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ANNOYANCE RESULTING FROM INTRUSION OF AIRCRAFT SOUNDS UPON VARIOUS ACTIVITIES

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ABSTRACT

Subjects participated in an experiment in which they were engaged in TV viewing, telephone listening, or reverie (no activity) for a ½-hour session. During the session, they were exposed to a series of recorded aircraft sounds at the rate of one flight every 2 minutes. Within each session, four levels of flyover noise, separated by 5 dB increments, were presented several times in a Latin Square balanced sequence. The peak level of the noisiest flyover in any session was fixed at 95, 90, 85, 75, or 70 dBA. At the end of the test session, subjects recorded their responses to the aircraft sounds, using a bipolar scale which covered the range from "very pleasant" to extremely annoying." Responses to aircraft noises were found to be significantly affected by the particular activity in which the subjects were engaged. Furthermore, not all subjects found the aircraft sounds to be annoying.

Annoyance Resulting from Intrusion of Aircraft Sounds Upon Various Activities

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This report is the culmination of a series of related reports dealing with basic factors related to response to aircraft flyover noise. The first report dealt with response to aircraft flyover noise as a function of the presence of strangers (see Appendix I), the second with the effect of number of flights prior to judgement on annoyance to aircraft flyover noise (see Appendix II). This research was a joint research effort of the above NASA and Memphis State University personnel, conducted at Memphis State University by the project director.

A frequently voiced complaint by those residing near airports is that the aircraft flyover noise interferes with their viewing and listening to television (1). A study was made of the acceptability of individual aircraft flyover noises by subjects who were either watching TV or not (2). Ratings in both cases were almost identical. A series of experiments in which S's watch videotaped TV, then rated the acceptability of the entire noise exposure during that time, was conducted by Langdon and Gabriel (3). They found that noise level produced significantly less effect than predicted by Williams, Stevens, and Klatt (2). They concluded that there is some positive effect, and believed this effect contradicts a pure masking hypothesis. Examination of their data can reveal no clear support for their belief.

A dynamic, stress-reduction model of human response to aircraft noise was recently proposed by Gunn and Patterson (see Appendix III). This model predicts S's engaged in different activities when exposed to the same aircraft noise will express differing degrees of annoyance.

The hypothesis of the present study was that annoyance will differ significantly as a function of the activity the listener is pursuing.

PROCEDURE

Subjects

Three hundred twenty-four S's were obtained from faculty, staff, and students at Memphis State University. All were screened for hearing and none had HL's greater than 20 dB ISO at any frequency from 125-6000 Hz. All S's were paid to participate in the study.

Method

The S's were divided into three groups of 108 and exposed in groups of 6 to ½ hr. of recorded aircraft landing noise. At the end of the session, they were asked to indicate their general response to the sounds they had heard. The first group, called "Reverie" (no task), had 18 groups of 6 S's each and simply sat and listened to the aircraft noise. The second group watched a TV program of their choice during exposure, while the third group listened to a recorded Modified Rhyme Test (speech intelligibility test) over a telephone during exposure to the recorded aircraft noise. All S's judged annoyance from the noise at the end of the session, using the same rating sheet. The test sequence for each of the three groups is shown in Table I. The specific procedure for each group was as follows.

Group I - Reverie

Subjects were ushered into the test room and seated. Seats were arranged before a loudspeaker so that the noise exposure would be equivalent for all subjects who were then left to themselves for a period of 15 minutes. This time was needed to provide a uniform experimental situation compared to the other two activities. Talking was permitted in this pretest period. Near the end of the 15 min. period, the experimenter re-entered the room and read the instructions given in Appendix IV. After this, the experimenter left the room and a tape recording of aricraft flyover sounds was activated. The same aircraft recording was used during all three activities. These flyover sounds and the method of presentation are described in the Apparatus and Stimuli sections of this report. At the end of the experimental session, the experimenter entered the room and distributed copies of the response sheet which is shown in Fig. 1. The scale used was bipolar and subject responses were not biased by the use of plus or minus signs at either end of the scale. Similarly, the flyover stimuli were never described as "aircraft noises", but rather as "aircraft sounds."

