The comparison of psychological evaluation between military aircraft noise and civil aircraft noise

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ABSTRACT

It is reported that community response to military aircraft noise is severer than that to civil aircraft noise in some former studies. In the present study, psychological experiments were conducted including the stimuli of military aircraft noise and civil aircraft noise. Participants were not informed whether each noise source was a military or civil aircraft. It was found that perceived noisiness and subjective annoyance to aircraft noises were almost the same between noises from military and civil aircraft when single-event, A-weighted sound exposure levels were equal. This suggests that participants did not distinguish between military and civil aircraft noise. These results imply that overestimation of military aircraft noise is caused by not only acoustic properties but also non-acoustic factors, such as attitude toward military aircraft noise.

Keywords: Military aircraft noise, Psychological evaluation, A-weighted sound exposure level
I-INCE Classification of Subjects Number(s): 52.2.2, 63.2

1. INTRODUCTION

It is reported that community response to military aircraft noise is severer than that to civil aircraft noise in some former studies. For example, Yokoshima et al. (1) showed the representative dose–response relation for transportation noise in Japan and reported that noise from military aircraft receives the highest annoyance ratings among transportation noise sources, including civil aircraft noise. In the case of military airfields, daily fluctuation of flight operations is considerable, and the variation in noise level is greater than that in the case of civil aviation. These acoustic characteristics of military airfields may be one of the reasons for the higher annoyance level of affected residents. However, it should be considered whether non-acoustic factors, such as the attitude toward the noise source, may contribute to the negative evaluation of military aircraft noise. Guski (2) reported that most citizens have a different mental image of each noise source and suggested that a negative attitude toward the noise source increased subjective annoyance.

In the present study, a psychological experiment was carried out using single event military and civil aircraft noises as stimuli. Our hypothesis was that participants who do not know whether noises are from military or civil aircraft will give similar evaluation to the stimuli with the same A-weighted sound exposure levels.

2. METHOD OF PSYCHOLOGICAL EXPERIMENT

2.1 Stimuli

Eighteen kinds of single-event aircraft noises were used as stimuli, and two conditions were considered (Table 1). The aircraft noises were recorded outdoors near civil airports and near military

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airfields by two-channel stereo recording with a data recorder (DA-20, Rion) and measured by two sound level meters (NL-05, Rion). In Condition 1, the stimuli were presented to the participants at the same sound level as was recorded outdoors. In Condition 2, the stimuli were presented after being passed through a filter that simulates the frequency characteristics of a typical wooden house, as shown in Figure 1. These single-event aircraft noises were presented to the participants through an audio interface (UA-25, Roland), an amplifier (4B SST2, Bryston), and two loudspeakers (IB1S, PMC) at the levels shown in Table 1. The duration of each stimulus was 45 s.

Table 1 – Specification of stimuli

Stimuli ID	Aircraft type	Aircraft model	Condition 1 (without filter)		Condition 2 (with filter)	
			$L_{A,Smax}$ [dB]	L_{AE} [dB]	$L_{A,Smax}$ [dB]	L_{AE} [dB]
1	Civil	B-767	89.6	94.4	70.6	76.8
2	Civil	B-767	84.6	87.5	68.6	71.4
3	Civil	B-767	79.6	85.8	64.1	70.1
4	Civil	B-767	74.3	83.0	57.7	66.9
5	Civil	B-767	66.9	76.6	54.2	61.2
6	Civil	B-767	69.2	76.5	51.5	61.5
7	Military	F-15	88.7	91.4	72.5	75.0
8	Military	F-15	83.1	87.5	69.1	71.7
9	Military	F-15	71.6	77.9	57.1	64.7
10	Military	F-15	68.5	77.2	53.9	62.9
11	Military	F-16	86.9	89.9	70.3	73.0
12	Military	F-16	83.6	87.0	67.5	70.0
13	Military	F-16	68.5	75.5	55.1	61.9
14	Military	F-4	77.7	80.3	61.8	64.6
15	Military	E-3	90.6	94.6	71.1	75.1
16	Military	E-3	88.6	93.0	69.7	74.3
17	Military	KC-135	75.5	79.6	58.9	62.9
18	Military	KC-135	68.7	76.0	52.2	59.7

