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Research paper

A field experiment on the impact of sounds from a jet-and-basin fountain on soundscape quality in an urban park☆

Östen Axelsson[a,b,*], Mats E. Nilsson[b], Björn Hellström[c], Peter Lundén[b]

[a] School of Architecture, University of Sheffield, Western Bank, Sheffield S10 2TN, United Kingdom
[b] Gösta Ekman Laboratory, Department of Psychology, Stockholm University, SE-106 91 Stockholm, Sweden
[c] Department of Fine Art, University College of Arts, Crafts and Design (Konstfack), Box 3601, SE-126 27 Stockholm, Sweden

HIGHLIGHTS

- Water sounds and ratings of soundscape quality were not directly related.
- Using water sounds to mask road-traffic noise is not simple and straight forward.
- Water sounds may affect the audibility of wanted as well as unwanted sounds.
- Water features ought to be pre-tested before constructed.

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ABSTRACT

A field experiment was conducted to explore whether water sounds from a fountain had a positive impact on soundscape quality in a downtown park. In total, 405 visitors were recruited to answer a questionnaire on how they perceived the park, including its acoustic environment. Meanwhile the fountain was turned on or off, at irregular hours. Water sounds from the fountain were not directly associated with ratings of soundscape quality. Rather, the predictors of soundscape quality were the variables "Road-traffic noise" and "Other natural sounds". The former had a negative and the latter a positive impact. However, water sounds may have had an indirect impact on soundscape quality by affecting the audibility of road-traffic and natural sounds. The present results, obtained in situ, agree with previous results in soundscape research that the sounds perceived—particularly roadtraffic and natural sounds—explain soundscape quality. They also agree with the results from laboratory studies that water sounds may mask road-traffic sounds, but that this is not simple and straight forward. Thus sound should be brought into the design scheme when introducing water features in urban open spaces, and their environmental impact must be thoroughly assessed empirically.

1. Introduction

Water features are well-acknowledged as an important element of the urban environment, particularly in urban open spaces (e.g., Booth, 1983; Burmil, Daniel, & Hetherington, 1999; Nasar & Lin, 2003; Whalley, 1988). Booth (1983) provides a general, theoretic approach to landscape architecture, including water features, whereas Burmil, Daniel, and Hetherington (1999) provide an extensive review of the literature on water in the landscape. Whalley (1988) adds to the discourse by a review of past and current practice with regards to water features in landscape architecture. Together these authors illustrate how central the visual aesthetic aspect of water features is in landscape architecture, although they also acknowledge the importance of water sounds. In contrast, Nasar and Lin (2003) conducted an empirical study to test some theoretic assumptions (e.g., Booth, 1983) about the visual impressions that water features may have on people. Thirty participants assessed five colour photographs of water from water features. The study revealed that the water features with several vertical jets or a mix of different kinds of moving water were most visually attractive. A surface of still water was less visually attractive, but rated as most calming. Falling or flowing water received the least favourable scores, both in terms of visual attractiveness

* Corresponding author at: Department of Psychology, Stockholm University, SE-106 91 Stockholm, Sweden. Tel.: +46 (0)8 164 605.
E-mail addresses: o.axelsson@sheffield.ac.uk, oan@psychology.su.se (Ö. Axelsson), mats.nilsson@psychology.su.se (M.E. Nilsson), Bjorn.Hellstrom@konstfack.se (B. Hellström), peter.lunden@psychology.su.se (P. Lundén).

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and calming. Thus, typically the visual aesthetic qualities of water features are considered, although their impact on the acoustic environment as it is perceived or experienced and/or understood by people, in context, (i.e., the soundscape; cf. Axelsson, 2012a) is increasingly recognised (see e.g., Axelsson, 2011, 2012b).

It has been suggested that sounds from water features may improve the urban soundscape (e.g., Booth, 1983; Brown & Muhar, 2004; Brown & Rutherford, 1994; Perkins, 1973), in particular that water sounds may be used to mask unwanted background sounds, chiefly from road traffic. In addition, the sound of flowing water may be positive in itself. Because of their practical implications for urban planning and design, researchers have begun to investigate these suggestions empirically, primarily through laboratory studies.

By listening experiments, Jeon, Lee, You, and Kang (2010) found that stream and wave sounds were preferred to sounds generated by birds, wind, and the bell of a church when they were combined with the sound from road-traffic or construction sites. They also found that the water sounds should be similar or not less than 3 dB below the sound-pressure level of the road-traffic and construction sounds. In a more recent study Jeon, Lee, You, and Kang (2012) found that the psychoacoustic metric *sharpness* had a strong positive correlation coefficient with preference scores of water sounds combined with road-traffic sound. Watts, Pheasant, Horoshenkov, and Ragonesi (2009) have previously reported similar results with regards to *sharpness*. In addition, they reported that people perceive naturally sounding water as more tranquil than water sounds that appeared manmade.

