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INDIVIDUAL DIFFERENCES IN HUMAN ANNOYANCE RESPONSE TO NOISE

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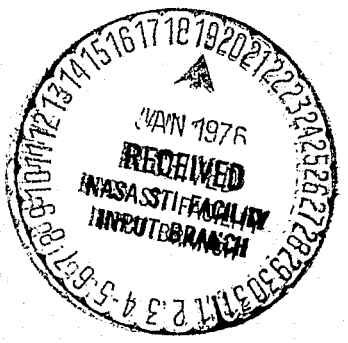

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Abstract

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 six types of aviation and industrial noise stimuli in a simulated living room environment. This followed assessment of personality and of attitudes toward transportation, their community, and noise. Mean annoyance ratings to the noise stimuli varied considerably despite the fact that the stimuli levels in the test room were equated at the same peak sound pressure level, 82dB. A considerable, significant range of variation in annoyance ratings was noted across subjects. Factor analysis of the personality-attitude data resulted in identification of several useful factors for multiple regression prediction of annoyance, e.g. noise sensitivity, anti-aviation, noise-health, interference with routine, phobic, imperturbable, and complainer. Since equations for multiple regression prediction of annoyance varied among noise stimuli, different factors may be responsible for individual annoyance response depending upon the type of noise involved. Finally, the results suggest that a generalized sensitivity to noise is a major determinant of the annoyance response, and argue against a simple definition of annoyance in terms of disturbance of activity.

Key Words

Subjective Response to Noise; Aircraft-Community Noise; Noise-Annoyance Rating; Factor Analysis; Attitude and Personality Factors in Noise Sensitivity; Individual Differences in Noise Response.

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Unclassified

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I. INTRODUCTION

The topic of noise pollution is one of considerable and contemporary concern in our society. Much technological effort is underway to reduce noise at its source and to control it within the environment of man. Yet, the fact that noise per se is a psychological attribute is generally overlooked or de-emphasized in many current approaches to the problem of noise pollution. While acoustic energy potentially can have adverse effects upon physical structures, the essence of the noise pollution problem must be recognized as a human reaction to noise as an annoyance.

Unfortunately for those who would like to predict the human response to noise, the solution is not an easy one. Previous studies of psychological reactions to noise suggest a multiplicity of determining factors to be involved, including personality variables, attitudes, history of exposure to noise, the type of task being performed under noise exposure, and the environmental context in which man is exposed -- not to overlook the frequency, amplitude, and duration characteristics of the noise stimulus itself (Bishop; Broadbent and Robinson; Hawel; Kryter; McKennell; Nixon and Borsky; Spieth). The work described herein was proposed to take a closer look at individual variations in annoyance and in susceptibility to noise. Our goal was a finer definition of the "ingredients" of the human annoyance response. The study involves interactions among a heterogeneous sample of human subjects, various noise stimuli, and different physical environments of exposure. To the extent that a clearer understanding of such interactions can contribute to improved prediction of annoyance responses. then steps toward mitigation, involving the human, psychological element, can be more precisely delineated.

II. METHOD

Test Facility

An initial effort involved the design of an experimental living room test facility which would permit individual exposure to noise stimuli under controlled laboratory conditions. The facility was developed within a large laboratory following typical 2" x 4" stud and dry wall construction. The exterior and floor were of 1/2" plywood. Contiguous with the living room was the experimenter's control room as shown in the floor plan, Figure 1. To be noted is a one-way vision mirror for observation of room activity by the experimenter. Also indicated are locations for a microphone, used to monitor sound pressure level, and speakers. A couch was positioned in front of and facing the fireplace. Plush chair, 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 (Lees' "Tribune"). Air-conditioning was a part of the design in order to ensure subject comfort within the test room.

In this study, testing was conducted under two conditions: (a) the somewhat plush environment just described, hereafter called "Soft"; and (b) one called "Hard" -- an austere room with all furnishings, drapes, and carpet removed, and hardwood, classroom chairs substituted. Reverberation time and absorption coefficient characteristics of the two test environments, with varying numbers of occupants, are detailed in a related report (Hart, Pearson, and Smith), together with data on the vibrational response of the structure under acoustic excitation.

Sound Capability

For sound storage and playback, a 1/4", AM, 7 1/2 i.p.s., magnetic tape system was used. This was a "Sony" Model 530 stereo tape recorder chosen for

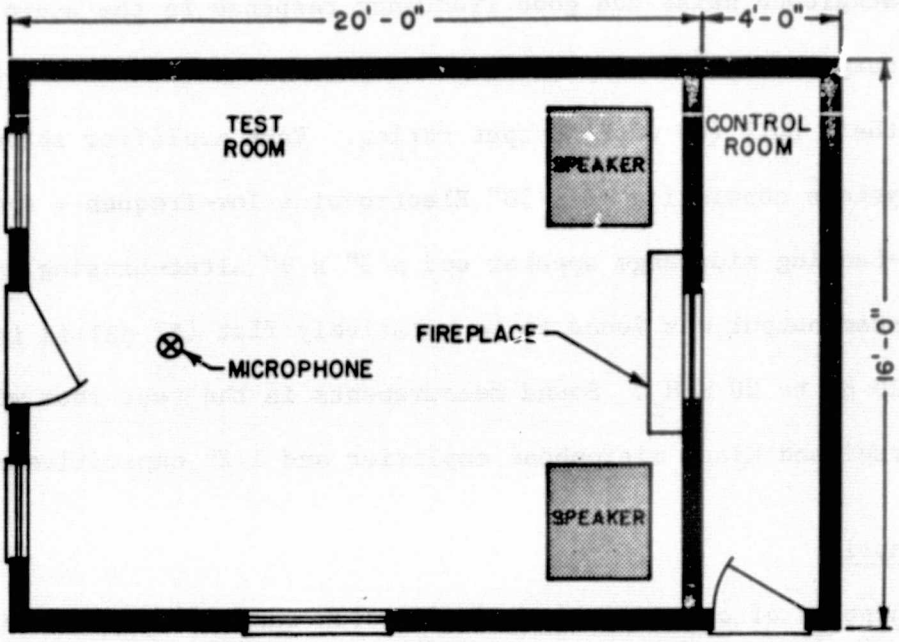


Figure 1. Floor plan of test facility

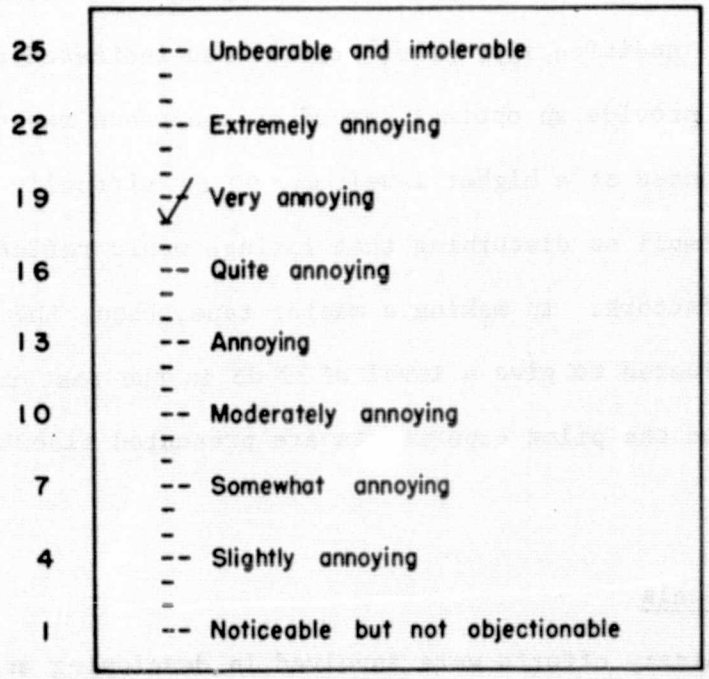


Figure 2. Copy of annoyance rating scale

its low background noise and good frequency response in the audio range. Recorder output was sufficient to drive a pair of (Altec #1568A) power amplifiers to their full (40 watt) output rating. Each amplifier served identical speaker systems consisting of a 30" Electrovoice low-frequency speaker, a 12" Altec-Lansing mid-range speaker and a 3" x 9" Altec-Lansing exponential horn. System output was found to be relatively flat (±2 dB) in its working range of 10 H_z to 20 K H_z. Sound measurements in the test room were made using a Bruel and Kjaer microphone amplifier and 1/2" capacitive microphone.

Noise Stimuli

For purposes of our experiment, a decision was made to work with stimulus sounds (or noises) that were of acknowledged industrial interest and also which were qualitatively different, that is, represented different frequency spectra. Several noise stimuli were recorded, and six were selected as meeting our criteria: (A) jet aircraft flyover; (B) burnishing machine in a factory; (C) a tractor trailer truck changing gears while climbing a hill; (D) a helicopter flyover; (E) an air (pneumatic chipping) hammer; and (F) a propeller aircraft flyover. Additionally, pilot studies had indicated that testing at around 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 disturbing that ratings would reflect little, if any, of psychological factors. 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. Details on tape editing and on the pilot experiments are presented elsewhere (Hart, Pearson, and Smith).

Annoyance Rating Scale

Several preliminary efforts were involved in developing an Annoyance Rating

Scale that would effectively cover the range of responses observed in noise situations. Initially the attempt was made to use a variety of adjectives and adverbs, in combination, to define the scale. Adjectives used included: annoying, disturbing, bothersome, objectionable, unbearable, and intolerable. College students were asked to sort the items, typed on cards, along a continuum. Several items were discarded at this point on the basis either of high dispersion in sorts or of receiving a mean scale rating close to another item. Further work in search of items which would satisfy the criterion of unidimensionality led to the decision to use nine items; except for the two items at opposite extremes of the continuum, all other items involved use of the adjective "annoying". Pilot studies mentioned in the previous section employed a 33-point scale with three "steps", or possible checkpoints, between scale items. On the basis of this latter work, it was agreed that optimal sensitivity and rater effort would be better served by using two steps between items, so that the 25-point scale shown in Figure 2 was adopted for the study to be described.

Attitude Survey

Development of an attitude survey proceeded over several months and involved several drafts. Literature searches, discussion of contemporary issues in the Raleigh-Wake County community, and consultation with a sociologist familiar with community attitude surveys provided a base for survey item development. Particularly influential was the Wilson Committee report (McKennell) from Great Britain. Specific biographical questions about occupation, education, income, residence, etc., were included in the early portion of the questionnaire, followed by items dealing with feelings toward Raleigh, the county area, and certain aviation subjects. The first question to mention the topic of noise was #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 area of commerce and taxation. A copy of the mimeographed "Community Social Survey" appears in Appendix A.

Personality Test

After a careful review of several existing personality tests, it was decided to use the Cattell 16 Personality Factor, or 16 P-F as it is commonly called, in two forms, A and B, of 187 items each. The test is scored along 16 dimensions or traits which are purported to represent or describe those differences or characteristics typically noted among individuals. For example, some of the dimensions are described by such words as the following: reserved, emotionally stable, aggressive, enthusiastic, conscientious, dependent, adaptable, imaginative, shrewd, analytical, and tense. A summary listing of selected words commonly used to define the 16 factors was provided by the test publisher and appears in Appendix B.

Subjects

Contact was made by phone and in person with over 30 industries, government offices, and churches in the Raleigh area to solicit their help in bringing the project to the attention of employees, friends, etc. 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, although callers were queried as to whether they had good hearing. Selection of more than one person from a household, drifters, and unemployed was avoided. A deliberate attempt was made, as the volunteer list grew, to direct solicitation efforts in the direction

of a heterogeneous sample.

