



## The effects of acoustic environment on pedestrians' anxiety on a night street

Ohno, Ryuzo <sup>1</sup> Matsuda, Tokuko <sup>2</sup>

Keywords: anxiety; acoustic environment; night street

**Abstract** In urban areas people tend to stay out later at night, making it more important than ever to keep public spaces free from crime. Since many people, particularly women, often overestimate the risk of actually falling victim to crime, measures moreover need to be taken to make places *feel* safe in order to prevent limiting nighttime activity. As a step toward designing public spaces to feel safe and comfortable at night, the present study employs an audio-visual simulation laboratory to examine how acoustic conditions affect pedestrians' sense of anxiety while walking along a night street.

For the study, virtual night streets were created inside an audio-visual simulation laboratory through images projected on a front screen and sounds transmitted over headphones. The 36 subjects were asked to imagine they were walking on the street to visit a friend's house late at night. Three settings (a small local shopping street, a street along a city park, and a street in a residential neighborhood) were combined with 13 types of sound (such as footsteps, conversation, an automobile, a streetcar, police car sirens, and silence) for a total of 35 experimental situations. The subjects rated their degree of anxiety on a 7-grade scale from "very anxious" to "very much at ease"; the reasons for their responses were queried in a later interview.

Major findings were as follows. 1) The sound of a man's footsteps from behind aroused the most anxiety. A woman's footsteps, on the other hand, were rated positively particularly by female subjects, suggesting that the presence of other female pedestrians was a source of reassurance. 2) In another, even clearer illustration of the effect of natural surveillance, the sound of female conversation was also shown to make pedestrians feel safer. Male conversation aroused concern in some subjects, however. 3) Environmental sounds such as that of an unseen running train made some subjects feel more secure than total silence because the association with nearby human activity reduced their sense of isolation.

In all, the results illustrate that pedestrians on a night street associate acoustic information with various possible scenarios that may arouse or assuage anxiety. One useful way to provide assurance is to give indications of other, non-threatening pedestrians present along the same path.



1. Department of Built Environment, Tokyo Institute of Technology, Yokohama, Japan

2. Sekisuihouse Co. Ltd, Yamagata, Japan

## Introduction

In urban areas people tend to stay out later at night, making it more important than ever to keep public spaces free from crime. Since many people, particularly women, often overestimate the risk of actually falling victim to crime, measures moreover need to be taken to make places feel safe in order to prevent limiting nighttime activity (Amamiya and Yokohari, 2002; Kimura and Kumagai, 2005). One common measure adopted to enhance both perceived and actual safety is to install street lights and/or increase their luminance (Newman, 1973; Kobayashi, Maki and Inui, 2003). However, growing environmental concern as well as power-supply issues, which have become especially pertinent in Japan in the wake of the March 2011 Fukushima nuclear accident, require that such lighting be used judiciously, for example by adjusting lamps to shine more brightly during hours that people tend to feel most unsafe but be kept lower in others. In darkness, perceptions are greatly influenced by the sense of hearing, which overtakes other senses as a source of environmental information (Anderson, 1983). To help design public spaces to feel safe and comfortable at night, the present study employs an audio-visual simulation laboratory to examine how acoustic conditions affect pedestrians' anxiety while walking along a night street.

## Method

### Experimental settings and situations

Virtual night streets were created inside an audio-visual simulation laboratory through images projected on a front screen and sounds transmitted over headphones (Fig. 1). The images were recorded on a video camera moved along three settings: a small local shopping street, a street along a city park, and a street in a residential neighborhood (Fig. 2). All three streets were straight and level with similar width. Common nighttime sounds were also recorded, of which 13 types were selected for the experiment including footsteps, conversation, an automobile, a streetcar, and police car sirens. The three settings were combined with the 13 types of sound for a total of 35 experimental situations (Tab. 1).

