Annoyance from road traffic noise with horn sounds: A cross-cultural experiment between Vietnamese and Japanese

Hai Anh Thi Phan[1]*, Tsuyoshi Nishimura[1], Hai Yen Thi Phan[2], Takashi Yano[2], Tetsumi Sato[3] ,Yoritaka Hashimoto[4]

1 Sojo University, Ikeda 4-22-1, Kumamoto 860-0082, Japan

2 Kumamoto University, Kurokami 2-39-1, Kumamoto 860-8555, Japan

3 Hokkai Gakuen University, Minami 26, Nishi 11, Chuo-ku, Sapporo 064-0926, Japan

4 Osaka City University, Sugimoto 3-3-138, Sumiyoshi, Osaka 558-8585, Japan

* corresponding author: e-mail: haianh.phan@gmail.com

INTRODUCTION

Over the past decades a large number of social surveys on community response to noise and psychoacoustic experiments have been conducted in developed and, to a lesser extent, developing countries (Schultz 1978; Namba et al. 1991a, b; Fastl et al. 1996; Miedema & Vos 1998; Lam 1994; Fields 2001; Sato et al. 2000).

The current authors have conducted social surveys on community response to noise in Hanoi in Vietnam since 2004 (Phan HYT et al. 2006; Phan HAT et al. 2006, 2007), and road traffic noise in Hanoi was found to be characterized by a great number of motorbikes creating frequent horn sounds. The $L_{Aeq,24h}$ was obtained, ranging from 70 to 77 dB.

In order to investigate the effects of horn sounds on road traffic noise annoyance systematically, a psychoacoustic experiment was carried out in 2006 with young Vietnamese and Japanese students in Hanoi and Kumamoto, respectively. The main findings obtained were that Japanese were more annoyed by noise with frequent horn sounds than that without horn sound, while there was no significant difference in annoyance between the two types of noise for Vietnamese and that Japanese were more annoyed by noise than Vietnamese. The authors have hypothesized the possible reasons for the above findings. (1) Vietnamese were more used to noise with frequent horn sounds; (2) Young Vietnamese were more tolerant to noise with frequent horn sounds than the older Vietnamese; (3) The modifiers of noise annoyance scale in Vietnamese were more intense than those in Japanese.

Accordingly, to validate these hypotheses, three additional experiments were carried out in Kumamoto and Hanoi, respectively, on the extended groups of subjects including a group of Vietnamese living in Japan for a certain period of time and a group of older Vietnamese living in Hanoi (over 30 years of age), and on the intensity of Vietnamese and Japanese modifiers for their annoyance scales.

EXPERIMENT

Four experiments were performed. The three experiments (Experiment A, B, C) were to cross-culturally investigate the annoyance caused by road traffic noise with and without horn sounds.

The first experiment (Experiment A) was performed to compare annoyance between young Vietnamese and Japanese students. The second experiment (Experiment B) was to compare annoyance evaluated by Vietnamese living in Japan for a period of time with that by young Vietnamese obtained in Experiment A. The third experiment

(Experiment C) was to compare annoyance evaluated by the older Vietnamese with that by young Vietnamese obtained in Experiment A. The last one (Experiment D) was carried out to compare the intensity of modifiers used for noise annoyance scales between Vietnamese and Japanese.

Experiments on road traffic noise annoyance (Experiment A; B; C)

Test sound

Twelve kinds of test sound at three noise levels (LAeq,35s): 75, 65, 55 dB and four horn sound frequencies were used: Road traffic noise in Japan without horn sound (RTNJ); Road traffic noise in Hanoi without horn sound (RTN0); Road traffic noise in Hanoi with 12 noticeable horn sounds (RTN12); Road traffic noise in Hanoi with 51 noticeable horn sounds (RTN51).

The road traffic noise in Japan at 75 dB and at 65 dB were obtained from the commercial CD, which were recorded at 5 m and 25 m distance from the road shoulder. To create RTNJ at 55 dB, noise at 75 dB was decreased by 20 dB through a “house filter” which was created based on indoor and outdoor level differences produced by Japanese typical house window in real-life conditions.

