Acoustics'08 Paris
June 29-July 4, 2008
www.acoustics08-paris.org

Can urban squares be recognized by means of their Soundscape?

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Squares have always played important functions in urban areas, being a reference place in the citizen's life. During last decades, road traffic noise has influenced the perception of the sonic environment in many squares, even though typical sound sources are still present in some of them. However, the sonic environment remains a feature of the square together with other aspects, like the visual information.
The paper describes an experiment aimed to study how the soundscape of a square can contribute to recognize the square itself. For this purpose 12 urban sites have been chosen to cover a wide range of different characteristics. In each site binaural recordings and photos have been taken simultaneously. Then the binaural recordings have been played back by headphone in laboratory to two groups of subjects together with the site photos. After listening each sound, the subject was asked to indicate the sources recognized in the sound and to rate on a 5 point scale the relevance of the sound heard with the sonic environment of the site as expected from its photo. The results show that no difficulties occurred in sound sources recognition and that, on average, 44% of subjects gave the correct site-sound association.

1 Introduction

In the past decade the increasing worldwide development of studies and researches on Soundscape has clearly shown how this topic requires a multidisciplinary approach, as it involves not only the auditory perception, but also other sensory (i.e. visual information [1]) and cognitive aspects [2, 3]. Nowadays, it is widely recognized that a sonic environment is subjectively rated acceptable when the overall context matches the individual expectation of the environment itself, rather than a low sound level only. This is observed often in urban spaces where different types of sound sources occur simultaneously.

The paper describes an experiment aimed to study how the soundscape of a site can contribute to recognize the site itself. For this purpose binaural recordings and photos have been taken in 12 urban sites (6 in Naples and 6 in Rome). Then the binaural recordings have been played back by headphone in laboratory to two groups of subjects (in Naples and Rome) simultaneously with the display on a screen of the photos of sites. After listening each sound, the subject was asked to recognize the sound sources heard and to rate the relevance of the sound with the sonic environment of the site as expected from its photo.

2 Experimental

2.1 Field recordings

Twelve places (6 in Naples and 6 in Rome) have been chosen to cover a wide range of different urban sites, including busy traffic roads, touristic attractions in pedestrian areas, large squares, markets.

In each site, at its usual weekday conditions, binaural recordings have been carried out during day-time for about 4 minutes. For this purpose an headset with ½" microphones was put on the head of the experimenter standing in the site. Simultaneously with the sound recordings, photos of the site have been taken and the selected ones are reported in Fig.1.

An example of the time history of the sonic environment recorded at site R12 is reported in Fig.2, where the occurring sound sources are also indicated. The range of L_{Aeq} values for all the sites was between 60 and 79 dB(A).

Fig.1 Urban sites selected for the experiment

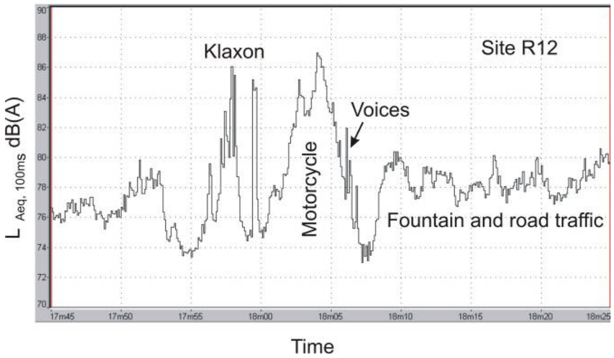

Fig.2 Example of the time history of the recorded sonic environments (site R12) and occurring sound sources

Fig.3 Laboratory listening tests: preliminary sound listening

2.2 Laboratory listening tests

In each binaural sound recording a sample lasting 30 s was chosen and 1 s fade-in and 1 s fade-out were included.

The obtained 12 binaural sound stimuli were played back by headphone in laboratory to subjects forming two groups, one in Naples (50 people) and the other in Rome (16 people). All people had normal hearing and their gender and age are reported in Table 1.

