35. STUDIES RELATING THE INDIVIDUAL CHARACTERISTICS OF PEOPLE WITH THEIR RESPONSES TO NOISE

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SUMMARY

One hundred sixty-six male and female adult subjects varying in age, occupation, educational level, race, and area of residence were exposed to and rated the annoyance of aviation and industrial noise stimuli under two "psychologically different" indoor room environments. This followed assessment of personality and of attitudes toward community, transportation, and noise. Mean annoyance ratings of the subjects exposed to several acoustic stimuli varied considerably despite the fact that the stimuli levels in the test room were held constant at 82 dB (sound pressure). Ratings did not vary with psychological environment but did vary extensively among subjects. Factor analysis of the personality-attitude data resulted in identification of several useful factors for multiple regression prediction of annoyance – for example, noise sensitivity, imperturbable personality, antiaviation and isolationist attitudes, and anxiety.

INTRODUCTION

The noise problem today is recognized to be a complex, multidimensional one. Whether unwanted sound is disturbing to man's composure and activity appears to be a function of a unique, and often unaccountable, subjective reaction. This reaction is unique because it resides within a particular person whose personality, attitudes, and experiences are unlike anyone else's, and it is often unaccountable because for many noise situations scientists find difficulty in isolating and relating the multiplicity of factors which seem to be involved.

Knowledge about many of the relevant factors, both physical and social-psychological, is being enlarged. Yet there does seem to be a lack of knowledge of how many of these factors interact and ultimately relate to the annoyance response. A clearer understanding of the interaction between physical and psychological variables in the noise situation, it seems, would permit prediction, and thus eventual mitigation, of annoyance. The laboratory study described in this paper is a step in this direction. The work represents progress on a program of research (under NASA Grant NGR34-002-055) that involves consideration of the interaction among three variables: noise, the environment of exposure, and the people exposed.

METHOD

Test Facility

An experimental living room test facility was designed which would permit individual exposure to noise stimuli under controlled laboratory conditions. The facility was within a large laboratory and was of typical 2-inch by 4-inch stud and dry wall construction. The exterior and floor were made of 1/2-inch-thick plywood. Contiguous with the living room was the experimenter's control room as shown in the floor plan (fig. 1). A one-way vision mirror was installed for observation by the experimenter of subject activity. Also indicated are the locations of a microphone, used to monitor sound pressure level, and speakers. A couch was positioned in front of and facing the fireplace. Plush chairs, tables, and lamps were positioned around the room. Other furnishings included bric-a-brac, wall accessories, and drapes. The floor was covered wall-to-wall with heavy, commercial-grade sponge-rubber pad and high-density, loop-pile carpet.

In this study testing was conducted under two conditions: (a) the somewhat plush environment just described, hereafter called "Soft," and (b) an austere room with all furnishings, drapes, and carpet removed and hardwood classroom chairs substituted, hereafter called "Hard."

Sound Capability

For sound storage and playback a 1/4-inch, $7\frac{1}{2}$-in./sec, AM magnetic tape system was used. The stereo tape recorder used was chosen for its low background noise and good frequency response in the audio range. Recorder output was sufficient to drive a pair of power amplifiers to their full (50 watt) output rating. Each amplifier served identical speaker systems consisting of a 30-inch low-frequency speaker, a 12-inch midrange speaker and a 3-inch by 9-inch exponential horn. System output was found to be relatively flat (±2 dB) in its working range of 10 Hz to 20 kHz. Sound measurements in the test room were made with a microphone amplifier and 1/2-inch capacitive microphone.

