Relation between noise evaluation and daily noise exposure to road traffic noise and railway noise

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ABSTRUCT

This study examined the effects of noise exposure in daily life on noise evaluation. Specifically, this study investigated road traffic noise and railway noise effects on the evaluation of annoyance evaluations. A questionnaire survey was administered to students walking near a construction site. I received responses from 316 people.

Conclusions of this study about relationship between daily exposure to road traffic noise and railway noise and annoyance of construction are, rrespondents exposed to railway noise evaluate that construction noise is annoying. On the other hand, there are no relationships between road traffic noise and annoyance.

INTRODUCTION

When exposed to various noises in daily life, we feel or do not feel them as noisy, loud, and annoying. Road traffic noise might disturb sleep in houses facing roads. Railway noise might disturb conversation or listening to TV in a house near a railway every time a train passes. Aircraft noise might disturb the rest of people in houses near an airport. We sometimes feel noise from voices of children playing and sounds of musical instruments played by neighbors.

Sensitivity to noise differs within and among individuals. For example, sensitive people often think that noise is unendurable or annoying even if they are healthy or if they live in a house with maximum consideration for noise. Psychological factors and social factors relate to the sensitivity to noise along with physiological hearing capability. Railway users might tend to accept railway noise and aircraft enthusiasts might feel that the aircraft noise is comfortable. Physical and psychological states might affect the sensitivity of the same person. The noise characteristics might also affect a person's sensitivity to it.

This study examines the relation between daily noise exposure and noise sensitivity. That sensitivity can be increased or decreased by noise exposure. This study also assesses their effects on the relation between sensitivity and noise evaluation. Moreover, this study addresses differences attributable to noise types.

Yano et al. reported that study of Kaku et al. showed that railway noise is more annoying than road traffic noise, but Tamura's study demonstrated that road traffic noise is more annoying than railway noise. This study examines road traffic noise and railway noise as usual daily noises and investigates the relation between daily noise exposure to these noises and evaluation of noise. Building construction noise at the actual spot of building construction is selected as an object of evaluation.

METHODS

We conducted a questionnaire survey near a construction site for building renewal at Osaka City University. Principal noise sources deriving from the construction were mobile concrete pumps and backhoes. The survey, which was administered from approximately 11:00 a.m. to 17:00 p.m. during 3 days (July 10–12, 2013), targeted students walking near the construction site (Fig. 1). Students taking a seat at point A evaluated the construction noise and filled out the questionnaire. The L_{AE} was

measured using a sound level meter (1 s interval, dynamic characteristic A) placed at 1.2 m height near point A.

Survey items included the following.

1) Age, Sex, Faculty, School year, Buildings commonly visited at the university
2) Sound sensitivity (sensitive–insensitive, four-point scale)
3) Format of university attendance (day-scholar or resident), type of residence (detached house or apartment building), Number of household members
4) Daily exposure (road traffic noise, railway noise, factory noise, airplane noise, commercial facility noise, construction noise, 'Are you exposed to noise in daily life?', three-point scale)
5) Noise in daily life (children, animals, musical instruments, etc., three-point scale)
6) Annoyance related to construction (0–10, 11 rated, 'How much do you feel annoyed by construction noise?').

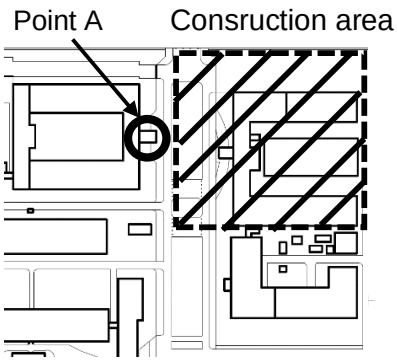

Figure 1: Location chart.

Picture 1: Survey scene.

RESULTS

1. Attributes of residents

Respondents were 314 (141 men, 173 women). Of all respondents, the age with the largest number was 19 (*n*=66), second largest was 20 (*n*=61). The school year with the largest number was first year (*n*=80), followed by second year (*n*=72), followed by fourth-year students (*n*=57). The faculty with the largest number of respondents was human life sciences (*n*=83), followed by technology (*n*=70).

Figure 1 shows the distribution of sound sensitivity. Of the total number of respondents, 15.8% answered that they are sensitive to sound, 52.5% answered that they are somewhat sensitive, 24.5% answered that they are somewhat insensitive, and 7.2% answered that they are insensitive to sound.

