

Effects of classroom acoustics on teachers' well-being and perceived disturbance by classroom noise

Jesper Kristiansen*, Søren Peter Lund, and Roger Persson

The National Research Centre for the Working Environment, DK-2100 Copenhagen, Denmark, * jkr@nrcwe.dk

Per Møberg Nielsen

Akustik Aps, DK-2500 Valby, Denmark, pmn@akustikaps.dk

Objective: To investigate how classroom reverberation times (RT) are associated with school teachers' job-related well-being and their perception of disturbance attributed to classroom noise. **Methods:** In total, 283 school teachers (194 women) in 10 public schools in Copenhagen, Denmark, classified as "Low RT" (3 schools, mean RT 0.41-0.47 s), "Medium RT" (3 schools, mean RT 0.50-0.53 s) and "High RT" (4 schools, mean RT 0.59-0.73 s) participated in a questionnaire survey. **Results:** Job satisfaction and fatigue after work expressed as lack of energy was significantly lower in teachers in high RT schools compared to teachers in low RT schools. In addition, high RT school teachers reported a significantly higher level of perceived disturbance attributed to noise in the class. Finally, an increased risk of contemplating quitting the job was observed among high RT school teachers compared to low RT teachers. The results remained statistically significant after adjustment for gender, age, health and other work place conditions. **Discussion and conclusion:** Working in high RT schools was negatively associated with several indicators of well-being in school teachers. The results support the view that classroom acoustics is an important determinant of an optimal teaching environment in schools.

1 Introduction

The influence of classroom noise and acoustical working conditions on school teachers' job commitment and job satisfaction has not been thoroughly investigated. Nevertheless, insight into this question is available from studies dealing with adjacent outcomes. For example, noise from external sources such as aircraft and road traffic have been found to be associated with annoyance, speech interference and vocal efforts among teachers [1-3]. Similarly, some studies have reported increased vocal efforts [4-6] and distraction and annoyance [7-11] related to internal noise sources and high RT. Thus, the available evidence suggests that poor acoustical working conditions have several negative effects on teachers, and although none of the studies provide direct evidence there are reasons to believe that poor acoustical working conditions may have consequences for their job commitment and job satisfaction. The aim of the study was therefore to explore the effect of noise and poor acoustical conditions on teachers' well-being. Since the effect of poor acoustics is to make teaching more mentally exhausting the main hypothesis was that high RT and noise exposure are associated with increased levels of fatigue after work, lower job satisfaction and an increased risk of considering leaving the job independent of other work conditions. Furthermore, with regard to fatigue we hypothesize that high RT and noise exposure are associated with the mental aspects of fatigue, but not with its physical aspects.

2 Methods

This presentation is based on work that has been described in details elsewhere [11,12]. The aim of the presentation is to give a condensed overview of the main results. For a more detailed description of the study design and methods the reader should consult the before-mentioned references.

2.1 Teachers and schools

In brief, 10 schools in the Copenhagen area were invited to participate in the study. All teachers on the 10 schools were invited to participate in a questionnaire survey. Of 419 potential respondents from 10 schools, 283 (67.5%) filled in a questionnaire on health, disturbance by noise, and other work-related items. Of the respondents, 89 were men (31%) and 194 women (69%), whose mean age (range) was 45 (21-65) years (men) and 45 (25-66) years (women). The response rate ranged from 43% to 89% between the schools.

The ten schools were judged to be acoustically "homogeneous" across classrooms and subsequent measurement confirmed the expert evaluations. These measurements were performed by impulse excitation and reverse integration of the impulse response as described in ISO 3382-2. Of the 10 included schools, three schools were classified as "short RT" (mean RT = 0.44 seconds, range 0.41-0.47), three schools as "medium RT" (mean RT = 0.51 seconds, range 0.50-0.53), and four schools as "long RT" (mean RT = 0.65 seconds, range 0.59-0.73). The teachers were not informed about the acoustic classifications of the schools during the study and were in effect blinded to this study parameter.

2.2 Procedure

Noise exposure: self-rated noise exposure was assessed by an item that read "Are you exposed to noise that disturbs you when you are teaching?" A trichotomous outcome was constructed by combining the six response categories into Never/rare ("Never" and "Rarely or very little"), a quarter to a half of the work time ("Approximately a quarter of the time" and "Approximately half of the time"), and $\times\frac{3}{4}$ of the time ("Approximately three-quarters of the time" and "Almost all of the time").