The road traffic noise in Hanoi was recorded in Hanoi in September 2005, at 12 m distance from the road shoulder. RTN51, RTN12, RTN0 at 75 dB were taken from the parts of the noise recording with many, few and no horn sounds, respectively. To make test sounds at 65 dB, the road traffic noise was decreased by 10 dB by adjusting the volume of amplifier. A house filter was used again to reduce 20 dB from 75 dB noise level of the recorded to create test sounds at 55 dB.

The sound level fluctuation of test sound RTN51 with RTNJ and of test sound RTN51 with RTN0 is demonstrated in Figure 1 (a) and (b), respectively. The sharp peaks identified on the solid line in both figures are the horn sounds. The relative cumulative frequency curves for test sounds RTNJ, RTN51 and RTN0 can be seen in Figure 2. Test sound RTN51 is distributed more widely, ranging from 42 to 92 dB, meanwhile, test sounds RTNJ and RTN0 have smaller range from approximately 45 to 85 dB.

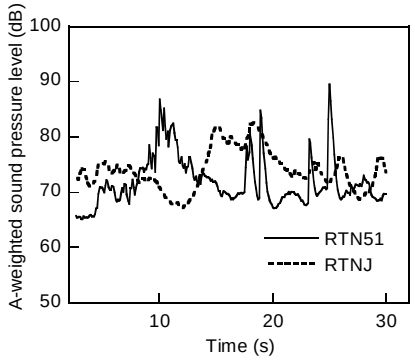

Figure 1(a) : Fluctuation pattern of sound level
Road traffic noise in Japan without horn sound (RTNJ) & road traffic noise in Hanoi with 51 horn sound (RTN51)

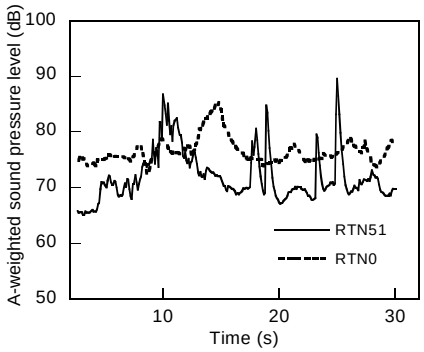

Figure 1(b): Fluctuation pattern of sound level
Road traffic noise in Hanoi without horn sound (RTN0) & road traffic noise in Hanoi with 51 horn sound (RTN51)

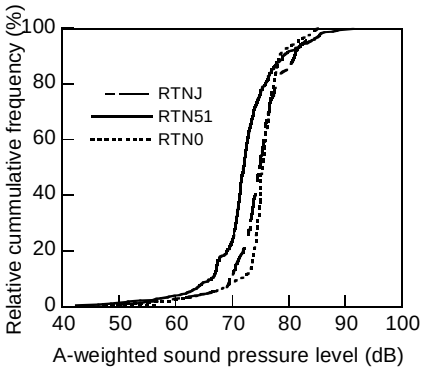

Figure 2: Relative cumulative frequency of noise level

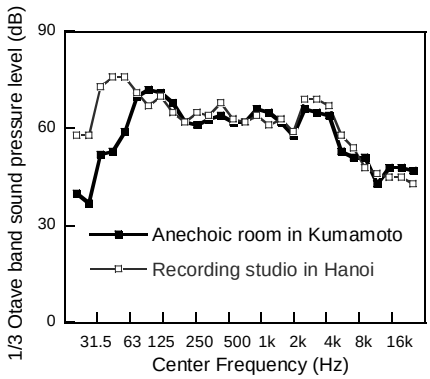

Figure 3: Frequency analysis of test sound RTN51

The result of 1/3 octave band frequency analysis of test sound RTN51 is shown in Figure 3. The thick line with filled symbols denotes the result produced in the anechoic room at Kumamoto University, and the thin line with open symbols indicates the result from the recording studio in Hanoi. In the 2-4 kHz range, main frequency components of horn sound can be seen clearly. Even though these results correspond well in the middle and high frequency ranges, the result at low frequency range of reproduced sound in the recording studio in Hanoi is seen higher due to the resonance.