Experimental Materials

For purposes of this experiment a decision was made to work with stimulus sounds (or noises) that were of acknowledged industrial interest and also that were qualitatively different – that is, represented different frequency spectra. Several noise stimuli were recorded, and the following six stimuli were selected as meeting these criteria:

A. Jet airplane flyover

B. Burnishing machine in a factory

C. Tractor-trailer truck changing gears while climbing a hill

D. Helicopter flyover

E. Air (pneumatic chipping) hammer

F. Propeller airplane flyover

Additional preliminary studies had indicated that testing at approximately 82 dB would provide an optimal spread of annoyance response; that is, if testing were conducted at a higher level, say 90 dB, virtually all subjects would find the stimuli so annoying that psychological factors would cease to be a part of the picture. In making a master tape, then, the input level for each sound was adjusted to give a level of 82 dB in the test room.

Other studies in the laboratory led to the development and refinement of an Annoyance Rating Scale (fig. 2). Subjects were allowed to indicate their response anywhere along the continuum (they could check a point between adjectives); therefore, 25 steps were determined to cover effectively the range of responses observed. Meanwhile steps had been taken toward developing an attitude survey, and when it seemed feasible to begin the main effort, attention was then given to the recruitment of subjects.

Subjects

Contact was made by phone and in person with over 30 industries, government offices, and churches in the Raleigh, North Carolina, area to solicit their help in bringing the project to the attention of employees, friends, and others. Initial screening was accomplished over the telephone when a volunteer called. Conditions of the study were described, and subjects were told they would receive $18.00 for participation. No mention was made of the use of noise. Selection of more than one person from a household, drifters, and unemployed persons was avoided. A deliberate attempt was made, as the volunteer list grew, to direct solicitation efforts in the direction of a broad, heterogeneous sample. Complete experimental data were ultimately obtained on 166 subjects who represented 57 different occupations and 47 employers. Distribution of subjects according to age, area of residence, sex, race, education, and income is given in table 1.

Procedure

Test sessions were conducted both afternoons and evenings. Upon reporting, each subject was tested for hearing deficit. Four volunteers were disqualified at this stage on the basis of serious hearing loss. The number in each group varied from 9 to 20. When all subjects had received the audiometric check, the experimenter described the procedures that would be followed that day, emphasized the importance of honest response, and confirmed volunteer status. Psychometric assessment followed, required about 2 hours' time, and involved both a personality test and an attitude survey.

The personality test employed was the Cattell 16 Personality Factor Test (generally called 16 P-F Test) in forms A and B. The test describes those attitudes or characteristics typically noted among individuals. For example, some of the 16 factors are described by such words as the following: reserved, emotionally stable, aggressive, enthusiastic, conscientious, dependent, adaptable, imaginative, shrewd, analytical, and tense. After completing the 16 P-F Test, subjects were given a "Community Social Survey" which included general biographical questions about occupation, education, income, and residence and sampled feelings toward Raleigh, the county area, and certain aviation subjects. The first question to mention the topic of noise was number 19 at the bottom of the second page. Later questions dealt more specifically with history of noise exposure, noise sources, complaints, and feelings regarding degree of sensitivity to noise. Lastly, the survey required subjects to indicate the strength of their agreement or disagreement with 10 statements representing attitudes toward aviation, noise sources, and local government policies in the areas of commerce and taxation.

The final phase of testing on the first day involved an orientation exposure to the noise stimuli in the experimental living room. Here groups were constituted of from 6 to 10 subjects and use of the Annoyance Rating Scale was described. Each of the six noise stimuli described previously was presented four times following a random schedule. Subjects were encouraged to relax and believe that they were spending a casual evening in their living room at home. Each stimulus was presented for 15 seconds after which the subjects were asked to make their rating with care and then sit back and relax during a 45-second interval between sounds. It should be emphasized that this test session was designed to acquaint subjects with procedures in the living room and give them practice in the use of the rating scale. The data to be used to compare the effects of the Soft and Hard room conditions were collected on the second and third test days. Upon returning for these sessions in the living room, subjects made six ratings of each of the six noise stimuli, following the same random schedule each day, but of course under different room conditions. A photograph of subjects being tested in the Soft room is shown as figure 3. An important point to note here is that room acoustic characteristics were taken into account in presenting the noise stimuli. A microphone in the room permitted both room conditions to be equated at the same peak sound pressure level, 82 dB. A further control involved testing half the subjects first in the Soft condition and then in the Hard condition; the other half, in the reverse order.

