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Susceptibility to Annoyance by Noise

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Introduction

It is common knowledge that there is a considerable inter-subject variation in susceptibility to annoyance by noise. This point is very obvious from interviews, carried out in depth, in a field study on four different industrial noise nuisances (1). The fact that large differences exist is also remarked upon in published surveys of noise nuisances due to such things as traffic (2) and aircraft (3).

We have suggested that there are different mechanisms at work in noise annoyance situations giving rise to two or three different patterns of behaviour (4). Further, account of such differences does not seem to be made in establishing criteria for annoyance. The assumption appears to be made that people may be treated as a homogenous group. Whilst considerable effort has been spent in setting up a multiplicity of criteria for annoyance for different types of noise - and where considerable redundancy seems to exist (5) - very little attention has been paid to studying perhaps the more fundamental problem, that of susceptibility to annoyance by noise (4). At the time of writing there is a poor understanding of the extent of its variation and the factors upon which it depends.

There appear to be two schools of thought. McKennell (3) considered that personal factors such as 'opinions about the effects on health' 'number of things disliked about the area' 'fear of aircraft' etc all work together to 'produce the overall variability between individuals' found in his survey of annoyance due to aircraft around London airport. On the other hand writers, from Schopenhauer (6) onwards, have considered certain personality traits are associated with noise annoyance sensitivity. Whilst this writer considered that 'noise was a torture to people of great intellect and people not sensitive to any kind of intellectual influence were not sensitive to noise' modern thought tends to relate noise susceptibility to such things as introversion (7), neuroticism (8) etc. The latter view that there is a relationship between noise sensitivity and neuroticism appears to be one which is widely held by the general public (1).

Unfortunately the above are only opinions and there is in fact very little published work on determining the causes of noise susceptibility (9). It was with this in mind we planned a laboratory experiment to study sensitivity to noise annoyance.

The experiment

Three different types of (tape recorded) noise were used; each noise presentation being of 20 seconds duration. The noises were:

(i) Street noises; mixed traffic accelerating away from roundabout on A6, Salford, original level 80 - 90 dBA.

(ii) Aircraft takeoff; Boeing 707, at 100 yards, from Knutsford end of runway, Manchester Airport. (original) Peak level 105 dBA.

(iii) Industrial noise; Drying plant, textile mill recorded in backyard of aggreived resident, original level 65 dBA with 4 dBA peak to peak modulation.

Listening room

The listening room dimensions were 12' x 12' x 12' having painted brick walls with a lino-tiled floor. There were six people per test session. The noises were played through two Goodmans Magnum K speakers via Mullard 20 W amplifier and Ferrograph 722 tape recorder. The background noise level in the room was less than 50 dBA and the noise levels were monitored by a Bruel and Kjaer sound level meter type 2203. The variation of noise levels between subject positions was not more than ± 1 dB and the levels on the tape were within ± 1 dB of their nominal values.

Test procedure

There were three test sessions, separated by at least 24 hours, with one noise per session. The order of noise presentation being (i). (ii) and finally (iii). In each session the noise was presented on six occasions at each of the following levels, 55, 65, 75, 85 and 95 dBA, the order of presentation of levels being randomised. The subjects were asked to make posterior judgements of three of the six noises at each level on a ranking scale of annoyance (11) whose categories were, 'Quiet', 'Noticeable' 'Intrusive', 'Annoying', 'Very Annoying' and 'Unbearable'. Each session took about 45 minutes. A distraction task was employed with the subjects being allowed to read material of their own choice. At the end of the experiment six subjects were retested on all three noises, using the same presentation order. The period between test and retest was about two months.

After the three test sessions the subjects were interviewed. As most had taken part in an earlier experiment on individual loudness (12) the following information was already available; loudness slopes, loudness discomfort levels, hearing thresholds at 1 kHz, and scores on the Maudsley Personality (Introversion/ neuroticism) and Minnesota Multiphasic Personality Inventories. In the interview the subjects; completed a noise questionaire (11) gave a self assesment of noise sensitivity and finally took part in the Rorschach Projection Test.