Facilities setting

Experiment A was performed in an anechoic room at Kumamoto University in Kumamoto, Japan (internal dimensions 4.8 m x 5.4 m x 4.5 m); and a recording studio in Hanoi, Vietnam (internal dimensions 3.98 m x 3.86 m x 2.83 m). Experiment B was performed in the same anechoic room at Kumamoto University. Experiment C was performed in the same recording studio in Hanoi. The test sounds were reproduced with a CD player, amplified and then played back from a loudspeaker which was set up in front of an internal wall. Subjects sat on chairs 3 m away from the loudspeaker.

Subjects

Experiment A: 30 Japanese students (15 males and 15 females) from 18 to 24 years of age and 30 Vietnamese students (15 males and 15 females) from 20 to 24 years of age. Experiment B: Nine Vietnamese students (6 males and 3 females) who have been living in Kumamoto from one to seven years. Experiment C: 18 Vietnamese (9 males and 9 females) from 30 to 45 years of age. All subjects have self-reported normal hearing threshold. One error, however, was identified on the result of one Japanese and one Vietnamese subject. Therefore, the analysis was made based on only the results of 29 Japanese and 29 Vietnamese.

Procedure

The procedures of all experiments were the same in both locations.The experiments were conducted with every three subjects entering the test room at once. Each subject was given a set of instructions outlining the purpose and procedures of the experiment. Subjects were seated at the assigned spots, and were told, “Please take your time and imagine that you are relaxing at home after school or work.”

Each experiment consisted of three parts: annoyance evaluation using a 5-point verbal scale or an 11-point numeric scale (Session 1), annoyance evaluation using the 11-point numeric scale or the 5-point verbal scale (Session 2) and semantic differential evaluation (Session 3). There was a five-minute pause between Session 2 and 3.

The 5-point verbal scale and the 11-point numeric scale were constructed according to ICBEN method in Japanese and Vietnamese (Yano & Ma 2004).

In Session 1 and 2, subjects were to evaluate noise annoyance twice for each of the 12 types of test sound using the 5-point verbal scale (Figure 4) and the 11-point numeric scale (Figure 5). Test sounds were presented randomly. The order of the numeric and verbal scales was switched every three subjects, that is, if the first three subjects evaluated using the numeric scale first, the next three subjects would evaluate using the verbal scale first. With this procedure, the order effect can be cancelled.

In Session 3, subjects were to evaluate the impressions of test sounds using semantic differential scales. Six test sounds, including RTNJ, RTN5, RTN0 at 75 dB and 55 dB, were chosen from the 12 sound types used in Session 1 and 2. The impressions are evaluated using 7-point dichotomous scales, which were labeled with 13 pairs of antonymous adjectives at the extremes (Fastl et al. 2003). The antonymous adjectives are shown in Figure 6. The total time of the experiment was 45 minutes.

Experiment on intensities of modifiers (Experiment D)

Modifiers

Ten modifiers in Japanese and Vietnamese, from 21 modifers used in the original study of Team 6 of the International Commission on Biological Effects of Noise (ICBEN) were selected (Table 1).

(a) English	(b) Japanese	(c) Vietnamese
Not at all	Mattaku…nai	Hoan toan khong
Slighly	Sorehodo..nai	On phan nao
Moderately	Tasho	Khong qua
Very	Daibu	On nhieu
Extremely	Hijoni	Cuc on

Figure 4: The 5-point verbal scale

Not at all										Extremely
0	1	2	3	4	5	6	7	8	9	10

Figure 5: The 11-point numeric scale

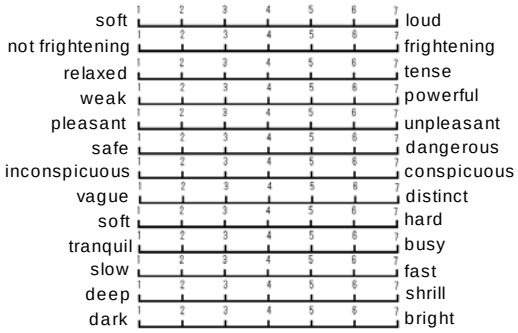

Figure 6: The semantic differential scale

Table 1: Modifiers

Japanese	Mattaku…nai, kanari, sugoku, sukoshi, sorehodo…nai, daibu, tasho, hijoni, hotondonai, warini
Vietnamese	Hoan toan...khong, kha on, cuc on, khong qua on, on phan nao, it on, on nhieu, qua on, rat on

