Influence of attitudes to noise sources on annoyance

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INTRODUCTION

The influence of transportation noise on the quality of life has so far been investigated by socio acoustical surveys, some of which have shown that noise annoyance is affected by not only noise exposure but also non-acoustical factors. Fields (1993) conducted meta-analysis on the effects of personal and situational variables on annoyance, in which he indicated that noise annoyance was strongly affected by three attitudes (fear, preventability, sensitivity) and weakly by situational factors but not by demographic factors (age, social status, etc.), exposure time, ambient noise and interview method. Miedema & Vos (1999) also pointed out that fear and sensitivity were important on the prediction of noise annoyance. Hong et al. (2007) also showed by ANOVA that sensitivity had a significant effect on sleep disturbance but sex and age of participants did not. Sandrock et al. (2008) demonstrated that people who are more sensitive to tram and bus noise gave higher annoyance at experimental study. On the other hand, using a magnitude estimation method in laboratory experiment, Ellermeier et al. (2001) showed that the degree of sensitivity did not affect response to noise. Though these studies were mainly related to sensitivity, there were a few other studies which investigated the influence of the attitudes towards noise sources. Since noise annoyance is usually affected by socio-cultural factors, investigating the effect of the attitudes on annoyance in Japan may be the key to find out the difference in dose-response relationships for transportation noises between Japan and Euro-American countries (Fields & Walker 1982; Knall & Schuemer 1983; Moehler 1988; Miedema & Vos 1998; Kaku & Yamada 1996 and Morihara et al. 2002). The purpose of this study is, therefore, to investigate whether the attitudes, in terms of the frequency of noise source usage, cognition to noise source and safety image of noise source, affect noise annoyance.

METHODS

Social surveys

Data from three socio-acoustic surveys, respectively on community response to road traffic and railway noises in Ishikawa 2007, on high speed train noise in Fukuoka 2003 and on aircraft noise in Kumamoto 2006 were analyzed, in which noise annoyance was measured by the ICBEN standardized 5-point verbal scale. Table 1 shows the summary of the socio-acoustic surveys. The sample sizes were 950, 724 and 413, respectively. The respondents were randomly selected on a one-person per family basis from detached houses. Questionnaires consisted of questions on annoyance due to transportation noise source as the key question, activity disturbances caused by each noise source, house structure, residential environment, attitudes towards transportation and personal factors. Questions on the three attitude variables and the relative frequency of responses are shown in Table 2.

Table 1: Summary of socio-acoustic surveys

Survey ID	Year	Source	Area	Sample size	Response rate (%)
HRW03	2003	High speed train	Fukuoka	724	66
AC06	2006	Aircraft	Kumamoto	413	53
RT&RW07	2007	Road traffic and Railway	Ishikawa	950	59

Table 2: Question wordings and relative frequency

	HRW03	AC06	RT&RW07 (car)	RT&RW07 (railway)
Q1 (frequency): How frequently do you use the transportation (noise source)?				
1. not at all	3.7	5.9	5.0	28.1
2. seldom	15.5	13.0	4.5	44.5
3. sometimes	36.1	30.9	14.5	21.5
4. often	8.0	7.2	23.3	4.3
5. very often	36.8	43.1	52.7	1.6
Q2 (cognition): What do you think about usage of transportation (noise source) in the general public?				
1. positively	9.7	6.1	5.0	15.5
2. as … as possible	30.9	19.0	10.6	52.7
3. neither	52.3	65.6	45.8	30.0
4. as … as possible not	4.5	6.3	37.9	1.6
5. not at all	2.7	2.9	0.8	0.2
Q3 (safety): What do you think about safety of transportation (noise source)?				
1. very safe	20.8	7.1	2.0	22.3
2. relative safe	46.2	31.4	19.6	54.6
3. neither safe nor dangerous	28.8	46.1	40.8	21.3
4. relative dangerous	3.5	12.0	31.9	1.6
5. very dangerous	0.7	3.4	5.6	0.1

Noise exposure

The outdoor noise exposure levels at the nearest points from the sound source were calculated by measurement and equation of estimating attenuation. Noise exposure levels have not yet measured in Ishikawa survey. Noise exposure levels of LAeq,24h ranged from 32 to 50 dB in high speed train survey and from 43 to 53 dB in aircraft noise survey.

RESULTS

In this study, the effects of the three attitudes on noise annoyance were investigated by correlation coefficient and dose response relationships. The correlation coefficient was calculated with the data of HRW03, AC06 and RT&RW07 (abbreviations see Table 1. The dose-response relationships were established by using the data of HRW03 and AC06 and were compared between two groups divided by the attitude degree.