Group	N. Subjects	N. male	N. female	Age (average)
1-Naples	50	25	25	31
2-Rome	16	13	3	39
Total	66	38	28	33

Table 1 Groups of subjects taking part in the listening tests

The sounds were presented in sequence to each subject according to a 12x12 digram-balanced Latin squares, modulo 13 [4]. The listening session lasted about 30 minutes plus the time for instructions provided at the beginning by the experimenter.

After the introduction, the photos of the 12 sites were shown all together on a screen to the subject simultaneously with the play-back of the first sound (Fig.3). Then the subject had to write on a form the sound sources recognized in the sound. Afterwards, a sequence of the 12 photos started, each photo shown for 4 s followed by 1 s of break, and at the end of each photo display the subject was asked to write on the same form a score from 1 (no relevance) to 5 (very good relevance) corresponding to the congruence of the sound heard with the sonic environment of the site as expected from its photo (an example is given in Fig.4). During this second part, lasting 1 minute, the sound was played back twice in loop. Then the procedure was repeated for the remaining 11 sound stimuli.

Fig. 4 Laboratory listening tests: example of site photo used for the assessment of sound-site congruence; the labels of the 5 point scale at the bottom are: 1 = no relevance, 2 = poor relevance, 3 = moderate relevance, 4 = good relevance, 5 = very good relevance

3 Results and discussion

All subjects have shown no difficulties in recognition of sound sources in the recordings; only 2 subjects have not indicate sources for the sound recording taken at site N11. On average, two types of sound sources were indicated in all the recordings with the exception of that taken at site R12 were three types were recognized. For each site the percentages of subjects indicating human (voices, steps) against non human (road traffic, aircraft flyover) and natural (water, wind, bird twittering) sources are plotted in Fig.5 and Fig.6 respectively.

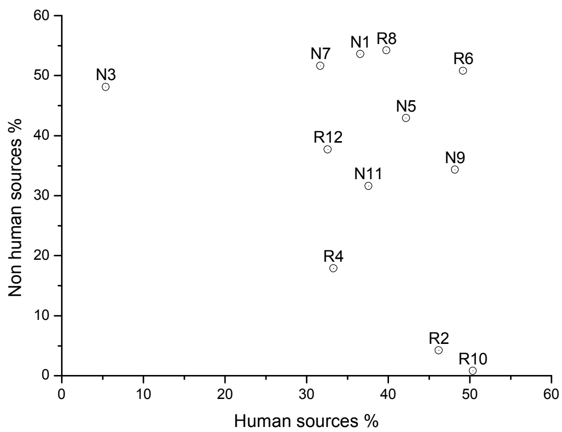

Fig.5 Percentages of subjects indicating human and non human sound sources in the selected sites

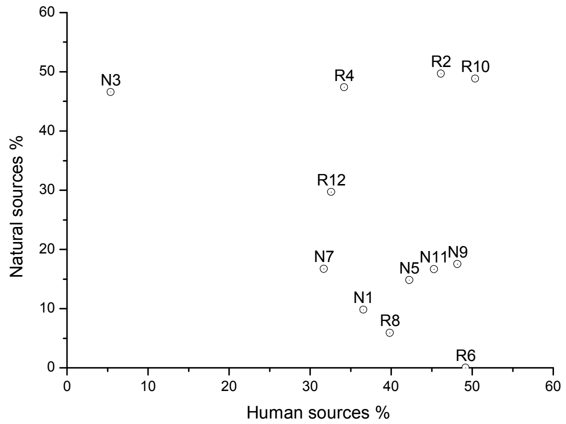

Fig.6 Percentages of subjects indicating human and natural sound sources in the selected sites

The good scatter of data confirms that the selected sites included a sufficiently wide range of sound source types.