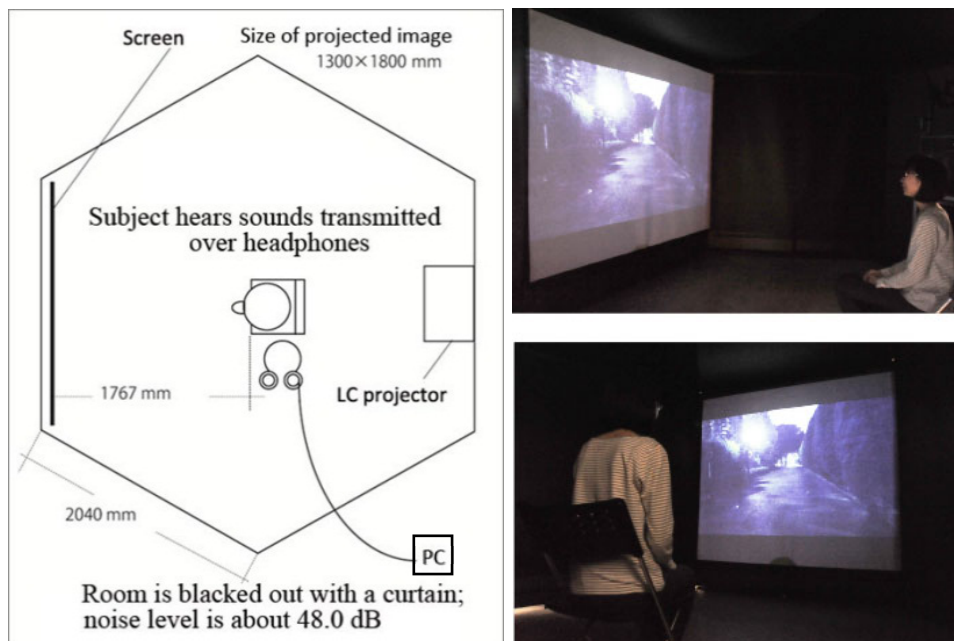


Fig. 1 The audio-visual simulation laboratory

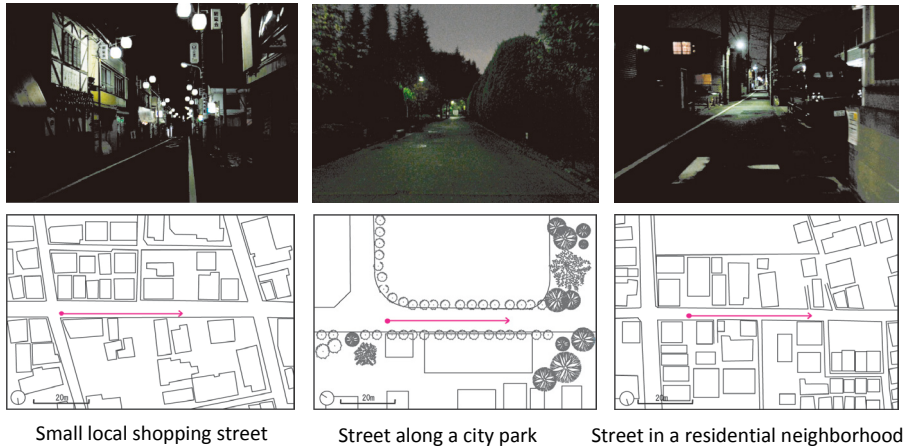


Fig. 2 Experimental settings (3 visual images of streets)

	Sound stimulus	Source	Details	Shopping street	City park	Residential neighborhood
1	Man's footsteps	people on the street	heard from behind	○	○	○
2	Woman's footsteps		heard from behind	○	○	○
3	Runner's footsteps		approaching from behind and passing	○	○	○
4	Men's conversation		two men's conversation heard from behind	○	○	○
5	Women's conversation	vehicle on the street	two women's conversation heard from behind	○	○	○
6	Bicycle		approaching from behind and passing	○	—	○
7	Motorcycle		approaching from behind and passing	○	—	○
8	Automobile		approaching from behind and passing	○	—	○
9	Household noise from buildings along the street	surroundings (unseen sources)	television (shopping street); washing of dishes (residential neighborhood)	○	—	○
10	Howling of dogs		dogs barking somewhere	○	○	○
11	Streetcar		crossing bell	○	○	○
12	Police car sirens		sirens of a police car	○	○	○
13	Silence		background noise without identifiable sound	○	○	○

Tab. 1 Experimental situations (combination of 3 visual images and 13 sound stimuli)

## Procedure

The 36 subjects (18 male and 18 female graduate students) were asked to imagine they were walking on the street to visit a friend's house late at night. The subjects experienced each situation for about 20 seconds, after which they rated their degree of anxiety on a 7-grade scale from "very anxious" to "very much at ease"; the reasons for their responses were queried in a later interview. Each subject required 50 to 70 minutes to complete the experiment.