Galbrun and Ali (2013) conducted a listening experiment to test the peacefulness and relaxation of various kinds of water sounds combined with the sound from dense road traffic. Stream sounds tended to be preferred to fountain sounds, which in turn were preferred to waterfall sounds. Like Jeon et al. (2010), they found that water sounds should be similar or not less than 3 dB below the sound-pressure level of road-traffic sound. However, they did not find the expected relationship with *sharpness*.

Rådsten-Ekman, Axelsson, and Nilsson (2013) conducted a listening experiment in order to explore how sounds of water, varying in degree of pleasantness, influence the overall pleasantness and eventfulness of acoustic environments dominated by road-traffic sound. They found that overall pleasantness increased when a highly pleasant water sound (sea waves) was added to the road-traffic sound. For less pleasant water sounds (stream or waterfall), no effect, or a decrease in pleasantness, was found. In addition, pleasant water sounds increased the perceived eventfulness.

Nilsson, Alvarsson, Rådsten-Ekman, and Bolin (2010) conducted two laboratory experiments in which they investigated to what extent sounds from the jet-and-basin fountain, recorded in the downtown park Mariatorget, in Stockholm, may mask road-traffic sounds, recorded in the same park. The first experiment showed that water sounds recorded close to the fountain partially masked background road-traffic sounds. The second experiment showed that it is easier to mask fountain sounds with road-traffic sounds, than the other way around. De Coensel, Vanwetswinkel, and Botteldooren (2011) showed that water sounds only reduced the loudness of road-traffic sound if the latter had low temporal variability, whereas adding bird sound substantially improved the pleasantness and eventfulness of soundscape even for road-traffic sound with high temporal variability.

In the present paper we extend this line of research and report the results from a field experiment in which we manipulated the acoustic environment in the park Mariatorget, in Stockholm, by turning its jet-and-basin fountain on or off at irregular hours. With the purpose to explore whether or not the water sounds from the fountain has a positive impact on the soundscape quality of the park (i.e., Good–Bad evaluation), we asked visitors to answer a questionnaire on how they perceived the park, including its acoustic environment. Thus, inspired by the notion that sounds from water features may improve the urban soundscape, we were interested in how water sounds from the jet-and-basin fountain in Mariatorget contributes to the soundscape quality in this urban park, in situ. Laboratory studies may provide a theoretic understanding of how water sounds may improve the urban environment, but for this knowledge to be useful in practice we also need to understand how to assess the environmental impact of water sounds in real life, from a user or visitor perspective.

2. Method

As stated above, soundscape research concerns how people perceive or experience and/or understand the acoustic environment, in context (cf. Axelsson, 2012a). In the present study, we measured soundscape in terms of the proportion of park visitors who rated the acoustic environment in specified ways (e.g., as 'good' or 'very good'). This approach allowed evaluation of how park visitors perceived the acoustic environment at various locations in the park.

2.1. Mariatorget

Mariatorget is a park located on the island Södermalm in downtown Stockholm, Sweden. The park is rectangular (130 m × 60 m) and surrounded by streets, lined with 5–7 storey buildings (Figs. 1 and 2). Traffic flows mainly on the two main streets along the short sides of the park. Hornsgatan, on the northern side of Mariatorget, is one of the main traffic arteries on Södermalm (Photograph B in Fig. 1 depicts a street view of Hornsgatan). At Mariatorget the traffic on Hornsgatan is restricted. The street has one lane in each direction, and the speed limit is 50 km/h. Still, the street is heavily trafficked (approximately 20000 vehicles every 24 h). St Paulsgatan, at the southern border of Mariatorget, is a one-way street, mostly used by residents, taxis and delivery services (approximately 3000–3500 vehicles every 24 h) (Photograph A in Fig. 1 depicts a street view of St Paulsgatan). The two by-streets, along the long sides of the park, are mostly used by residents for parking (Photographs C and D in Fig. 1 depicts street views of the west and east by-streets, respectively).

Two perpendicular footpaths, running through the middle of the park, divide Mariatorget into four rectangular grass areas (Fig. 2). Where the footpaths intersect, the jet-and-basin fountain 'Tors fiske' (Thor's fishing) is located. Tors fiske has an elliptic basin (21 m × 14.5 m), and three large and two smaller nozzles mounted on a group of three bronze statutes (Fig. 3). The centrepiece depicts the moment when Thor has caught the Midgård Serpent, and raises his hammer, Mjölnir, to destroy it. The centrepiece is flanked by two prehistoric lizards. One of the three large nozzles is located in the jaws of the Midgård Serpent (Enlargement B in Fig. 3), and the other two in the noses of the lizards (Enlargements A and C in Fig. 3). Each produces a single, concentrated jet of water. The two smaller nozzles are located in the nose of the Midgård Serpent, and sprays smaller jets (Enlargement B in Fig. 3).

Park benches are located around the fountain, as well as along the main footpath, which extends through Mariatorget in the north–south direction, between the two main streets. Close to St Paulsgatan, there is a small playground frequently visited by parents with small children (marked "Pg" in Fig. 2).

2.2. Acoustic measurements

During the study period, we measured the sound-pressure levels around the park. On both Hornsgatan and St Paulsgatan we mounted a measurement microphone on the façade of a building