ANNOYANCE AND SPEECH INTERFERENCE FROM NOISE

Peggy Ou, Helen Gough and Stephan Konz

Dept. of Industrial Engineering, Kansas State University
Manhattan, Kansas 66502

ABSTRACT

In Experiment One, noise from five home appliance and five shop tools was evaluated for speech interference (ie words missed) and annoyance by 23 subjects (11 male, 12 female). Both speech interference and annoyance were highly (r^2 = .76 and .66) correlated with dbA noise level.

In Experiment Two, 15 "industrial" noises (mean dbA=84; range = 59 to 97) were evaluated for annoyance by 100 subjects (79 male, 21 female). The annoyance vote was analyzed by analysis of covariance. In addition to annoyance being a function of dbA, the subject's gender, age and whether they were a student or not were significant predictor's of annoyance. A simple predictor equation was ANNOY (vote on scale 1 to 5) = 3.05 + .124 (dbA - 84) + .001 $(dbA-84)^2$ + .16 (if student) with r^2= .60.

INTRODUCTION

People are exposed to many noises. At higher levels (say 90 dbA) there is the possibility of physical damage. However many decisions are made on criteria other than health. At lower (say 60 to 90 dbA) levels, the appropriate criteria may be annoyance and speech interference.

Annoyance can be defined as the displeasure or resentment caused by sound. Some relevent "environmental" factors are loudness or intensity, frequency of occurrence, predictability, recognition, meaning of the noise, attitudes as to whether it is necessary or not, the value attached to the related function causing the noise, and the context in which the noise occurs. Fenwick (1959) reported low frequency noise has less effect on annoyance. Starr (1972) said noise in octave bands outside 2000 to 8000 Hz is less annoying than within the range. Epp and Konz (1975) reported annoyance and speech interference for appliances were a function of dbA and that dbA alone (rather than by octave band) was a sufficient predictor. Frey (1976) concluded that individual and concentration skills (such as archery shooting) are more affected than team skills (such as volleyball) by jet noise levels.

Annoyance also may be a function of individual factors (Pearson and Hart, 1968). Bryan and Tempest (1973) state "There is also evidence that, in some circumstances, factors relating to the individual can be more valuable in predicting the response to noise than is the nature of the noise itself." Bender (1972) reported a positive relationship between annoyance and socio-economic status. Pearson, in two studies (Pearson, and Bregman, 1972; Pearson, Hart and O'Brien, 1974) investigated individual differences. Females, younger (18-29) ages, college degrees and rural residence were factors associated with more annoyance. Babiker (1977) reported individual sensitivity to noise and to glare was a function of various individual factors.

Speech interference occurs when the noise interfers with a message. The result could be an incomplete or inaccurate reception of the message or a requirement of both the sender and receiver to work unnecessarily hard.

In the first experiment, males and females listened to shop tool and home appliance noises. The criteria were annoyance and speech interference. In the second experiment, males and females listened to "industrial" noises; annoyance was the criterion.

EXPERIMENT ONE

Task

Noise from five home appliances and five shop tools (microwave oven, dishwasher, metal lathe, sewing machine, drill press, blow dryer (hair), band saw, blender, belt sander and planer) were recorded on tape using a Craig Model 212 tape recorder. These sounds were chosen to give a wide range of noise levels. "Quiet" shop tools as well as "noisy" appliances were included.

The appliances and tools were taped while operating under normal conditions. The microphone was placed 1.5 m above the floor and 1 m from the source of the noise to simulate the sound effect on the operator. Only the dbA scale was used to measure each noise as the decibel levels by octave bands or decibel levels on the C scale show no significant differences in prediction of annoyance (Epp & Konz, 1975) so their use was omitted.

The decibel levels for the home appliances ranged from 57 dbA to 88 dbA with a mean of 72.6 dbA; the decibel levels for the shop tools ranged from 65 dbA to 94 dbA with a mean of 81 dbA.

Speech interference was measured by the percentage of words not clearly heard while the noises were playing.

Annoyance was measured by asking the subjects to rate each noise to the nearest whole number using the following scale:

1. Not annoying--would be willing to listen to it up to 8 hr per day.
2. Slightly annoying--would be willing to listen to it up to 2 hr per day.
3. Moderately annoying--would be willing to listen to it up to 30 minutes per day.
4. Very annoying--would be willing to listen to it up to 7 minutes per day.
5. Extremely annoying--would not want to listen to it at all.

