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Choice of Japanese modifiers in noise annoyance scale during exposures to white noise

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Abstract

The linearity of a Japanese verbal scale of annoyance was estimated under real noise exposure. Young healthy adults, 32 male and 132 female were exposed to white noise of 30, 45, 60, 75 and 90 dBA in rooms where the exposure levels could be controlled according to contours. The series of noise exposure consisted of three components; white noise, pure-tone for conditioning and silence for evaluating noise. During the exposures the noisiness of each emission was evaluated with the verbal scale and a line-rating scale. The data showed a significant correlation of about 0.9 between the exposure level and the line length on the rating scale. The regression line of the noise level to the line length exhibited a reasonable locus of zero on the line length at the ambient noise level. The rank correlation between the selected modifier and the noise level was nearly 0.8 ($p<0.001$). When the five modifiers were converted to 1–5 points, respectively, the regression of the line length to the selected modifier revealed an adequate and consistent fitness (coefficient of determination was >0.8). The results suggest that the scale can be used as an equally divided linear scale in community noise research.

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1. Introduction

Based on the synthesized data reported by Schultz [1], the rating of top-one or top-two categories on the annoyance scale have been used for community noise research. To compare the rates of annoyed people in different districts, countries or surveys, the degrees of annoyance must be of equal value. It is particularly important to make the degrees comparable among different languages.

As the ICBEN team 6 recommended [2], Yano and his co-workers proposed a linear annoyance scale with five Japanese modifiers in 2001 [3]. They chose "HIJOUNI" for extremely, "DAIBU" for very, "TASHO" for moderately, "AMARI-nai" for slightly and "MATTAKU-nai" for not at all. These five words were extracted from a word pool with their image for degrees of annoyance by interviewing 1600 persons in Japan. This verbal scale of annoyance is expected to be an equally divided linear scale in noise research.

The purpose of this report was to estimate the feasibility of the scale with the data from persons exposed to real noise.

2. Subjects and methods

2.1. Subjects

Young healthy volunteers from various parts of Japan participated in the experiments. They were all students in a university who attended this program voluntarily after announcements in their classes. The experiments were performed with three groups of them:

1. Six males (average age 21.7 years), 39 females (21.4 years).
2. Eleven males (20.5 years), 38 females (19.7 years).
3. Fifteen males (19.6 years), 55 females (19.3 years).

All subjects were asked about their clinical history and the present condition of the auditory system. Information about the district where participants grew up and their social background was also obtained.

2.2. Exposure

2.2.1. Seating area in the laboratory

The contours of two classrooms were drawn in the laboratory and a noise level for each seat was calculated under experimental conditions with white noise emission. Seating areas were limited to control the distribution of noise exposure levels within 6 dBA difference.

2.2.2. Noise emission levels

The maximum and minimum emission levels were defined with data from 66 persons exposed to white noise of various levels. The maximum level was set to 90 dBA where 80% of the audience chose the highest modifier. The minimum level of ambient noise level was set up at 30 dBA where

90% chose the lowest modifier. For the intermediate levels, 45, 60 and 75 dBA were chosen by dividing the range equally.

2.2.3. Experimental design

The series of exposure consisted of three conditions; silence, pure tone and white noise emissions. Each noise emission followed a 20 s silence and 2 s of pure tone 400 Hz of 45 dBA. The time of each white noise emission was 20 s. The noise level was raised stepwise from an ambient level up to 90 dBA and then lowered to ambient level of 30 dBA at the monitoring point. Exposure levels of each participant were determined from contours and calibration with monitoring data.

2.3. Tasks and questionnaire

A verbal scale with the five Japanese modifiers and a line rating scale were used for noise evaluation. The Japanese adjective of "URUSAI" was adopted as a modified word, which had been used to pick up suitable Japanese modifiers. Evaluation with the verbal scale was carried out by selecting one modifier. In the line rating scale marking, a cut line on the 10 cm line was used to express the unpleasant feeling, "URUSAI". The audience was requested to listen to the noise with their eyes shut, and to perform the tasks during the silent period. The task evaluations were made with the verbal scale during the upward phase and with the line-rating scale during the downward phase of the emission program. The audience had no information about the program.

2.4. Data analysis

Data from a few subjects with hearing disorders or a history of tympanitis were excluded. Responses and the noise exposure level of each participant were analyzed statistically with SPSS ver. 11.5.

3. Result

The correlation between the noise exposure level and the line length on the rating-scale was approximately 0.88 ($p<0.0001$). The regression line of the noise level to the line length for all cases was

$$L = -4.946 + 0.1589X,$$

where L is the line length in rating scale and X the noise exposure level to each participant.

Table 1 shows the selected modifiers at each noise level in three experiments. The rank correlation between these two variables was more than 0.77 ($p<0.001$) in every experiment. The correlation of the two was almost at the same level in total data.