Because 89.5% answered that they are not exposed to factory noise, 92.0% to airplane noise, 93.3% to commercial facility noise, and 70.5% to construction noise in daily life, daily exposure is mainly attributed to road traffic noise and railway noise.

Table 1 shows the number of combinations of road traffic noise and railway noise with group number (#1 – #9). Of the total number of respondents, 42 people reported road traffic noise; 26 people reported railway noise.

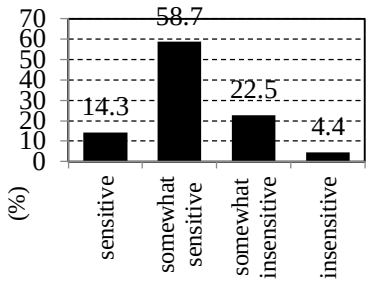

Figure 2: Distribution of sound sensitivity answers.

Table 1: Number of responses related to road traffic noise and railway noise with group numbers (#1 – #9).

		Raiway noise		
		Existence(n=26)	Slight existence(n=51)	No existence(n=236)
Road traffic noise	Existence(n=42)	9	6	27
		#1	#2	#3
	Slight existence(n=126)	9	28	89
		#4	#5	#6
	No existence(n=145)	8	17	120
		#7	#8	#9

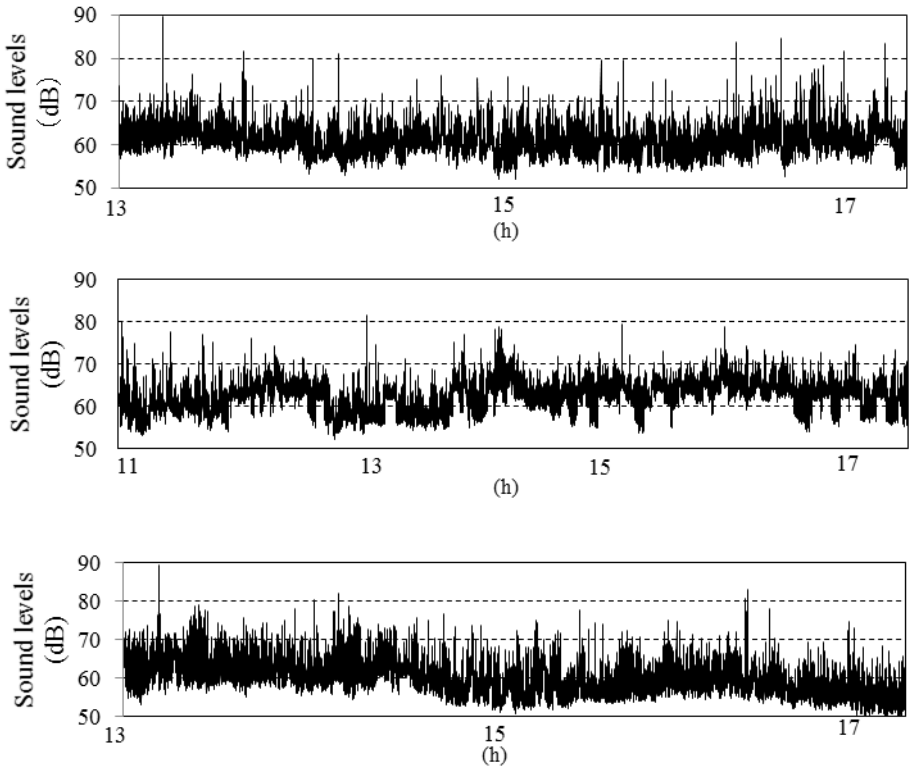

Figure 3: Sound level (Lp) in questionnaire survey (July 10–12).

Figure 3 shows sound levels (L_p) in the questionnaire survey. The average value of measured period (L_{eq}) was 62.9 dB on July 10, 63.6 dB on July 11, and 62.6 dB on July 12. Therefore, the third day was the lowest. L_{max} was 84.6 dB on July 10; L_{min} was 50.9 dB on July 12.

