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## Relationships between rating scales, question stem wording, and community responses to railway noise

Tetsumi Sato<sup>a,\*</sup>, Takashi Yano<sup>b</sup>, Takashi Morihara<sup>b</sup>, Kirk Masden<sup>c</sup>

<sup>a</sup>*Department of Architecture, Hokkai Gakuen University, Minami 26, Nishi 11, Chuo-ku, Sapporo 064-0926, Japan*

<sup>b</sup>*Department of Architecture and Civil Engineering, Kumamoto University, Kumamoto 860-8555, Japan*

<sup>c</sup>*Department of International Economics, Kumamoto Gakuen University, Kumamoto 862-8680, Japan*

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### Abstract

Two series of social surveys on community responses to railway noise were carried out in Japan to evaluate the relationships between two verbal scales and a numeric scale, and those among four base descriptors. In the first survey, two types of questionnaires were prepared in which a 0–10-point numeric scale was used in combination with either a four-point or a five-point verbal scale. The key questions concerned annoyance, activity disturbance and related effects caused by railway noise. Community responses were compared on the basis of the dose–response relationships. Regarding the percentages of respondents who answered, “highly annoyed,” it was found that there were no systematic differences between the two verbal scales. It was also found that the extent of noise annoyance rated on the four-point or five-point verbal scale corresponded with that rated on the 11-point numeric scale by percentages of scale steps. In the second survey, four types of questionnaires were prepared, each using one of the four base descriptors. Community responses to general noise annoyance among the four base descriptors were compared. No systematic differences were found among the four base descriptors.

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### 1. Introduction

Social surveys on environmental noise have been conducted in many countries. Since Schultz [1] proposed a synthesis curve on dose–response relationships for various noise sources, a

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\*Corresponding author. Tel: +81-11-841-1161, fax: +81-11-551-2951.

E-mail address: [sato@arc.hokkai-s-u.ac.jp](mailto:sato@arc.hokkai-s-u.ac.jp) (T. Sato).

considerable number of reviews have been carried out to try to summarize dose–response relationships obtained from different surveys. Some problems have been pointed out in comparing the results of surveys using verbal scales with different numbers of categories. In 1997, the Community Response to Noise Team (Team 6) of the International Commission on the Biological Effects of Noise (ICBEN) agreed to construct two different annoyance questions, one with a four- or five-point verbal scale and one with a 0–10- point numeric scale. As a part of the international joint study, experiments were performed in Japan to determine the modifiers for four- and five-point verbal scales [2]. The base descriptor, which is defined here as the part of the question stem that refers to the subjective impression of noise, was also considered in the joint study. The present paper discusses the relationships between the two verbal scales and the numeric scale, and those among the four base descriptors by using the data obtained from social surveys on railway noise in Japan.

## 2. Surveys

Two series of social surveys on community responses to railway noise were carried out in Hokkaido and Kyushu, Japan. In the first survey, conducted in 2001, a distribute-collect method was used in residential areas along four railway lines around Sapporo, Hokkaido. All of the houses surveyed were detached and faced the railways. Two kinds of questionnaires were prepared in which a 0–10-point numeric scale was used in combination with either a four- or a five-point verbal scale. The questionnaire consisted of about 40 questions related to environmental, housing and personal factors. The key questions concerned annoyance, activity disturbance and related effects caused by railway noise. The modifiers for the four- and five-point verbal scales are shown in Table 1 and the numeric scale is shown in Table 2, in the Japanese language. The English language modifiers that were determined in the joint study in England, Australia and USA are also shown in Table 1 for comparison. The respondents, from 20 to 75 years of age, were randomly selected from voter lists on a one-person-per-family basis. Two kinds of questionnaires

Table 1  
Annoyance modifiers for each category determined in the joint study by the ICBEN Team 6