Regarding the congruence of the sound heard with the sonic environment of the site as expected from its photo, the occurrences of the five scores were analised for each combination site-sound. For instance the score occurrences obtained for the sound recorded at site R8 are reported for all the twelve site in Fig.7.

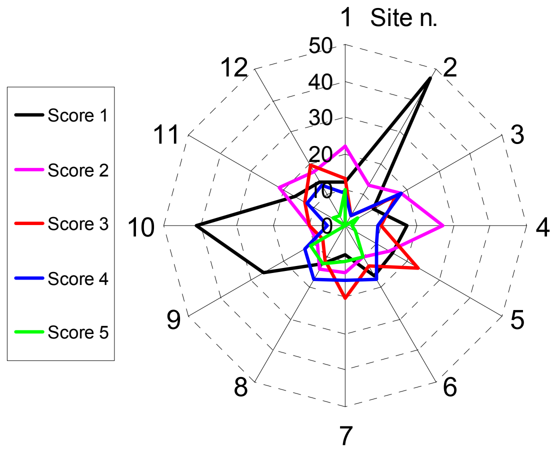

Fig.7 Example of occurrences of the five scores obtained for each combination site-sound (recording at site R8)

In particular, the occurrences of score 4 (good relevance) and 5 (very good relevance) were added together, as well as those of score 1 (no relevance) and 2 (poor relevance). In Fig. 8 the maximum value of the percentage of the above occurrences, calculated across all the responses, are plotted for the sites rated most (blue circles) and least (black squares) relevant with the sound heard. Among the former, only 4 sites were from Naples, while site R2 and R8 from Rome were judged mostly relevant for three sound recordings.

The correct association site-sound, reported with red stars in Fig.8, matched the occurrences of scores 4 and 5 in five sites (4 in Rome and 1 in Naples) and the highest values correspond to sites R2 and R10. On average, 44% of subjects gave the correct site-sound association with a standard deviation of 17.7%.

As expected, the maximum values of percentage of occurrences of scores 1 and 2 are higher, and they show a smaller variability across the sounds. Sites N9 and R8 were considered both poorly congruent for four sound recordings each.

In the sites R2 and R10, showing the highest correct site-sound association, the sources recognized by the subjects were human and natural sounds (see Fig. 5 and 6), while these sites were considered non relevant with sound recorded at N7 and R8, where non natural sources were frequently detected (Fig.5).

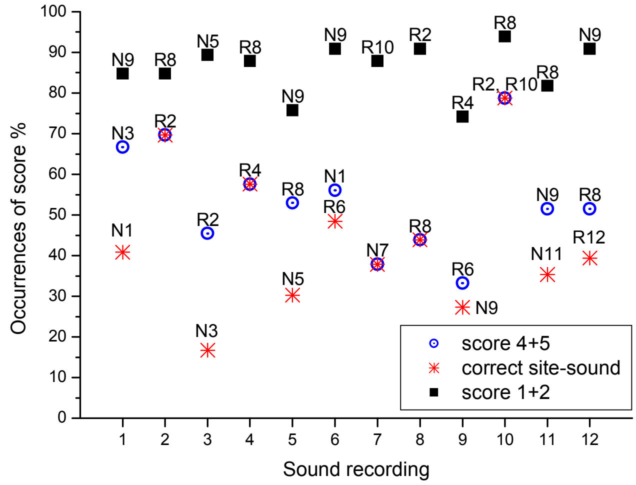

Fig.8 Sites rated most (blue circles) and least (black squares) relevant with the sound recordings and correct site-sound association (red stars)

4 Conclusions

The experiment has confirmed the importance of both the auditory perception and visual information on landscape assessment of a site.

The results have shown that the recognition of sound source nature, accurately made by the subjects, provides an important cue to assess the correct site-sound congruence. On average, 44% of subjects gave the correct site-sound association with a standard deviation of 17.7%.

Acknowledgments

The Authors wish to thank Flaminia Verardi for her assistance in the binaural recordings carried out in Rome.

References

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