Over 170 people appeared for the first hour of testing on campus, with only a few failing to return for later sessions because of personal hardship or for other reasons. Complete experimental data were ultimately obtained on 166 subjects who represented 57 different occupations and 47 employers. As can be noted from tabular data presented below, the sample included persons: in nearly equal numbers from both sexes; with a wide range of ages; from a variety of residential areas; and with varied amounts of education and income. Of the total sample, 152 were observed to be of the Caucasian race, 14 of the Negroid. The overall sample reflects a higher level of education and income than exists in the population, but while considerable effort was made to recruit low education-low income subjects, such persons, for reasons unknown to us, failed to volunteer.

Procedure

An overview of the three-day experimental procedure appears in Figure 3. Test sessions were run both afternoons and evenings. Upon reporting, each subject was tested for hearing deficit using a clinical audiometer. Test tones were presented to each ear separately at each of five frequencies (500, 1000, 2000, 3000, and 4000 Hz) with the attenuator set at 20 dB for subjects up to age 40, and at 30 dB for those over age 40. Four volunteers were dropped at this stage on the basis of hearing loss. Our criterion attempted to take into account both the range and amount of hearing loss, and as an approximation, required no greater loss than 30 dB for one frequency, 20 dB for two frequencies, or 10 dB for four or more frequencies.

The size of the groups reporting for "Day 1" testing varied from 9 to 20. When all subjects had completed their audiometric check, the experimenter confirmed volunteer status, then presented an overview of the three-day study,

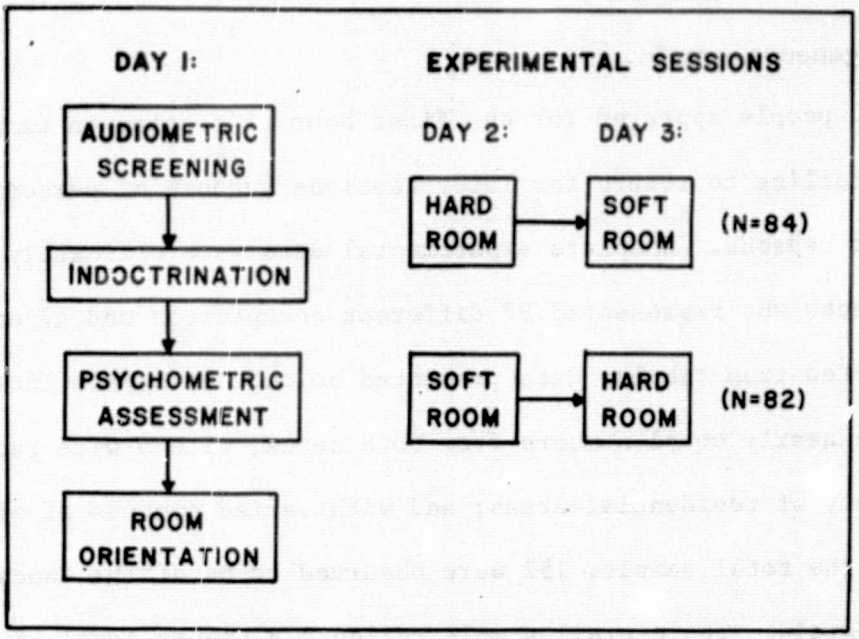
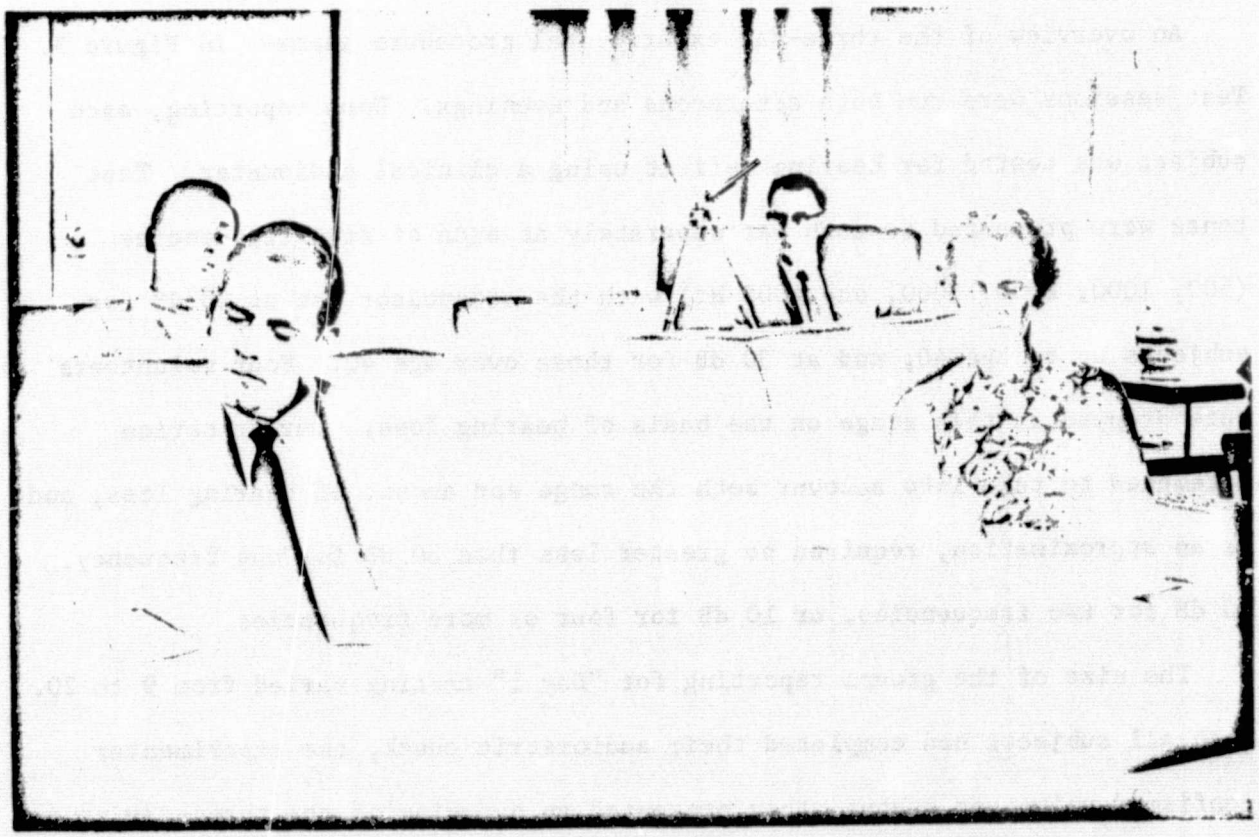


Figure 3. Test procedure



stressing the importance of cooperation and objective, considered response. Again, no mention of the role of noise in the study was made in this indoctrination. Next, a brief description of the personality test and attitude survey was given. The 16 P-F test was administered first, in both forms, followed by the "Community Social Survey", and required about two hours' time on the average. Subjects were encouraged to take a "break" between each part of the psychometric assessment, and since refreshments were provided, most did.

The final phase of testing on Day 1 involved an orientation exposure to the noise stimuli in the experimental living room. Here groups of from 6 to 10 subjects were constituted 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 they were spending a casual evening in their living room at home. Each stimulus was presented for 15 seconds following 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 noted that this test session was designed only for the purposes of acquainting subjects with procedures in the living room and of giving them practice in the use of the rating scale; the data involved in comparing the effects of the Soft and Hard room conditions were collected on the second and third test days.

Upon returning for the experimental sessions in the living room (Days 2 and 3), 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. Pilot testing had suggested that 36 total stimuli were not an unreasonable number to be rated; beyond this it was felt that problems of fatigue and/or boredom might be encountered. Also anticipated was some warm-up effect involving initial exposure to the six stimuli. On the basis of intra-rater reliabilities

computed between adjacent trial ratings it was then decided to ignore the first rating made for each noise stimulus and to use the mean of the five remaining ratings of each stimulus for each subject as a reliable metric of his annoyance response.

Figure 4 shows subjects being tested in the Soft room configuration. An important point to emphasize here is the extent to which room acoustic characteristics were taken into account in presenting the noise stimuli. Through location of a microphone in the living room it was possible to equate exposures at the same peak sound pressure level, 82 dB. A further control involved testing half of the subjects in the Soft followed by the Hard condition, and half in the reverse order.

III. RESULTS

Analysis of Variance

The first approach taken in data analysis involved a statistical evaluation of the variation in the mean annoyance ratings (hereafter abbreviated MAR) made by the 166 subjects under the twelve experimental conditions, i.e., two room environments x six noise stimuli. The analysis of variance (Table I) was a mixed model with Rooms and Sounds as fixed treatment effects and Subjects as random treatment effects. The tests for significance of the main independent variables (Rooms; Sounds) were made against the mean squares involving the corresponding first-order interaction with Subjects, while the test involving their interaction was made against the residual term (the three-way interaction lumped with error).

The analysis revealed statistically significant differences among the mean ratings for the different noise stimuli. As shown in Table II, the highest rating, 19.2, was associated with stimulus E, the pneumatic chipping hammer, characterized by intermittent bursts of raucous, predominant high-frequency

TABLE I. ANALYSIS OF VARIANCE OF ANNOYANCE RATINGS

Source	df	MS	F
Subjects	165	239.31	
Room Condition	1	0.00	—
Sounds	5	5645.50	274.75**
Subjects x Room	165	8.27	4.78**
Subjects x Sounds	825	20.55	11.88**
Room x Sounds	5	1.81	1.05
Residual	825	1.73	
Total	1991		

** $p < .01$

TABLE II. MEAN ANNOYANCE RATINGS

Sounds		Room Condition	
A. Jet Flyover	12.48	Hard	11.76
B. Factory Noise	10.76	Soft	11.76
C. Truck	8.00		
D. Helicopter	12.19		
E. Air Hammer	19.16		
F. Propeller Aircraft	7.96		

noise. This was significantly more annoying (as determined by the Duncan Multiple Range Test) than stimuli A, the jet aircraft flyover, and D, the helicopter flyover. Two stimuli, C and F, the truck and propeller aircraft flyover respectively, tied for the lowest ratings; these were significantly less annoying than stimulus B, the factory noise. Figure 5 shows the spectra for the noise stimuli having the highest (air hammer) and lowest (truck) MAR's, 19.2 and 8.0 respectively. The high-frequency characteristics of the air hammer are obvious in this plot and, as implied above, probably relate to the higher MAR obtained.

Bearing in mind that all sounds were equated for peak sound pressure level, a considerable range of MAR's made with the 25-point scale was observed. In terms of scale wording, the ratings represent a range of from "very annoying" to "somewhat annoying".

The MAR's obtained under the Hard and Soft room conditions were identical. The authors had expected a higher rating in the Hard room, having postulated that the austere environment would invoke some psychological stress that would summate with noise and lead to a greater degree of annoyance. While 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 per se was of little importance in the ratings.

The greatest amount of variance in ratings can be attributed to the subjects themselves. The range of individual responses was considerable. Some subjects found the noises extremely annoying while others found them hardly objectionable. In terms of the 25-point scale, mean individual ratings varied from a low 1.65 to a high of 22.20.