DISCUSSION OF RESULTS

The first approach in data analysis involved a statistical evaluation (analysis of variance) of the annoyance ratings as made under the two room and six noise conditions.

This evaluation revealed statistically significant differences among average (mean) ratings for the different noise stimuli. The spectra for the noise stimuli with the corresponding mean rating-scale values are shown in figure 4. The highest rating, 19.2, was associated with stimulus E, the pneumatic chipping hammer, characterized by the intermittent burst of raucous, predominantly high-frequency noise. This was significantly more annoying (as determined by the Duncan Multiple Range Test) than stimuli A, the jet airplane flyover, and D, the helicopter flyover. Stimuli C and F, the truck and propeller airplane flyover, tied for the lowest ratings; these were significantly less annoying than stimulus B, the factory noise. Bearing in mind that all sounds were equated for peak sound pressure level, a considerable range of mean annoyance ratings made with the 25-point scale is observed. In terms of scale wording this represents a range of from "very annoying" to "somewhat annoying." This finding was, of course, not unexpected and reemphasizes the often-stated need to take spectral characteristics of the noise source into account in attempts to understand annoyance.

The mean annoyance ratings obtained under the Hard and Soft room conditions, surprisingly, were identical (11.76). A higher rating had been expected in the Hard room, the postulate being that the austere environment would invoke some psychological stress that would summate with noise and lead to a greater degree of annoyance. Although some subjects did respond in this direction, still others responded in a reverse manner. In any event the magnitude of differences overall was small, so that the room condition as such was of little importance in the ratings. What may be of more importance in this context is the task which the subject is performing in a given room environment – for example, the disruption of conversation or television viewing; further study is proposed in this direction. The ratings among the subjects showed a large range – from a low of 1.65 to a high of 22.20 on the 25-point scale. This range of variation indicated that some subjects found the noises extremely annoying, whereas others found them hardly objectionable.

Recognizing then that the major factor determining the varied responses obtained with the ratings was not a physical one but a human one, an analysis was undertaken which focused on the behavioral psychometric data. This analysis involved the technique of factor analysis which is often used in attempts to isolate the major factors that account for relationships among large amounts of descriptive data. The data input included 53 measures obtained in the personality testing and social survey. The factor analysis output listed 18 factors (table 2) which can be taken to describe the subject sample. In this technique, each factor is defined by several items which are related by some common theme or thread – an example is given in table 3 – and it is up to the investigator to give this theme a name. This can be a tedious, arbitrary process and the names chosen are open to debate. With regard to the question mark next to Factor 9 (table 2) it should be

noted that while the major survey item involved here was concerned with aviation employment, it is difficult to argue for a "Proaviation" factor since only 6 of the 166 subjects were so employed.

Implications of the factors as they relate to the annoyance ratings should be noted.[1] It should be interjected that many of the factors are weighted heavily in terms of attitudes and not personality traits. This is important to note since personality traits are relatively permanent characteristics of an individual, whereas attitudes can be dealt with and changed! Factor 1, Noise Sensitivity, is a rather general factor defined by individual attitudes and feelings toward noise – for example, concern about present sources of noise disturbance and about noise in the years ahead. Factor 2, Worldly Exposure, involves income, education, and experience with noise sources and air travel. At one extreme this could, for example, characterize a person who has never flown. It would be interesting to determine at some future date the effect on such a person of exposure to urban commerce, air travel, and noise sources. Factor 5, Antiaviation, was concerned with attitudes toward community air service, use of taxes to support aviation, condemnation of private property for airport expansion, and the possibility of an air crash threatening life and property. One extreme of attitudes in this factor is characterized by opposition to everything related to aviation. Factor 6 involved attitudes toward growth and commerce, generally; therefore it was called an Isolationist factor.