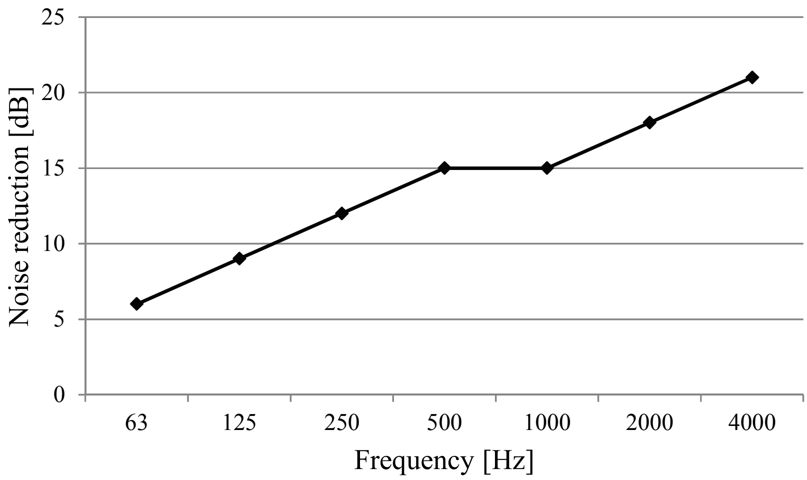


Figure 1 – Filter for simulating frequency characteristics of a typical wooden house

2.2 Participants

The participants were 7 women and 18 men aged between 19 and 59 years (average: 42 years), all with normal hearing.

2.3 Procedure

A soundproof room at the Kobayasi Institute of Physical Research, pictured in Figure 2, was used as the location of the experiment. An indoor ambient noise of less than 30 dB and a reverberation time of 0.36 s at 500 Hz were achieved by placing plasterboard on the front of the windows and installing sound-absorbing materials in the room. After the presentation of each stimulus, the participant asked to evaluate the stimulus on a 7-point semantic differential scale for 12 pairs of adjectives. The adjective scales are shown in Table 2. Participants were not informed whether noises were from military or civil aircraft. In the experiment, the orders of the adjective scales were randomized to prevent bias from the order effect.