A logical next step, and one in keeping with the main objective of the study, then, was to evaluate the relationships between the annoyance ratings and the

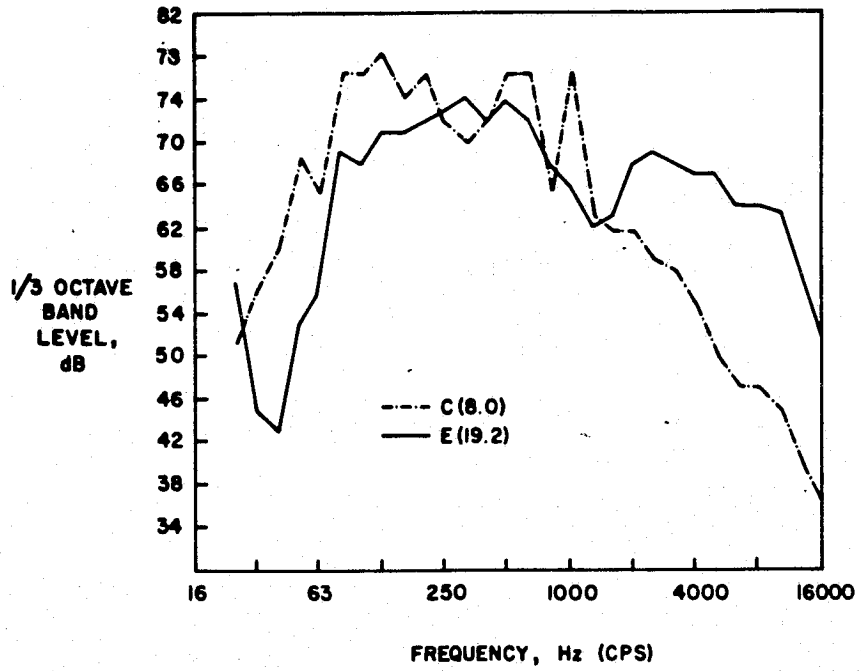


Figure 5. Frequency spectra for highest and lowest rated noises

psychometric data. While several approaches were thus taken, as discussed later, it was deemed desirable, as a preliminary effort to look more closely at the descriptive characteristics of the subject sample.

Sample Characteristics

Response data from the "Community Social Survey" are tabulated in Tables III, IV, V, and VI. In these tables, the "variable number" refers to the order in which variables were coded for computer data reduction. For each category of response, the scoring weights assigned, the frequency of observed response, the MAR's, and the correlation with the criterion annoyance ratings are given in the tables. To facilitate comparisons of interest, variables have been grouped to constitute the four tables according to biographical data, attitudes toward aviation, history of annoyance exposure, and attitudes toward noise.

Table III reveals the extent to which we were able to obtain a heterogeneous sample. While a strong attempt was made to obtain subjects from rural areas and with lower educational levels, such persons simply did not volunteer in proportion to those in other categories. Recognizing hazards associated with generalizing from small observed frequencies and differences in MAR's, it is nonetheless of interest to note some of the trends which characterize the data. In Table III, higher MAR's tend to be associated with female respondents, with those in the younger age range 18-29, with college degrees, and with rural residence; however, criterion correlations reveal these relationships to be low.

In Table IV, it is of interest to note the extent to which negative attitudes are held toward aviation. There is, for example, a moderate concern among the 166 respondents for aircraft flyovers (#8) and the danger of a

TABLE III. BIOGRAPHICAL DATA

Variable Number	Variable Name	Categories	Scoring Weight	Observed Frequency	Mean Annoyance Rating	Criterion Correlation
1	Sex	Male	0	84	11.5	.06
		Female	1	82	12.0	
2	Education	Some Senior High School	1	2	8.2	.13
		High School Graduate	2	37	11.1	
		Some college -- 1 or 2 years or more - including technical institute or business college	3	72	11.2	
		College graduate with B.A., B.S. or equivalent 4-yr.	4	48	13.0	
		Graduate degree M.A., M.S., or higher	5	7	12.9	
3	Income	Below 5000 per year	0	25	12.1	.01
		5000 - 7000 per year	1	24	11.9	
		7000 - 9000 per year	2	31	10.6	
		9000 - 12000 per year	3	43	12.3	
		Over 12000 per year	4	43	11.9	
5	Area of residence	City proper	0	67	11.8	.01
		Suburban area	1	86	11.6	
		Rural area - farm area	2	13	12.5	
35	Age*	18-29	-	68	12.4	.08
		30-39	-	53	11.2	
		40-49	-	39	11.4	
		Over 50	-	6	11.7	

*Scoring weight based on subject's age.

TABLE IV. ATTITUDES TOWARD AVIATION

Variable Number	Variable Name	Category	Scoring Weight	Observed Frequency	Mean Annoyance Rating	Criterion Correlation
4	Aircraft associated employment	Yes	0	7	10.6	.05
		No	1	159	11.8	
8	Frequency of concern about aircraft fly over	Yes -- very often	2	1	--	.18
		Yes -- occasionally	1	30	13.7	
		No or hardly ever	0	135	11.3	
9	Frequency of concern about aircraft crash nearby	Yes -- I think this often	2	1	--	.14
		Yes -- I think this on occasion	1	38	13.0	
		No -- I rarely give it any thought	0	127	11.4	
10	Exposure to air travel	Done considerable flying as a passenger and/or pilot	0	23	11.5	.00
		Done a moderate amount of flying	1	52	11.9	
		Flown only one or two or a few times	2	56	11.8	
		Never flown	3	35	11.6	
11	Adaptation to aircraft	Have become used to aircraft	0	90	11.0	.18
		About the same	1	73	12.6	
		More bothered now	2	3	14.3	
22	Can aircraft noise be prevented (opinion)	Yes	1	21	14.7	.25
		No	0	145	11.3	
25	Community would suffer without air service	Strongly agree	0	144	11.6	.04
		Agree	1	20	13.2	
		Indifferent	2	1	--	
		Disagree	3	1	--	
		Strongly disagree	4	0	--	
26	Property values have been hurt by aircraft location and noise	Strongly agree	4	2	13.6	.19
		Agree	3	7	15.3	
		Indifferent	2	25	13.7	
		Disagree	1	74	10.9	
		Strongly disagree	0	58	11.6	

nearby crash (#9). Yet, over half of the sample indicates they have become adapted to the presence of aircraft (#11). With regard to opinions held, 39 respondents opposed the taking of property for airport expansion (#27), 101 felt an aircraft crash in the community was a distinct danger (#28), and 65 were opposed to use of local tax funds to support airport development (#30). MAR's are noted to be higher for those respondents having concern about flyovers (#8) and the danger of a nearby crash (#9). Those who claim to have adapted to the presence of aircraft (#11) have lower MAR's than those who feel they have not. Variable 22 reveals an interesting relationship; while 145 respondents feel that aircraft noise cannot be prevented, the 21 who do, nonetheless, have a much higher MAR. Lower MAR's tend to be associated with respondents who feel that property values have not been hurt by aircraft location and noise (#26), who support the taking of property for airport expansion (#27), who disagree with the threat of an aircraft crash to the community (#28), and who feel that the community needs more air service (#31).

The exposure experience of respondents to noise and other annoyances is detailed in Table V. From an examination of the MAR's it would appear that respondents with higher annoyance ratings find more to dislike about the Raleigh area (#7), list a greater number of annoying noises at work and home (#14), but yet have had a minimal exposure to noise in the past(#17).

Table VI extends the picture of the individual who is more annoyed by noise. Higher MAR's were more characteristic of those who felt they were less sensitive to noise than the average person, who expressed greater concern over future increases in noise level in the world (#18), who admit that they have difficulty in adapting to noise (#19), who feel that there is too little concern today about noise (#21), who believe noise has an effect on one's

TABLE V. NOISE AND ANNOYANCE EXPOSURE EXPERIENCE

Variable Number	Variable Name	Category	Scoring Weight	Observed Frequency	Mean Annoyance Rating	Criterion Correlation
6	Residential annoyances	No — nothing at all	0	45	11.2	.08
		Yes — a few things, 1 or 2	1	100	12.0	
		Yes — several things	2	18	11.4	
		Yes — many things	3	3	15.2	
7	Number of annoyances in Raleigh-Wake County area	0	1	27	10.8	.16
		1-3	2	116	11.6	
		4-6	3	23	13.4	
		7-9	4	0	0	
12	Residential noise	Generally quiet — rarely noisy	0	143	11.9	-.04
		Moderately noisy and at times disturbing	1	20	10.9	
		Frequently noisy and disturbing	2	3	12.7	
		Very noisy and at times unbearable	3	0	0	
14	Number of noise sources in work and home	0	1	12	9.4	.22
		1-3	2	123	11.6	
		4-9	3	31	13.5	
15	How often disturbed in job or work by noise	Never — rarely	0	61	10.6	.19
		Sometimes	1	84	12.2	
		Moderately often	2	13	14.6	
		Quite often	3	5	11.7	
		Most of the time — continually	4	3	12.4	
17	Extent of noise exposure	None — hardly any exposure	3	24	12.1	.11
		A little exposure	2	44	12.5	
		A moderate amount of exposure	1	70	11.6	
		A great deal of exposure	0	28	10.8	
36	Disturbance of daily activities (frequency)	0-3	-	152	11.7	.10
		4-7	-	13	12.8	
		8-12	-	1	10.5	
37	Bothered by specific noises in list of 12	1-4	-	-	--	.38
		5-9	-	-	--	
		9-12	-	-	--	

TABLE VI. REACTIONS TO AND ATTITUDES TOWARD NOISE

Variable Number	Variable Name	Categories	Scoring Weight	Observed Frequency	Mean Annoyance Rating	Criterion Correlation
13	Are you more sensitive to noise than other people?	More sensitive than the average person	2	29	10.5	.24
		About the same as the average person	1	115	11.5	
		Less sensitive than the average person	0	22	14.6	
16	Complaints about noise source	Wrote, telephoned, or visited an elected official, city police, etc.; signed a petition; attended a protest meeting. Scored 1 for each activity or 0 if none.	0	151	11.7	.04
			1	13	12.7	
			2	2	11.5	
18	Concern about increase in noise	Hardly at all	0	31	8.5	.45
		It would matter a little	1	88	11.5	
		It would matter very much	2	47	14.4	
19	Adaptability to noise	Never bothers me	0	8	7.8	.36
		Noise hardly ever bothers me	1	58	10.4	
		Noise bothers me a little	2	58	12.4	
		Noise bothers me a moderate amount	3	37	13.1	
		Noise bothers me very much	4	5	17.1	
		Extremely so — I am bothered considerably by any and all noise	5	0	0	
20	Prefer noise or quiet	Would rather hear noise	0	110	11.0	.23
		Would prefer complete quiet	1	56	13.2	
21	Amount of fuss about noise	Too little fuss made about noise	2	22	13.9	.22
		About the right amount of concern	1	119	11.7	
		Too much fuss made about noise	0	25	10.2	
23	Affects health	Yes -- definitely	2	21	13.2	.30
		Probably -- perhaps indirectly	1	60	13.4	
		No — I don't think so	0	85	10.2	

TABLE VI. Continued

Variable Number	Variable Name	Categories	Scoring Weight	Observed Frequency	Mean Annoyance Rating	Criterion Correlation
24	Opinion of noise in general	Not at all disturbing	0	25	9.9	.31
		A little disturbing	1	119	11.6	
		Disturbing	2	21	14.7	
		Very disturbing	3	1	-	
29	Noise is one of biggest nuisances	Strongly agree	4	9	13.9	.28
		Agree	3	24	13.5	
		Indifferent	2	28	12.2	
		Disagree	1	80	11.7	
		Strongly disagree	0	25	9.1	
32	Sources of noise minor consideration when buying home	Strongly agree	0	12	9.8	.38
		Agree	1	34	9.8	
		Indifferent	2	8	9.4	
		Disagree	3	75	11.5	
		Strongly disagree	4	37	15.2	
34	Low priority for public funds spent on noise problems	Strongly agree	0	12	8.2	.28
		Agree	1	70	11.5	
		Indifferent	2	33	10.7	
		Disagree	3	46	11.6	
		Strongly disagree	4	5	14.3	