Subjects

A total of 23 subjects participated in the experiment, 11 males and 12 females. The males ranged in age from 21 to 48 (mean 35); females ranged in age from 21 to 43 (mean 32). No hearing test was administered. The subjects were asked if they had any known hearing loss or were subjected to loud noises during the day. Four males said they had some hearing loss; two males indicated that they were subjected to loud noises during the day. None of the females indicated any hearing loss; three said they were subjected to loud noises during the day.

Procedure and Experimental Design

All 23 subjects listened to all ten noises. The experiment was performed on four groups. Groups one and three had six subjects each, group two had four subjects and group four had seven subjects. The subjects were seated in a semi-circle with the tape recorders in the center. Each seat was checked with the sound level meter to insure that each subject heard the noises and words at the proper decibel levels.

Each subject was given a questionnaire to obtain background information and a form for writing the words and annoyance ratings. The instructions were taped and the rating scale was posted for reference during the experiment.

The noises were played in random order. The order was different for each group. The order of the taped words also was random but this order was the same for all four groups.

The number and source of each noise was announced before it was played; i.e. Noise 1, band saw; Noise 2, dishwasher; Noise 3, drill press; etc. Each noise was played for 90 s.

While the tape of the noises was playing, another tape was played with ten different words per noise read (at approximately seven second intervals) by a female in a normal conversational voice (76 dbA). The words read were of a one-syllable phonetically balanced and two-syllable spondee type. (List 4, for example, was "stairway, fuss, grove, are, wigwam, yardstick, ford, rub, cupcake, pin ball"). The subjects wrote these words as they heard them.

Measurements and Instrumentations

Tool and appliance noise levels were measured with a sound level meter using the dbA scale at the same location that the microphone was positioned for taping. The tape volume was adjusted to give the same decibel reading from the recording as was actually recorded. The subject seating arrangement also was checked so that each subject received the noise at the proper level.

Results

The two criteria, percent words missed (PMISS) and annoyance (ANNOY) each were analyzed by analysis of variance.

For percent words missed, dbA was highly significant ($F = 820$; $\alpha < .0001$). PMISS = -124 + 2.30 dBA with $r^2 = .758$ and SE = 16%. For example, if dbA = 80, then PMISS = -124 + 2.30(80) = 60% with SE = 16%. For every dbA increase, it is estimated that PMISS increases by 2.3%. Females missed 5% less words than males but the difference was not statistically significant.

For annoyance, dbA was highly significant ($F = 642$; $\alpha < .0001$). ANNOY = -2.88 + .083 dbA with $r^2 = .657$ and SE = .7 vote. For example, if dbA = 80, then ANNOY = -2.88 + .083(80) = 3.76 with SE = .7 vote. (For reference, 3 was moderately annoying and 4 was very annoying).

The type of noise (shop vs appliance) was not significant for either criterion. Neither was the type x gender interaction. Subject age was not a significant predictor for either criterion.

EXPERIMENT TWO

Task and Procedure

A tape was made of 15 noises--11 from a dog food plant for areas ranging in noise level from a team leader's office (60 dbA) to an oven area (96 dbA) and filling room (96 dbA). Four university areas ranged from a student activity room (64 dbA) to the student cafeteria (80 dbA). These noises were re-recorded onto one tape--losing some fidelity in the process.

When a group of subjects came to the reasonably quiet (50 dbA) experimental room, they completed a form giving their gender, age, student vs non-student status and whether they had "previous noise experience". Then they sat in a semi-circle around the tape recorder. The experimentor adjusted the volume for sound 1 by using a sound level meter at the ear of one of the subjects. The remaining sounds then were the same amount above or below their standard levels. Due to the experiment being conducted in various rooms and the use of inexpensive amplifier, tape and tape recorder the sound quality was "not good" and the dbA levels are "not exact".

The sequence of noises was without a pattern except the first noise was the loudest and the second the quietest; the subjects were not informed of this. They listed to each noise for 20 s and judged its annoyance on a scale of 1= not annoying, 2= slightly annoying, 3= moderately annoying, 4= quite annoying and 5= extremely annoying. During the 10 s break between noises they voted to the nearest tenth (eg 3.4, 4.1).