Category	Japanese	English
<i>Five-point verbal scale</i>		
5	hijoni	extremely
4	daibu	very
3	tasho	moderately
2	sorehodo...nai	slightly
1	mattaku...nai	not at all
<i>Four-point verbal scale</i>		
4	hijoni	extremely
3	daibu	significantly
2	sukoshi	somewhat
1	mattaku...nai	not at all

Table 2  
Numeric scale

0	1	2	3	4	5	6	7	8	9	10
mattaku...nai										hijoni

Table 3  
Number of trains a day

	2001 survey in Hokkaido			2002 survey in Kyushu		
	Way and swift	Express	Freight	Way and swift	Express	Freight
Line 1	166–212	70	6	78–135	76	14–19
Line 2	159–266	—	—	52	—	—
Line 3	226	59	59	209–226	89	66–69
Line 4	87–100	—	—	83–137	—	—

Table 4  
Japanese base descriptors used in four questionnaires in 2002 survey

Base descriptor	Meaning
fukai	annoyed (used for all nuisances, such as sound, vibration, smell, etc.)
urusai	annoyed (usually used for sound source)
standard*	bothered, disturbed or annoyed
nayamasareru	bothered

\*The “standard” base descriptor, “nayamasareru, aruiwa jamasareru, urusai” is the translation of the English descriptor, “bothered, disturbed or annoyed,” that is used in the standardized question wording by the ICBEN Team 6.

were distributed in alternation to the homes, such that neighbors received a different type. The total numbers of respondents for the questionnaires with four- and five-point scales were 490 and 467, and the response rates were 70.2% and 66.6%, respectively. After the questionnaires were completed, noise measurements were made at several points. At reference points close to the railway, noise levels from various types of trains were recorded with an integrating sound level meter from morning to evening, and the  $L_{AE}$  value was calculated. The number of trains are shown in Table 3. Distance reductions at points 5, 10, 20 and 40 m from the reference points were measured simultaneously, and equations for estimating the distance reductions of  $L_{AE}$  were formulated. Noise exposure to each house was calculated from  $L_{Aeq(24)}$  at the reference point and the distance reduction.

In the second survey, conducted in 2002 in Kyushu, four types of questionnaires were prepared, each using one of the four Japanese base descriptors shown in Table 4. Both the words, “fukai” and “urusai,” mean “annoyed” in English. The former is used for all nuisances, such as sound, vibration, smell, etc, whereas the latter is usually used for sound. The word “nayamasareru” means “botherd” in English. The “standard” base descriptor, “nayamasareru, aruiwa jamasareru,

Table 5  
Response rates of questionnaires in two surveys

	Verbal scales in 2001 survey		Base descriptors in 2002 survey			
	Four-point scale	Five-point scale	fukai	urusai	standard	nayamasareru
Sample	698	701	630	629	634	634
Respondents	490	467	408	403	397	404
Response rate (%)	70.2	66.6	64.8	64.1	62.6	63.7