2. Annoyance with construction

It takes about 5 min to fill out all questionnaire items. It takes about 2 min to fill out as far as the item of annoyance of construction on average. Figure 4 shows the distribution of answers of annoyance. Annoyance has a bimodal distribution (3 and 7). Figure 5 shows the average value of $L_{Aeq(2min)}$ of respondents in each annoyance (2–5), where $L_{Aeq(2min)}$ means the average value of L_p per 2 min. No statistically significant difference was found by the Kruskal–Wallis test. Figure 6 presents the correlation between $L_{Aeq(2min)}$ and annoyance (R^2=0.0304).

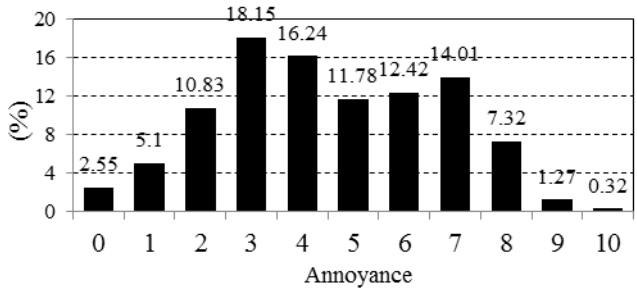

Figure 4: Distribution of answer of annoyance.

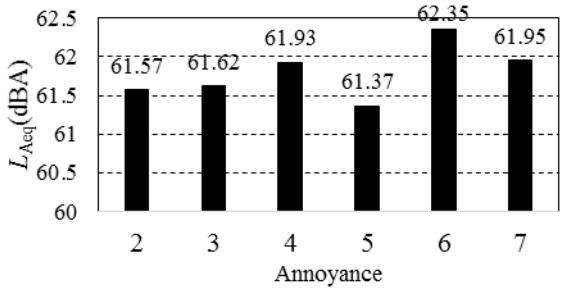

Figure 5: Average value of $L_{Aeq(2min)}$ of respondents for each annoyance (2--7).

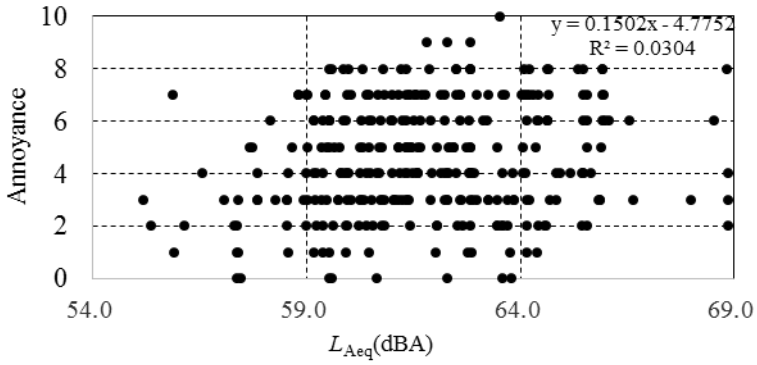

Figure 6: The correlation between $L_{Aeq(2min)}$ and annoyance.

3. Relation between daily exposure and annoyance

Figure 7 shows the average value of annoyance divided by each group number of daily exposure (#1 – #9). Significant differences were found by the Kruskal--Wallis test (*p* value=0.1498).

Figure 8 shows the distribution of annoyance evaluated by the group that was not exposed to neither road traffic nor railway noise (#9) and the group that was exposed to either road traffic or railway noise (#1 – #8). Significant difference was found (*p* value=0.0284).

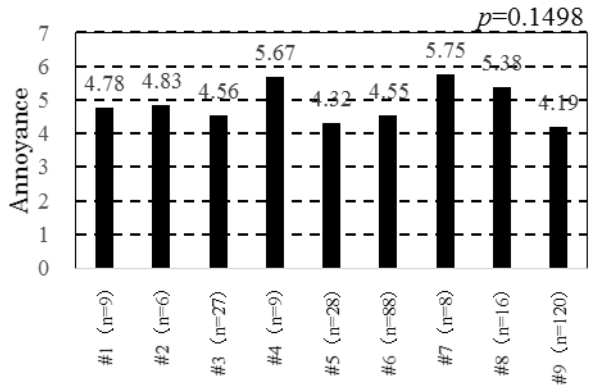

Figure 7: Average value of annoyance divided by each group number of daily exposures (#1 – #9).