Figure 7: Intensity line-marking

Subjects

Twenty subjects from 23 to 56 years of age, who speak fluently both Japanese and Vietnamese participated in the study. Japanese was the first language of six males (mean age: 45) and four females (mean age: 37), while Vietnamese was the first language of five males (mean age: 39) and five females (mean age: 30). The Japanese subjects had lived in Vietnam for an average of five years and the Vietnamese subjects had lived in Japan for an average of four years.

Procedure

Based on the method devised by ICBEN Team 6 (Masden & Yano 2004), all of the subjects assigned the intensity associated with each word of the 20 Japanese and Vietnamese modifiers by placing a mark on a 10 cm line that extends from “No/lowest degree of annoyance” to “Highest degree of noise annoyance” as shown in Figure 7. The modifiers were presented sequentially in a random order. The experiment took the total time of approximately 15 minutes to complete.

RESULTS

The trends of the results are almost the same between the verbal and the numeric scales. Thus only the results from the numeric are presented hereafter.

Comparison of annoyance of road traffic noise with and without horn sounds between young Vietnamese students living in Hanoi and Japanese

Mean annoyance score A

The mean values of noise annoyance score evaluated by the numeric scale by young Japanese and Vietnamese students are displayed in Figures 8 and 9, respectively. The mean values of noise annoyance from test sounds RTN51 and RTNJ were compared between Japanese and Vietnamese subjects. Japanese seemed to be more annoyed by the test sound with horn sound, while for Vietnamese horn sound did not seem to affect noise annoyance (Figure 10).

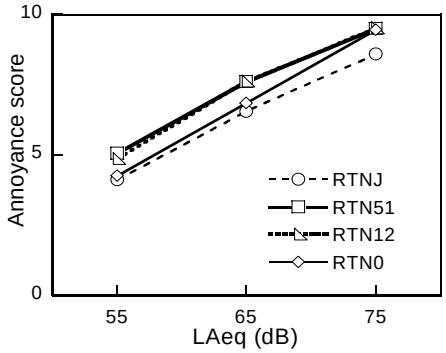

Figure 8: Noise annoyance evaluated by Japanese using an 11- point numeric scale

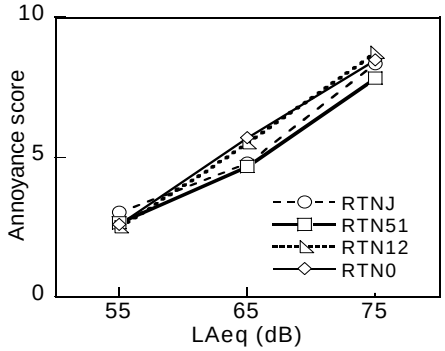

Figure 9: Noise annoyance evaluated by young Vietnamse using an 11-point numeric scale

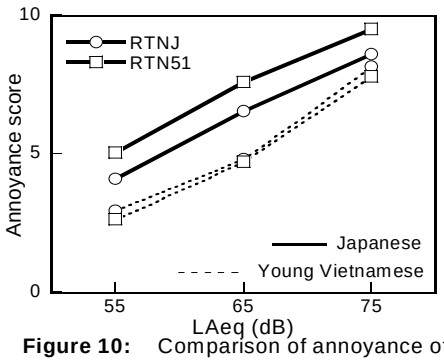

Figure 10: Comparison of annoyance of RTN51 & RTNJ evaluated using an 11-point numeric scale between Japanese and young Vietnamese

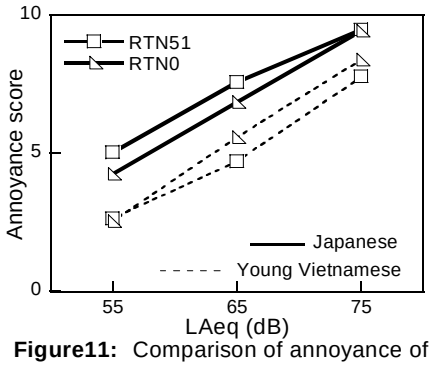

Figure11: Comparison of annoyance of RTN51 & RTN0 evaluated using an 11-point numeric scale between Japanese and young Vietnamese

