The role of activity in urban soundscape evaluation

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Summary

While soundscape as a field continues to grow, there remain few opportunities to put its ideas into practice, evidenced by the lack of cities embracing soundscape approaches. Moreover, without reaching broader audiences who make key decisions on urban environments, the application of soundscape theories will be hindered. A meta-analysis is presented providing converging evidence for the influence of urban activity (i.e. an observable behavior) on soundscape evaluation from the perspective of city users. A review across literatures from urbanism to environmental psychology supports the analysis. Three studies conducted by the authors each focused on urban activities in various ways. The first is a series of interviews with urban planners, addressing the gaps between planners and soundscape researchers. Questions were posed about how they plan for sound and other factors, including how activity plays a role in their plans. Results show that, while planners primarily focus on the negative aspects of sound (i.e. sounds are only capable of interrupting relaxation), they describe non-sound topics in a more resource-oriented way, utilizing activity or quality-of-life justifications positively for intervention. The second study varied (envisioned) activity while collecting evaluations of soundscape appropriateness. The results show a strong effect of activity on appropriateness across varied urban soundscapes. The third study was carried out using the so-called experience sampling method (ESM) where momentary (i.e. in-the-moment), in-situ soundscape evaluations were collected at various points of the day along with data on activity-at-hand, mood, and cognitive effort. The ESM study reveals that activity has a significant effect on pleasantness and further influences mood, attention, and effort. Besides contributing generally toward a theory of soundscape evaluation, our findings on the role of activity point toward further justification of the importance of soundscape over physical measurements in urban planning and design and provide a common link to achieve cross-disciplinary synthesis.

1. Introduction - Converging Evidence, soundscape is modulated by activity

Soundscape is defined as the acoustic environment as perceived or experienced and/or understood by a person or people, in context (ISO 12913-1:2014). Central to soundscape research is the shift from quantitative analytic approaches (e.g. psychophysics) to more qualitative cognitive approaches focusing on meanings attributed to sounds in relation to human activities (e.g. [1, 2]). Indeed, there is converging evidence that soundscape cannot be assessed/measured exhaustively in terms of acoustic criteria.

1.1. Factors influencing soundscape evaluations

Several models have been proposed to account for soundscape evaluation. A study on pleasantness judgments of image/sound pairings of natural and urban scenes, found no relationship between the pleasantness rating and intensity of the acoustic

signal, highlighting the need to explore more dimensions governing soundscape perception [3]. Toward that model, another study [4] demonstrated that up to 65% of variance in soundscape quality judgments was described through just four words from a list posed to respondents: "relaxation", "vibrancy", "communication", and "spatiality". Lastly, Axelsson et al [5] performed a principal components analysis on 116 soundscape attributes from laboratory evaluations of 100 recordings (N=50) and found that 74% of the variance in evaluation could be attributed to just three perceptual attributes: pleasantness, eventfulness, and familiarity.

Further, studies [1, 5, 6] found that soundscapes dominated by mechanical sources were rated as less pleasant than those dominated by human sounds. One [1] revealed that participants made use of a richer categorization and vocabulary when describing the human-dominated soundscapes, and the second study found participants described the human soundscapes to be more eventful [5]. In [2]'s free sorting tasks of recorded sound environments, participants spontaneously grouped soundscapes in terms of activities, describing them in terms of the actions performed (e.g. "do the groceries", "take a walk", "have a drink"), the type of locations ("market," "café", "restaurant," "park") and specific sound sources ("vendors," "music," "birds"), indicative of the activities.

The findings above and other soundscape literature referencing activity (e.g. [7, 8, 9]) point toward the need for studies that explicitly explore soundscape evaluations as they are modulated by activity and sound sources. Further evidence for an activity-centered approach comes from [10], which analyzed in-situ soundscape evaluations (measured with semantic differentials and free-response) across locations and demonstrated that activity has a stronger effect on the overall evaluation than spatial and temporal features.

Once the notion of activity is considered, we propose that soundscapes can then be evaluated in terms of their appropriateness for the setting. One known study linked soundscape with appropriateness and activity [11]. It was conducted using an electronic questionnaire with residents of a beachside city in the U.K. asking people to 1) identify a single outdoor location in their city, 2) indicate how suitable a list of 27 social and recreational activities would be there, and 3) indicate the appropriateness of 29 sound sources for that location. Their analysis showed a statistically significant effect between the activities that people find suitable and the degree to which they find that

specific sound sources are appropriate there. These findings considered imagined activities and single sound sources rather than playing recordings or going in-situ, thus it remains to be seen how appropriateness varies over a whole soundscape.