Fig. 1 shows regression lines of the line length to the selected modifier in three groups on the assumption that five modifiers can be converted to 1–5 points, respectively. Three slopes in lines exhibited high statistic significance although the slope for group 3 was statistically different from the other two values. The coefficient of determination in each group was over 0.8, and error variance that indicates the goodness-of-fit value was around 2.1. Overall data of these groups gave

Table 1
Rank correlation between selected modifier and noise exposure level

	ANL (dB)	Modifier 1 [Mattaku]	Modifier 2 [Amari]	Modifier 3 [Tasho]	Modifier 4 [Daibu]	Modifier 5 [Hijohni]	Rank correlation	
							Kendall ôb	Probability
Group #1		37	7	0	0	0		
$n = 44$	45	0	21	21	2	0		
	60	0	0	22	21	0	$r = 0.800$	$p<0.001$
	75	0	0	0	12	31		
	90	0	0	0	0	43		
Group #2		42	6	0	0	0		
$n = 48$	45	7	34	7	0	0		
	60	0	13	28	7	0	$r = 0.846$	$p<0.001$
	75	0	0	4	34	10		
	90	0	0	0	0	48		
Group #3		41	13	7	2	0		
$n = 63$	45	11	45	7	0	0		
	60	0	9	38	14	2	$r = 0.774$	$p<0.001$
	75	0	0	4	36	23		
	90	0	0	0	4	59		
Total		120	26	7	2	0		
$n = 155$	45	18	100	35	2	0		
	60	0	23	88	42	2	$r = 0.779$	$p<0.001$
	75	0	0	8	82	64		
	90	0	0	0	4	150		

ANL: Ambient noise level around 30 dBA.

a regression line as follows:

$$M = 0.373 + 1.381L$$

(M = assumed point for modifier and L = the length of rating scale). Analysis of variance exhibited propriety of the model with significance ($p<0.0001$).

The regression line for intermediate three modifiers was also obtained and compared:

$$M = 0.238 + 1.987L.$$

The slope was much closer to 2.5 of the ideal value, although the 95% confidence range did not include a value of 1 on the axis M.

4. Discussion

The Japanese word "URUSAI" is the simplest and the most popular expression to complain about daily noise. It contains some meanings of annoyance, though it is usually used to evaluate

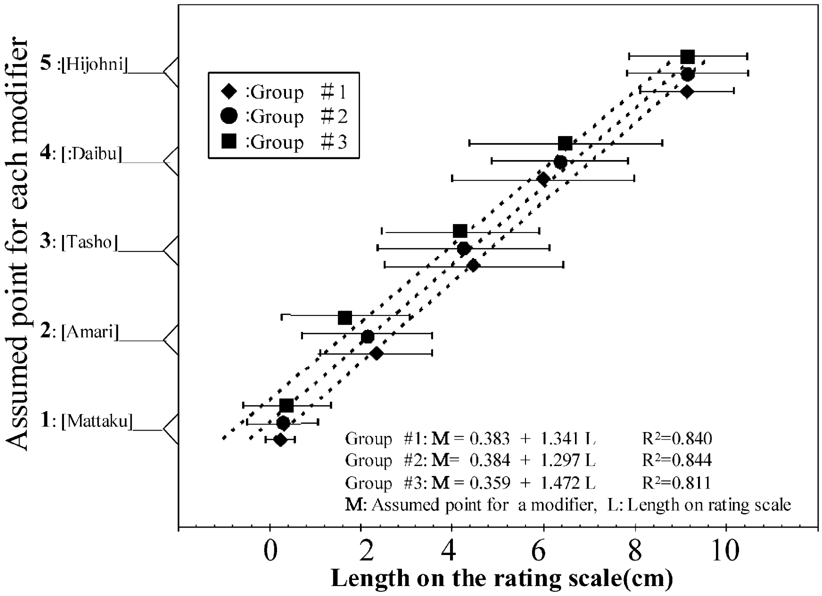

Fig. 1. Regression lines between the length in rating scale and the assumed points for selected modifier in three groups.

noisiness. Therefore, the modifiers for noise annoyance are comparable with those for noisiness to noise emitted in seconds as used in this study.

The results showed linearity between modifiers and the length in rating scale, and an equity of distances between closest modifiers. The correlation between the line length in the rating scale and the fitness of the regression model revealed that the data from the rating scale express the noisiness well. The rank relationship between noise levels and modifiers also showed a highly significant correlation, which means that these modifiers can reflect the noise exposure levels. The fitness of regression models were compared on the assumption that modifiers can be converted to interval scores, 1–5 points, to see the linearity of the verbal scale. Five modifiers in the verbal scale seem to be based rather on the length in rating scale reflecting the degrees of unpleasant feeling than on the real exposures to noise. The regression of line length for three intermediate modifiers exhibited ideal figures in the model. Considering that the maximum and minimum emission levels were fixed, the result seems to be reliable as for evaluating the intermediate levels of noise exposure.

The adequate fitness of a linear regression model on the assumption that each modifier can be converted to quantitative data of interval scale suggests that the scale with five Japanese modifiers can be used as an equally divided linear scale in community noise research. Furthermore, the scale might enable us to evaluate the annoyance of a whole community quantitatively.

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