three consecutive configurations of 30 or more days each. During 2 of these configurations, a custom audio installation involving 4 outdoor, public speakers was installed by Audiotopie, a local audio design collective that specializes in sound installations. Each audio installation was on site for a minimum of 10 days. We measured the effect of the sound installation on users’ experience using questionnaires that included the Swedish Soundscape Quality Protocol, person-related (e.g. personality) and situation-related (e.g. activity) variables (N = 329). We observed changes in soundscape evaluations when the sound installations were in place compared to the baseline condition. Specifically, for Configuration 1, the sound installation increased calmness and the capacity for respite and reduced the perceived overall sound level in the proximity of the sound installation, where the audio content was clearly audible. For Configuration 2, the installation increased pleasantness and calmness over the whole site, while again reducing the perceived sound level. The results suggest implications for urban design and planning in that sound design can improve perceived sound character, but more importantly for traditional planning purposes, perceived sound level.

Keywords: soundscape, sound art, added sound, loudness, urban design and planning
1. Introduction and Review

A large body of literature indicates that sound levels influence health and well-being, in terms of e.g. quality of sleep [1], [2], stress [3], [4] or attention [5] and a subsequent desire for lower sound levels is reflected in laws, regulations and overall decision-making processes around the world (see [6] and associated references). This practice of seeking lower sound levels has generally been extended to apply to individual urban projects and spaces (except for a select few, like concert venues and other entertainment spaces), but especially parks and similar public spaces [7].

Ample evidence shows that large urban parks dominated by greenery have measurable effects on stress relief for their users [8]–[10]. Small urban public parks, however, referred to as “pocket parks” [11], are often as busy as the surrounding city and, despite, being extensively used for socializing purposes, with a documented effect on restoration [12], remain understudied. While a laboratory-based study [11] showed that, based on visual assessment of pocket parks, they have the potential to afford recovery and restoration-related activities, to our knowledge, their sonic dimension has only recently been touched upon in a systematic manner (e.g., see [13]).

A body of work on urban soundscape (defined by the International Organization for Standardization (ISO) as the “acoustic environment as perceived or experienced and/or understood by a person or people, in context” [14]) has focused on human perception over sound levels and makes for a potential framework to study the sound environments of pocket parks. Within the conceptual framework defined by the ISO, context “includes the interrelationships between person and activity and place, in space and time” [14]. Soundscape research considers multidisciplinary and mixed methods approaches in characterizing acoustic environments, with an emphasis on human perception, rather than physical measurements (e.g. dBA) used in traditional noise control approaches, translating into a shift from the idea of sound as a pollutant to the potential of using sound as resource [15]. While there is increasing array of methods available for soundscape researchers to this end (see [16] for a review), one commonly used method to document remained the questionnaire.

In the last decade, a number of soundscape scales have been developed and refined to measure human perceptions of acoustic environments and exploring variations on what “sound as resource” could mean in practice [17]–[19]. Axelsson and his team [18] created and validated the Swedish Soundscape Quality Protocol (SSQP), comprised of eight unidimensional scales (pleasant, unpleasant, eventful, uneventful, calm, monotonous, vibrant, and chaotic). Another emerging question of interest in soundscape studies is the potential for restoration [20] of different soundscapes, including urban park soundscapes [21]. Restorative soundscapes enable users to recover from the negative effect of noise exposure, including drained cognitive resources and increased stress levels, and to reflect upon daily or life issues [20]. Restorativeness has been variously operationalized as comprising: fascination, break from routine, and ease of conducting desired activity, among other components [22].

Going back to the quest for lowering sound levels, there is increasing evidence on the benefits of added sounds in public spaces through various types of soundscape interventions. One such study [23] demonstrated that added sound can make people stay significantly longer and do more activities such as chatting or eating, while another [24] noted that people tended to centralize their path around a musical source. On the contrary, [25], [26] suggest that classical music can act as a loitering deterrent in a specific context. Sound installations can also change ratings of eventful and exciting [27], or increase evaluations of soundscape pleasantness, vibrancy, and eventfullness [28].

Curated sound content was designed for several of the above studies [27], [29]–[31]. In [30], added sounds took into account appropriateness and concordance with visual cues, whereas [31] focused on the concept of informational masking, such that added sounds deflected or distracted the listener’s attention.
The process of documenting the aforementioned effects warrants a closer look. (Covert) behavioural observation has frequently been used to study added sounds effects on such variables as walking pace [24]–[26], duration of stay [23] or activities and loitering [23], [25], [26], [29]. Questionnaire studies have looked at descriptors of the sound environment rated on scales: e.g. modified versions of the Soundscape Quality Protocol (see below) [27], [28], and other bipolar semantic scales [30], [33]. Semi-structured interviews [13], [30], [31] or open interviews [29] have been used to detail findings such as people’s awareness of an installation.