1.2. Overview

We report three studies each focused on the relationship between activities and urban soundscapes in various ways. In Study 1, city users were presented with recordings of varied urban environments while envisioning different activities and asked to rate the appropriateness of each. As laboratory constraints limit the types of activity that can be considered, real-world studies are needed that capture evaluations of people conducting complex activities. To do so, Study 2 uses the Experience Sampling Method where momentary (i.e. in-the-moment), in-situ evaluations are collected at various points of the day along with information on activity-at-hand and mood, attention, and mental effort. Lastly, it remains to be seen how to build good soundscapes based on this knowledge. The gaps between researchers and those who build cities have been explored [12]. Study 3 consists of interviews with urban planners and designers exploring their existing conceptualizations of soundscape and sources for new information. The presented meta-analysis explores the potential for using activity as a common link – one that modifies soundscape evaluations, represents an observable feature of urban spaces, and allows communication across communities of practice with clear, shared terminology.

2. Study 1 - soundscape appropriateness

2.1. Method

As presented in [13], 15 participants rated the appropriateness of 4 imagined activities (*studying for an exam, riding a bicycle, meeting with friends, and relaxing*) over 8 urban soundscapes (12-15 second recordings of Montreal and Paris, rated as highly characteristic of those places in a pre-study) on a 100-point scale. Each judgment was repeated. Participants were invited to leave comments about each appropriateness rating, but were not required.

2.2. Results

Findings showed that some of the tested soundscapes were appropriate for all of the activities, and some appropriate for no activities. Most interestingly, a few of the soundscapes were appropriate for some of the activities but not

others. An ANOVA showed main effects across soundscapes, across activities, and between soundscapes and activities, as described in the original study, and in agreement with the literature [11].

Optional verbal comments were also taken in tandem with the scale judgments of appropriateness. Approximately 34% of the ratings were accompanied by comments, as many of the participants declined to leave comments on both runs. From the responses, 4 main categories emerged: acoustical properties (e.g. *too noisy*), effect on listener (*distracting*), spatial properties (*in a park*), and event/scene/source descriptions (*the seagulls are out*). It was possible for responses to be counted in multiple categories. Across all data, the frequency of descriptor categories was roughly equal, but event/scene/source descriptions were used the most. This may be related to the instructions, which only directed them to write down things they thought of while listening to the recording, and not necessarily give a justification for their response.

The frequency of response category by activity showed more variation. For *studying for an exam*, the categories of acoustical properties and effect on listener were used more heavily, while for *riding a bicycle*, spatial and event descriptions were used much more often. This finding gives rise to the idea that different activities require different types of attention be given to the soundscape. Within activity, comments also varied when they supported high or low appropriateness ratings. For all activities except bicycling, and especially for studying, comments largely took the format "too noisy," "too busy," and "too much traffic." Low bicycle ratings included "watch out for the diners" and "rain" more so than "noisy"; we conclude that people on bicycles are not attending strongly to background noise in their determination of bicycling suitability. For *meeting with a friend*, the very high appropriateness ratings had justifications utilizing words like "atmosphere," "socializing," "environment," and "conducive".

It remains a methodological weakness that comments were not required, as participants who left comments tended to leave many comments and vice versa, such that the 7 or so of 15 participants who left many comments carry more weight in the verbal analysis.

3. Study 2 - the Experience Sampling Method

3.1. Method

The Experience Sampling Method (ESM) study of soundscapes is presented in great detail in these same proceedings [14]. Briefly, the study deployed 26 participants with apps on their personal mobile phones. Participants were prompted 10 times per day over the course of 7 days to take a 1-minute questionnaire about their soundscape. The questionnaire asked for their: rating of the soundscape pleasantness, eventfulness, and familiarity; mood; predominant sound source(s); attentiveness to the soundscape; activity and amount of mental effort required for it; rating of visual pleasantness; type of location; and the presence of others.

Activity data was collected as free-response. Participants were instructed to use at least two words to help us understand the context. For example, *reading* would not be sufficient and should be phrased as *reading a textbook* or *reading a novel.* We then categorized the activity responses roughly according to [15], who proposed the following 9 aggregated activity types: home, work, school, transportation/transitions, shopping/errands, personal business, recreation/entertainment, civic/religious, other. Based on our data and the fact that many of our participants were students, we amended the classification scheme to include: work/study/school, transportation/transitions, shopping/errands, personal business/home activities, recreation/entertainment, and other. If the reported activity was too vague for that classification, it became: walking, writing, reading, talking/chatting, or meeting.