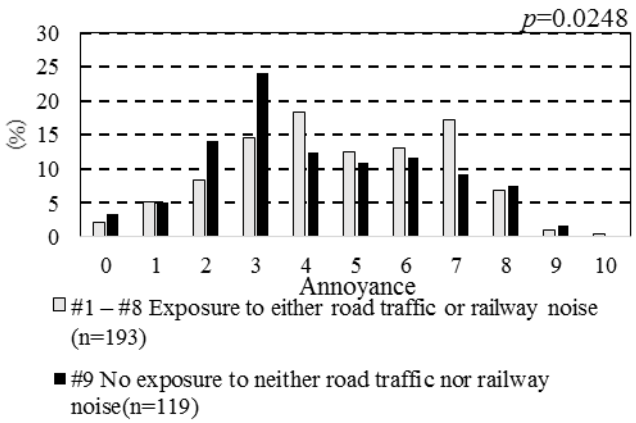

Figure 8: Distribution of annoyance evaluated by #1 – #8 and #9.

Figure 9 shows the distribution of annoyance evaluated by the extent of exposure to road traffic noise; Fig. 10 shows a distribution of annoyance as evaluated by the extent of exposure to railway noise.

Figure 11 shows a distribution of annoyance as evaluated by the group that was more affected strongly by road traffic noise than by railway noise (#2, #3, and #6) and the group that was more strongly affected by railway noise than by road traffic noise (#4, #7, and #8). Figure 12 presents the average value of annoyance divided by each extent of exposure of Figs. 9–11 with *p* values by the Kruskal–Wallis test.

No relation was found between daily exposure and annoyance (Fig. 9). Respondents exposed to railway noise are distributed on the annoyed side (Fig. 10), and respondents exposed more strongly to road traffic noise than railway noise are also distributed on the annoyed side (Fig. 11). Therefore, significant differences were found between exposure to railway noise and annoyance related to construction noise.

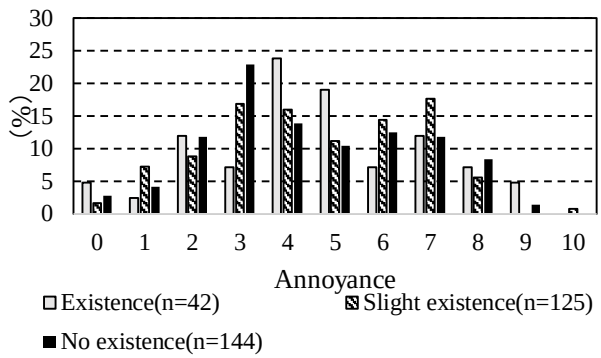

Figure 9: Distribution of annoyance evaluated by the extent of exposure to road traffic noise.

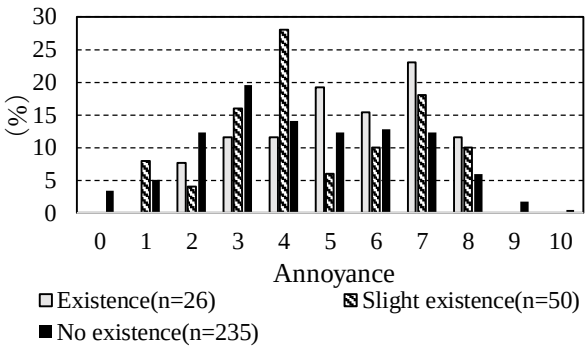

Figure 10: Distribution of annoyance evaluated by the extent of exposure to railway noise.

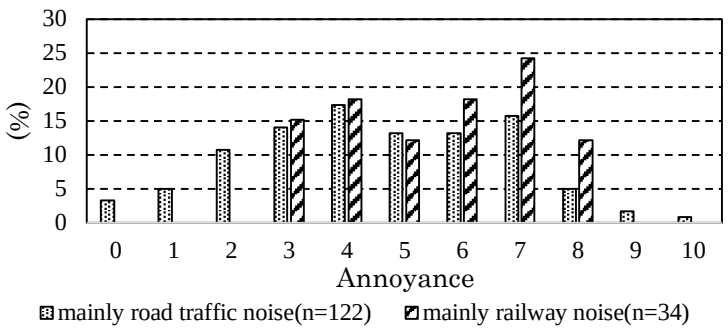

Figure 11: Distribution of annoyance as evaluated by #2, #3, #6 and #4, #7, #8.