The subjects Thirty-four (5 female, 29 male) subjects all of whom had thresholds within 10 dB of ISO threshold values took part in the noise rating experiment, whilst 26 of them had taking part in the loudness experiment. They were all members of the University staff.

Results The results can be conveniently considered under the following two headings:

(i) Are there significant and stable differences between subjects in their rating of noise?

(ii) If such differences exist which if any of the personality traits correlate with noise annoyance sensitivity?

Mean data

As a first step noise function for the group (noise ratings converted to 0 to 10 scale vs noise level in dBA) were calculated for each of the three noises. The functions obtained are not linear but are concave upwards being similar in shape to those curves obtained by Perrei et al. (13) for the rating of tape recorded aircraft noise. The agreement between the rating curves for the street and the industrial noise was excellent whilst that for aircraft lay below the other two - the greatest difference being one and a half divisions on the rating scale. However, as this difference was not significant, each subjects results, for all three noises, were combined. As it was found that a square root transformation linearised the mean data each subject's results were transformed and regression lines fitted to their data. The other measure of annoyance which was used to determine an average rating (AR) for each subject for all five levels of a particular noise. This is a somewhat crude measure but it was found useful when correlations were being looked for between personality and annoyance.

(i) Inter subject differences

Rating differences between subjects of the same noise was considerable. As an example, the level in dBA at which a subject's annoyance function reached a value of '5' on the rating scale ('fairly annoyed') varied over the range from 75 dBA to 97 dBA with one extreme case giving an extrapolated value of 108 dBA. These differences are borne out by the subjects' own comments; the least annoyed could miss rating some of the quieter noises if absorbed in a 'good book'. On the other hand the most annoyed found even the quietest levels intruded and caught their attention whilst the higher levels became unbearable.

Using the average ratings and analysis of variance showed that the between subject variance was 3.9 whilst the within subject variance was 0.2. The difference between variances applying Snedecor's test is highly significant and this is highly suggestive that there are real differences between subjects in their rating of noise.

The fact that these differences are stable is shown by an examination of the retest data. Considering correlations between the AR in the first and second tests for street, aircraft and industrial noises separately, the correlations and their significance levels were; $r = +0.85$, $p = 2\%$; $r = +0.74$, $p = 6\%$ and $r = 0.83$, $p = 3\%$ respectively. The overall effect was significant at better than the 0.5% level. The stability of the subjects on retest is even more striking if we examine the regression lines for their transformed noise functions. For instance in the case of street noise the correlation between the first and second test is $r = +0.89$, ($p = 1\%$) and $r = +0.92$, (p 1%) for the slopes and intercepts respectively.

Thus we conclude that there are significant differences between subjects in their rating of the annoyance of noise and that subjects are capable of giving reproducible data after a period of two months.

(11) Causes of susceptibility to noise annoyance

Having established that differences do exist between the noise rating functions given by different subjects it is necessary to look for correlations with personality. At the time of writing the analysis is incomplete and so we are unable to come to any definite conclusions about noise annoyance and personality. We can however examine the relationship between the former and loudness susceptibility.

It might be anticipated that those subjects with steep loudness functions (10) would also be those who found noise most annoying. This is in fact the case; the correlation between the average rating of the noises for 29 subjects and the slopes of their loudness function is $p = +0.56$. This result is significant at better than the 1% level. The loudness data was obtained in an experiment carried out one year previously (12). More interesting is the relationship between the transformed noise annoyance data of this experiment and the loudness slopes. Here the correlations between the slopes and the intercepts of the transformed data and the loudness slopes, are $r = -0.52$ ($p = 1\%$) and $r = +0.64$, ($p = 0.1\%$) respectively. The fact that there is a negative correlation between the two slopes suggests that the relationship between loudness and noise annoyance is not quite as straightforward as might be expected.

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