3.2. Results – questionnaires

We found that our participants, in the 12-hour daily study period, were somewhere other than home, work, or on-the-way (i.e. commuting) for $22 \pm 11\%$ of their day. An ANOVA revealed significant effects (all $p<.01$) of activity on all factors: pleasantness (F=19.1, df=10), eventfulness (F=11.3, df=10), familiarity (F=12.2, df=10), attention (F=9.3, df=10), cognitive effort (F=40.4, df=9), visual environment (F=16.5, df=7), and mood (F=14.8, df=10). The mood and attention to the soundscape is higher when people are performing recreational activities or talking compared to when they are at work or on transport (Mood/Attention: Mean(Talking)=6.0/4.9, STD=1.0/2.0; Mean(Recreation)=5.6/4.0, STD=1.2/2.1; Mean(Work)=4.8/3.1, STD=1.1/1.7; Mean(Transport)=4.9/3.1, STD=1.1/1.8.) Participants reported the highest eventfulness while shopping (Mean=4.2, STD=1.6) and the lowest while writing (Mean=2.4, STD=0.8). While there was a significant effect of activity on cognitive effort, there was no corresponding effect of cognitive effort on other evaluations.

3.3. Results – exit interviews

Each (non-pilot) participant was given an exit interview (N=15) where they were invited to give their opinion on whether they felt the activity they were conducting had an effect on their soundscape evaluation. Currently, 8 said their activity did or probably did play a role in their judgment, and 7 said it did not or probably did not.

One participant clearly captured the soundscape ethos, saying, "I was working once a day using a vacuum sealer and I did not describe it as unpleasant, but it really is [an] unpleasant noise…So, I think that because of the context, because I was doing the action, I was minding the sound less than if I were a bystander." Curiously, one of the "probably not" respondents reported that, for normal activities that were neither stressful nor relaxing, evaluating the soundscape became the activity.

4. Study 3 – interviews with urban planners and designers

4.1. Method

The third study was a series of semi-structured interviews with urban planners and designers (UPDs), expanded from a pilot study [16] with 3 participants (P1 through P3, urban planners from northern Europe). This analysis includes 9 more participants (N=12), 6 planners from Montreal (M1 through M6), and 3 designers from New York City (NYC) (N1 through N3). The interviews began with rapport questions and a request to list all of the technical factors (like historic preservation and public transportation) that must be considered for their work. From the list, 2 factors, noise and another, were selected for further discussion in such a way that it was not clear that the interview was about noise. This mild deception avoided the feeling that participants must report noise being important if it is not the case for them. The second part of the interviews focused on their conceptualizations of their 2 factors, while the third part put those factors into context with questions about how they were applied to past and present projects. The interview concluded with questions about information sources, demographic details, a debriefing, and an opportunity to add more about noise. Soundscape was never mentioned by a planner and was only discussed as part of the debriefing.

4.2. Results

In their listing of factors, 5 planners and 0 designers mentioned noise on their own. The remaining 7 confirmed that they indeed considered noise when it was offered to them from a list of prepared factors offered by the interviewer, a list that was made as a contingency in case noise had not been listed. N1, a designer, added noise *and acoustics*, differentiating unintentional from intentional. None mentioned soundscape. Many UPDs later reported that noise held a high priority for them, suggesting that their failure to include it in their list of factors only highlights how many factors they need to think about on a daily basis. The number of factors offered without assistance ranged from 10 to 26, and grew after discussion.

When asked if noise is something UPDs should know something about, many reported that, yes, they should know a little, but not on a "technical level." Two UPDs strongly linked noise to quality of life or well-being, but only in the sense that too much noise can compromise them. All participants repeatedly mentioned words referring to the distance of noise sources, such as *proximity*, *neighbour*(ing), *next to*, and *orientation*, suggesting planners and designers are especially sensitive to projects adjacent to noisy infrastructural elements that will endanger their project outcomes.

Conceptualization of noise is strongly linked to the place of work and training (in the case of our participants, all had trained and obtained employment in their native countries.) P1, P2, and P3 all reported that they consider noise because the environmental law protecting requires it; P1 and P3 recalled healthcare and educational projects had been cancelled due to noise concerns. In Montreal, noise compliance is largely handled by the various departments of inspections who are called in response to citizen complaints. While most of the Montreal planners mentioned complaints or phone calls from residents, only one non-Montreal planner (N1) mentioned it. Meanwhile, all NYC designers said only noises that cause disruption really need to be addressed; N2 and N3 discussed the benefits of positive noises for their projects, articulating soundscape themes.

Lastly, an analysis of the information sources of the public-sector workers revealed that the employees of very small offices rely on a network of colleagues with similar positions in similar, small cities to share information about problems that arise in their work, while employees of large, central districts go to their specialist colleagues within their organization. These data suggest that the way we reach UPDs would be different based on the size of the organization; for large organizations, it may be necessary to reach those specialist colleagues with more technical

information on soundscape while, in smaller organizations, one may need to tailor soundscape information for a non-specialist audience.

