NOISE, ACCIDENTS, MINOR INJURIES AND COGNITIVE FAILURES.

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Introduction Smith (1990) reviewed studies of the effects of noise on accidents. Cross-sectional studies have produced conflicting results, with some showing a greater accident rate in high noise areas (e.g. Kerr, 1950; Cohen, 1974) but others (e.g. Lees, 1980) reporting no effect of noise. All of these early studies suffer from the problem that noise exposure was confounded with other uncontrolled factors. Intervention studies (e.g. Cohen, 1976) suggest that reduction of noise exposure does lead to lower accident rates. However, these results can be interpreted in other ways (e.g. changes in morale) and a reduction in injuries was seen in both workers who used hearing protectors regularly and those who did not. Another major problem in this area is the definition of an accident. In some studies it is likely that an accident refers to an injuring requiring medical attention whereas in others the injuries are likely to have been more minor. There is a need, therefore, to examine associations between noise exposure and both accidents and minor injuries.

Many everyday errors (failures of attention, memory or action) do not lead to accidents. However, in certain contexts human error is a major cause of accidents and it is important to determine where noise exposure influences the occurrence of cognitive failures. Smith and Stansfeld (1986) compared self-reports of everyday errors given by people who lived in a high aircraft noise area with those given by people in a quieter area. The results showed that the high noise group reported a greater frequency of everyday errors. It is now important to determine whether such associations are also observed in the workplace.

The aim of the present study was to examine associations between perceived noise exposure at work and the occurrence of accidents, injuries and cognitive failure. This was done using a questionnaire survey of two large samples. In addition, information was available about other job characteristics (e.g. working hours, job demands, other physical hazards such as exposure to fumes or handling dangerous substances) and analyses were carried out including these variables to determine whether any noise effects reflected other aspects of the workplace. In addition, demographic factors were co-varied, as was negative affectivity. Inclusion of the last variable was important as both perceptions of noise exposure and the dependent variables were measured by self-report and any association between the two might reflect a general bias in sensitivity or reporting of negative events.

Methods The analyses reported here are based on data from the second phase of the Bristol Stress and Health at Work Study (Smith et al., 2000) and the Cardiff Health and Safety at Work Study (Simpson et al., submitted). Postal surveys were carried out selecting samples from the electoral register. The questionnaire collected information on demographics, occupational characteristics, noise exposure, working hours, job demands/control/support, negative affectivity and accidents, injuries and cognitive failures (see Smith et al., 2000).

The analyses reported here were based on data from 6512 workers. Details of the sample are shown in Table 1. Perceived noise exposure was measured by two questions. One asked how frequently they were exposed to noise which let to a ringing in the ears. The second asked about exposure to noise that disturbed concentration. A 4-point scale (from 'Never' to 'Often') was used to respond to the questions. Frequency of accidents required

medical attention was recorded (number in last 12 months) and the frequency of minor injuries (not requiring medical attention from another person e.g. cuts and bruises) and cognitive failures were rated using a 5-point scale ('not at all' to 'very frequently').
The following variables were also included in the regressions to control for other factors: age, gender, income, educational level, social class based on occupation, full/part-time employment, negative affectivity, working hours and the Karasek dimensions of job demands/control/support.

Table 1 Description of the sample

Gender x full-time/part-time Employment	**N**	**% of sample**
Males, full-time	2529	39.8%
Males, part-time	231	3.6%
Females, full-time	2266	35.6%
Females, part-time	1332	20.5%
Age Groups		
16-24 years	745	12.3%
23-39	2307	38.0%
40+	3023	49.8%
Income		
Less than £10,000	1484	23.5%
£10-19,000	2590	41.0%
£20-29,000	1386	21.9%
£30,000 +	863	13.6%
Highest educational qualification		
None	656	10.5%
GCSE/'O' Level	1425	22.8%
'A' Level	512	8.2%
City % Guilds	1534	24.5%
University Degree (BA/BSc)	804	12.8%
Higher Degree/Professional qualification	1326	21.2%
Occupation		
Non-Manual	4691	73.9
Manual	1654	26.1
Location		
Bristol	1892	29.1%
Cardiff	4620	70.9%

Results 89% of the sample reported that they were never exposed to noise levels that produced a ringing in their ears and 63.7% reported that they were never exposed to noise that disturbed their concentration. 4.7 % of the sample reported at least one accident requiring formal medical attention in the last year; 16% reported frequent/very frequent minor injuries at work and 22.3% frequent/very frequent cognitive failures at work. Tables 2 and 3 show that cross-tabulations between noise exposure and accidents, injuries and cognitive failures. All of these effects were highly significant and the next set of analyses examined whether they were still present when the other factors were statistically controlled.

Table 2 Ringing in ears and accidents, minor injuries and cognitive failures.