Subjects

The 100 subjects had the following characteristics: Gender: 79 male and 21 female; Age: 2 between 15-19, 63 between 20-29, 16 between 30 and 39, 10 between 40 and 49, 8 between 50 and 59, and 1 between 60 and 69; Occupation: 64 students and 36 non-students; Noise Experience: 56 yes and 44 no. The non-students were from the University power plant, utilities department and maintenance department.

Results

The criterion, the annoyance vote (ANNOY), was analyzed by analysis of covariance. Noise experience was not significant ($\alpha<.05$) but dbA, $(dbA)^2$, age, $(age)^2$, gender, student, dbA x gender and age x gender were significant. The mean noise exposure was 84 dbA and mean age was 30.3 years. The equation was ANNOY = 3.34 + .141 (dbA -84) + .001$(dbA -84)^2$ + .042(age-30.3) - .001 $(age- 30.3)^2$ -.29(if male) + .27(if student) -.02 (dbA-84)(if male) -.02 (age -30.3) (if male). The coefficient of determination, r^2 = .62 and the standard error was .82 vote.

The 1499 degrees of freedom permitted the computer program to establish statistical significance on some factors even though they do not contribute much to the explanation of the variance. Therefore we computed a more simple model where ANNOY = 3.05 +.124 (dbA -84) + .001$(dbA -84)^2$ +.16 (if student). The coefficient of determination, r^2 = .60 and the standard error was .84 vote.

Discussion

The primary variable again was dbA. The linear term (for the simple model) of dbA had F =1726. The squared term of dbA only had a F of 26 while the student term had a F of 11. In the complex model, the linear term of dbA had F of 1430 while the linear term of age had F= 53.

After considering dbA, age effects noise annoyance with older people being more annoyed with vote increasing .042/year for the linear term. The significant age squared term (for subjects mostly in the 20s with a few in each older decade) decreases the age effect during the 20s but increases it for those in the 40s and 50s.

The gender effect shows females are more annoyed with noise than males (mean difference of .29 vote). This may be due to the better hearing that females as a group have vs males (Corso, 1959); hearing was not tested for our subjects.

The significance of gender and age in the second experiment but not the first probably is due to the large sample size (15 noises for 100 subjects vs 10 for 23) and the instructions to vote to tenths instead of whole numbers (3.5 vs 3 or 4).

Students were more annoyed than non-students when age and gender effects were removed. This may reflect the tendency of higher socio-economic groups to complain more (Kryter, 1970).

The non-significance of noise experience tends to indicate that people do not adapt to noise.

REFERENCES

Babiker, M.M., Prediction of Noise Annoyance and Discomfort Glare from Personal Characteristics. Master Thesis, Kansas State University, Manhattan, Kansas, 1977.

Bender, E.K., Noise from Construction, Home Appliance, and Building Equipment. Journal of Environmental Sciences. 1972, 15(5), 9-17.

Bryan, M.E., and Tempest, W., Are Our Noise Laws Adequate? Applied Acoustics, 1973, 6, 219-231.

Corso, J. F., Age and Sex Differences in Pure-Tone Thresholds. Acoustical Society of America, Vol. 31, PT. 1, Jan-June, 1959.

Epp, S., and Konz, S., Home Appliance Noise: Annoyance and Speech Interference. Home Economics Research Journal, March 1975, 3, 205-209.

Frey, E.M., A Study to Determine the Effects of Jet Noise on the Learning of Selected Skills and Knowledges in Physical Education, Dissertation Abstracts International, Vol. 37, No. 3, Sept-Oct, 1976, 1419-A.

Fenwick, C.A., Judged Annoyance of Differing Noise Spectra. Unpublished Master's Thesis, Purdue Univ., 1959.

Kryter, K.D., The Effects of Noise on Man. New York and London: Academic Press, 1970.

Pearson, R.G., and Bregman, H.L., Development of a Noise Annoyance Sensitivity Scale. Raleigh, North Carolina State University, NC 27607, February, 1972.

Pearson, R.G., and Hart, F.D., Studies Relating the Industrial Characteristics of People with Their Responses to Noise. Virginia: Langley Research Center, 1968.

Pearson, R.G., Hart, F.D., and OBrian, J.F., Industrial Differences in Human Annoyance Response to Noise, Raleigh, North Carolina State University, NC 27607, July 1974.

Starr, E.A., Measuring Noise Pollution, IEEE Spectrum, 1972, 9, (6), 18-25.