



THE EFFECTS OF NONPHYSICAL NOISE CHARACTERISTICS, ONGOING TASK AND NOISE SENSITIVITY ON ANNOYANCE AND DISTRACTION DUE TO NOISE AT WORK

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Abstract

Factors influencing the subjective responses to noise were studied in a group of 439 persons working in offices, laboratories or industries. In each person's workplace noise was measured. Information about responses to noise and factors that might affect annoyance were collected in questionnaires. An annoyance and a distraction index were formed on the basis of a factor analysis. Annoyance was found mainly to be related to sound level, self-rated 'necessity' of the noise, hearing status and sex. Distraction was most strongly related to degree of self-control of the noise and noise predictability. The most critical noise sources for the annoyance response were other machines than those used by oneself, whereas telephone signals had the largest effect on distraction.

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Introduction

In studies of noise annoyance in residential areas, technical noise measures like the dB(A) level, have generally been found to explain only a minor part of the interindividual variance in annoyance (McKennell, 1963; Griffiths & Langdon, 1968). There is a lack of comparable data from occupational environments, but in a study from our own group (Landström *et al.*, 1995) we were able to explain about 25 per cent of the variance in a group exposed to noise levels between 40 and 85 dB(A). These results may partly be explained by shortcomings of the annoyance and the physical noise measures, but it is also evident that nonphysical noise characteristics and other situational and individual characteristics are of great importance. Unfortunately, research on the influence of such factors on the subjective response is rare and virtually nonexistent within the work environment field.

Several factors of these types have, in different contexts, been suggested to be of importance for the annoyance response (Weinstein, 1976; Gawron, 1982; Moch-Sibony, 1984; Vallet, 1987; Green & Fidell, 1991).

Predictability and controllability

It is easier to habituate to constant noise than to variable noise, and constant noise, therefore, is on the whole less annoying than a variable noise (Vanderhei & Loeb, 1977; Kuwano *et al.*, 1980). Results from stress research indicate that an unpredictable and uncontrollable stressor generally yields a stronger stress response than a predictable and controllable event (Thompson, 1981). A predictable stressor offers greater possibilities to prepare oneself for the stressor, and the predictability also implicates that there are periods during which the person does not have to be prepared for the stressor. Accordingly, a variable noise should be less annoying when the changes are expected than when they are unexpected. Similarly, the person who operates a machine and, thus, controls its noise should be less annoyed by it than are other people exposed to the same noise.

Aspiration level and the 'necessity' of the noise

Jonah *et al.* (1981) found that those who believed that it would be very difficult to reduce the noise in their homes were less disturbed by the noise than

those who believed it would be an easy thing to do. In a workshop a major part of the noise may be regarded as an unavoidable consequence of the activity, whereas the same noise would be considered unnecessary in an adjacent office. This is probably the main reason why a noise deemed acceptable in a workshop would be regarded as unbearable in an office. Schönplug and Schulz, as quoted by Sust (1987), in a field study in offices found that even very high noise levels were tolerated when the noise was a result of the employee's own work. This might be a conjoint effect of several factors. Thus, the noise may contain information about the work process (performance feedback), the person has a certain amount of control over the noise source and the noise may be viewed as an almost unavoidable consequence of the task. Such an effect of the connection between task and noise on annoyance has also been demonstrated in the laboratory (Munz *et al.*, 1971).

Informational content

Sound level has been found to be a poor predictor of annoyance where irrelevant speech is the main noise problem (Nemecek *et al.*, 1976; Nemecek & Turrian, 1978). Rather, the intelligibility of the irrelevant speech seems to be the main factor in determining how disturbing it is. Sounds other than speech may also carry information, which makes them more or less acceptable.

Ongoing activity

It is obviously true that one is more disturbed when the noise masks auditory information required for the ongoing activity (Taylor, 1984; Hall *et al.*, 1985). However, few systematic studies have been reported on the importance of other task characteristics than sensitivity to masking effects. Nemecek and Turrian (1978) found that persons with higher positions in the office were more easily disturbed by noise than other employees. They interpreted this result as indicating that one is more vulnerable to noise during work with more complex tasks. Boyce (1974) and Nemecek (1984) report similar results, whereas Hay and Kemp (1972) found no differences between occupational groups. The noise disturbance diaries collected by Purcell and Thorne (1977) indicated that calculation tasks were the ones most sensitive to noise disturbance. Landström *et al.* (1993) determined annoyance thresholds and tolerance levels during work with a simple reaction time task and a more difficult reasoning task. These levels

were found to be 6 dB lower during the more complex task. In the series of experiments reported by Kjellberg and Sköldström (1991) subjects rated their noise annoyance during work with different tasks. Among other tasks they used the same ones as Landström *et al.* (1993) and also obtained differences in rated annoyance corresponding to 6 dB. However, during work with a somewhat more complex reaction time task, annoyance was as high as during proof-reading and reasoning tasks. They also found that the most annoying sound-task combination was irrelevant speech during work with a verbal task.

Individual differences in the response to noise

It is obvious that the same noise elicits widely different responses in different persons. Although it is not clear how these differences should be interpreted (Jones & Davies, 1984), people who rate themselves as more sensitive than others also are likely to show stronger annoyance responses. Research attempting to identify critical characteristics of the persons most annoyed by noise has not been very successful (Jones & Davies, 1984). The only group that has been found to deviate clearly from others in their response to noise are those with a hearing impairment, who most often are more annoyed by noise than others (Aniansson & Peterson, 1983; Aniansson *et al.*, 1983).

The main aim of the present study was to evaluate how these factors contribute to the noise annoyance responses in the work place.

Method

Subjects

The study included 439 participants, 292 women and 147 men with a mean age of 37 years (range: 17–65 years). It was conducted in three types of workplaces: offices, laboratories and industries. Only workplaces with noise exposure levels below 85 dB(A) were chosen, i.e. workplaces with an exposure level below the current exposure limit for unprotected workers in Sweden. The places were chosen to obtain as varying frequency characteristics as possible. Most of the office-workers were exposed to low frequency noise at moderate levels. Most of the industrial workers were exposed to middle or low frequency sounds at relatively high levels. The laboratory workers were exposed to different types of noise frequencies and levels.

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