Correlation Coefficient

Correlation coefficient between each attitude and noise/exhaust gas/vibration annoyance is shown in Table 3. It was indicated that the correlation coefficients between frequency of transportation usage and three kinds of annoyance were very small in all surveys (maximum value is -0.096). The correlation coefficients between cognition and annoyance were also small. Though the correlation coefficients between safety and annoyance were small for HRW03 and RT&RW07, the correlation coefficient between safety and noise/vibration annoyance for AC06 were slightly larger, 0.165 and 0.238, respectively.

Table 3: Correlation Coefficient between attitudes and annoyance

attitude	survey ID	annoyance		
		noise	exhaust gas	vibration
frequency	HRW03	-0.052	-	-0.001
	AC06	0.039	-	0.055
	RT&RW07(car)	-0.012	-0.096	-0.022
	RT&RW07(rail)	0.044	-	0.029
cognition	HRW03	0.046	-	0.072
	AC06	0.062	-	0.041
	RT&RW07(car)	0.043	0.026	0.001
	RT&RW07(rail)	0.055	-	0.058
safety	HRW03	0.030	-	0.082
	AC06	0.165	-	0.238
	RT&RW07(car)	0.062	0.044	0.048
	RT&RW07(rail)	0.059	-	0.057

Dose-response relationships

This section shows whether dose-response curves would differ statistically between the two groups divided based on attitude factors. The curves were drawn by a nominal logistic regression analysis: the objective variable was noise annoyance, and the explanatory variables were noise exposure (LAeq, 24h) and each attitude. Annoyance was set to dummy variables as 1 is extremely; 0 is not at all, slightly, moderately and very. The attitudes were also set to dummy variables accordingly. The estimates of the parameters and their standard errors are shown in Table 4 (HRW03) and Table 5 (AC06), except the cases that the sample sizes were under 100. Figure 1 shows that aircraft usage significantly affected the dose-response relationships between noise annoyance and LAeq,24h for AC06 at 5 % level. However, the cognition and the safety did not significantly affect annoyance in AC06. Also the frequency of usage, the cognition and the safety had no significant effects on noise annoyance in HRW03. This may be because the people who frequently use aircraft know the airplane well, and they recognize that the aircraft should be quieter than the present circumstances.

CONCLUSIONS

The frequency of usage and the cognition of the noise sources had almost no correlations to noise, exhaust gas and vibration annoyance. The safety image of aircraft had very small correlations to noise and vibration annoyance. Dose-response curves were affected by the frequency of aircraft usage. It was found that the group frequently using aircraft was more annoyed than the other group. The cognition and the safety image of noise sources not affect dose-response curves in both noise sources. This study does not investigate the indirect effect of the attitudes towards noise sources, and there is scope for further discussion.

Table 4: Estimates, standard errors and p values are based on HRW03

(a) Frequency of transportation usage

	1+2 [1] vs. other [0]			5 [1] vs. other [0]			4+5 [1] vs. other [0]		
	Estimate	s.e.	P value	Estimate	s.e.	P value	Estimate	s.e.	P value
Constant	-13.96	1.80	<.0001	-13.95	1.81	<.0001	-13.96	1.81	<.0001
LAeq, 24h	0.28	0.04	<.0001	0.28	0.04	<.0001	0.28	0.04	<.0001
Frequency	0.24	0.25	0.346	-0.35	0.22	0.116	-0.29	0.21	0.164

(b) Cognition of noise source

	1+2 [1] vs. other [0]		
	Estimate	s.e.	P value
Constant	-13.71	1.75	<.0001
LAeq, 24h	0.27	0.04	<.0001
Cognition	0.22	0.21	0.289

(c) Safety images to noise source

	1 [1] vs. other [0]			1+2 [1] vs. other [0]		
	Estimate	s.e.	P value	Estimate	s.e.	P value
Constant	-13.37	1.73	<.0001	-13.30	1.74	<.0001
LAeq, 24h	0.27	0.04	<.0001	0.26	0.04	<.0001
Safety	-0.04	0.25	0.877	-0.08	0.21	0.706

Table 5: Estimates, standard errors and p values are based on AC06

(a) Frequency of transportation usage

	5 [1] vs. other [0]			4+5 [1] vs. other [0]		
	Estimate	s.e.	P value	Estimate	s.e.	P value
Constant	-11.15	1.66	<.0001	-11.33	1.67	<.0001
LAeq, 24h	0.19	0.03	<.0001	0.19	0.03	<.0001
Frequency	0.70	0.31	0.025	0.76	0.32	0.018

(c) Safety images to noise source

	1+2 [1] vs. other [0]		
	Estimate	s.e.	P value
Constant	-10.52	1.6	<.0001
LAeq, 24h	0.18	0.03	<.0001
Safety	-0.10	0.31	0.756

ACKNOWLEDGMENTS

This work was partially supported by Grant-in-Aid for Scientific Research (Project No: 19760408).

