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# COMPARISON OF COMMUNITY ANNOYANCE FROM RAILWAY NOISE EVALUATED BY DIFFERENT CATEGORY SCALES

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A considerable number of reviews on community responses to noise have been carried out to compare dose–response relationships obtained from different noise sources and to investigate the effects of various factors on noise annoyance by using the data from different surveys. In order to compare the findings from various surveys precisely, it is very important to know how the different subjective or objective scales are transformed to unified scales. The present paper discusses the effect of four kinds of category scales on the annoyance response by using the data obtained from a social survey on community response to railway noise and compares the dose–response relationships between railway and road traffic noise obtained with the same scale. The extent of annoyance, such as % very annoyed, is strongly affected by the descriptors just below the annoyance range. This means that the descriptors are very important in constructing questionnaires and comparing the findings of different surveys. No systematic difference is found in dose–response relationships between railway and road traffic noises, using data obtained with the same method in the same area. This finding is quite different from those of European studies.



## 1. INTRODUCTION

Since the time that Schultz [1] proposed a synthesis curve to show a unified dose–response relationship for various kinds of noise sources, a considerable number of reviews on community response to noise have been carried out to compare dose–response relationships obtained in the case of different noise sources and to investigate the effects of various factors on noise annoyance by using data from different surveys [2–11]. Most of the studies show different dose–response relationships for different noise sources. However, in order to compare the findings of different surveys precisely, it is very important to know how the different subjective or objective scales are transformed to unified scales. Furthermore there is a great need for a unified annoyance scale acceptable to many researchers.

As concerns the establishment of a standard annoyance scale, Levine [12] developed a seven-point category scale in a Los Angeles survey. Furihata [13, 14] also constructed a

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seven-point category scale in Japan by collecting the descriptors of annoyance in Nagano. Fields proposed a guideline for reporting community noise surveys [15] and a four-point verbal scale and 11-point numerical scale as the international standard by reviewing a large number of studies [16]. There is now an international movement toward establishing a unified standard annoyance scale.

Four- to seven-point category scales were constructed in Japanese for noise annoyance based on the meanings of the descriptors assigned to the categories and the effect of the different category scales on the annoyance response in a psycho-acoustic experiment investigated [17]. As a further development of the previous study, the present study discusses the effect of the four kinds of category scales on the annoyance response by using data obtained from a social survey on community response to railway noise specifically designed for this purpose. It also compares the dose–response relationship between railway and road traffic noise obtained with the same scale. Because of the lack of social survey data on the community response to ordinary railway noise in Japan, there is now a great need for data to relate the two [11].

## 2. METHOD

### 2.1. SOCIAL SURVEY

A social survey on community response to railway noise was carried out by a distribute–collect method in urban and rural areas along railways in Kyushu, Japan, during the periods from May to June, September to October, 1994, and June, 1995. The selected houses were all detached houses and faced the railways. The distance from the railways to the houses ranged from 2 to 450 m and possibly affected noise exposure to houses.

Four kinds of questionnaires were constructed, in which four- to seven-point category scales, as shown in Table 1 (the original is in Japanese), were used for questions on annoyance caused by various environmental factors and the effects of railway noise. The same scales were used for other items on the different questionnaires. Respondents 20 to 75 years of age were randomly selected from voter lists on a one person per family basis. Four kinds of questionnaire were allotted to the respondents in a consecutive order. The reponse sizes for the questionnaires with four- to seven-point scales were 464, 462, 434 and 468, respectively. The total response rate was 80%.

### 2.2. NOISE MEASUREMENT

At reference points set along the shoulder of the railroad, noise levels from various types of trains were recorded with a sound level meter and a level recorder from morning to

TABLE 1

*Category scales used in the present survey*

| 4-point scale | 5-point scale | 6-point scale | 7-point scale |
|---|---|---|---|
| 1. **not at all** annoyed | 1. **not at all** annoyed | 1. **not at all** annoyed | 1. **not at all** annoyed |
| 2. **a little** annoyed | 2. **a little** annoyed | 2. **a little** annoyed | 2. **a little** annoyed |
| 3. **rather** annoyed | 3. annoyed | 3. annoyed | 3. **somewhat** annoyed |
| 4. **very** annoyed | 4. **rather** annoyed | 4. **rather** annoyed | 4. annoyed |
| | 5. **very** annoyed | 5. **very** annoyed | 5. **rather** annoyed |
| | | 6. **unbearably** annoyed | 6. **very** annoyed |
| | | | 7. **unbearably** annoyed |

evening. The sound exposure level for every train type was calculated from the peak level and effective duration. $L_{eq(24)}$ was calculated by using the sound exposure levels for various train types and the number of trains shown in the train timetable. The number of trains ranged from 70 to 400 per day. Distance reductions at points 5, 10, 20 and 40 m from the reference points were measured simultaneously, and equations for estimating the distance reductions were formulated. Noise exposure to each house was calculated from $L_{eq(24)}$ at the reference point and the distance reduction.