## Results and Discussion

### Overall trends

#### Effect of type of sound

Fig. 3 shows the anxiety rating for each sound stimulus averaged across subjects and settings. A man's footsteps from behind aroused the most anxiety, followed by a runner's footsteps and the sound of a vehicle, while women's conversation and household noise from buildings along the street seemed to provide positive associations of safety. This suggests that evidence of other people and their activities provokes either negative or positive associations depending on their nature.

### Effect of subject sex and street location

Fig. 4 indicates the proportion of male and female subjects who responded in each category of the 7-grade scale. The women generally showed a higher level of anxiety than the men did, as expected. In terms of street location (Fig. 5), anxiety ratings for the park street was slightly higher than those for the shopping street and residential neighborhood, where subjects were more likely to think they could expect some help in case of an emergency.

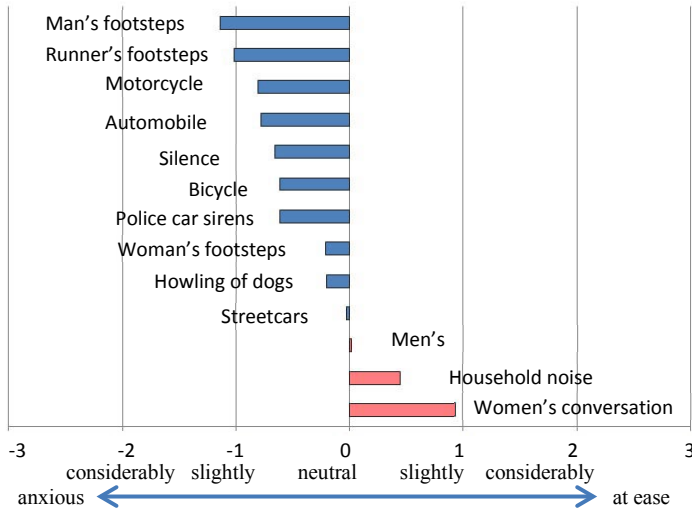


Fig. 3 Average anxiety ratings

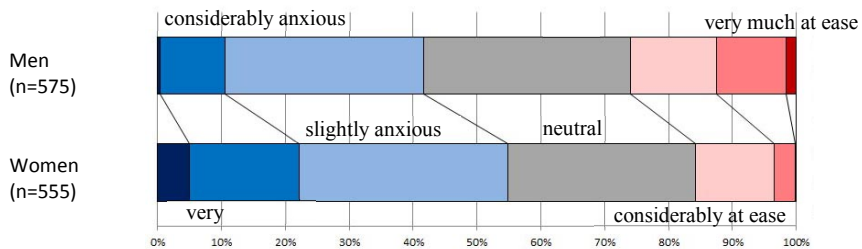


Fig. 4 Ratings by sex

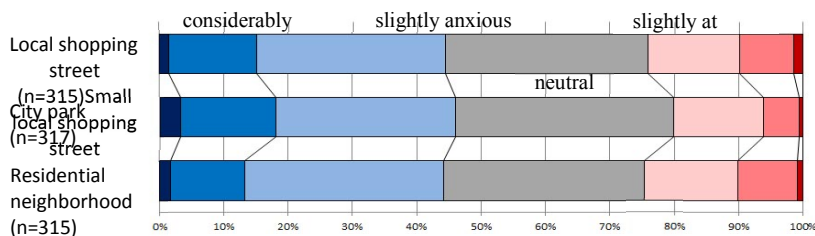


Fig. 5 Ratings by location

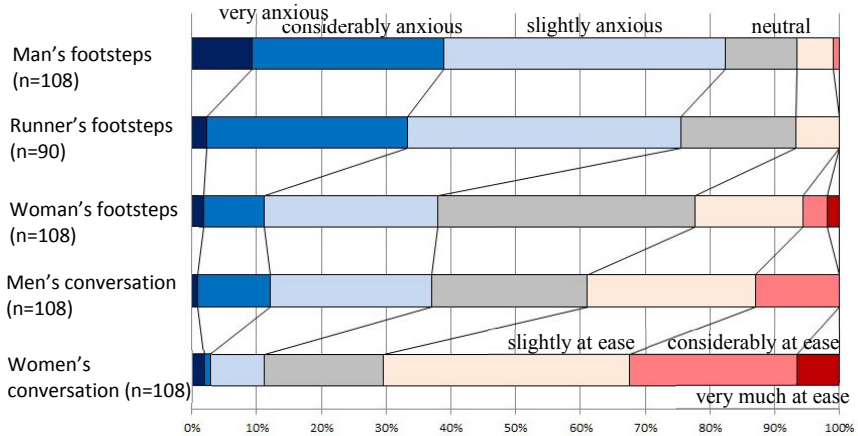


Fig. 6 Ratings of sounds caused by other people's activities

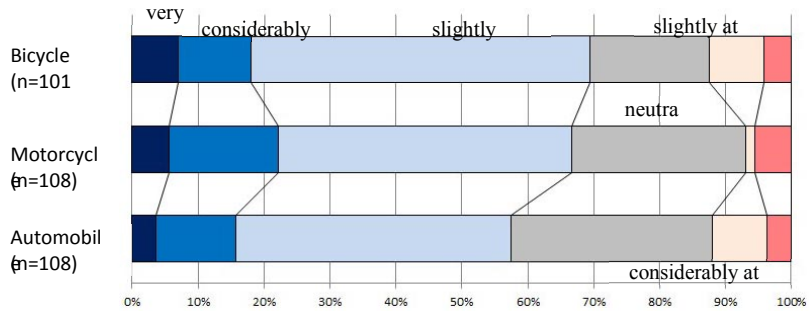


Fig. 7 Ratings of vehicle sounds