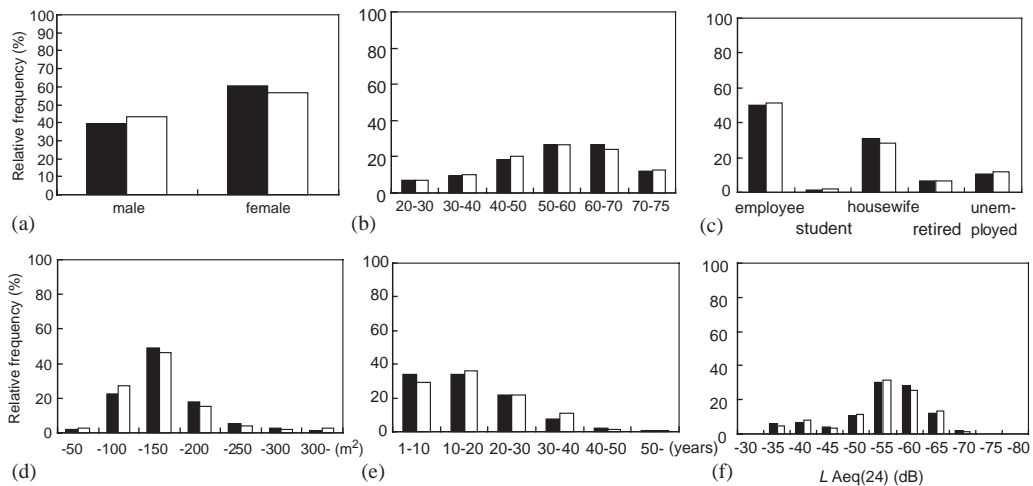


Fig. 1. Relative frequencies of responses to questions concerning personal and housing factors, and of noise exposure level in 2001 survey: (a) sex; (b) age; (c) present status; (d) floor space; (e) length of residence; (f) noise exposure level. ■, four-point scale; □, five-point scale.

urusai,” is the translation of the English descriptor, “bothered, disturbed, or annoyed,” that is used in the standardized question wording recommended by the ICBEN Team 6. These base descriptors are usually used for questionnaires in Japan. The survey procedure was the same as in the first survey, and the five-point verbal scale and the 11-point numeric scale were used. The numbers of respondents for each of the four types of questionnaires were between 397 and 408, and the response rates were between 62.6% and 64.8% as summarized in Table 5.

### 3. Results

Figs. 1 and 2 show the relative frequencies of responses to questions concerning personal and housing factors, and of noise exposure level. There were no systematic differences in distribution patterns between two questionnaires in the first survey, and those among four questionnaires in the second survey. This means that the populations selected for different annoyance scales or those for different base descriptors were uniform.

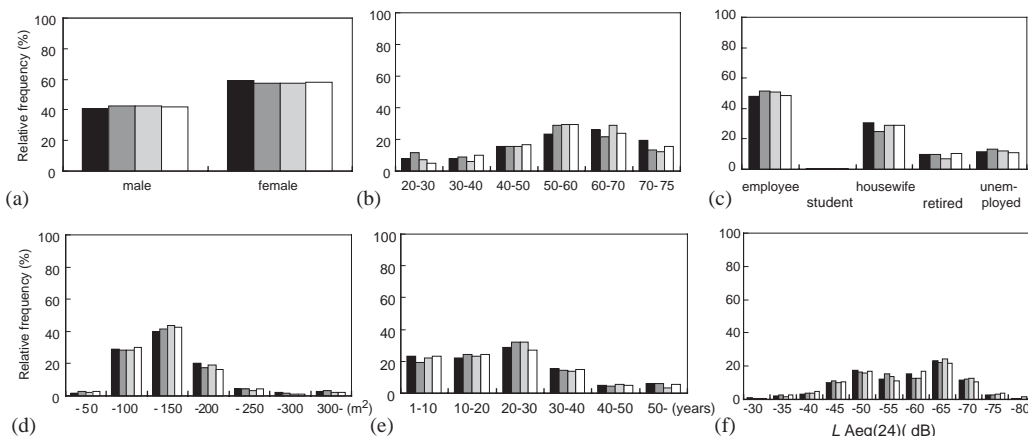


Fig. 2. Relative frequencies of responses to questions concerning personal and housing factors, and of noise exposure level in 2002 survey: (a) sex; (b) age; (c) present status; (d) floor space; (e) length of residence; (f) noise exposure level. ■, fukai; ▒, urusai; □, standard; ◻, nayamasareru.