The mean values of noise annoyance from test sounds RTN51 and RTN0 measured in the numeric scale were also compared between Japanese and Vietnamese (Figure 11). Japanese seemed to clearly distinguish test sounds with and without horn sound at 55 dB and 65 dB, in which the subjects considered test sound with horn sound more annoying. Meanwhile, at 75 dB, Japanese found almost no difference between RTN51 and RTN0. Vietnamese, on the other hand, found no difference between RTN51 and RTN0 at noise level 55 dB, but at 65 dB and 75 dB, Vietnamese were more annoyed by RTN0 than RTN51.

Semantic differential profile A

Semantic profiles of test sounds RTNJ and RTN51 at 75 dB were compared between Japanese and Vietnamese (Figure 12). For Japanese, noise impression was discriminated between test sounds with and without horn sound. RTN51 was more negative than RTNJ for Japanese. However, there is almost no difference in semantic profile between RTN51 and RTNJ for Vietnamese. The presence of horn sound, therefore, did not seem to affect Vietnamese's noise impression evaluation, though it contrastively emphasizes a multi-dimensional evaluation of noise impression among Japanese.

The impression evaluation from test sounds RTN51 and RTN0 at 75 dB is displayed in Figure 13. Here, the impression from Japanese was also discriminated between test sounds with and without horn sound, and RTN51 was more negative than RTN0. However, Vietnamese showed only little difference in their impression between the two test sounds, and RTN0 is consistently slightly more negative than RTN51. The gap in noise impression between Japanese and Vietnamese exposed largely at the axis "Deep-Shrill".

The semantic differential profiles are consistent to the annoyance evaluation.

Comparison of annoyance of road traffic noise with and without horn sounds between Vietnamese living in Hanoi and in Kumamoto

Mean annoyance score B

Figures 14 and 15 compare the noise annoyance score of noise with and without horn sound in numeric scales between Vietnamese living in Hanoi and Vietnamese livng in Kumamoto, respectively. The annoyance score for Vietnamese living in Kumamoto is just in-between those for Vietnamese living in Hanoi and Japanese. Figure 15 shows that Vietnamese living in Kumamoto are more annoyed by road traffic noise than Vietnamese living in Hanoi. At 55 and 65 dB, annoyance caused by RTN51 is higher for Vietnamese living in Kumamoto, meanwhile, there is no differ-

ence between RTN51 and RTNJ for Vietnamese living in Hanoi at almost every level of noise exposure. However, at 75 dB, no difference between two types of noise was found for both groups of Vietnamese.

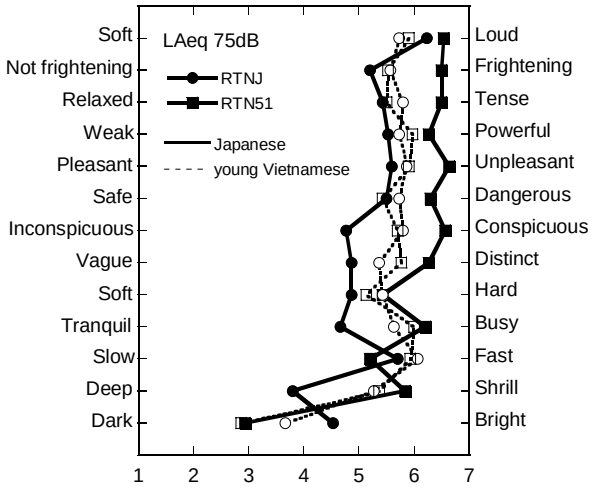

Figure12: Comparison of semantic profiles of RTN51 & RTNJ between Japanese and young Vietnamese