Factor 10, Phobic, is described by statements measuring generalized anxiety toward flying and fear regarding the sound of airplanes overhead. Factor 14, Exposure Experience, is to be distinguished from Factor 2 in that it is concerned with noise exposure at work or home and its effect on one's health. Again, at one extreme this factor would characterize a person who seeks a low-noise work environment and is concerned about noise as a stress affecting his health. Factor 17, Neighborhood Attitude, is described in terms of feelings toward one's neighborhood and its degree of noisiness; and, finally, Factor 18, Complainer, identifies tendencies toward complaining or protesting about noise.

A brief summary of the analysis which focused on the behavioral psychometric data is as follows:

(a) A general noise sensitivity factor was identified as a major one in prediction of an individual's annoyance rating; this implies a need to be concerned with noise as a general problem and not as one specific to aviation.

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[1] A multiple regression prediction, based on the 18 factors, was made for each of the 12 experimental conditions, that is, 6 rooms by 2 environments.

(b) On the other hand, some of the subjects were identified as having antiaviation attitudes and as reacting more negatively to noise; both industry and government will have to be concerned with such attitudes.

(c) Some fear, anxiety, and health complaints were identified as relating to the annoyance ratings; this may indicate a need for informational campaigns on the part of those who defend the aviation safety record.

Although it was encouraging to find in the sample a few "Imperturbables," one might wonder if this group will decline. One could postulate that noise in a peacetime, affluent, suburban culture would be less welcome.

CONCLUDING REMARKS

Three points concerning human reaction to noise are emphasized: First, the annoyance response is an individual characteristic since it resides within a particular person whose personality, attitudes, and experiences are unlike anyone else's. Second, the response is a complex product of these individual characteristics (including history of exposure to noise) and the noise stimulus characteristics. Third, the response is predictable if the appropriate factors are assessed. The factors identified in this study should be important in this regard, and it is hoped that the approach taken by the authors to the noise problem will be used in future noise alleviation programs.

TABLE 1.- DISTRIBUTION OF SUBJECTS ACCORDING TO CHARACTERISTICS

Age	Number	Residence	Number
20 to 29	68	City proper	67
30 to 39	53	Suburban	86
40 to 49	39	Rural	13
50 to 59	6		
Sex	**Number**	**Race**	**Number**
Male	84	Caucasian	152
Female	82	Negro	14
Education	**Number**	**Family income**	**Number**
Grade school	0	Below $5000	25
Some high school	2	$5000 to $7000	24
High school graduate	37	$7000 to $9000	31
Some college	72	$9000 to $12,000	43
College graduate	48	Over $12,000	43
Graduate degree	7		

TABLE 2.- RESULTS OF FACTOR ANALYSIS

Factor	Name
1	Noise Sensitivity
2	Worldly Exposure
3	Self-Sufficiency
4	High Anxiety
5	Antiaviation
6	Isolationist
7	Pragmatist
8	Passivity
9	Aviation Employment (?)
10	Phobic
11	Residential Area
12	Idealist
13	Conservative
14	Exposure Experience
15	Interference With Routine
16	Imperturbable
17	Neighborhood Attitude
18	Complainer

TABLE 3.- EXAMPLE OF DEFINITION OF ONE FACTOR IN FACTOR ANALYSIS

[Factor 16 (Imperturbable)]

Attitude:

Finds little to criticize about community

Personality traits:

Humble, mild, accommodating
Prudent, serious, sober
Trusting, adaptable
Conscientious, persevering

