Are different noise sources judged independently from each other?

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Introduction

As a part of the Swiss Noise Study 2000, a noise annoyance survey was carried out in August 2001 (see also [1, 2]). The aim of this survey was to assess the aircraft noise annoyance situation in the surroundings of the airport Zurich. Beside aircraft noise annoyance, road traffic noise annoyance, railway noise annoyance and noise annoyance at work were assessed as well. The Swiss Federal Laboratories for Material Testing (EMPA) calculated several aircraft noise measures for every subject. Objective noise data for other noise sources, however, were not collected.

The aim of this paper is to find out if the different noise sources are judged independently from each other. Research about the effects of combined noise sources showed conflicting results. On the background of the Swiss Noise Study 2000, the following questions will be approached in this presentation:

1. Are there relationships between the degree of annoyance of different noise sources?
2. Is the annoyance judgment of aircraft noise influenced by the annoyance of other kinds of noise?
3. Do subjects with high aircraft noise judge other noise sources differently than subjects with no or little aircraft noise?

1. Correlations between the degree of annoyance of different noise sources

Table 1 shows the correlation coefficients between the degree of annoyance of aircraft noise, road traffic noise, railway noise and noise at work. Even when controlled for noise sensitivity (assessed on a scale from 0 to 10) and for the L_{eq} 24h for air traffic, there remains a weak correlation between aircraft and work noise annoyance and between road traffic, railway and work noise annoyance. These are indications that the noise annoyance judgments of different noise sources are not entirely independent from each other in this sample.

	annoyance because of…					
annoyance because of…	**aircraft noise**		**road traffic noise**		**railway noise**	
road traffic noise	.11	.08[1)]	-	-	-	-
railway noise	.13	.08[1)]	.29	.26[1)]	-	-
noise at work	.15	.12[1)]	.16	.15[1)]	.18	.14[1)]

Table 1: Correlation coefficients (Spearman's ρ) between the degree of annoyance of different noise types. N between 1142 and 1258. $p<.05$. [1)] controlled for noise sensitivity and L_{eq} 24h for aircraft noise.

2. Influence of aircraft noise annoyance by the annoyance of other kinds of noise

Analysis show that the dose-response-relationship between aircraft noise and aircraft noise annoyance is partly influenced by the degree of annoyance of other noise sources (see fig. 1). At same aircraft noise levels, subjects with medium or high *road traffic noise annoyance* are significantly more annoyed with aircraft noise than subjects with low road traffic noise annoyance in regions with an aircraft noise level around 60 dB(A) (L_{eq} 24h). Subjects with medium or high *railway noise annoyance* are less annoyed with aircraft noise than subjects with low railway noise annoyance, if they live in regions with L_{eq} 24h for aircraft noise below 47.5 dB(A) and more annoyed with aircraft noise if they live in regions with L_{eq} above 47.5 dB(A). This annoyance difference is, however, only significant at the 50 dB-interval. Subjects with medium or high *noise annoyance at work* are more annoyed with aircraft noise than subjects with low noise annoyance at work. This difference is significant in the 45 and 55 dB(A)-interval of aircraft noise (L_{eq} 24h).

3. Difference in the noise annoyance level between subjects with high and with little / no aircraft noise

Do subjects with high aircraft noise judge other noise types differently than subjects with little or no aircraft noise? With other words, does the presence of a highly dominant noise source influence the judgment of other noise sources? In order to answer this question, the subjects of the lowest quartile of L_{eq} 24h for aircraft noise (L_{eq} <= 44.7 dB(A)) were compared with the subjects of the highest quartile of L_{eq} 24h for aircraft noise (L_{eq} >= 54.4 dB(A)). Mann-Whitney's U-tests show that the subjects of the highest L_{eq}-quartile are significantly less annoyed with road traffic noise than the subjects of the lowest L_{eq}-quartile. There is, however, no significant difference in railway and work noise annoyance between the persons of the highest and the lowest L_{eq}-quartile for aircraft noise (see table 2).