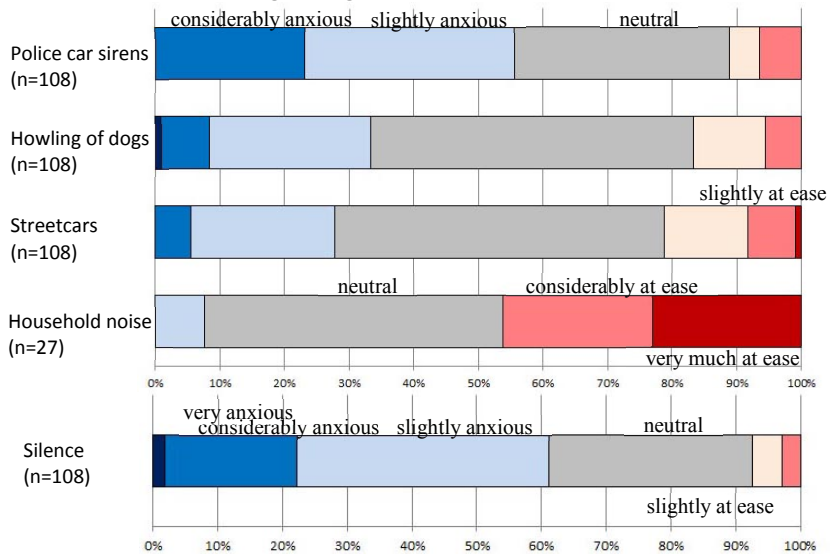


Fig. 8 Ratings of environmental sounds

### Effect of sound source

As already mentioned, a man's and a runner's footsteps from behind raised anxiety. Women's and men's conversation, on the other hand, were rated positively (Fig. 6). Interestingly, a bicycle or motorcycle approaching from behind was felt to be more threatening than an automobile (Fig. 7). This may be explained by subjects' concern about bag-snatching, which is reported to occur frequently in Japan.

### Effect of environmental sounds

More than half the subjects felt at least slightly anxious on hearing police car sirens (Fig. 8). Subjects may have associated the sirens with a troublesome incident nearby and worried about encountering criminals or judged the area to be unsafe. On the other hand, household noise from buildings along the street, such as the sound of television or of dishes being washed, made subjects feel at ease probably because it let them know the residents were still awake. Unseen running trains made some subjects feel more secure than total silence because the association with nearby human activity reduced their sense of isolation. Interestingly, total silence without identifiable sound made subjects feel even more anxious than police car sirens did. Environmental sounds seem to evoke associations leading to positive or negative inferences about circumstances beyond one's sight.