## 3. RESULTS

The distribution patterns of responses for demographic variables and key variables for annoyance response, such as sensitive to noise and evaluation of the natural environment and noise exposure, were compared between the four groups of respondents to whom the different questionnaires were distributed. There is of course no systematic difference in distribution patterns between different questionnaires owing to the method of allotting the questionnaires to the respondents in a consecutive order. This means that the selected populations for different annoyance scales are uniform and that the annoyance response for the different scales can be compared. Details of the distribution patterns are: about 60% of the respondents were women, and the majority, 27%, of the respondents were in their 40's, followed by those in their 50's, 60's and 30's. The mode of frequency of noise exposure is in the range of 60–65 dB(A) $L_{eq(24)}$.

### 3.1. COMPARISON OF DOSE–RESPONSE RELATIONSHIPS OBTAINED WITH DIFFERENT SCALES

Figures 1–3 show the relationships between $L_{eq(24)}$ and the extent of annoyance, % very annoyed, % rather annoyed or % annoyed, respectively. The rates of % very annoyed for four-, five-, six-, and seven-point scales are defined here as the rates of the numbers of people who responded to either one, one, two or two categories from the top category, respectively, to the numbers of people exposed in a range of noise levels divided into five dB steps. The rates of % rather annoyed for four-, five-, six-, and seven-point scales are defined as the rates of people who responded to either two, two, three or three categories from the top, respectively. The rates of % annoyed for four-, five-, six- and seven-point scales are the rates of people who responded to either two, three, four or four categories from the top, respectively.

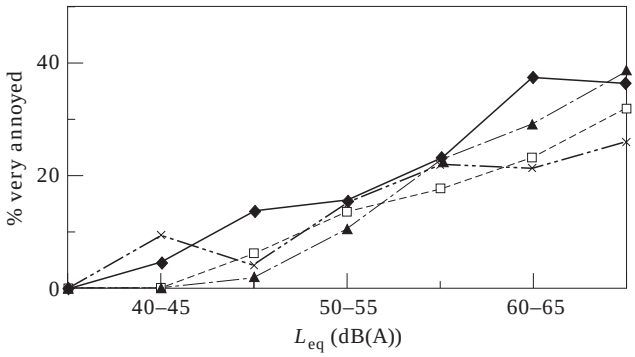


Figure 1. Comparison of relationships between $L_{eq}$ and % very annoyed with 4-, 5-, 6- and 7-point category scales. —◆—, 4 point scale (top 1 categogy); --□--, 5 point scale (top 1 category); --▲--, 6 point scale (top 1–2 category); --×--, 7 point scale (top 1–2 category).

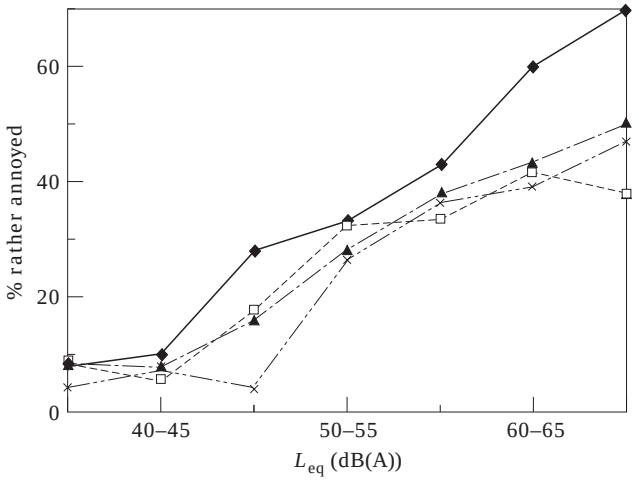


Figure 2. As Figure 1 except: —◆—, top 1–2 category; --□--, top 1–2 category; --▲--, top 1–3 category; -- × --, top 1–3 category.

Figure 1 shows no systematic difference between the dose–response relationships for different annoyance scales, although the folded line for the four-point scale is somewhat higher than for the others. When the chi square test was applied to all combinations of pair of the rates in each noise level range, only two significant differences were found at a 1% level between the four-point and the seven-point scales and at a 5% level between the four-point and the five-point scales in the range of 60–65 dB(A). Figure 3 shows no significant difference in dose–response relationships between four kinds of scales. On the other hand, Figure 2 shows that the folded line for the four-point scale is systematically higher than the others, particularly in higher noise level ranges. When the chi square test was applied to the plots in Figure 2, significant differences were found at a 1% level between the four-point scale and the others in the range of 60–65 dB(A), at a 5% level between the four-point scale and the others in the 65–70 dB(A) range and at a 1% level between the four-point scale and the seven-point scale in the 45–50 dB(A) range.