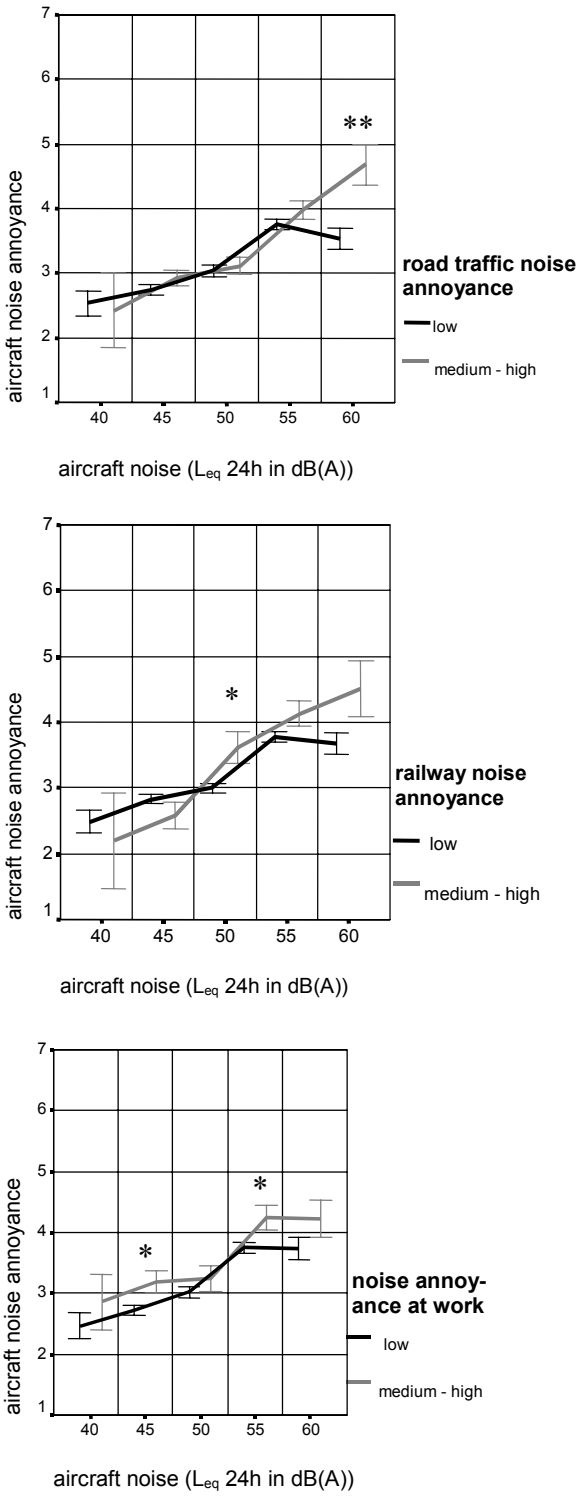

Figure 1: Dose-response relationship between aircraft noise and annoyance, for subjects with low and with medium or high annoyance caused by another noise source. N between 1142 and 1248. *significant aircraft noise annoyance difference at the respective 5dB-interval: p<.05; **p<.01.

annoyance caused by…	aircraft noise group	N	Sum of ranks	p
road traffic noise	L_{eq} <= 44.7 dB(A)	386	161409.0	<.005
	L_{eq} >= 54.4 dB(A)	371	125494.0	
railway noise	L_{eq} <= 44.7 dB(A)	381	144794.5	.61
	L_{eq} >= 54.4 dB(A)	371	138333.5	
noise at work	L_{eq} <= 44.7 dB(A)	353	118866.0	.13
	L_{eq} >= 54.4 dB(A)	341	122299.0	

Table 2: Mann-Whitney's U-tests between subjects of the lowest and the highest quartile of aircraft noise (L_{eq} 24h).

Discussion

In this sample the annoyance judgments of different noise sources are not completely independent from one another. There exists a weak correlation between the annoyance levels of some noise sources, even when the noise sensitivity and the aircraft noise level are controlled. Moreover, there is a tendency to more aircraft noise annoyance at same aircraft noise levels if the annoyance caused by other noise sources is medium or high. It could also be shown that subjects with little or no aircraft noise are significantly more annoyed with road traffic noise than subjects with high aircraft noise.

At the moment, there are no objective noise levels available other than aircraft noise levels. Therefore, it is questionable whether these findings are due to the distribution of the noise levels, or if there is a interdependence of the annoyance judgments of different noise sources. It is also possible that the noise sensitivity scale did not assess every aspect of noise sensitivity. There may be another underlying variable that is responsible for the common variance in the noise annoyance judgments, something like a tendency to complain.

There is some evidence that persons with a highly dominant noise source (aircraft noise in this case) are less annoyed with another noise source (road traffic noise). As long as there are no road traffic noise data available, however, it is difficult to draw final conclusions on this question.

References

[1] Wirth, K., Brink, M. & Schierz, C.: Lärmstudie 2000 – Projektdesign und erste Resultate. Fortschritte in der Akustik (2002), 346-347.

[2] Wirth, K., Brink, M. & Schierz, C.: Aircraft noise annoyance at different times of day. Proceedings of the joint meeting of DAGA and CFA, March 22-25, 2004, Strasbourg, France.