Fig. 9 Ratings of footsteps from behind by sex and location

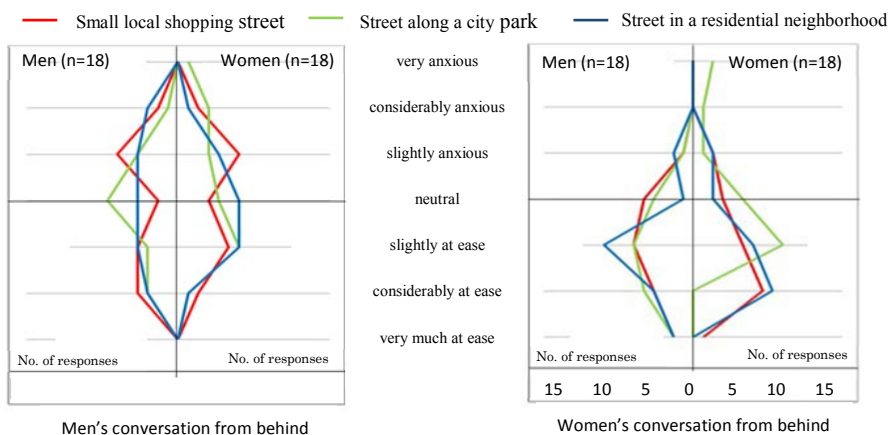


Fig. 10 Ratings of conversational voices by sex and location

## Results by subject sex

### Footsteps

For both sexes, a man's footsteps from behind (Fig. 9 left) aroused more anxiety than a woman's footsteps (Fig. 9 right). In fact, a woman's footsteps were rated positively particularly by female subjects, suggesting that the presence of other female pedestrians was a source of reassurance.

### Conversational voices

As shown in Fig. 10 left, men's conversation from behind prompted both positive and negative responses. Women's conversation from behind was reassuring for both sexes, although the effect was more pronounced for female subjects.

## Results by location

As shown in Fig. 11 left, total silence along the shopping street made subjects more anxious than it did near the park or in the residential neighborhood, while as shown in Fig. 11 right, a runner's footsteps made subjects less anxious when heard along the park street than on the shopping street or in the residential neighborhood. These results suggest that sounds felt out of place arouse anxiety. In the former case, total silence along a shopping street is more unusual than near a city park or in a residential neighborhood; in the latter, a runner in a city park is more explainable than one in either of the two other settings.



Fig. 11 Influence of location on degree of anxiety

## Conclusion

The results of the experiment illustrate that pedestrians on a night street associate acoustic information with various possible scenarios that may arouse or assuage anxiety. One useful way to provide assurance is to give indications of other, non-threatening pedestrians present along the same path. Effective lighting control that takes the acoustic environment into account should contribute to the creation of public spaces that feel safe and comfortable even at night.

## Acknowledgement

This work was supported by Japan Society for the Promotion of Science (JSPS) KAKENHI Grant Number 23360265.

## **References**

Amamiya, M. Yokohari, M. (2002). The Physical Characteristics of Greenways that Instill the Fear of Crime in a New Town, *Journal of the Japanese Institute of Landscape Architecture* 65(5), 823-828.

Anderson, L.M. (1983). Effects of sounds on preference for outdoor setting. *Environment and Behavior* 15(5), 539-566.

Kimura, C., Kumagai, Y. (2005). A Study on Spatial Characteristic of Tree-lined Sidewalk that Causes a Fear of Crime (Papers of the 23th Scientific Research Meeting), *Journal of the Japanese Institute of Landscape Architecture*, 68(5), 825-828.

Kobayashi, S., Maki, K., Inui, M. (2003). A Study related to the low illuminance of Street Lighting with Incorporated Natural Surveillance, Part 1: Aptitudes of night-time street lighting that considers house-street relevance, *J. Environmental Engineering, AIJ*, (568), 25-31.

Newman, O. (1973). *Defensible Space; Crime Prevention through Urban Design*. Macmillan Pub Co.