	RINGING IN EARS	
	Never	**Seldom/Sometimes/Often**
1 or more accidents	6.7%	14.4%
Quite/very frequent minor injuries	7.6%	23.2%
Quite/very frequent cognitive failures	10.9%	14.9%

Table 3 Background noise and accidents, minor injuries and cognitive failures

	BACKGROUND NOISE			
	Never	**Seldom**	**Sometimes**	**Often**
1 or more accidents	6.3%	8.8%	9.4%	12.1%
Quite/very frequent minor injuries	6.8%	8.5%	14.7%	20.2%
Quite/very frequent cognitive failures	9.2%	12.4%	15.0%	19.5%

1. *Accidents*: The effect of background noise on accidents was no longer significant when demographic and occupational factors were entered into the model. However, noise that led to a ringing in the ears was still found to be significant (OR = 1.65 CI: 1.1 – 2.46).
2. *Minor injuries*: Those who reported that they were 'sometimes/often' exposed to a level of background noise that disturbed their concentration were more likely to report 'quite/very frequent' minor injuries (Sometimes: OR = 2.1 CI: 1.55-2.84. Often: OR=2.79 CI: 1.93-4.03) even when other factors (including 'ringing in the ears') were controlled for. Similarly, those who were exposed to noise that led to 'ringing in the ears' were more likely to report 'quite/very frequent' minor injuries (seldom exposed: OR = 3.81 CI: 2.52-5.74. Sometimes/often exposed: OR = 4.25 CI: 3.04-5.94).
3. *Cognitive failures*: A clear dose response was observed for exposure to a level of background noise that disturbs concentration and 'quite/very frequent' cognitive failures (see Table 4). Exposure to noise that led to ringing in the ears was also associated with greater reporting of cognitive failures (sometimes/often: OR = 1.85 CI: 1.24-2.74), although this did not account for the background noise effect.

Table 4 Perceived exposure to background noise that disturbs concentration and reporting of cognitive failures (quite/very frequent)

	OR	**CI**
Noise exposure:		
Sometimes	1.51	1.12-2.03
Often	1.91	1.32-2.77

Exposure to noise is often associated with other physical hazards and the next set of analyses examined whether the effects of noise remained when those exposed to other hazards (e.g. exposure to fumes, handling dangerous substances) were excluded.

1. *Accidents*: The effect of exposure to noise that led to ringing in the ears was no longer significant when those exposed to other physical hazards were excluded.
2. *Minor injuries*: Those who reported that they were 'sometimes' or 'often' exposed to noise that led to ringing in the ears were more likely to report 'quite/very frequent' minor injuries (Sometimes: OR = 3.35 CI: 1.44-7.78. Often: OR=3.67 CI: 1.66-8.09) even when workers exposed to other physical hazards were removed from the analysis. This was also found for those who reported that background noise 'sometimes' or 'often' disturbs their concentration (sometimes: OR = 1.76 CI: 1.12-2.76; Often: OR = 2.34 CI: 1.28-4.31).
3. *Cognitive failures*: Exclusion of those exposed to other physical hazards did not alter the association between background noise that disturbed concentration and 'quite/very frequent' cognitive failures (see Table 5). However, the association between noise that led to ringing in the ears and reporting of cognitive failures was no longer significant.

Table 5 Perceive exposure to background noise that disturbs concentration and reporting of cognitive failures (excluding those exposed to other physical hazards).

	OR	**CI**
Noise exposure		
Sometimes	1.88	1.30 – 2.72
Often	2.40	1.42 – 4.04

Discussion The initial findings from the present study showed that perceptions of noise exposure were related to reports of accidents, minor injuries and cognitive failures. Clear dose-response effects were observed and this suggests that some causal relationship may be present. The next series of analyses aimed to determine whether the associations between noise exposure and the outcomes reflected noise or other correlated job characteristics. Furthermore, the analyses controlled for demographic factors and for negative affectivity, a crucial determinant of subjective reports. When these other factors were included in the regression models the effect of 'background that disturbs concentration' was no longer significant in the analysis of accidents. Similarly, when other aspects of the physical working environment were considered (exposure to fumes, handling of dangerous substances) the effect of 'exposure to noise that led to ringing in the ears' was no longer significant. These results suggest that the association between noise and accidents largely reflects other correlated job characteristics.

In contrast to this, controlling for other factors and excluding those exposed to other physical agents did not remove the effects of noise exposure on minor injuries or cognitive failures. The effect of noise on minor injuries was greater at higher perceived intensities. However, the effect on cognitive failures was more apparent in those who perceived that background noise disturbed their concentration. As this last measure of noise exposure implies a functional deficit it is not too surprising that it should be associated with another measure of cognitive problems. However, Smith (2002) has shown that the measures of noise exposure used here are highly correlated with general questions about noise exposure which makes it unlikely that it is the specific nature of the question that is crucial. It may, however, be the case that the question measures not only exposure to noise but also sensitivity to its effects which may make it more useful than general questions about exposure.

Overall, the present findings suggest that it is important to conduct further research on noise exposure, accidents, injuries and cognitive failures. Future research should obtain objective measures of exposure to determine whether similar patterns of results are obtained. Similarly, it is important to investigate whether similar associations are observed outside of work. Finally, it is important to consider combinations of noise and other factors to determine whether its effects are increased in certain situations and possibly reduced in others.

Keywords: Perceived noise exposure; accidents; minor injuries; cognitive failures

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