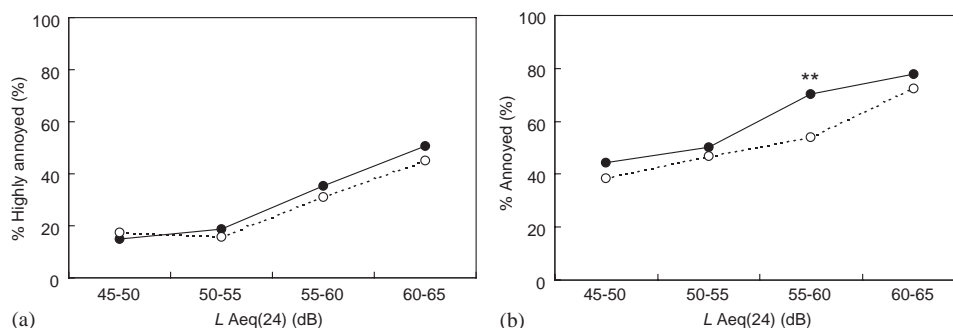


Fig. 3. Relationships between  $L_{Aeq}(24)$  and the extent of general noise annoyance with four- and five-point category scales: (a) top 1 category; (b) top 2 categories. —●—, four-point scale; —○—, five-point scale (\*\*, significant above 1% level).

### 3.1. Comparison of the two verbal scales

Fig. 3 shows the relationships between  $L_{Aeq}(24)$  and the extent of general noise annoyance. The rates of % annoyed for the top 1 and top 2 categories are defined here as the rates of the numbers of people who responded to either the top one or two, respectively, to the numbers of people exposed in a range of noise exposure level divided into five dB steps. It is seen that no significant differences were found in the rate of % annoyed for top 1 category, so-called “highly annoyed,” between the four-point and the five-point scales, whereas significant differences were found at one noise exposure level for the top 2 categories. Almost the same results were obtained for the activity disturbances, such as interference with TV/radio listening and falling asleep. Regarding the percentages of respondents who answered, “highly annoyed,” it was found that there are no systematic differences between the two verbal scales.

3.2. Relationships between the verbal scales and the numeric scale

Fig. 4 shows the relationship of the mean values rated on the 11-step numeric scale by the people who answered questionnaires with the four- or the five-point scales. Almost the same values were obtained in each noise exposure level. Community responses to general noise annoyance were compared between the two verbal scales and the numeric scale as shown in Fig. 5. It was found that the rates of % annoyed for the top 1 category on the four- and the five-point verbal scales (upper 20–25% of scales) were between those for the top two numbers and top three numbers on the numeric scale (upper 18–27% of scale). It was also found that the rates of %

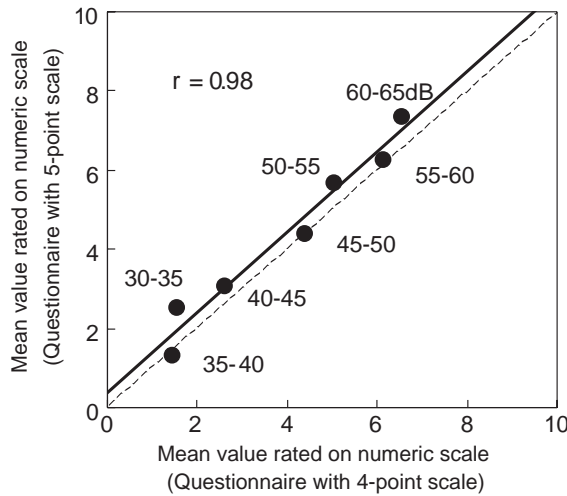


Fig. 4. Relationship between mean values rated on the numeric scale in questionnaires with four- and five-point scales.