4.3. Contrasting urban designers with planners

Contrasting the planners with designers, urban designers may be more ready than their planning peers to integrate soundscape into their practices. The terms urban planning and urban design have sometimes been used interchangeably (as described by [17],) but the fields don't strictly correspond (see [12] and associated references).

An analysis of conceptualizations reveals substantial differences in the discourse of planners and designers around noise. Urban planners were far more likely to spontaneously mention the words *law*(s) or *bylaw*(s) suggesting that planners feel more constrained by the regulatory framework to only achieve low noise levels than their designer peers who are free to spend extra resources on specialization and individualization. Urban designers differentiate "good noises" from bad ones, talk about noises that help them achieve specific outcomes (e.g. masking from a fountain, making people smile), and are willing to consider that their project may add decibels to the soundscape (e.g. N2 - "creating a place that's really good for music.")

Designers are also more likely to talk about activities on the scale on which we have demonstrated effects on soundscape evaluations. While planners speak of *zoning*, implying the scale of city blocks, designers speak of *program*, on a smaller, and variable scale - N3 says the activities he envisions when talking about programming take place in about a 3-meter radius.

5. Links between three studies – activity, design, soundscape

A number of studies aim to bridge gap between UPDs and soundscape researchers [18, 19, 20] but they have not been published in sources read directly by urban planners – in fact, a number of interview participants reported that they find academic literature "interesting, but not helpful". Urban planners have been described as focused on rationality, making it difficult to incorporate concepts like sound aesthetics [21]. Especially for planners in smaller offices, activity remains a concept that can be expressed and shared without technical vocabulary or expertise. The results showing the information networks of small-city planners suggests this sort of terminology may be necessary to communicate with them on soundscape interventions. We should strive for plain-

language descriptions detailing appropriate urban soundscapes for the activities planned for a space. Urban designers, however, appear less constrained by these notions and should be more open to creative approaches. Nearly all of the ESM activity responses were on the scale of *program*, used by designers, so a tailored report for that community showing preferences for (e.g.) eventfulness by activity would be an interesting contribution.

The finding from the ESM study that participants pay more attention to and are in a better mood for recreational and entertainment soundscapes (where they spend 22% of their time) suggests that particular care must be taken in the design of spaces where the associated activities are conducted. In urban design parlance, there may be some overlap with the existing concept of 3rd spaces [22], or common spaces that aren't work or home. Recent research links 3rd places with urban quality of life, enumerating and characterizing the spaces and activities that they entail [23] and describing some of their main reported qualities, like distinctiveness and permeability [24].

The appropriateness study verbal data suggested a potential link between cognitive effort and soundscape evaluations, such that it could serve as a proxy for activity. The ESM study included a measure of cognitive effort, but since no effect of it on evaluation was shown, this link has been dropped.

As a case study, recall that the appropriateness study revealed that people may not attend to background noise in their decision to ride a bicycle. In light of the findings that UPDs from the interview study experience difficulty with the adjacency of highway or rail to other uses, and struggle to find things to do with those unusable areas, a bicycle path may be well-suited adjacent to these noisy infrastructural elements without compromising the usability of the path.

5.1. Future work

In order to provide meaningful advice to urban planners and designers, it will become necessary to validate categorizations of activity type (for example, expanding on the analysis conducted for the ESM classification) especially with regard to minimum soundscape requirements. In order to capture the value of expensive interventions and prevent soundscapes that undermine efforts in the visual domain, UPDs will want to know what sorts of sound sources should and should not be present; and these recommendations should be sensitive to the type of UPD that is going to be reading them. One place to start would be with a more comprehensive laboratory appropriateness study

that, for example, takes the various sound sources into account and manipulates them systematically to understand the role of individual sources. Further, we should explore more closely evaluations along emergent place categories, such as those from the ESM study or the (rather) location-specific) recreational soundscapes found in [11]: seaside, park, peri-urban recreation area, "my space", and downtown. Soundscape appropriateness remains a concept worth investigating. In future studies, the validity of the experiment can be manipulated by having participants actually read a book while they evaluate recordings. The ESM study recorded soundscape evaluations, but it could also be valuable to consider soundscape outcomes for its urban design consequences, such as: acceptability, comfort, importance, and variety, to name a few [25]. The interview work should be expanded to include urban designers from other cities beyond NYC, and more European practitioners should be engaged. Lastly, it would be very interesting to explicitly modify a real city soundscape and observe the change in activities that result.

Acknowledgement

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