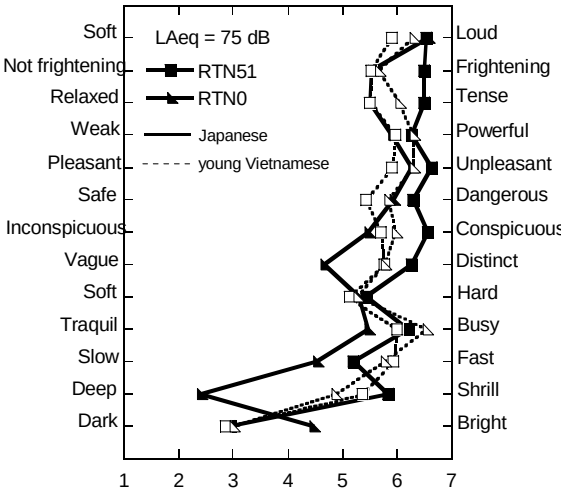

Figure13: Comparison of semantic profiles of RTN51 & RTN0 between Japanese and young Vietnamese

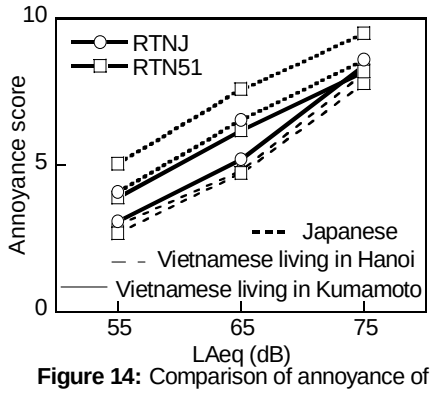

Figure 14: Comparison of annoyance of RTN51 & RTNJ evaluated using an 11-point numeric scale among Japanese and Vietnamese living in Hanoi & Kumamoto

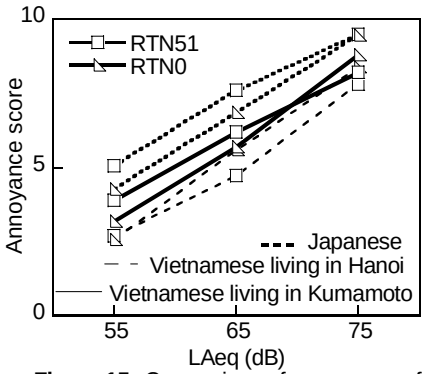

Figure 15: Comparison of annoyance of RTN51 & RTN0 evaluated using an11-point numeric scale among Japanese and Vietnamese living in Hanoi & Kumamoto

Semantic differential profile B

Semantic profiles of test sounds RTNJ and RTN51 at 75 dB were compared between two groups of Vietnamese (Figure 16). For Vietnamese living in Kumamoto, noise impression was slightly distinguished between test sounds with and without horn sound. The impression of RTN51 was slightly more negative than that of RTNJ. For Vietnamese living in Hanoi, there is almost no difference in semantic profile between RTN51 and RTNJ.

The profiles of Vietnamese living in Kumamoto is in-between Vietnamese living in Hanoi and Japanese.

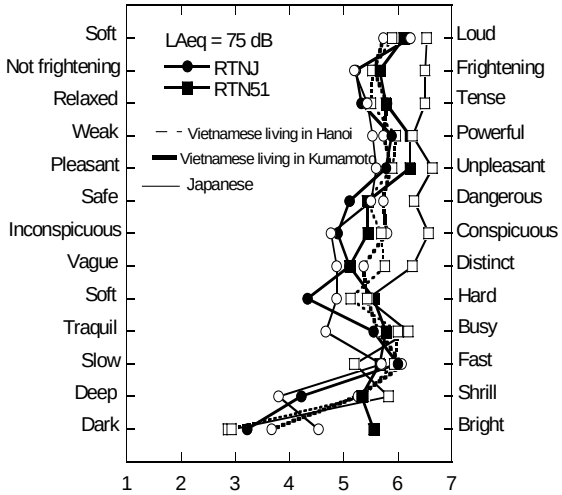

Figure 16 : Comparison of semantic profiles of RTN51 & RTNJ among Japanese and Vietnamese living in Hanoi & Kumamoto

Validate hypothesis (1)

From the experiments, the hypothesis was validated that Vietnamese were more used to noise with frequent horn sounds. Both results from Vietnamese who are living in Hanoi and who are living in Kumamoto associated well to the hypothesis. Mean annoyance scores have shown that there was no difference between road traffic noise with and without horn sounds for Vietnamese living in Hanoi. For Vietnamese living in Kumamoto, even though, at lower levels of noise exposure, i.e. 55 and 65 dB, road traffic noise with horn sounds created slightly higher annoyance than road traffic noise without horn sounds. Yet, at 75 dB the difference in annoyance between two types of noise was no longer found in this group. Results from semantic profiles also supported the hypothesis.