TABLE IV. Continued

Variable Number	Variable Name	Category	Scoring Weight	Observed Frequency	Mean Annoyance Rating	Criterion Correlation
27	Private property should be taken for airport expansion	Strongly Agree	0	33	11.1	.16
		Agree	1	83	11.3	
		Indifferent	2	11	14.0	
		Disagree	3	27	12.6	
		Strongly disagree	4	12	12.9	
28	Aircraft crash in the community is a distinct danger	Strongly agree	4	35	13.5	.20
		Agree	3	66	11.6	
		Indifferent	2	23	11.8	
		Disagree	1	56	10.5	
		Strongly disagree	0	6	10.7	
30	Public tax funds should be used to support local airports	Strongly agree	0	11	12.5	.02
		Agree	1	62	11.4	
		Indifferent	2	28	11.0	
		Disagree	3	52	12.1	
		Strongly disagree	4	13	12.9	
31	Raleigh area needs more air service	Strongly agree	0	43	10.4	.21
		Agree	1	87	11.9	
		Indifferent	2	29	12.8	
		Disagree	3	5	13.9	
		Strongly disagree	4	2	15.4	
33	Airport brings more industry to Raleigh and this is good	Strongly agree	0	92	11.4	.15
		Agree	1	61	11.8	
		Indifferent	2	7	14.9	
		Disagree	3	3	12.3	
		Strongly disagree	4	3	14.8	

health (#23), and, in general, who find noise to be disturbing (#24). With regard to the opinion data, higher MAR's tend to be associated with feelings that noise is a big nuisance (#29), that it is not a minor consideration in choice of a home (#32), and that funds for dealing with noise problems should not receive low priority (#34). Also of interest is the finding that those who would prefer to have some noise inside their home have a lower MAR than those who prefer complete quiet (#20).

Factor Analysis

The technique of factor analysis was used in an attempt to isolate and define the major dimensions accounting for relationships among the descriptive data collected on the subject sample. As a first step, inter-correlations were computed among the 53 measures obtained on each subject in the personality testing and social survey. Weights assigned to the response categories of the social survey appear in Tables III - VI (except for #14 which used a frequency count of listed annoyances); measures for the 16P-F were the raw scores obtained on each dimension. Special programs were written for computer analyses involving the inter-correlation matrix, and the factor analysis (extraction and rotation) which followed. The complete inter-correlation matrix appears in Appendix C, Table XXIX, while the results of factor rotation are presented in Table VII. The computer output listed 18 factors, all but one of which appeared to be interpretable. For purposes of factor interpretation, it was decided to consider all loadings on each factor that were greater than 0.25. For reference purposes the names given to the factors are presented in Table VIII. These names, of course, are derived in a judgmental process involving review of the factor loadings. The discussion to follow represents a defense of and explanation for the factor structure in question.

TABLE VII. RESULTS OF FACTOR ANALYSIS SHOWING LOADING VALUES FOR EACH VARIABLE ON EACH FACTOR GREATER THAN .25 (DECIMALS DELETED)

VARIABLE NUMBER	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	-58									-25								
2	44														49		27	
3	52							26			44							
4									-84									
5											82							
6																	79	
7							-40								28	-41	30	
8										-77								
9										-76								
10	-77																	
11						29		52										
12																	64	
13	51						44											
14	36																47	
15	34												47	-37				37
16																		75
17		-29																-56
18	73														33			
19	77																	
20	35							-48										
21	42												-34					
22		26						-52		-28		-25						
23														68				
24	72																	
25					-70													
26							-32			-31				30				
27					-75													
28		-34						-27	-31	-44								
29	53							27		-36								
30					-34	48		28										

TABLE VII. (Continued)

VARIABLE NUMBER	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
31						77												
32	43										-34				45			
33						80												
34	39						-33					-27		43				
35													76					
36							-25								-58			
37	56						-36											
38			76															
39															73			
40		36		-70														
41																-81		
42			64													-47		
43				-33							26		-29			51		
44			63	-42												-42		
45												-78						
46				46												-56		
47										-32		-58				-27		
48			28				62											
49				80														
50			-26					29					42					
51			-79															
52				-75														
53				81														

TABLE VIII. RESULTS OF FACTOR ANALYSIS

Factor	Name
A	Noise Sensitivity
B	Worldly Exposure
C	Self-Sufficiency
D	High Anxiety
E	Anti-Aviation Attitudes
F	Isolationist
G	Pragmatist
H	Passivity
I	(Uninterpreted)
J	Phobic
K	Residential Area
L	Idealist
M	Conservative Temperament
N	Noise-Health
O	Interference with Routine
P	Imperturbable
Q	Attitude Toward Neighborhood
R	Complainer

Table IX lists 13 variables which have substantial loadings on Factor A, defined here as Noise Sensitivity. With 13 of the 53 variables defined by

TABLE IX. FACTOR A, NOISE SENSITIVITY

Variable		Loading
19.	Adaptation to noise	.77
18.	Concern if world gets noisier	.73
24.	Opinion of noise	.72
37.	Noises which annoy people	.56
29.	Noise--one of worlds biggest nuisances	.53
13.	Sensitiveness to noise	.51
32.	Noise--minor consideration when buying a home	.43
21.	Amount of concern about noise	.42
34.	Priority of public funds	.39
14.	Noise sources that annoy	.36
20.	Choice between noise and quiet	.35
15.	Number of noise disturbances at work	.34
26.	Property values hurt by airport and noise	.29

this factor it is the most general factor emerging from the analysis, emphasizing individual attitudes and feelings toward noise, and concern both for present

sources of noise disturbance and for increased noise in the years ahead.

Factor B, Table X, appears to give major emphasis to elements related to opportunity for worldly experience. It is loaded most highly on air travel

TABLE X. FACTOR B, WORLDLY EXPOSURE

	Variable	Loading
10.	Air travel and flying	-.77
1.	Sex	-.58
3.	Total family income	.52
2.	Education level	.44
40.	Factor C--Lower ego strength vs. Higher ego strength	-.36
28.	Effect of airplane crash in community	-.34
22.	Prevention of aircraft noise	.26
17.	Exposure to noise	-.25

experience and, to a lesser extent, on variables which underly similar opportunities, i.e., higher income and education, and male sex. At the opposite extreme the factor, defined as Worldly Exposure, might characterize the low-income female who has never flown

The next factor, Table XI, is based entirely upon loadings on personality trait scores. The loadings describe a personality that is detached, serious,

TABLE XI. FACTOR C, SELF-SUFFICIENCY

	Variable	Loading
52.	Factor Q_2 -- Group adherence vs. Self-sufficiency	-.79
38.	Factor A -- Reserved vs. Outgoing	.76
42.	Factor F -- Sober vs. Happy-go-lucky	.64
44.	Factor H -- Shy vs. Venturesome	.63
48.	Factor N -- Forthright vs. Shrewd	.28
50.	Factor Q_1 -- Conservative vs. Experimental	-.26

restrained, aloof, and free-thinking, all seemingly in congruence with the highest loading, hence the name Self Sufficiency for Factor C. Table XII, lists the loadings on Factor D, again all from personality trait scores.

TABLE XII. FACTOR D, HIGH ANXIETY

Variable		Loading
53.	Factor Q_4-- Relaxed vs. Tense	.81
49.	Factor O^4-- Placid vs. Apprehensive	.80
52.	Factor Q_3-- Low integration vs. High self-concept control	-.75
40.	Facotr C -- Lower ego strength vs. Higher ego strength	-.70
46.	Factor L -- Trusting vs. Suspicious	.46
44.	Facotr H -- Shy vs. Venturesome	-.42
43.	Factor G -- Expedient vs. Conscientious	-.33

The factor is readily interpreted as High Anxiety since the first six principal loadings together comprise what Cattell defines as a second-order anxiety factor.

Factor E, Table XIII, identifies as major loadings three variables involving attitudes toward community air service, use of taxes to support aviation, and

TABLE XIII. FACTOR E, ANTI-AVIATION ATTITUDES

Variable		Loading
27.	Possession of private property	.75
25.	Deprivation of air service-community loss	.75
30.	Use of tax funds for community airport	-.34

condemnation of private property for airport expansion. The extreme of attitudes characterizing this factor is opposition of everything related to aviation, hence our name, Anti-Aviation Attitudes. Also loaded on attitude variables, as noted in Table XIV, Factor F was defined as Isolationist. Attitude responses comprising this factor involved general opposition to growth and commerce.

TABLE XIV. FACTOR F, ISOLATIONIST

Variable		Loading
33.	Airport and superhighways bring more industry to Raleigh	.78
31.	Airport should expand services	.75
30.	Tax funds used to support community airport	.48
11.	Aircraft--bothered more now than in the past	.38

Factor G, Table XV, is somewhat difficult to interpret. If principal focus is made upon the loading for the personality trait, then, taking into account the

TABLE XV. FACTOR G, PRAGMATIST

	Variable	Loading
48.	Factor N -- Forthright vs. Shrewd	.69
13.	Sensitivity to noise	.44
14.	Dislikes about the Raleigh-Wake County area	-.40
37.	List of noises which annoy people	-.36
34.	Funds for noise problems should have low priority	-.33
26.	Damage done to values of private property due to airport	-.32
36.	Do sources of noise disturb daily activities?	-.25

other loadings, the picture that emerges is of an individual who is aware of community problems (such as noise) but may feel it is not practical to worry much about them. Hence, we define this factor as the Pragmatist. Factor H is also difficult to interpret and to distinguish from Factor G. The principal loadings on this factor, Table XVI, would appear to give emphasis to a greater

TABLE XVI. FACTOR H, PASSIVITY

	Variable	Loading
11.	Aircraft noise--bothered more this year or not	+.52
22.	Can aircraft noise be prevented?	-.52
20.	Preference between noise or quiet inside home	-.48
50.	Factor Q_1 -- Conservatism vs. Radicalism	.29
30.	Should tax funds be used to support community airport?	.28
28.	Concern for airplane crashes in community	-.27
29.	Noise--one of the biggest nuisances in today's world	-.27
3.	Total family income	.26

concern for noise (as contrasted with Factor G), yet a reluctance to do deal with the problem, bordering on the characteristic chosen to name the factor, Passivity.

The major survey item in loading on Factor I, Table XVII, involved aviation employment. While it is tempting to identify this as a Pro-Aviation factor (in

contrast to Factor E) it is probably best to leave it uninterpreted since only

TABLE XVII. FACTOR I, (UNINTERPRETED)

	Variable	Loading
4.	Employed in aviation or a related aerospace industry	-.84
28.	Concern for airplane crashes in community	-.31

6 of the 166 subjects were so employed.

Factor J, Table XVIII, is readily defined as Phobic. Principal loadings here reflect items measuring generalized anxiety towards flying and fear regarding

TABLE XVIII. FACTOR J, PHOBIC

	Variable	Loading
8.	Low-flying aircraft effects	-.77
9.	Danger of airplane crash	-.76
28.	How to deal with airplane crashes in community	-.44
29.	Noise as a big nuisance in today's world	-.36
47.	Factor M -- Practical vs. Imaginative	-.32
26.	Property values hurt airport and noise	-.31
22.	Can aircraft noise be prevented?	-.28
1.	Sex	-.25

the presence of aircraft overhead. The principal loadings on Factor K, Table XIX, appear sufficiently related to define this factor as Residential Area.