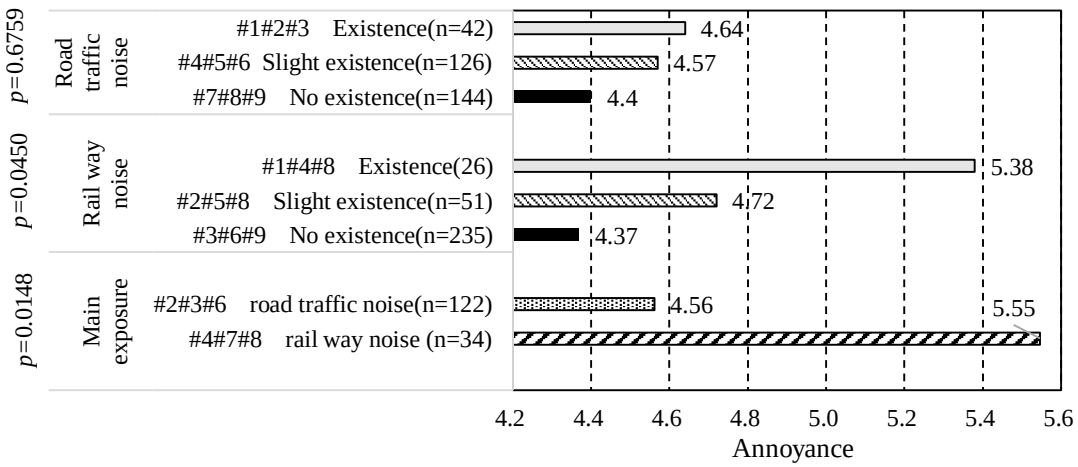

Figure 12: Average value of annoyance divided by each extent of exposure of Figs. 9–11.

4. Sensitive to sound and daily exposure

4.1 Daily exposure and sensitivity

Figure 13 shows distribution of sensitivity divided by the extent of exposure to (a) road traffic noise, (b) railway noise, or (c) groups strongly affected by road traffic noise or railway noise than the other. No significant difference was found in any group by chi-square test *p* value=0.8689, (b) *p* value=0.5363, (c) *p* value=0.6611, or (d) *p* value=0.3307). Therefore, no relation is inferred between daily exposure and sensitivity.

4.2 Sensitivity divided by daily exposure and annoyance

Figure 14 shows the distribution of annoyance divided by sensitivity (sensitive side, insensitive side) that respondents exposed to road traffic noise (#1, #2, and #3) or railway noise (#1, #4, and #7) answered. Figure 15 presents a distribution of annoyance divided by sensitivity of respondents with slight or no exposure to road traffic noise or railway noise. Furthermore, Fig. 16 presents the distribution of annoyance divided by sensitivity that respondents who were exposed to neither the road traffic nor railway noise (#9) or who were exposed either to road traffic or railway noise (#1 – #8). The sensitive side is the group that respondents answered sensitive or somewhat-sensitive, and insensitive side is the group that respondents answered insensitive or somewhat-insensitive. *P* values are shown in all figures.

For respondents exposed to road traffic noise or railway noise in daily life, no relationship was found between sensitivity and annoyance. However, for respondents not exposed to any noise, sensitive people answered that construction is annoying.