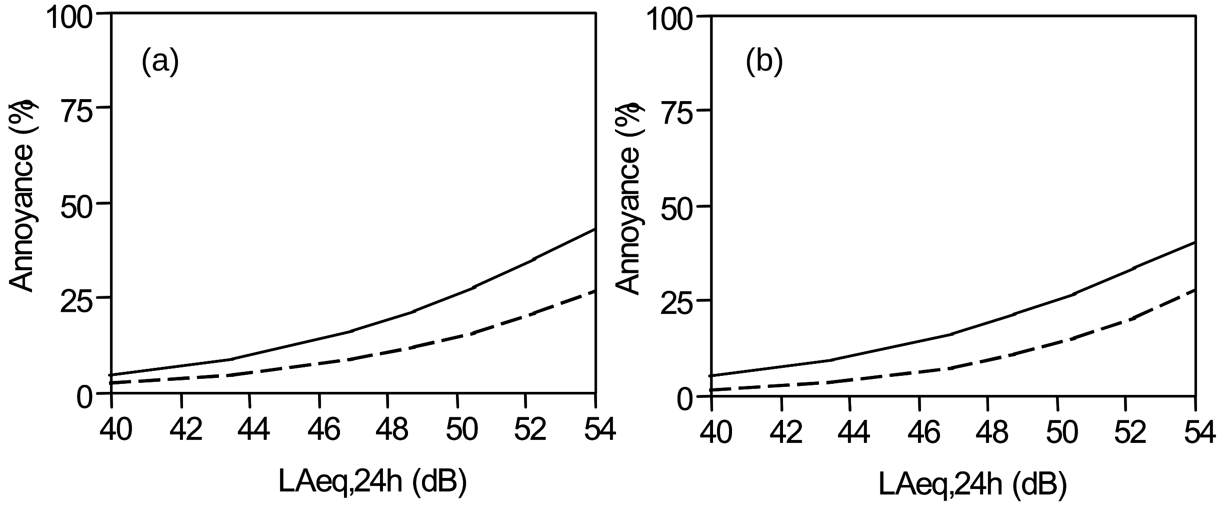

Figure 1: Dose-response relationships between annoyance and LAeq, 24h: (a) comparison extremely (solid line) with all other degrees of the frequency (broken line); (b) comparison very and extremely (solid line) with all other degrees of the frequency (broken line).

REFERENCES

Ellermeier W, Eigenstetter M, Zimmer K (2001). Psychoacoustic correlates of individual noise sensitivity. J Acoust Soc Am 109: 1464–1473.

Fields JM (1993). Effect of personal and situational variables on noise annoyance in residential areas. J Acoust Soc Am 93: 2753-2763.

Fields JM, Walker JG (1982). Comparing the relationships between noise level and annoyance in different surveys: a railway noise vs. aircraft and road traffic comparison. J Sound Vibr 81: 51-80.

Hong J, Kim J, Lim C, Lee S (2007). Comparative study on sleep disturbance from railway and road traffic noise. In: Proceedings of Inter-Noise.

Kaku J, Yamada I (1996). The possibility of a bonus for evaluating railway noise in Japan. J Sound Vibr 193: 445-450.

Knall V, Schuemer R (1983). The differing annoyance levels of rail and road traffic noise. J Sound Vibr 87: 321-326.

Miedema HME, Vos H (1998). Exposure-response relationships for transportation noise. J Acoust Soc Am 104: 3432-3445.

Miedema HME, Vos H (1999). Demographic and attitudinal factors that modify annoyance from transportation noise. J Acoust Soc Am 105: 3336-3344.

Moehler U (1988). Community response to railway noise: a review of social surveys. J Sound Vibr 120: 321-332.

Morihara T, Sato T, Yano T (2002). Comparison of dose-response relationships between railway and road traffic noises in Kyushu and Hokkaido. In: Proceedings of Inter-Noise.

Sandrock S, Griefahn B, Kaczmarek T, Hafke H, Preis A, Gjestland T (2008). Experimental studies on annoyance caused by noises from trams and buses. J Sound Vibr 313: 908-919.