TABLE XIX. FACTOR K, RESIDENTIAL AREA

	Variable	Loading
5.	Area of residence	.82
3.	Total family income	.44
32.	Consideration of noise in buying a home	-.34
43.	Factor G -- Expedient vs. Conscientious	.26

The two principal loadings on Factor L, Table XX, involving personality traits, would seem to define an individual who is impractical, lacks mature judgment, and

gives up easily. In contrast to Factors G and H, the term Idealist is used to

TABLE XX. FACTOR L, IDEALIST

	Variable	Loading
45.	Factor I -- Tough-minded vs. Tender-minded	-.78
47.	Factor M -- Practical vs. Imaginative	-.58
34.	Public funds for noise problems -- low priority	-.27
22.	Prevention of aircraft noise	-.25

distinguish this factor. Factor M, Table XXI, appears to reflect a picture of the older, mature individual who, when exposed to noise, is willing to tolerate it.

TABLE XXI. FACTOR M, CONSERVATIVE TEMPERAMENT

	Variable	Loading
35.	Year of birth	.76
15.	Numbers of times disturbed by noise at work	.47
50.	Factor Q_1 -- Conservative vs. experimenting	.42
21.	Concern over noise -- too much or too little	-.34
43.	Factor G -- Expedient vs. Conscientious	-.29

Again this factor bears some resemblance to Factor G, but we distinguish it as Conservative Temperament.

As distinguished from Factor B, Factor N is defined by loadings (Table XXII)

TABLE XXII. FACTOR N, NOISE-HEALTH

	Variable	Loading
23.	Effect of noise on health	.68
34.	Public funds for noise problems -- low priority	.43
15.	Number of times disturbed by noise at work	-.37
18.	Concern if world gets noisier	.33
26.	Property value damage caused by airport and noise	.30

on variables which reflect noise exposure at work or home and its effect on health. This factor could characterize a person, for example, who seeks a

low-noise home environment and is concerned about noise as a stressor affecting his health. We have termed it Noise-Health.

While Factor O, Table XXIII, loads heavily on education and intellectual

TABLE XXIII. FACTOR O, INTERFERENCE WITH ROUTINE

	Variable	Loading
39.	Factor B -- Less Intelligent vs. More Intelligent	.73
36.	Noise -- disturbance of daily activities	-.58
2.	Level of education	.49
32.	Noise -- minor consideration when buying a home	.45
14.	Dislikes about the Raleigh-Wake County area	.28

items, we define the factor as Interference with Routine. The other loadings contribute to a picture of a conscientious individual who desires a minimum of disruption of his activities. Factor P, Table XXIV, loads primarily upon

TABLE XXIV. FACTOR P, IMPERTURBABLE

	Variable	Loading
41.	Factor E -- Humble vs. Assertive	-.81
46.	Factor L -- Trusting vs. Suspicious	-.56
43.	Factor G -- Expedient vs. Conscientious	.51
42.	Factor F -- Sober vs. Happy-go-lucky	-.47
44.	Factor H -- Shy vs. Venturesome	-.42
7.	Dislikes about the Raleigh-Wake County area	-.41
47.	Factor M -- Practical vs. Imaginative	-.27

personality traits. In combination with Variable 7 which refelcts few dislikes for the community, the personality attributes in toto lead us to name this factor Imperturbable.

Factor Q, Table XXV, has been termed Attitude toward Neighborhood since principal loadings are on items which assess feelings towards one's neighborhood and its degree of noisiness.

TABLE XXV. FACTOR Q, ATTITUDE TOWARD NEIGHBORHOOD

Variable	Loading
6. Dislikes about residential area where you live	.79
12. Amount of noise in neighborhood	.64
14. Sources of noise that annoy	.47
7. Dislikes about the Raleigh-Wake County area	.30
2. Level of education	.27

Finally, Factor R, Table XXVI, reflects loadings on variables assessing tendency

TABLE XXVI. FACTOR R, COMPLAINER

Variable	Loading
16. Ever made any complaints about a noise source	.75
17. Exposure to noise in work and other experiences	-.56

to complain or protest about noise, and hence it has been termed Complainer.

Prediction of Annoyance Response

The third major analysis, which was carried out in two parts, was undertaken to determine whether the 53 biographical, attitudinal, and personality (hereafter, BAP) measures could be used to predict annoyance response to noise. Part I: Predictor variables for Part I were factor scores calculated for each subject. These were obtained in the following manner. First, raw scores for the 53 BAP measures were standardized (converted to t scores). Next, 18 factor scores (one corresponding to each factor) were computed for each subject. An individual's factor scores was defined as the algebraic sum of the product of each factor loading (for the given factor) and the subject's standardized score on the variable corresponding to the loading.

The original loadings identified by the factor analysis described previously were not those used in the computation of factor scores, but were given additional weights in the following manner. Eighteen separate multiple regression analyses,

one for each vector of factor loadings, were performed. In each of these analyses, correlations between variables represented by the factor loadings were treated as independent variables and the actual loadings obtained for each variable on that factor were treated as measures of the dependent variable. As with interpretation of rotated factors, only those variables with a rating above .25 were included in these analyses. For each factor, the new loadings were the beta weights (regression coefficients) obtained from each multiple regression analysis.

Six different criterion variables were used in Part I. These were the MAR's obtained for each sound during the experimental phase of the study. MAR's for sounds were used since the ANOVA revealed no significant difference in annoyance response as a function of room condition.

Table XXVII shows the multiple correlation coefficients (R) obtained when the factor scores were combined as predictors of each of the above criterion measures. A stepwise multiple regression procedure was used to obtain these R's. This analysis began with the best single predictor variable and on each step added that predictor variable which made the greatest reduction in the error sums of squares. The analysis terminated when the F ratio of the next predictor variable to be added failed to reach significance at the .25 level (F=2.50). Included in Table XXVII along with each R are those variables that contribute significantly to its prediction.

Part II: It was felt that salient relationships between individual BAP measures and the MAR might be obscured by the factor structure. For example, an attitudinal variable might correlate highly with the MAR, but load only slightly on a given factor. Such a relationship would be obscured by the low factor loadings. Thus an additional analysis was undertaken in which the predictor variables were the raw scores for each subject on the 53 BAP measures. The criterion measure

TABLE XXVII. REGRESSION OF FACTOR SCORES

	Factor Entered	Beta Coefficient	Multiple R	R^2
A.	AGAINST TRUCK MEANS			
	Noise Sensitivity (A)	2.31	0.46	0.23
	Self Sufficiency (C)	-0.95	0.49	0.24
	Interference With Routine (O)	1.07	0.51	0.26
B.	AGAINST AIR HAMMER MEANS			
	Noise Sensitivity (A)	2.09	0.42	0.18
	Idealist (L)	-0.96	0.46	0.21
	Passivity (H)	0.98	0.49	0.24
	Complainer (R)	-0.62	0.51	0.26
	Noise-Health (N)	0.63	0.52	0.27
C.	AGAINST JET FLYOVER MEANS			
	Noise Sensitivity (A)	2.09	0.40	0.16
	Isolationist (F)	0.50	0.43	0.18
	Idealist (L)	-1.09	0.45	0.20
	Anti-Aviation (E)	0.86	0.47	0.22
D.	AGAINST INDUSTRIAL MEANS			
	Noise Sensitivity (A)	2.36	0.44	0.19
	Noise-Health (N)	1.08	0.46	0.21
E.	AGAINST HELICOPTER MEANS			
	Noise Sensitivity (A)	2.37	0.45	0.20
	Isolationist (F)	0.66	0.48	0.23
	Noise-Health (N)	0.82	0.50	0.25
F.	AGAINST V-10 MEANS			
	Noise Sensitivity (A)	1.56	0.41	0.17
	Phobic (J)	0.07	0.47	0.22
	Interference With Routine (O)	1.48	0.50	0.25
	Anti-Aviation (E)	-0.84	0.52	0.27
	Isolationist (F)	0.49	0.53	0.28
	Complainer (R)	-0.76	0.54	0.30
	Conservative Temperament (M)	1.86	0.56	0.31
	Noise-Health (N)	0.95	0.57	0.32
G.	AGAINST GRAND MEAN			
	Noise Sensitivity (A)	2.08	0.52	0.27
	Idealist (L)	-0.75	0.54	0.29
	Isolationist (F)	0.40	0.56	0.31
	Noise-Health (N)	1.00	0.57	0.32
	Conservative Temperament (M)	1.31	0.58	0.34

for this analysis was the grand MAR obtained by averaging annoyance response across rooms and sounds. Once again stepwise multiple regression was used to obtain a multiple correlation between the combined predictors and the criterion. This R and the significant (.25 level) predictors are presented in Table XXVIII.

IV. DISCUSSION

It is well accepted that spectral characteristics of noises relate to the degree to which humans perceive them as noxious and annoying. Hence, the results of the analysis of variance were not surprising in this regard. However, emphasis should be given to the considerable range in MAR's over the six stimuli, considering the fact that all sounds were equated for peak sound pressure level.

The finding of no differences in MAR's as a function of room conditions was surprising since pilot research had indicated this might be a contributing variable (Hart, Pearson, and Smith). We had thought that subjects' perception of the environment, e.g., as "cold", "austere", etc. would have an effect on the ratings, but evidently this was not the case. Our pilot work had indicated that the presence of 8 to 12 people in the Hard room tended to mitigate reverberation times (comparable to the effect of adding plush furnishings), so it would seem that perceptual factors related to room conditions were not a factor in the ratings of annoyance.

The considerable variation in MAR's among subjects is, of course, the major finding of the study, and serves as the rationale underlying the exploitation of the psychometric, predictor variables. The finding is in agreement with British work concerned with aircraft noise annoyance (McKennell), and thus it should be of interest to contrast the respective, definitive analyses of the underlying socio-psychological variables.

TABLE XXVIII. COMPLETE MULTIPLE REGRESSION EQUATION OF 53 INDEPENDENT VARIABLES (ATTITUDE AND PERSONALITY) AGAINST GRAND MEAN OF ANNOYANCE

Variable Entered	Beta Coefficient	Multiple R	R^2
Constant	4.49	--	--
18	1.42	0.45	0.20
32	0.60	0.52	0.27
50	0.33	0.56	0.31
37	0.23	0.59	0.34
23	0.91	0.61	0.37
22	0.97	0.62	0.38
11	0.57	0.63	0.40
27	0.25	0.64	0.41
15	0.83	0.65	0.42
17	0.41	0.65	0.42
29	-0.64	0.65	0.43
47	0.25	0.66	0.43
52	-0.39	0.66	0.44
49	-0.43	0.66	0.44
40	-0.35	0.67	0.45
51	0.42	0.67	0.45
38	0.29	0.68	0.46
26	0.28	0.68	0.46
12	-0.92	0.68	0.46
7	0.26	0.68	0.47
25	0.54	0.69	0.47
2	0.56	0.69	0.47
53	-0.19	0.69	0.48
39	-0.26	0.69	0.48
48	-0.12	0.69	0.48
30	-0.31	0.70	0.49
45	0.07	0.70	0.49
33	0.30	0.70	0.49
14	0.14	0.70	0.49
43	0.14	0.70	0.49
13	0.29	0.70	0.49
34	0.21	0.70	0.49
10	-0.34	0.71	0.50
28	0.22	0.71	0.50
20	0.36	0.71	0.50
4	-0.75	0.71	0.50
31	0.31	0.71	0.50
9	-0.27	0.71	0.50

TABLE XXVIII. Continued

Variable Entered	Beta Coefficient	Multiple R	R^2
46	0.09	0.71	0.50
41	-0.11	0.71	0.50
1	0.28	0.71	0.50
36	0.06	0.71	0.50
42	0.03	0.71	0.50
3	-0.04	0.71	0.50
19	-0.08	0.71	0.50
24	0.10	0.71	0.50
44	0.05	0.71	0.50
8	-0.10	0.71	0.50
35	0.00	0.71	0.50
21	-0.06	0.71	0.50
6	0.03	0.71	0.50
5	0.02	0.71	0.50
16	-0.03	0.71	0.50

The form for regression equations is as follows:

$$Y' = a+b_1x_1+b_2x_2+\ldots+b_kx_k$$

where Y' = predicted value of the dependent variable
a = a constant
b = beta coefficients
x = actual value of independent variables

Specific Item Comparisons

Biographical data (Table III) were found to have little or no relationship to the MAR's. This finding, in direct support of the British work, is of considerable significance in terms of the problem of noise. Obviously, one must look at other variables if one is to explain the considerable individual differences in response to noise as an annoyance as observed in this study.