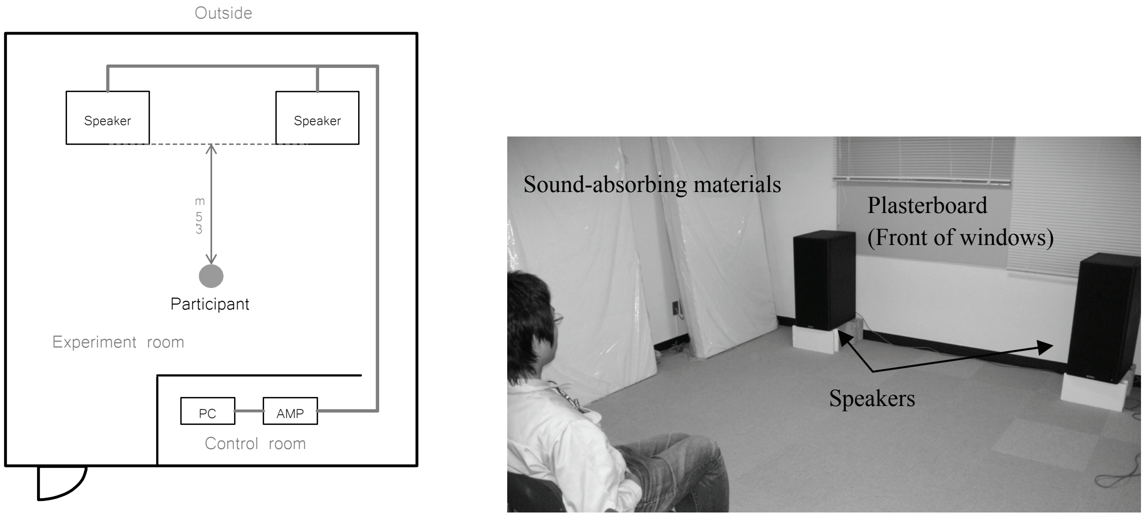


Figure 2 – Experimental setup. (PC: personal computer; AMP: amplifier)

Table 2 – Adjective pairs

Annoying – Not annoying
Quiet – Noisy
Powerful – Weak
Pleasant – Unpleasant
Pleasing – Unpleasing
Harsh – Mild
Loud – Soft
Sharp – Dull
Shrill – Calm
Pure – Impure
Heavy – Light
Gentle – Hard

3. RESULTS

3.1 Factor analysis

Factor analysis with varimax rotation was conducted on the full set of data, and two factors were extracted for each condition. The full loadings are shown in Table 3. For Condition 1, Factor 1 shows high factor loadings on certain adjective pairs, such as “Annoying – Not annoying,” “Quiet – Noisy,” and “Powerful – Weak.” Factor 1 accounts for 58.3% of the variance under Condition 1. Factor 2 shows high factor loadings on the adjective pairs “Sharp – Dull,” “Shrill – Calm,” and “Pure – Impure.” This factor accounts for 14.2% of the variance under Condition 1. Similarly, Factor 1 shows high factor loadings on many adjective pairs, such as “Annoying – Not annoying,” “Quiet – Noisy,” and “Powerful – Weak” under Condition 2. This factor accounted for 59.7% of the variance under Condition 2. Factor 2 shows high factor loadings on the adjective pairs “Pure – Impure” and

"Sharp – Dull." This factor accounted for 15.0% of the variance under Condition 2. For both conditions, Factor 1 can be interpreted as indicating pleasantness/power and Factor 2 can be interpreted as indicating a metallic quality.

Table3 – Factor loadings in each condition

Condition 1 (Without house filter)

Adjective pair	Factor 1	Factor 2
Annoying – Not annoying	0.92	0.18
Quiet – Noisy	-0.92	-0.15
Powerful – Weak	0.87	0.06
Pleasant – Unpleasant	-0.85	-0.03
Favorable – Unfavorable	-0.84	-0.14
Harsh – Mild	-0.82	-0.08
Loud – Soft	0.81	0.23
Sharp – Dull	0.43	0.69
Shrill – Calm	0.63	0.65
Pure – Impure	-0.16	0.58
Heavy – Light	0.59	-0.33
Gentle – Hard	-0.56	-0.21

Condition 2 (With house filter)

Adjective pair	Factor 1	Factor 2
Annoying – Not annoying	0.93	-0.95
Quiet – Noisy	-0.93	0.11
Favorable – Unfavorable	-0.86	0.09
Pleasant – Unpleasant	-0.85	0.11
Powerful – Weak	0.84	-0.14
Harsh – Mild	-0.84	0.07
Loud – Soft	0.84	-0.11
Shrill – Calm	0.78	0.38
Gentle – Hard	-0.67	-0.19
Pure – Impure	0.12	0.68
Sharp – Dull	0.56	0.63
Heavy – Light	0.56	-0.36

3.2 Comparison of Factor 1 score between military aircraft and civil aircraft

The linear regressions of L_{AE} against the score of Factor 1 which contains the impression of annoyance and noisiness were examined. A dummy variable for aircraft type (civil or military) was also used in the regression model as an independent variable in order to examine the contribution of aircraft type to the evaluation. Table 4 shows the result of multiple regression analyses on each condition. It was found that A-weighted sound exposure level, L_{AE}, was statistically significant at the 5% level under both conditions. In contrast, aircraft type was not significant under either condition. The coefficients of determination of the regression models under Conditions 1 and 2 were moderately high, at 0.78 and 0.75, respectively. It can be said that Factor 1 score was not affected by aircraft type, with similar scores for similar values of L_{AE} independent of aircraft type. Figure 3 shows scatterplots of L_{AE} versus the score of Factor 1 with regression lines according to aircraft type.