The work detailed here focuses on documenting and comparing the effects of (non-music) sound art installations in the same newly designed public space, by using the same research instrument i.e. a questionnaire. This research is done in the context of the Montreal-based Sounds in the City project¹, a collaboration between researchers at McGill University, the City of Montreal (including multiple boroughs) and private partners to co-design and co-create knowledge about soundscapes in public spaces, offering unique experimental design opportunities. This paper reports on a collaboration including the Plateau Borough of the City of Montreal and Audiotopie, a Montreal-based cooperative working specializing in the creation of installations, performances, and soundwalks, to offer immersive and sensory experiences that highlight places and themes. The collaboration resulted in two designs installed in a Montreal pocket park, the effects of which we report on below.

2. Method

2.1 Sound installations

This section outlines the 2 (Design) x 2 (Sound conditions) factorial design resulting in four experimental conditions. As part of a broader public space project in collaboration with the Plateau Borough of the City of Montreal, an empty public space underwent 2(*) prototype designs between July and September 2018. The space was completely overhauled for each prototype with different layouts, amenities, and intended vocations. The first of these designs was a space for Relaxation (Design 1) and had a quiet side with benches and a more active side with meeting tables. The second design (Design 2), was intended for Culture, and included a stage, a large viewing area, and assorted seating elements. Each of these designs was in place for 4-6 weeks.

In collaboration with the Audiotopie collective (author EL), audio content was developed for each of the designs and were meant to “resonate” with the desired ambiances (i.e. Relaxation and Culture) established by the municipality. See Fig. 1.

The first installation² - Design 1+, is described here as a naturalistic one for the purposes of this paper. The installation consisted of a series of 4 speakers in an L-shape. The four audio tracks played through the speakers were played independently on loops of different lengths to avoid repetition. The sounds used were evocative of natural sound elements (primarily bird and insect) and musical elements (with percussive and melodic elements). Relatively long periods of silence in addition to a relatively low sound level were used to create a confusion between the “real” sound environment and the added sounds.

The second installation, Design 2+, is described as having added speech sounds. This installation also consisted of 4 speakers with 4 synchronized audio tracks of the same length. The speakers were arranged approximately in a square, in the middle of which were placed 3 chairs. The content, oriented toward the theme of culture, consisted of extracts of music and urban elements, which made up a light background sound. In the foreground, words were said successively in a woman’s voice followed by a man’s voice at a varying rate. The position of the voices changed every 30 seconds. The change of position was preceded by the voicing of different quotations of roughly 10 to 15 words in length (in French) related to the culture theme.

¹ www.sounds-in-the-city.org
² https://vimeo.com/310202642
Each installation (1+ and 2+) was in place for roughly half (2-3 weeks) of the full design duration (4-6 weeks) in order to conduct a controlled study.

2.2 Data collection methods

The research team deployed questionnaires (N = 329) roughly evenly across each condition (1, 1+, 2, 2+). Questionnaires contained the SSQP; one restorativeness scale - respite (“Spending time in this soundscape gives me a break from my day-to-day routine); perceived loudness (“I find the sound level here to be loud”); and contextual and personal questions like noise sensitivity, social interaction, reported gender, and age (See Table 1). Researchers manually notated the locations within the space of each user who took the questionnaire. Participants were able to complete the questionnaire entirely in English or entirely in French. All results refer only to the English wordings for the purposes of this study, but data has been collapsed across both languages.

We report here only on the scale data, measured as 5-point Likert scales, for SSQP, appropriateness, perceived loudness, and respite between the control and installation conditions between Designs 1 and 2. A MANOVA analysis was performed on the scale data; only post-hoc t-tests are reported here.