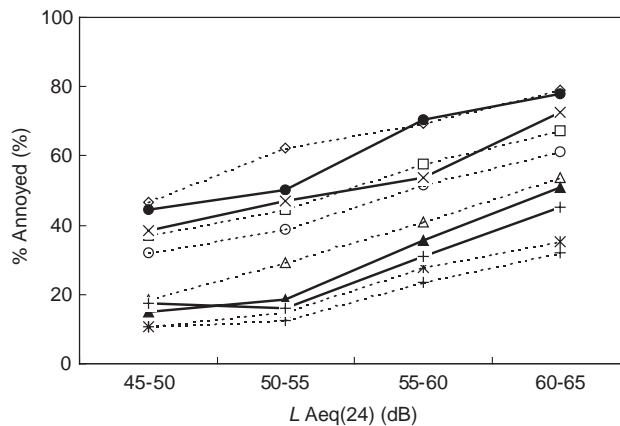


Fig. 5. Relationships between  $L_{Aeq}(24)$  and the extent of general noise annoyance with the verbal scales and the numeric scale:  $\cdots\cdots$ , 10 on numeric scale;  $\cdots\cdots$ , 9–10 on numeric scale;  $\cdots\cdots$ , 8–10 on numeric scale;  $\cdots\cdots$ , 7–10 on numeric scale;  $\cdots\cdots$ , 6–10 on numeric scale;  $\cdots\cdots$ , 5–10 on numeric scale;  $\cdots\blacktriangle$ , top 1 on four-point verbal scale;  $\cdots\bullet$ , top 1–2 on four-point verbal scale;  $\cdots\blacktriangle$ , top 1 on five-point verbal scale;  $\cdots*$ , top 1–2 on five-point verbal scale.

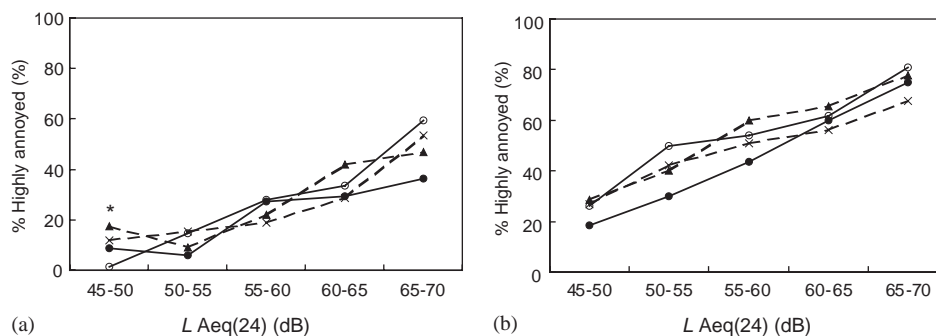


Fig. 6. Comparison of dose–response relationships among the four base descriptors regarding the verbal scale: (a) top 1 category; (b) top 2 categories. —●—, fukai; —○—, urusai; ····▲···, standard; —×—, nayamasareru (\*, significant above 5% level).

annoyed for top 2 categories on the four-point verbal scale (upper 50% of scale) were close to those for the top six numbers of the numeric scale (upper 55% of scale) and the rates of % annoyed for top 2 categories on the five-point verbal scale (upper 40% of scale) were almost the same as those for the top five numbers of the numeric scale (upper 45% of scale). This means that the extent of noise annoyance rated on the four- or five-point verbal scale corresponded with that rated on the 11-point numeric scale by percentages of scale steps.

### 3.3. Comparison of the four base descriptors

Fig. 6 compares the community responses to general noise annoyance among the four base descriptors regarding the top 1 and top 2 categories of the verbal scale. Generally, no systematic differences were found among the four base descriptors, although significant differences were found at low noise exposure level. The results regarding the top 1, top 2 or top 3 numbers of the numeric scale corresponded with those for the verbal scales. Regarding the percentages of respondents who answered, “highly annoyed”, there were no systematic differences among the four base descriptors.

## 4. Summary

To compare community responses obtained with different rating scales constructed in the joint study by the IC BEN Team 6, and those obtained with different base descriptors, two social surveys on railway noise were performed in Japan. The relationships between the two verbal scales and the numeric scale, and those among the four base descriptors were evaluated. The results are summarized as follows:

1. Regarding the percentages of respondents who answered, “highly annoyed,” there were no systematic differences between the four- and the five-point verbal scales.
2. The extent of noise annoyance rated on the four- or five-point verbal scale corresponded with that rated on the 11-point numeric scale by percentages of the scale steps.

3. There were no systematic differences among the four base descriptors that are usually used in Japan.

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