Comparison of annoyance of road traffic noise with and without horn sounds between young and older Vietnamese

Mean annoyance score C

The mean values of noise annoyance score from test sounds RTN51 and RTNJ and from test sounds RTN51 and RTN0 using the numeric scale were compared between the young and older groups of Vietnamese in Figures 17 and 18, respectively. Both figures illustrate that the tendencies of noise annoyance for both groups are the same for all test sounds at every noise exposure levels.

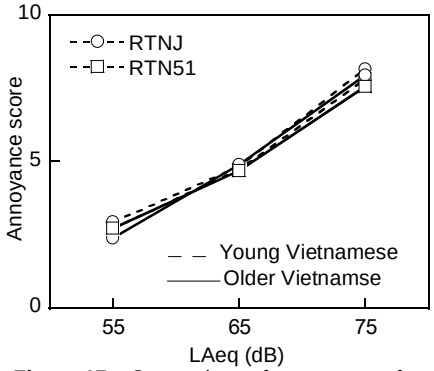

Figure 17: Comparison of annoyance of RTN51 & RTNJ evaluated using an 11-point numeric scale between young Vietnamese and older Vietnamese

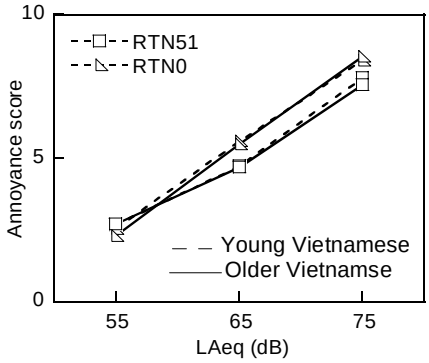

Figure 18: Comparison of annoyance of RTN51 & RTN0 evaluated using an 11-point numeric scale between young Vietnamese and older Vietnamese

Semantic differential profile C

Semantic profiles of test sounds RTNJ and RTN51 at 75 dB were compared between the young and older groups of Vietnamese. There is also no difference in noise impression evaluation between these two groups. The semantic profiles of both groups overlay each other, and the tendency to have negative or positive impression on test sounds for both groups are relatively the same.

Validate hypothesis (2)

The hypothesis that the young Vietnamese were more tolerant to noise with frequent horn sounds than the older Vietnamese was rejected. Analysis of variance showed that generation has no significant main effect on noise annoyance between these two groups. As well as, results from mean annoyance values and semantic profiles have emphasized the fact that the young and older groups of Vietnamese had relatively similar degree of annoyance and impression to road traffic noise with and without

horn sounds. Generation factor, therefore, has no influence in noise annoyance between the young and older group of Vietnamese.

Comparison of intensity of annoyance modifiers between Vietnamese and Japanese

Figure 19 shows the comparison of annoyance modifiers intensity between Vietnamese and Japanese languages. This figure demonstrates that even though the lowest intensity modifiers of two languages have the same degree, the other Vietnamese annoyance modifiers exert slightly higher intensity than those in Japanese. The intensity of the extreme annoyance modifier in Vietnamese “Cuc on” was 97, therefore higher than Japanese “Hijoni”, wich was 92.2. The result of t-test also demonstrated that there were significant difference between "CO" and “Hijoni” ($p = 0.006$).