The extent to which the sample held negative attitudes toward aviation-related subjects (Table IV) should be of concern to those in the industry. While there was some overall tendency for negative attitudes to be related to the annoyance ratings as noted previously, the magnitude of the correlations was not remarkable. In agreement with the British work it is of interest to note that those who feel that aircraft noise can be prevented had generally higher annoyance ratings. While the British work identifies "fear of aircraft" as a major factor related to annoyance, variables #8 and #9 (Table IV) which assess this in the present study, while reflecting the same trend, correlated only moderately with the annoyance ratings. Variables from Table IV relating to the value of the airport to the community, e.g., #25, #26, #27, #30, #31, #33, were observed to bear minimal relationships to the MAR's in agreement with the British work.

Noise and annoyance exposure experiences (Table V) were generally correlated to a minor degree with the annoyance ratings. While our results on Variable #7 tended to support McKennell's finding that the more one finds to dislike about his community the greater he tends to find noise to be annoying, the correlation here of .16 with the annoyance ratings again was not remarkable. As assessed by Variable #7, the subject sample included a somewhat smaller percentage of imperturbables (27% as compared to McKennell's 30%). However, our factor analysis identified an imperturbable core as will be discussed later.

Higher correlations were generally observed throughout Table VI which included reactions to and attitudes toward noise. Three variables noted in the British work to be major factors related to annoyance were confirmed by the results of Table VI; these included capacity to adapt to noise (#19), concern for the effect of noise upon one's health (#23), and susceptibility to noise as a disturbance (#24).

An important generalization from the above discussion is that the more critical variables related to rating noise as an annoyance were those dealing with an individual's current reactions to and attitudes concerning noise. Biographical and experience factors were of minimal importance; and this is fortunate so far as the noise problem is concerned, since, as variables, they are largely unmodifiable. On the other hand, attitudes can be changed, and thus it is encouraging to be able to consider attempts to deal with the noise problem thru educational campaigns.

Factorial Structure

The technique of factor analysis was useful in identifying the principal dimensions characterizing the sample of subjects. It further provided a base for several multiple regression analyses where dimensions predictive of annoyance could be isolated, as will be discussed below.

McKennell did not make extensive use of factor analysis, but relied mainly upon the Guttman technique of scalogram analysis to define several scales of interest in his study. His scales were generally comprised of only a few items and where Guttman scale criteria are not met, he refers to these as "quasi-scales" or "indices". But owing to the fact that few items (4 to 6) comprise his scales, one may question whether it is legitimate to infer scalability, as McKennell himself acknowledges. Notwithstanding, it is of some value to contrast his "scales" with "factors" identified in the present study.

Factor A, Noise Sensitivity, is quite comparable to McKennell's Scale G, "General Attitude to Noise". All six items in his scale are similar to attitude items which load on Factor A (# 18, #24, #29, #21, #20, #15). One item assessing sensitivity to noise (#13) which did load on Factor 1 was, however, excluded by McKennell from his Scale G. Additionally, the item representing variable #19 having the highest loading on Factor A was not asked in precisely comparable form in the London survey, and thus was not considered by McKennell for Scale G. Overall, however, the degree of comparability between Factor A and Scale G would appear to substantiate the validity of a general cluster of noise sensitive attitudes.

Factors B, C, and D were not correspondingly represented in the British study. In the case of Factors C and D this should not be surprising since personality characteristics were not formally assessed in the London survey. The same exception applies to Factor L, and probably, to a lesser extent, to Factor M. Both Factors E and F load heavily on attitude items; together there logically appears to be some overlap between these two factors and McKennell's Scale F, "Attitudes to the Local Importance of the Airport". To the extent that negative attitudes are reflected by these two factors, it is well to emphasize the need for concern upon the part of industry and government. Can these attitudes be changed?

Factor G contains four items (#14, #37, #26, #36) which represent a variety of McKennell's scales (A, F, H, M, N) that collectively are concerned with noise annoyance, attitudes toward neighborhood, and disturbance of activities by aircraft. Our analysis suggests a single scale measuring cognizant, yet accepting, attitudes. Neither Factor H or I are represented by McKennell's scales, but Factor J, Phobic, contains three items (#8, #9, #26) which are represented in Scale B, "Fear of Aircraft". This confirmation would underscore the need for informational campaigns on the part of those who would defend the

record of aviation safety.

Factor K, Residential Area, based mainly on two demographic items (#5, #3), appears distinct from Scale A based on attitudes toward neighborhood. Only one variable (#26) from Factor N appears in McKennell's scales, and this does not appear useful to distinguish. Factor N, Noise-Health, like Factor J, may also be amenable to educational efforts. Additionally, some desirability might be seen in considering Factor N when it comes to employee health and work assignments involving noise exposures.

Items #36 and #14 from Factor O are similarly represented in Scales M and N concerned with disturbance of activity by aircraft. Our analysis suggests a more general factor of interference with routine, not tied specifically to aircraft. Indeed in considering the overall problem of noise pollution, it would appear that Factor O should represent the essence of our concern, i.e. with disturbance of activities such as sleeping, relaxing, watching television, or carrying on a conversation. McKennell, in fact, uses as his "overall scale of annoyance" a list of specific types of disturbance experienced (based strongly, however, on aircraft effects).

McKennell has used the word "imperturbable" to describe individuals who find nothing to dislike about their neighborhood. Our assessment is reflected in part in Factor P by variable #7. Since the factor loads strongly on personality traits, it seems somewhat encouraging to note that at least some individuals may have relatively permanent characteristics which predisposes them to being imperturbed by noise. [Borsky has similarly identified such a group in his studies of community response to noise].

Factor Q contains two variables (#6, #14) which are assessed by McKennell's Scale A, Attitude toward Neighborhood. Since Scale A was also confirmed by factor analysis, the existence of this dimension seems firm and distinct from

Factor K, Residential Area. Finally Factor R, while comprised of only two items, contains variable #16 which is represented in Scale K. The existence as a critical dimension of a tendency to complain about noise should again be noted by those concerned with approaches to dealing with problems of noise pollution. As McKennell notes, however, only a small percentage of the population actually register a complaint, but those that do generally are highly annoyed by noise. His analysis further indicates that complainers as a group cannot be classed as neurotic subjects, at least as measured by responses to questions reflected in our variable #36. This variable, according to McKennell, has been shown to discriminate normal from neurotic subjects. In our analysis the variable appears in Factors A and G. Following this logic, the person who does not let noise disturb his activities is mature and pragmatic, while the person who cannot adapt and is sensitive to noise may often be neurotic.

Multiple Regression Prediction

A most interesting finding is the fact that "equations" (Table XXVII) involving multiple regression prediction of the annoyance response to individual noise stimuli involved only a moderate level of commonality. While Factor A, Noise Sensitivity, itself is uniquely the most important predictor in all cases, it is significant to note that, beyond this point, the order in which predictor variables are identified is also unique in each of the six analyses involving individual noise stimuli. In short, the results emphasize overall two important points: (a) irrespective of the noise environment, a generalized sensitivity to noise exists as a basis from which the annoyance response to noise is generated; and (b) superimposed upon this base are other factors which account for the variance in individual annoyance response to different types of noise. Putting this another way, the threshold of annoyance for a particular noise may be seen

to vary with the general sensitivity of an individual to any noise, as well as with the sensitivity of the individual to that particular noise.

With regard to the individual analyses some validity may be argued for the importance of individual factor scores in the "equations" for the different noise stimuli (Table XXVII). For example, significant predictors for the two noises most readily identified with commercial aviation, the jet and propeller aircraft flyovers, include both Anti-Aviation and Isolationist factors (E,F). Since both of these factors are heavily colored by attitudes toward aircraft and airports it seems reasonable to conclude that such attitudes do, in fact, contribute significantly to the annoyance response to aircraft noise (note that Isolationist is also a predictor in the case of the helicopter noise).

In contrast, it is interesting to note that the Noise-Health factor (N) is a significant predictor in four cases (air hammer, industrial, helicopter, and propeller aircraft). Since these cases include both the lowest and highest rated noises in terms of annoyance the results here suggest that a concern for the effects of noise upon health may be relatively independent of the type of noise. Still the pulsating character of three of the noises here (air hammer, industrial, helicopter) raises some speculation regarding the extent to which such a quality may be perceived as noxious and/or hazardous to one's health, thereby lowering the annoyance threshold.

The observation that the Interference with Routine factor (O) is a significant predictor for the two lowest-rated noises, truck and propeller aircraft, raises another interesting question. Why was this factor not a significant predictor for the more annoying noises? Such a concern relates to the common, contemporary attempt (cf, Borsky, 1974) to define annoyance in terms of disturbance of activities. As noted in our earlier discussion McKennell uses a list of activities disturbed as an overall index of annoyance. However, since McKennell's

work dealt only with aircraft noise effects, the findings of the present work suggest that the basis for the human annoyance response to noise involves a more complex set of ingredients. Indeed the regression involving the grand mean (Table XXVII-G) includes the general Noise Sensitivity factor (A), two factors loading somewhat heavily on personality traits, one factor loading heavily on attitudes (Isolationist - F), and a factor involving concern for the effects of noise upon health.

Results of the regression of the 53 biographical, personality, and attitudinal variables on overall MAR are presented in Table XXVIII. The criterion measure, overall MAR, in this analysis was obtained by aggregating annoyance responses across both environmental and sound conditions. Although the entire prediction equation including all 53 variables is presented in Table XXVIII, descriptions are provided only for those that contributed most to prediction of MAR.

This particular analysis was undertaken to reveal the nature of any relationships that might exist, independent of the factor structure, between the 53 predictors and MAR. As was pointed out previously, the factor structure could obscure strong relationships between individual predictors and MAR. However results presented in Table XXVIII, with one exception, do not reveal any relationships that were not detected in the previous regression analyses. Of the top four predictors (i.e. variables 18, 32, 50, and 37) all but variable 50 manifested high loadings on Factor A, Noise Sensitivity, which was identified previously as the prime predictor of MAR for all six noise stimuli. The next 5 variables (23, 22, 11, 27, and 15) all had high loadings on either Factor A or other factors (i.e. Factor N, L, E, and F) which were shown to selectively predict the MAR to the six noise stimuli.