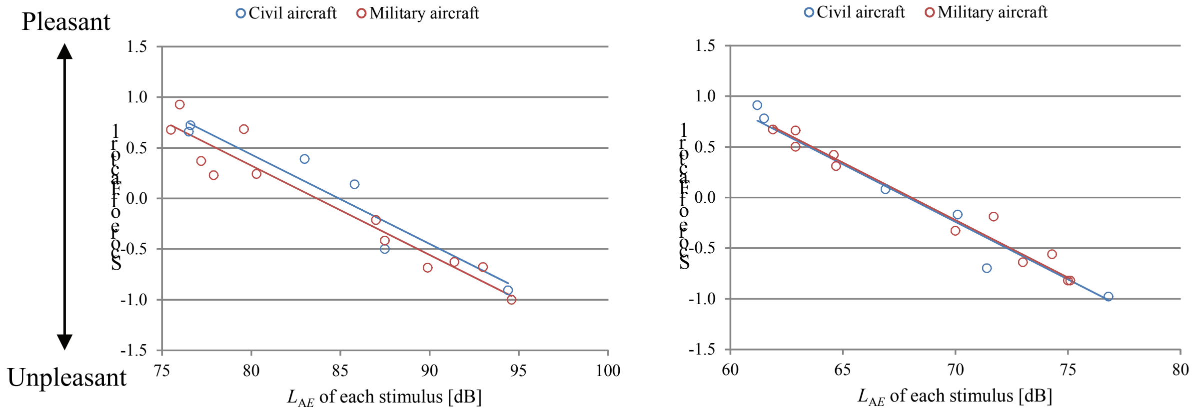
Table 4 – Results of multiple regression analyses

Condition 1: Without house filter

	Coefficient	Standardized coefficient	*t*-value	*p*-value	95% confidence interval	
					Lower	Upper
Constant	8.02		14.33	0.00	6.92	9.12
L_{AE}	-0.09	-0.56	-14.28	0.00	-0.10	-0.08
Aircraft type (Military = 1)	-0.10	-0.05	-1.24	0.22	-0.26	0.06

Condition 2: With house filter

	Coefficient	Standardized coefficient	*t*-value	*p*-value	95% confidence interval	
					Lower	Upper
Constant	7.71		17.40	0.00	6.84	8.68
L_{AE}	-0.11	-0.64	-17.59	0.00	-0.13	-0.10
Aircraft type (Military = 1)	-0.02	-0.01	0.24	0.81	-0.13	0.17



Condition 1 (Without house filter) **Condition 2 (With house filter)**

Figure 3 – Relations between L_{AE} and score of Factor 1

4. CONCLUSIONS

Participants were asked to respond to military and civil aircraft noise stimuli without being given information on the aircraft type of the source. Factor analyses and multiple regression analyses were conducted, with the result that the type of aircraft did not significantly contribute to the subjective evaluation. This result supports the hypothesis that resulting annoyance and perceived noisiness are not affected by the type of aircraft, which is evidenced by the impression being almost the same for stimuli of similar L_{AE} in the present experiment.

As described in Section 1, community responses to military aircraft noise, as obtained by social survey, are more negative than to civil aircraft noise. This may partly be due to the fact that in social surveys the respondents can identify the noise source when they answer the questionnaire. Taken together, the results of the present experiment suggest that the reason for the more negative evaluation of military aircraft noise in social surveys is caused by not only acoustic properties, such as large fluctuations in flight operations from day to day and high noise levels, but also non-acoustic factors, such as attitude to military aircraft noise.

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