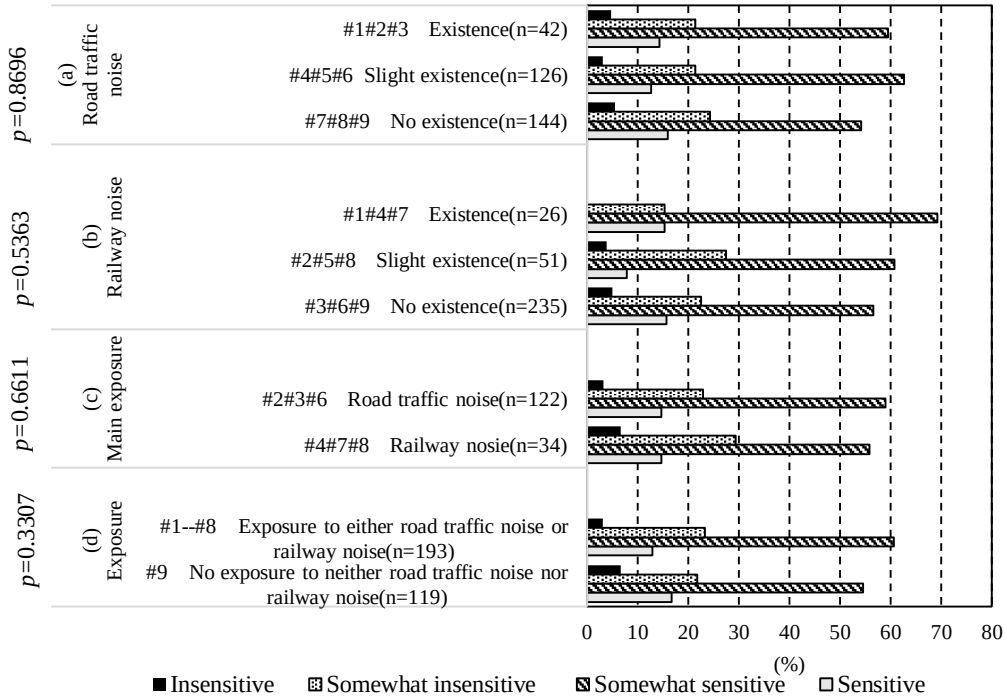

Figure 13: Distribution of sensitivity divided by (a)–(d).

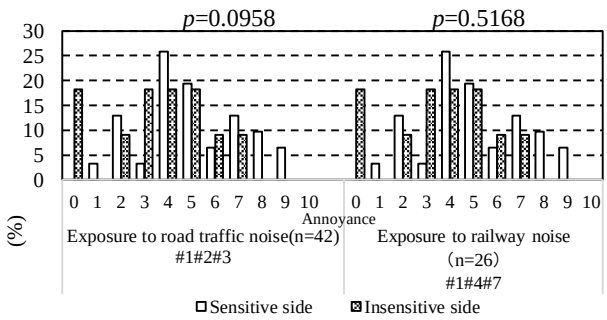

Figure 14: Distribution of annoyance divided by sensitivity (#1, #2, #3 and #1, #4, #7).

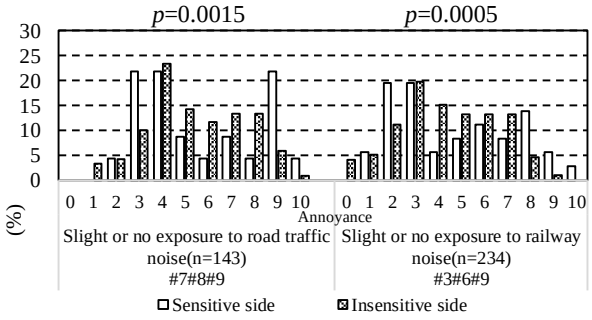

Figure 15: Distribution of annoyance divided by sensitivity (#7, #8, #9 and #3, #6, #9).

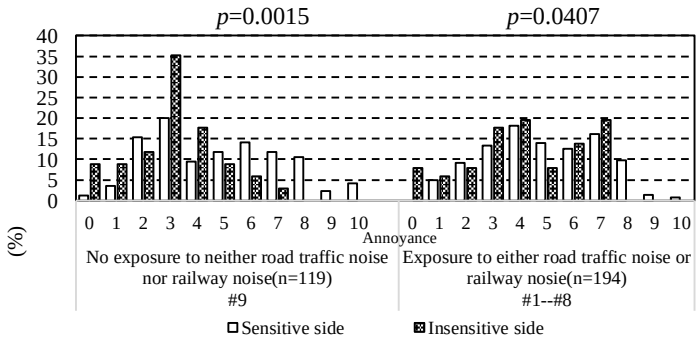

Figure 16: Distribution of annoyance divided by sensitivity (#9 and #1 – #8).

CONCLUSIONS

Conclusions of this study of the relation between daily exposure to road traffic noise and railway noise and annoyance of construction are the following.

(1) Respondents exposed to railway noise evaluated construction noise as annoying. However, no relation was found between road traffic noise and annoyance.

(2) No relation was found between daily exposure and sensitivity to sound.

(3) Among respondents not exposed to any noise in daily life, sensitive people answered that construction was annoying.

REFERENCES

Takashi YANO, Tetsumi SATO, Keizi KAWAI et al. (2004). Comparison of community response to road traffic and railway noises, Acoustical Science and Technology, Vol.60 (4), (pp 165-175).