FLOOR PLAN OF TEST FACILITY

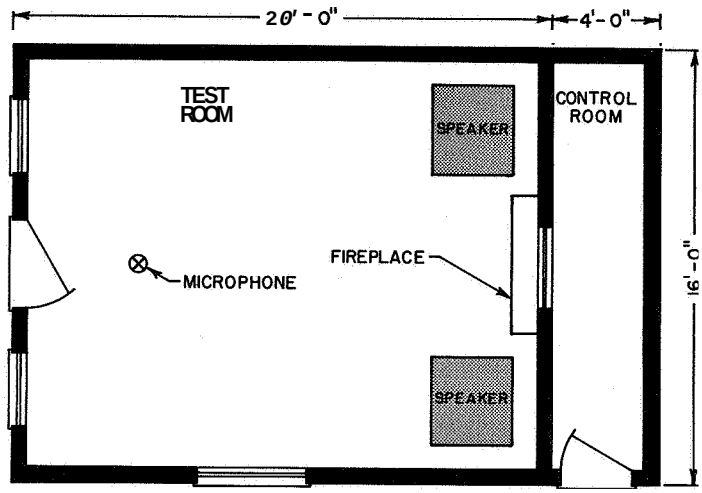

Figure 1

COPY OF ANNOYANCE RATING SCALE

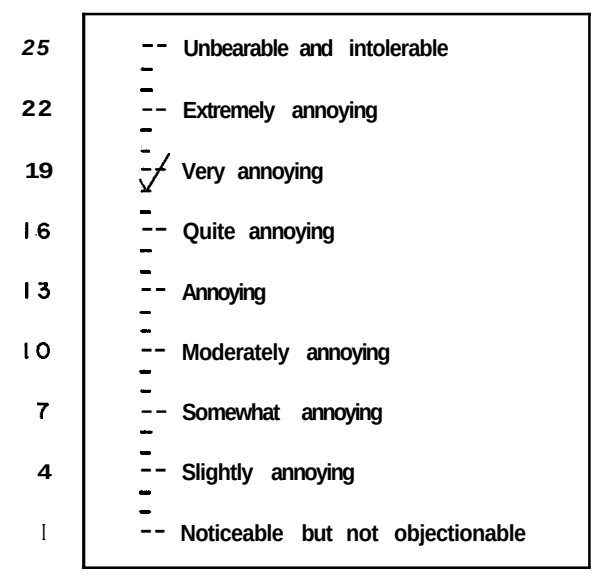

Figure 2

SUBJECTS IN TEST ROOM

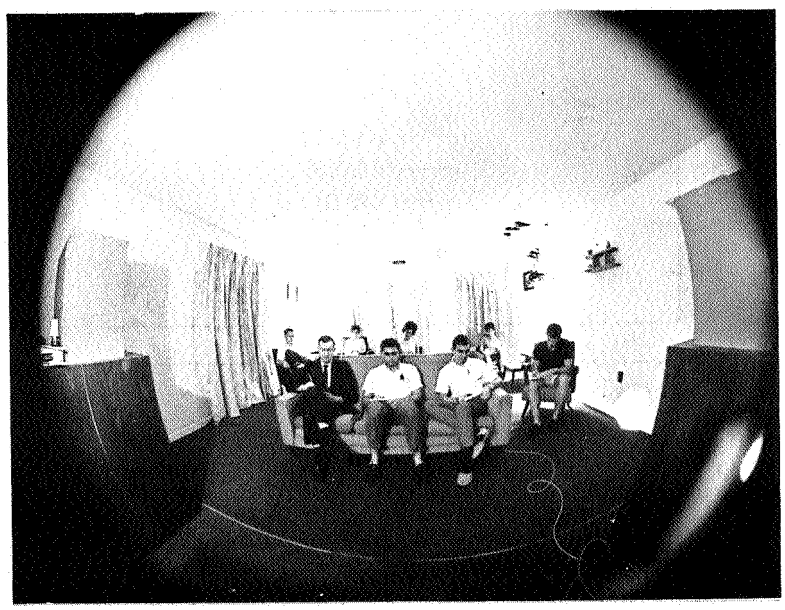