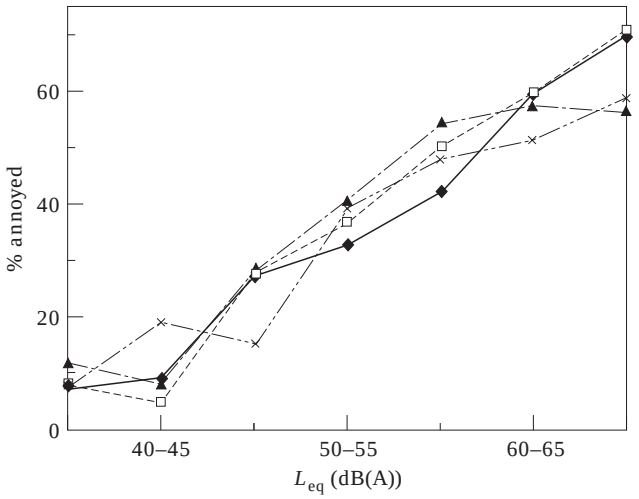


Figure 3. As Figure 2 except: --□--, top 1–3 category; --▲--, top 1–4 category; -- × --, top 1–4 category.

The agreement or difference in dose–response relationships seems to be able to be attributed to the strength of the descriptors assigned to the categories just below the annoyance range. The descriptors just below the range are all the same, "rather annoyed" in Figure 1. In Figure 3 the descriptors are "a little annoyed" and "somewhat annoyed", which have almost the same strength of the meaning in the original Japanese expression. However, in Figure 2, the descriptors are different; "a little annoyed" for the four-point scale whereas "annoyed" for the other three scales. This suggests that the annoyance response is strongly affected by the descriptor just below the annoyance range and that people tend to respond not to the numbers but to the descriptors assigned to the categories. If people responded to the numbers regardless of the descriptors, the relationships between $L_{eq(24)}$ and % rather annoyed for the four- and six-point scales would agree with each other because the rates of the categorical numbers adopted as % rather annoyed are the same, 50%. This finding brings us to the conclusion that the descriptors are very important in planning social surveys and in comparing annoyance responses obtained from different surveys.

### 3.2. COMPARISON OF DOSE–RESPONSE RELATIONSHIPS BETWEEN RAILWAY AND ROAD TRAFFIC NOISES

The authors have been carrying out social surveys on community responses to road traffic noise in the Kyushu district since 1993, using the same method and the same four-point annoyance scale as in the railway survey [18, 19]. The sample size of the data accumulated so far is 434. The distributions of the responses for demographic and other key variables for annoyance show similar patterns for both noise sources, although the distribution patterns of noise level are somewhat different. This suggests that the dose–response relationships for railway and road traffic noises are highly comparable.

Figure 4 compares the dose–response relationships for railway and road traffic noises. No systematic difference is found between the noise sources. A significant difference is statistically confirmed at a 5% level only in 60–65 dB(A). This is quite different from the findings of Fields *et al*. [2] and Moehler [3], where annoyance caused by railway noise is significantly lower than that caused by road traffic noise. The difference between European studies and ours may be the results of cultural or social factors relating to the respondents. To elucidate the cause of the difference, further cross-cultural analyses are necessary as regards culture/social factors such as lifestyle, residential environment, attitude to the noise source, the effect of vibration and so on.

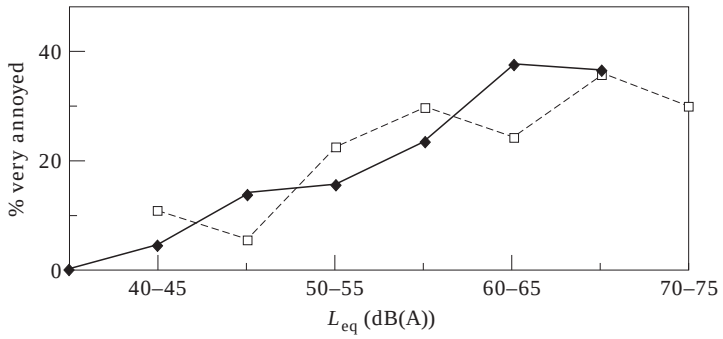


Figure 4. Comparison of dose–response relationships between railway (—◆—), and road traffic (--□--) noise.

## 4. CONCLUSIONS

A social survey on community response to railway noise was carried out in Kyushu, Japan, using four kinds of questionnaires with four- to seven-point annoyance scales. The questionnaires were distributed to uniform groups of respondents. The distribution patterns of responses for demographic variables and key questions for annoyance were similar. Thus the annoyance responses were comparable.

The following main conclusions were reached in the present study.

1. Annoyance responses such as % very annoyed and % rather annoyed are strongly affected by the descriptors just below the annoyance ranges.
2. This suggests that people respond not to the numbers but to the descriptors assigned to the categories, and that the descriptors are very important in constructing questionnaires and comparisons of the findings of different surveys.
3. No systematic difference is found in dose–response relationships between railway and road traffic noises, obtained from social surveys carried out with the same method in the same area. This finding is quite different from those of European studies.

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