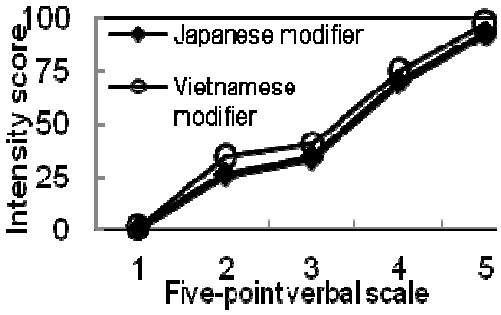

Figure 19: Comparison of intensity of annoyance modifiers between Vietnamese and Japanese

Validate the hypothesis (3)

The last hypothesis that the modifiers of noise annoyance scale in Vietnamese were more intense than that in Japanese was accepted. However, the difference in intensity between Vietnamese and Japanese modifiers was so small that it did not create any major change in the results of annoyance evaluation of Vietnamese.

DISCUSSION

The results from Experiment A have shown that Japanese were more annoyed by noise with frequent horn sounds than that without horn sounds while there was no difference in annoyance between two noise types for Vietnamese and that Japanese were more annoyed by noise than Vietnamese. The first hypothesis for the difference between Vietnamese and Japanese in which Vietnamese people are more used to horn sounds, therefore was accepted based on the results obtained from Experiment B.

Vietnamese subjects seem to be more tolerant with road traffic noise with frequent horn sounds, and somewhat refer to it as a mean of safety. Living in a road traffic environment where horns are used abundantly, Vietnamese get used to the use of horn and horn sounds much more than Japanese who live in a rather difference road traffic environment where horn sounds are very limitedly used. Statistics from the questionnaires answered by the respondents upon the completion of the experiments have shown that 68 % of Vietnamese respondents used horn when operating motorbikes while this number was only 7% for Japanese respondents. Moreover, 83 % of Vietnamese respondents confirmed the fact that horn usage was a mean of safety. Therefore, the presence of horn sounds did not seem to create any difference in annoyance evaluated by Vietnamese. Meanwhile, for Japanese, road traffic noise in Hanoi created high annoyance, particularly higher with the presence of horn sounds.

When experiments were performed on the group of Vietnamese living in Kumamoto for a period of time, this group showed identified annoyance score with Vietnamese living in Hanoi for road traffic noise without horn sounds. However, when road traffic noise with horn sounds presented at lower levels of noise exposure, Vietnamese liv-

ing in Kumamoto seemed to be more annoyed than Vietnamese living in Hanoi, but less annoyed than Japanese. From this result and the analysis of variance, environment factor seemed to have certain significant impact on annoyance from Vietnamese living in Kumamoto. Nevertheless, when road traffic noise with horn sounds was presented at high level of noise exposure, Vietnamese living in Kumamoto then developed the same annoyance score with Vietnamese living in Hanoi. Again, no difference between road traffic noise with and without horn sounds was found between these two groups. The first hypothesis is accepted.

Under the second hypothesis that the younger Vietnamese are more tolerant with road traffic noise with horn sounds than the older Vietnamese, a number of analysis were done, however, no evidence was found for generation as an influencing factor on noise annoyance evaluation. This finding confirmed the stableness in annoyance score evaluated by Vietnamese, both young and older groups who are living in Hanoi.

For the third hypothesis, the comparison of intensity of annoyance modifiers between Japanese and Vietnamese and between the present study and the ICBEN Joint study have shown that Vietnamese modifiers used for the verbal scale are consistently more intense than Japanese. The intensity score was applied to noise annoyance evaluation between Vietnamese and Japanese. This result, even though confirmed the third hypothesis to be true, did not influence the outcome of noise annoyance evaluation by both groups.

SUMMARY

Results from a series of cross-cultural psychoacoustic experiments can be summarized as follows:

1. There was almost no effect of horn sound on road traffic noise annoyance for Vietnamese subjects.
2. Japanese subjects were more annoyed by noise with frequent horn sounds than noise without horn.
3. Japanese subjects were more annoyed by road traffic noise than Vietnamese
4. The semantic differential evaluation showed that road traffic noise with frequent horn sounds were more negative for Japanese than Vietnamese and that there was small differences in loudness impression between Japanese and Vietnamese subjects.
5. The above difference is caused by the fact that Vietnamese people are used to noisy environment with frequent horn sounds.
6. Generation did not affect the above difference.
7. The difference in intensity between Vietnamese and Japanese noise annoyance modifiers did not affect the above differences

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