Disturbance attributed to noise coming from the class was estimated by an item that read "How disturbing is noise from the following sources?" and the sub-item "Noise from children in the class (for example, speech, rattling with furniture, agitation)?" The teachers rated their degree of disturbance on a discrete scale 1-7, where 1=not disturbing and 7=almost unbearable.

Fatigue: a Danish translation of the Swedish Occupational Fatigue Inventory-20 (SOFI-20) was used to measure work-related fatigue in four dimensions: lack of energy, physical discomfort and exertion, physical discomfort, lack of motivation, and sleepiness.

Job satisfaction: job satisfaction was assessed by a single item that read, "Are you satisfied with your job?" with response categories 1= no, or very little, 2= little, 3= somewhat, and 4= very much.

Interest in leaving the job: teachers were asked if they were thinking about leaving their job. Response options were "No" and "Yes". Respondents who were considering leaving owing to retirement were excluded from the analyses.

2.3 Analysis

Job satisfaction and fatigue were analysed in multilevel mixed-model regression models with schools as a random factor. Results were expressed as differences in job satisfaction or fatigue score between high level and the reference level of the determinants, adjusted for potential confounders (the teachers' age, gender and self-rated health). The risk of expressing interest in leaving the job was estimated in multiple logistic regression analysis and expressed as an odds ratio (OR). All effect estimates were adjusted for multiple comparisons where appropriate. Statistical computations were made with IBM SPSS version 19. Two-sided P-values ≤ 0.05 were considered significant.

3 Results

3.1 RT and sound levels

Results regarding disturbance, job satisfaction and fatigue scores are presented in Table 1. A high degree of disturbance attributed to noise in the class, low job satisfaction and lack of energy after work was associated with working in high RT schools, and medium and high levels of self-reported noise exposure. Lack of motivation and sleepiness, but not other physical fatigue symptoms, was associated with self-reported noise exposure.

The association between expressing interest in leaving the job and noise exposure and RT is presented in Table 2. Working in high RT schools and reporting noise exposure was associated with increased risk of expressing interest in leaving the job.

Table 1. Effects based on estimated marginal means of acoustical classification and noise exposure on disturbance and well-being indicators. Effects are expressed as estimated the from reference level with 95% confidence intervals. All estimates are adjusted age, gender and self-rated health of the teacher.

Well-being measure	Independent variable used in the statistical model:			
	Acoustical classification (reference: Low RT)		Self-rated noise exposure (reference: Never/rare)	
	Medium RT	High RT	¼-½ of the time	≥½ of the time
Disturbance attributed to noise from the class	0.37 (-0.12 – 0.87) P=0.19	0.55 (0.08 – 1.01) P=0.017	1.18 (0.73 – 1.62) P<0.001	2.37 (1.84 – 2.90) P<0.001
Job satisfaction	-0.21 (-0.45 – 0.20) P=0.68	-0.33 (-0.67 – -0.03) P=0.035	-0.32 (-0.53 – -0.11) P=0.001	-0.44 (-0.69 – -0.19) P<0.001
Physical discomfort and exertion	0.02 (-0.31 – 0.26) P=1.000	0.18 (-0.09 – 0.45) P=0.26	0.17 (-0.12 – 0.47) P=0.38	0.27 (-0.08 – 0.62) P=0.17
Lack of energy	0.08 (-0.47 – 0.62) P=1.000	0.52 (0.01 – 1.03) P=0.047	0.99 (0.44 – 1.54) P<0.001	1.58 (0.94 – 2.23) P<0.001
Lack of motivation	-0.01 (-0.70 – 0.68) P=1.000	0.24 (-0.40 – 0.88) P=0.66	0.66 (0.20 – 1.11) P=0.003	0.93 (0.38 – 1.47) P<0.001
Sleepiness	-0.18 (-0.98 – 0.63) P=1.000	0.26 (-0.50 – 1.01) P=0.74	0.60 (0.10 – 1.10) P=0.014	0.70 (0.10 – 1.30) P= 0.017

Table 2. Effects of acoustical classification and noise exposure on the risk of expressing interest in quitting the job. Effects are expressed as odds ratios with 95% confidence intervals. All estimates are adjusted for health factors and socio-economic characteristics of the school.