The only new relationship detected in this final analysis was between variable 50, a personality variable, and MAR. While variable 50 did load on several factors (C, H, and M) which emerged as predictors of MAR in the previous analyses, its relationship to MAR was obscured somewhat in those analyses by its low loadings on the above factors. Even so the results of this analysis do substantiate the use of the factor structure to predict MAR.

The nine variables identified in Table XXVIII may be used to construct a profile of an idealized individual likely to give a high annoyance response to noise. In terms of his attitudes and beliefs about noise in general such an individual is concerned about the world getting noisier, would give consideration to noise problems when buying a home, tends to be bothered overall by noises from a number of different sources, is concerned that noise may have some effect on his health, and is often disturbed by noise at work. Concerning aircraft noise in particular, this individual has had a difficult time adjusting to current aviation-related noise levels and feels that they could be reduced. Furthermore he is opposed to the taking of private property for airport expansion. Finally in terms of his personality he is likely to be described as "experimenting" (as opposed to conservative) i.e. more critical, liberal, analytical, and free-thinking.

CONCLUSIONS

1. Significant differences in annoyance ratings among six noise stimuli involved in the study, all equated for peak sound pressure level, were found.
2. Mean annoyance ratings did not differ as a function of physical differences in test room conditions.
3. The range of annoyance ratings among subjects was great. For individual subjects, the annoyance response undoubtedly represents a complex product of attitudes, personality, and prior experience with noise.
4. As predictors of individual annoyance ratings, biographic and demographic factors were found to be of minor importance. More significant determinants of annoyance were attitudes held by subjects toward noise and noise-related topics, e.g. airport location, industrial development, local government policy, etc. Negative attitudes toward aviation were noted and should be regarded as an area to receive attention through educational efforts.
5. The overall importance of the role of attitudes in this study must be underscored. Attitudes can be changed, and thus on this positive note one approach to the problem of noise pollution emerges.
6. Factor analysis of survey and personality test data identified several useful dimensions characterizing the subject sample which can be related to the problem of noise pollution. These include (a) a general noise sensitivity factor (perhaps reflecting some underlying neurotic tendency to be annoyed), (b) fear of aircraft, (c) concern for the effects of noise on health, and (d) tendencies toward being "imperturbable" and toward being a "complainer." Generally, the results lend considerable support to McKennell's social survey findings around London.

7. Recognition of the general noise sensitivity factor as basic to an individual's annoyance response should emphasize the need to be concerned with noise as a general problem and not as one specific to aviation.
8. The existence of fear and health concerns related to aviation and noise suggests again that informational campaigns might be of value in dealing with the overall problem of noise pollution.
9. Equations involving multiple regression prediction of annoyance were found to vary among noise stimuli. This suggests that different factors may be responsible for individual annoyance response depending upon the noise stimulus involved, i.e. the individual's perception of noise as being noxious, threatening, etc. In short, while an individual's threshold to annoyance is partially a function of his general sensitivity to noise (conclusion 7), it is also clearly a function of the type of noise to which he is exposed.
10. While there has been an increasing trend toward defining annoyance somewhat simplistically in terms of disturbance of activity, the results of this study suggest that the annoyance response to noise is a more complex function involving a generalized sensitivity to noise, personality dimensions, attitudinal factors, and concern for the effects of noise upon health.

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APPENDICES

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Community Social Survey

Instructions. Please respond to all questions. Read each question carefully and answer as honestly and objectively as possible. Note that most questions require only a single check ("x") response; a few may require more than one check or a few words for your answer. Read and answer the questions in the order in which they appear -- do not skip around.

****

1. Your Name: _____ Home Phone No. _____
   (please print) last first middle initial

2. Address: _____; _____ Office Phone No. _____
   street city

3. Year of Birth: _____ 4. Sex: Male ( ) Female ( ) 5. Race: Caucasian ( ) Negroid ( ) Other ( )

6. Occupation (please be specific): _____

7. What is the highest level of education you have had? Check one.

   a. ( ) Grade school only (up to 8th. grade)
   b. ( ) Some Senior H. S.
   c. ( ) H. S. graduate
   d. ( ) Some college -- 1 or 2 years or more -- including technical institute or business college.
   e. ( ) College graduate with B. A., B. S. or equivalent 4-yr.
   f. ( ) Graduate degree M. A., M. S., or higher

8. Approximately, what is your total family income (include spouse if applicable)?

   a. ( ) Below 5000 per year
   b. ( ) 5000 - 7000 per year
   c. ( ) 7000 - 9000 per year
   d. ( ) 9000 - 12000 per year
   e. ( ) over 12,000 per year

9. Where are you employed? _____
   (Skip if housewife or unemployed)

10. Are you employed in aviation or a related aerospace industry or derive any income from such sources? a. ( ) Yes b. ( ) No

11. Where do you live? Check one.

   a. ( ) City proper
   b. ( ) Suburban area
   c. ( ) Rural area - farm area

12. How long have you lived in the Raleigh--Wake County area? ( ) Years ( ) Months

13. In the residential area (neighborhood) where you live, are there things which you don't like about it? Check one.

a. ( ) No -- nothing at all
b. ( ) Yes -- a few things, 1 or 2
c. ( ) Yes -- several things
d. ( ) Yes -- many things

14. What are some of the things you don't like about the Raleigh--Wake County area? List as many things as you can.

_____

_____

_____

_____

15. Are you ever bothered by or do you ever feel anxious about aircraft flying close over your home or work location? Check one.

a. ( ) Yes -- very often
b. ( ) Yes -- occasionally
c. ( ) No or hardly ever

16. When you hear aircraft fly overhead, do you ever feel there is any danger of a crash nearby? Check one.

a. ( ) Yes -- I think this often
b. ( ) Yes -- I think this on occasion
c. ( ) No -- I rarely give it any thought

17. Regarding air travel and flying I have: Check one.

a. ( ) Done considerable flying as a passenger and/or pilot.
b. ( ) Done a moderate amount of flying.
c. ( ) Flown only one or two or a few times.
d. ( ) Never flown.

18. On the whole, would you say that you were more bothered by aircraft this year than in the past, or have you become used to aircraft? Check one.

a. ( ) Have become used to aircraft
b. ( ) About the same
c. ( ) More bothered now

19. How would you describe the area where you live in terms of being noisy? Check one.

a. ( ) Generally quiet -- rarely noisy
b. ( ) Moderately noisy and at times disturbing
c. ( ) Frequently noisy and disturbing
d. ( ) Very noisy and at times unbearable

20. Would you say you are more sensitive or less sensitive than other people are to noise? Check one.

a. ( ) More sensitive than the average person
b. ( ) About the same as the average person
c. ( ) Less sensitive than the average person

21. What are some of the noise sources in your work and home area that annoy you?

Please list as many as possible. _____

_____

_____

_____

_____

22. How often are you disturbed in your present job or work by noise? Check one.

a. ( ) Never--rarely
b. ( ) Sometimes
c. ( ) Moderately often
d. ( ) Quite often
e. ( ) Most of the time--continually

23. Do sources of noise (such as aircraft, road traffic, trains, playgrounds, manufacturing, construction, etc.) disturb any of your daily activities? Check frequency for each.

	Rarely or No	Occasionally	Often
a. Do such sources startle and surprise you?	( )	( )	( )
b. Do they keep you from going to sleep?	( )	( )	( )
c. Do they wake you up?	( )	( )	( )
d. Do they disturb radio and TV listening?	( )	( )	( )
e. Do they interfere with conversation?	( )	( )	( )
f. Do they disturb your rest and relaxation?	( )	( )	( )

24. Have you ever made any complaints about a noise source? Check one or more.

a. ( ) Wrote or telephoned an elected official, city police, etc.
b. ( ) Visited or telephoned an elected official, city police, etc.
c. ( ) Signed a petition
d. ( ) Attended a meeting to protest
e. ( ) Never did any of above

25. To what extent have you been exposed during your lifetime to noise in your work and in other experiences (war, travel, home, etc.)? Check one.

a. ( ) None-hardly any exposure
b. ( ) A little exposure
c. ( ) A moderate amount of exposure
d. ( ) A great deal of exposure

26. If the world in which you live gets noticeably noisier in the future, would this matter much to you? Check one.

a. ( ) Hardly at all
b. ( ) It would matter a little
c. ( ) It would matter very much

27. Do you adapt readily to noise -- or does noise generally bother you a great deal? Check one.

a. ( ) Never bothers me
b. ( ) Noise hardly ever bothers me
c. ( ) Noise bothers me a little
d. ( ) Noise bothers me a moderate amount
e. ( ) Noise bothers me very much
f. ( ) Extremely so -- I am bothered considerably by any and all noise.

28. Would you rather hear some noise or have complete quiet when you are inside your home? Check one.

a. ( ) Would rather hear noise
b. ( ) Would prefer complete quiet

29. On the whole would you say there is too much fuss or too little fuss made about noise today? Check one.

a. ( ) Too little fuss made about noise
b. ( ) About the right amount of concern
c. ( ) Too much fuss made about noise

30. Here is a list of noises which sometimes annoy people. Check any that ever bother you.

a. ( ) Lawn mowers
b. ( ) Dripping water faucet
c. ( ) Dogs barking
d. ( ) Banging doors
e. ( ) Someone turning on the radio when you want quiet
f. ( ) Jack hammers and pneumatic drills; air compressors
g. ( ) Air conditioning units
h. ( ) Sound of a knife grating on a plate
i. ( ) Church bells
j. ( ) Automobile horns
k. ( ) Motor bikes, motor cycles, and scooters
l. ( ) Someone whistling out of tune

m. ( ) Not bothered by any of the above

31. In your opinion can aircraft noise be prevented? a. ( ) No b. ( ) Yes

32. Do you believe noise has any effect on <u>your</u> health? <u>Check one</u>.

a. ( ) Yes -- definitely
b. ( ) Probably -- perhaps indirectly
c. ( ) No -- I don't think so

33. Could you sum up your opinion by saying how you feel about noise in general? <u>Check one</u>.

a. ( ) Not at all disturbing
b. ( ) A little disturbing
c. ( ) Disturbing
d. ( ) Very disturbing

ATTITUDES

Instructions: Please indicate how you feel on each of the following statements. Check the appropriate column for each.	Strongly Agree a	Agree b	Indifferent c	Disagree d	Strongly Disagree e
34. Our community would suffer a loss if deprived of air service.	( )	( )	( )	( )	( )
35. Property values in my community have been hurt by airport location and noise.	( )	( )	( )	( )	( )
36. The taking of private property (including homes) for airport expansion and highway construction should be accepted by all citizens as a necessary step in community growth.	( )	( )	( )	( )	( )
37. An airplane crash in the community, affecting life and property, is a distinct and early danger to be dealt with soon.	( )	( )	( )	( )	( )
38. Noise is one of the biggest nuisances in today's world.	( )	( )	( )	( )	( )
39. Local public tax funds should be used to support the community airport.	( )	( )	( )	( )	( )
40. The airport should expand its services; more jet aircraft should serve the Raleigh area.	( )	( )	( )	( )	( )
41. Sources of noise are a minor consideration when it comes to buying a home.	( )	( )	( )	( )	( )
42. The airport and our superhighways bring more industry to the Raleigh area -- and this is a good thing!	( )	( )	( )	( )	( )
43. Public funds to be spent on dealing with noise problems should have low priority, i.e. be considered after other problems.	( )	( )	( )	( )	( )