Sound level measurements are taken with a B&K 2250 Sound Level Meter, calibrated by the CIRMMMT research centre. Values are reported in 10-minute L_eqS.
Table 1: Questionnaire data collected

<table>
<thead>
<tr>
<th>Section</th>
<th>Variable</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSQP</td>
<td>Pleasantness</td>
<td>Likert scale</td>
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<tr>
<td></td>
<td>Monotony</td>
<td>Likert scale</td>
</tr>
<tr>
<td></td>
<td>Vibrancy</td>
<td>Likert scale</td>
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<tr>
<td></td>
<td>Chaoticness</td>
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<td>Eventfulness</td>
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<td></td>
<td>Appropriateness</td>
<td>Likert scale</td>
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<tr>
<td></td>
<td>Perceived loudness</td>
<td>Likert scale</td>
</tr>
<tr>
<td></td>
<td>Restorativeness</td>
<td>Likert scale</td>
</tr>
</tbody>
</table>

3. Results

To establish a park baseline, a sound level meter was used to collect LAeqs over 10-minute periods on 4 occasions (weekday/weekend, evening/night) during Condition 1 at 3 locations within the site (avenue-side, centre, and quiet-side). Readings were not taken separately for each of the 4 conditions because the overall sound level was assumed to be comparatively small with respect to the sound installations and design. The min and the max values by location within the space are reported in Figure 2.

LCeq-LAeq values (usually used to estimate the presence of traffic noise) ranged from 9.1 to 15.1 across the site but did not appear to vary between measurement locations. These levels indicate a moderate presence of low-frequency noise, presumably from traffic.

329 questionnaires were collected over the data period. The number collected for each condition is: Design 1: 76; Design 1+: 67; Design 2: 98; Design 2+: 88. See Fig. 3 for photos of each installation.

3.1 Naturalistic sounds – comparing Designs 1 and 1+

Across the entire space, no significant result was found between scales in the control and installation condition. It should be noted, however, that, as designed, this installation was not audible over the entire space. Instead, the installation was noticeably more audible (as noted by the researchers) on the “quiet”

![Figure 2: L_\text{eq} 10\text{-minute min and max values at various locations within the site}](image-url)
half of the space, furthest from the busy commercial artery. The new sample size is N(1; quiet side) = 31; N(1+; quiet side) = 26.

When data was considered only from the “quiet side” of the space, the questionnaires revealed a significant lowering of perceived loudness (df = 46.35; p = .006; t = 2.9), rise in calmness (df = 50.35; p = .007; t=-2.8), and a rise in respite (df = 53.97; p = .034; t = -2.17), see Fig. 4.

3.2 Speech sounds – Comparing Designs 2 and 2+

Compared to Design 1+, 2+ was audible over a larger range of the space, sometimes the entire space (as noted by the researchers). In this case, position information was not used.

In this context, questionnaires revealed a significant lowering of perceived sound level (df = 176.82; p = .0005; t = 3.56) and a rise in calmness (df = 173.41; p = .02; t = -2.33); as well as a trending rise in pleasantness (df = 176.71; p = .088, t = -1.72), see Fig. 4.

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Figure 3: left: photo of Design 1+; right: photo of Design 2+

Figure 4: left: comparing Design 1 (control) and 1+ (installation) for a naturalistic added sound intervention. Right: comparing Design 2 (control) and 2+ (installation) for a speech added sound intervention.

Legend: * (p<.05); ** (p<.01); ***(p<.001)
4. Discussion and Conclusion

The questionnaire demonstrates the ability of the SSQP [18] and restorativeness scales [22] to capture changes in soundscape evaluations, and supports the idea of including an evaluation of overall perceived loudness. With a comparatively small literature on the effects of soundscape experience using added sound, (see [13], [23]–[33]), and many of those using the observation method, we also demonstrate the potential of the questionnaire instrument to capture soundscape evaluations in the event of a public space intervention. It should be noted that, according to the observations of the researchers, not all space users noticed the added sounds, yet the installations had a significant effect across all users. Support for the idea that users do not need to actively notice sound art will be presented in future manuscripts on this data set.

Also, on methodological grounds, it is unusual to have two controlled evaluations of the modified soundscapes of public spaces (due to the relative rarity of such interventions) that show such distinct benefits of added sound, especially in the same space (hence controlling for variables like background noise). While not completely unexpected to find that naturalistic sounds benefited calmness and lowered perceived sound levels, the fact that these benefits extended similarly strongly for added speech sounds is more surprising.

On both theoretical and practical grounds, this work shows the potential benefits for cities and other professionals of the built environment to bring sound expertise to the table and to consider the role of sound art in enhancing their spaces and supporting intended design goals. The results further support the practical implication that that comparatively low-cost audio installations are capable of improving the perceived sound environment. Interventions like these could be considered alongside more resource-intensive (infra)structural elements, such as noise barriers, to purposefully shape the sound environment in public spaces.

Future work will entail incorporating findings from free-response and demographic data on this dataset. For future studies, we are deepening this partnership (Audiotopie, City of Montreal) by collaborating on further designs of this space and attempting to incorporate different categories of added sound and measure changes.

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