Well-being measure	Independent variable used in the statistical model:			
	Acoustical classification (reference: Low RT)		Self-rated noise exposure (reference: Never/rare)	
	Medium RT	High RT	¼-½ of the time	≥½ of the time
Interest in quitting the job	1.27 (0.53 – 3.08) P=0.59	3.56 (1.62 – 7.80) P=0.002	1.88 (0.67 – 5.28) P=0.23	3.93 (1.28 – 12.0) P=0.007

4 Discussion

Overall, statistically significant associations were observed between a poor acoustical working environment and indicators of well-being in schoolteachers. The results are in accordance with the finding in previous studies. For example, Enmarker and Boman [10] found that well-being expressed by stress symptoms, which comprised tiredness, irritation, tenseness without obvious reason, headache, concentration problems and sleeping problems, were predicted by noise annoyance in both teachers and pupils and, furthermore, that noise annoyance was predicted by hearing status and noise sensitivity. Moreover, Skarlatos & Manatakis [7] in a study in Greek schools found a high correlation between noise discomfort and measured classroom noise levels among teachers as well as among pupils. The background noise levels in unoccupied classrooms (average 50 dBA) and RT in the classrooms (average 2.58 s) was relatively high, however, which limits the possibility of generalizing these findings to schools in other countries.

5 Summary

In conclusion, we observed significant associations between poor acoustical conditions and several indicators of well-being among schoolteachers. The results are in accordance with the known negative impact of noise on children's and teachers' well-being in schools. All things considered, the results further strengthen the evidence for the importance of an optimal acoustical environment in school classrooms for learning and teaching.

6 Funding

This study was supported by the National Working Environment Fund (Project no. 16-2008-03).

References

- [1] M. A. Crook and F. J. Langdon, The effects of aircraft noise in schools around London airport, *J Sound Vibr* 34, 1974, 221-232.
- [2] N. W. M. Ko, Responses of teachers to aircraft noise, *J Sound Vibr* 62, 1979, 277-292.
- [3] J. W. Sargent, M. I. Gidman, M. A. Humphreys, and W. A. Utley, The disturbance caused to school teachers by noise, *J Sound Vibr* 70, 1980, 557-572.
- [4] E. Pekkarinen and V. Viljanen, Acoustic conditions for speech communication in classrooms, *Scand Audiology* 20, 1991, 257-263.
- [5] E. Pekkarinen, Himberg L, and J. Pentti, Prevalence of vocal symptoms among teachers compared with nurses: A questionnaire study, *Scand J Log Phon* 17, 1992, 113-117.
- [6] V. L. Åhländer, R. Rydell, and A. Löfqvist, Speaker's Comfort in Teaching Environments: Voice Problems in Swedish Teaching Staff, *Journal of Voice* 22, 2011, 430-440.
- [7] D. Skarlatos and M. Manatakis, Effects of classroom noise on students and teachers in Greece, *Percept. Mot. Skills* 96, 2003, 539-544.
- [8] P. Lundquist, K. Holmberg, L. Burström, and U. Landström, Sound levels in classrooms and effects on self-reported mood among school children, *Percept. Mot. Skills* 96, 2003, 1289-1299.
- [9] P. Lundquist, K. Holmberg, and U. Landström, Annoyance and effects on work from environmental noise at school, *Noise Health* 2, 2000, 39-46.
- [10] I. Enmarker and E. Boman, Noise annoyance responses of middle school pupils and teachers, *Journal of Environmental Psychology* 24, 2004, 527-536.
- [11] J. Kristiansen, S. P. Lund, P. M. Nielsen, R. Persson, and H. Shibuya, Determinants of noise annoyance in teachers from schools with different reverberation times, *Journal of Environmental Psychology* 31, 2011, 383-392.
- [12] J. Kristiansen, R. Persson, S. P. Lund, H. Shibuya, and P. M. Nielsen, Effects of classroom acoustics and self-reported noise exposure on teachers' well-being, *Environ. Behav.* 2011