* * * * * * * * * * * * * * *

44. Please check to see if you've answered all questions in this survey! Yes, I have ( ).

Appendix B. Primary Dimensions of the Cattell 16 Personality Factor Test*

Factor	Words Used to Describe Person with a Low Score	Words Used to Describe Person with a High Score
A	RESERVED—detached, critical, cool	OUTGOING—warmhearted, easy-going, participating
B	LESS INTELLIGENT—concrete-thinking	MORE INTELLIGENT—abstract-thinking, bright
C	AFFECTED BY FEELINGS—emotionally less stable, easily upset	EMOTIONALLY STABLE—faces reality, calm
E	HUMBLE—mild, obedient, conforming	ASSERTIVE—independent, aggressive, stubborn
F	SOBER—prudent, serious, taciturn	HAPPY-GO-LUCKY—heedless, gay, enthusiastic
G	EXPEDIENT—a law to himself, bypasses obligations	CONSCIENTIOUS—persevering, staid, rule-bound
H	SHY—restained, diffident, timid	VENTURESOME—socially bold, uninhibited, spontaneous
I	TOUGH-MINDED—self-reliant, realistic, no-nonsense	TENDER-MINDED—dependent, overprotected, sensitive
L	TRUSTING—adaptable, free of jealousy, easy to get on with	SUSPICIOUS—self-opinionated, hard to fool
M	PRACTICAL—careful, conventional, regulated by external realities, proper	IMAGINATIVE—wrapped up in inner urgencies, careless of practical matters, bohemian
N	FORTHRIGHT—natural, artless, sentimental	SHREWD—calculating, worldly, penetrating
O	PLACID—self-assured, confident, serene	APPREHENSIVE—worrying, depressive, troubled
Q_1	CONSERVATIVE—respecting established ideas, tolerant of traditional difficulties	EXPERIMENTING—critical, liberal, analytical, free-thinking
Q_2	GROUP-DEPENDENT—a "joiner" and good follower	SELF-SUFFICIENT—prefers own decisions, resourceful
Q_3	CASUAL—careless of protocol, untidy, follows own urges	CONTROLLED—socially-precise, self-disciplined, compulsive
Q_4	RELAXED—tranquil, torpid, unfrustrated	TENSE—driven, overwrought, fretful

*Summary provided by Institute for Personality and Ability Testing, Champaign, Illinois.

TABLE XXIX. INTERCORRELATION MATRIX OF 53 VARIABLES TO 2 DECIMAL PLACES, DECIMAL DELETED EXCEPT FOR UNITY (1.0)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.0+	-23	-10	03	-01	-10	-03	18	14	28	11	03	08	07	15	-08	23	07
2		1.0	23	-08	07	21	20	-04	-10	-27	-01	08	09	16	-02	-02	-07	09
3			1.0	-17	23	10	07	-04	-09	-42	-12	-05	-04	18	-00	02	-18	06
4				1.0	-01	-09	-01	10	-02	20	13	01	15	07	14	06	15	-01
5					1.0	-04	10	-11	-07	01	-10	-18	-02	08	05	-04	-10	06
6						1.0	33	-02	-08	-07	-01	30	-10	24	-09	03	-10	05
7							1.0	-05	04	-02	01	11	-15	08	-03	08	-13	-01
8								1.0	34	05	24	07	17	19	19	16	15	21
9									1.0	03	20	12	09	18	18	08	14	18
10										1.0	23	-05	-11	-07	09	-01	26	04
11											1.0	04	11	08	12	06	08	11
12												1.0	-02	26	06	14	-11	05
13													1.0	21	30	02	08	32
14														1.0	20	03	00	13
15															1.0	13	-08	13
16																1.0	-18	14
17																	1.0	07
18																		1.0

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	19	-07	03	-05	-09	02	-11	-02	03	20	16	-14	-15	-03	-02	06	00	03
2	12	12	-01	18	14	04	-06	01	-00	-13	05	-01	02	23	01	08	14	-11
3	09	-16	01	01	-07	08	-05	-08	06	-21	-16	12	-04	-00	02	00	-20	-10
4	-00	09	-01	-01	01	05	07	05	-10	20	09	-09	08	04	00	10	04	-05
5	04	03	-02	05	00	01	08	-06	-02	-04	12	-02	03	-10	06	07	07	-14
6	05	08	-01	-09	13	01	06	-10	08	06	-09	05	-02	07	-11	03	-07	01
7	09	11	12	12	18	01	11	-05	18	08	05	05	07	04	-04	15	08	-10
8	23	10	10	13	07	22	-01	21	05	31	29	03	05	10	03	-01	-02	17
9	23	01	10	20	11	19	-64	17	-11	26	32	-01	06	04	-00	00	03	25
10	03	02	-11	-17	-02	04	00	01	01	25	04	02	08	-04	07	03	12	-02
11	16	-02	05	-07	-07	08	00	03	02	10	07	13	13	11	17	09	-07	02
12	19	13	12	03	02	17	-07	15	-03	19	04	04	01	-06	-16	-00	03	23
13	40	12	22	13	07	26	-02	04	-03	19	33	-09	05	95	17	-05	03	-07
14	30	11	12	20	12	23	94	11	06	14	23	11	11	10	-03	12	-02	22
15	21	04	05	04	01	27	-08	-12	-00	16	21	08	05	10	-06	05	16	16
16	15	08	21	05	14	20	-03	05	06	18	16	18	10	17	13	08	-03	08
17	00	-15	-12	-06	-00	-06	[illegible]	-16	-09	08	08	-11	-03	96	09	03	12	-11
18	57	29	41	24	38	50	-10	18	13	20	[illegible]	02	21	28	10	26	-03	11
19	1.0	22	32	24	16	52	-03	21	05	22	38	10	21	32	02	25	-04	27
20		1.0	24	30	19	34	-00	14	09	09	18	-01	21	22	03	13	01	01
21			1.0	18	18	27	13	18	12	11	30	11	20	12	08	15	-14	17
22				1.0	08	14	06	14	-01	20	[illegible]	-04	19	08	06	14	06	18
23					1.0	25	02	15	14	13	30	10	14	07	11	27	18	08
24						1.0	-06	27	06	18	46	04	12	27	00	19	-04	16
25							1.0	-07	28	08	-08	21	20	-05	10	-06	12	03
26								1.0	06	28	31	03	12	05	10	17	03	22

	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
1	13	-07	-04	-23	10	06	04	11	16	00	23	08	-06	03	-15	14	-08
2	11	-15	43	17	14	-05	-01	02	-02	-06	04	03	-07	12	11	01	-01
3	11	07	26	21	00	01	18	07	-11	-08	-08	-00	-15	-02	-00	-05	08
4	09	-00	-09	-04	06	11	-01	-03	-00	04	10	01	07	05	02	-02	-04
5	-03	-12	13	05	10	-00	07	-04	04	09	-02	-01	-03	04	11	01	06
6	15	10	13	-12	08	-03	07	-05	06	12	10	-10	11	-11	01	-03	16
7	08	-13	26	-07	28	05	-17	06	-03	24	10	-26	-05	18	07	-01	09
8	18	-06	05	-10	-01	-01	04	-02	10	04	26	-02	14	02	01	-15	05
9	10	-03	-09	-22	-00	-04	-07	-11	-02	03	21	00	17	06	03	-08	04
10	06	02	-19	-27	-18	-09	-02	-16	09	09	-04	-04	17	-01	-04	-04	02
11	12	02	-12	-21	-05	-08	-05	-09	07	-00	16	06	18	10	05	-13	-02
12	02	03	04	-11	21	08	-05	01	-11	28	04	-06	09	-05	02	-03	06
13	14	19	-05	05	-09	15	-06	-06	-05	06	05	19	15	05	18	-05	05
14	38	-07	09	00	11	04	00	-03	08	02	24	-05	13	02	17	-05	03
15	09	-13	-06	-07	13	-02	-18	-17	05	02	17	-01	10	09	03	-13	11
16	04	-16	09	-01	-04	-09	08	-02	-07	06	10	-02	05	-06	06	05	08
17	01	16	-13	-09	-06	01	02	-00	08	00	08	04	09	11	-19	-05	-01
18	34	-07	05	-16	11	-06	06	-06	-02	21	17	-01	08	-02	17	00	09
19	50	-13	18	-23	07	-09	-05	-15	18	18	20	-13	16	-04	26	-07	20
20	12	-14	12	-00	08	-03	-11	-11	06	10	03	-08	02	01	17	08	-02
21	19	-13	-03	-16	06	-11	-11	-07	00	09	15	-12	10	-14	24	05	02
22	16	-14	15	08	06	-06	-05	-03	10	06	18	-11	00	00	23	-04	03
23	09	-00	08	-12	10	11	-12	07	-06	20	21	-10	12	03	02	-07	13
24	31	-03	07	-11	-02	-06	-01	-18	05	11	14	-12	14	01	13	-11	07
25	-05	-06	-09	02	07	09	-07	05	-11	-07	-11	-02	03	03	13	02	08
26	24	-02	-16	-17	-09	-01	-06	-11	-03	08	09	-10	20	00	-06	-19	05

TABLE XXIX. Continued

	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
27	1.0	07	04	23	19	06	17	09	06	-06	02	-10	05	-09	07	08	-03	05	-12	11	00	-01	-04	-11	09	-02	16
28		1.0	33	-03	06	09	-04	08	-04	20	23	-02	-01	-29	04	-04	-02	-01	17	15	15	-02	16	-06	-00	-10	11
29			1.0	-12	17	26	-01	18	11	17	32	-12	08	-22	09	02	-13	-08	11	22	31	-08	18	-03	12	-12	11
30				1.0	23	14	23	03	09	05	-04	-01	-14	02	-03	06	-07	-06	-01	-01	-04	-05	02	-01	07	-04	-00
31					1.0	23	49	05	06	-04	08	-15	06	05	07	-02	-09	-07	-05	-04	03	-16	-08	-01	15	09	-09
32						1.0	12	22	02	-07	28	-07	23	-08	03	03	-01	-06	10	-04	16	-02	02	08	08	-11	03
33							1.0	-01	-05	-06	-04	01	07	-04	-08	-16	08	-05	-02	-11	-12	-12	02	03	00	09	-06
34								1.0	09	08	28	02	11	-03	03	14	-04	07	09	00	16	02	-03	-04	-02	-08	-03
35									1.0	-07	-14	-02	-02	07	24	24	-21	07	-04	14	07	02	-03	23	-09	-11	05
36										1.0	17	05	-19	-14	-10	-04	-20	-10	12	11	15	-19	16	-13	03	-12	16
37											1.0	-12	25	-22	-04	-05	00	-19	20	06	22	-20	20	04	27	-18	14
38												1.0	-24	01	04	35	-03	41	14	-04	-08	28	01	-20	-51	-04	-00
39													1.0	06	14	-01	04	02	08	-05	10	-15	-09	11	17	-04	03
40														1.0	01	09	25	31	-20	-40	-20	08	-62	10	-04	41	-53
41															1.0	53	-26	53	-24	37	20	14	-15	16	-11	04	02
42																1.0	-21	64	-16	18	04	20	-17	02	-41	-01	-08
43																	1.0	06	-03	-32	-16	05	-18	-08	-05	25	-23
44																		1.0	-18	00	-01	30	-45	-01	-44	28	-27
45																			1.0	-07	30	-03	22	00	-03	-11	21
46																				1.0	20	-14	32	-00	10	-16	40
47																					1.0	02	15	06	12	-07	23
48																						1.0	-21	04	-22	22	-20
49																							1.0	-04	21	-52	57
50																								1.0	07	03	-12
51																									1.0	03	13
52																										1.0	-52
53																											1.0