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Figure 3

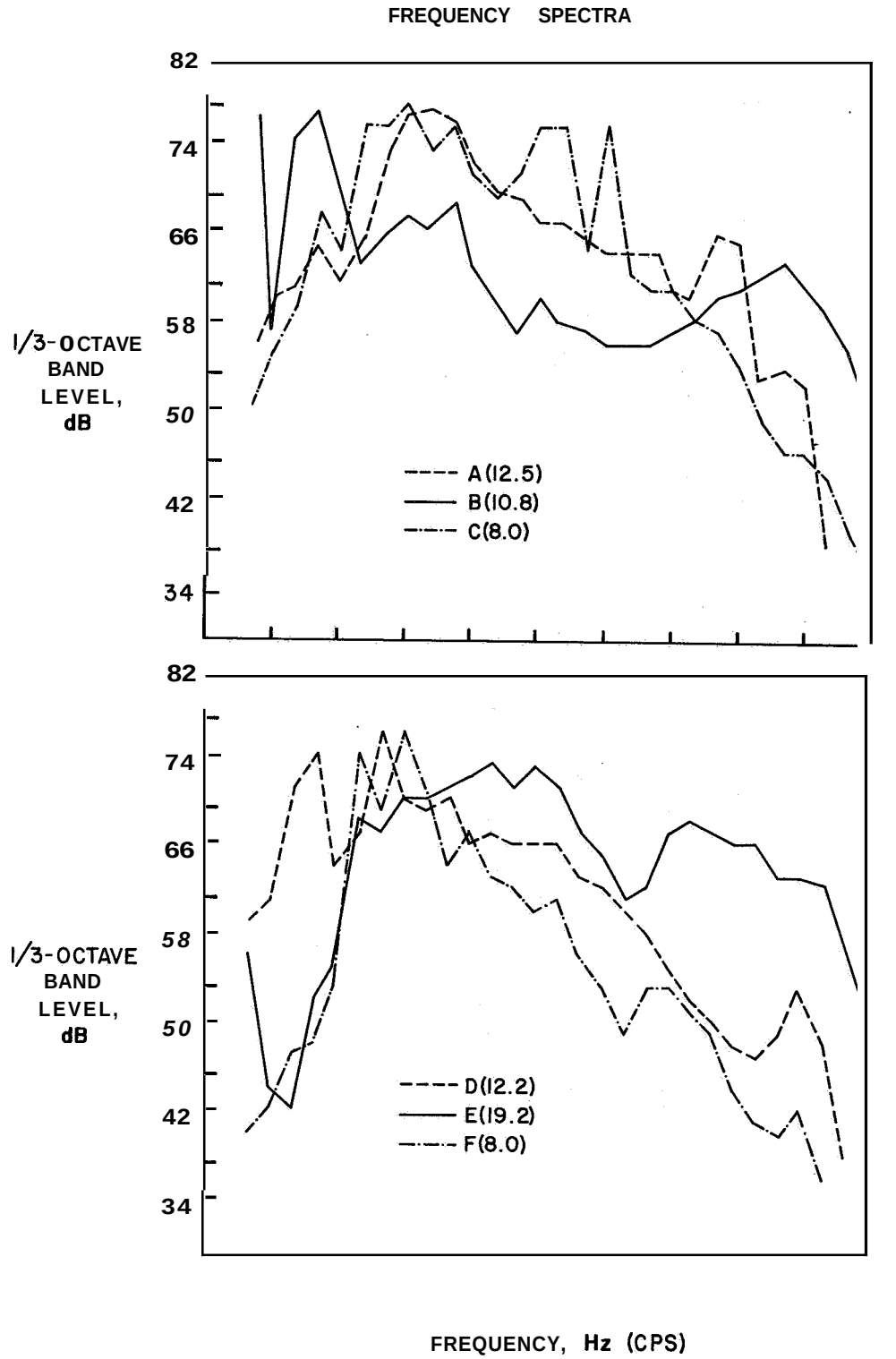
FREQUENCY SPECTRA
82
74
66
58
50
42
34
1/3-OCTAVE BAND LEVEL, dB
A(12.5)
B(10.8)
C(8.0)
82
74
66
58
50
42
34
1/3-OCTAVE BAND LEVEL, dB
D(12.2)
E(19.2)
F(8.0)
FREQUENCY, Hz (CPS)

Figure 4