Group II - TV Viewing

Subjects were ushered into the test room and seated in an arc before a color television set. The TV set was situated in front of the loudspeaker mentioned previously, as it was in the no-task condition. These subjects had earlier indicated that the program they were about to watch was one of their favorite programs. The TV set was turned on and the subjects were read the instructions shown in Appendix V and the TV audio volume control was adjusted to a level acceptable to all subjects. Two minutes prior to the beginning of the program, the subjects were read the instructions shown in Appendix V. The TV set was then turned on to the selected program and the experimenter left the room. The aircraft flyover noise tape was immediately activated at the beginning of the TV program. After the last aircraft flyover in this session, the television set was left on so as not to cause changes in subjects' annoyance that would be unrelated to the flyover sounds. The experimenter quietly distributed copies of the response sheet shown in Fig. 1 and indicated that they were to complete this form according to the written instructions. After all subjects had completed this response form, the experimenter collected them and distributed copies of the response form shown in Fig. 2.

Group III - Telephone Listening

Prior to the beginning of this phase of the experiment, a pilot study was conducted with several listeners to determine the playback levels that would be required to achieve an average of about 90 percent correct on the speech interference tests, in quiet. This was done so that performance on the tests would be degraded even further during simulated aircraft flyovers. It must be remembered that the measure of primary concern here was annoyance related to the interference with telephone use, not speech intelligibility, per se. It was necessary to use an intelligibility test to provide a device that would hold subjects' attention to verbal stimuli.

Subjects in this phase of the study were ushered into the test room and seated. Beside each seat was a telephone handset. The subjects heard the instructions shown in Appendix VI. The first instruction was read to the subjects by the experimenter. The second instruction was tape recorded and given to the subjects over the telephone handsets. Following these recorded instructions, the experimenter read to the subjects the instructions shown in Appendix IV. (These latter instructions were read to all subjects in each phase of the experiment, thus providing maximum uniformity in instructions.) The experimenter then left the room and the recorded speech and aircraft noise stimuli were presented.

Six lists of the Modified Rhyme Test (MRT) as developed by House, et al., 1963 (4) were presented to subjects. The answer ensembles in these tests consist of six words each with a total of 50 ensembles per test. Prior to tape recording the tests, the correct word from each ensemble was selected by use of a table of random numbers. The tests used are shown in Appendix VII. The recorded test word is underlined in each ensemble. Subjects' response forms were identical to the lists shown in Appendix VII, except that no words were underlined, of course. Subjects were required to draw a line through the correct word in each ensemble per the instructions given in Appendix VI. At the end of the experimental session, the experimenter collected the speech test response forms and distributed copies of the response form shown in Fig. 1. These forms were then completed by the subjects and collected by the experimenter.

Apparatus

The apparatus used in this experiment is shown in block diagram form in Fig. 3. During the TV viewing and reverie conditions, the speech track was disconnected at the tape recorder. The voltmeter was used to set noise and speech levels prior to each experimental session. The color TV set was positioned in front of the Klipschorn speaker in such a way that it did not significantly block the sound output from the speaker during presentation of aircraft flyover sounds. The test room was a 15 x 24 ft. room furnished to resemble a living room. Ambient noise level in the room was 43 dBA as determined with a sound level meter set on slow reading position.

Stimuli

Aircraft noise.. Each subgroup of subjects was exposed to a ½ hr. duration playback of recorded Boeing 747 landing sounds at the rate of one overflight every 2 minutes. In order to make the noise exposure a little more realistic, the peak levels of the individual flyover noise were varied from one overflight to the next. Within any session, there were four peak levels of aircraft noise, designated A, B, C, and D. There were 16 overflights during each 30-minute session and there were four overflights at each level A, B, C, and D, in a balanced Latin Square sequence. Table II shows the corresponding sound levels for each peak flyover level and Fig. 4 shows a plot of noise level, in dBA, versus time. For each activity, the aircraft noises, in general, were presented at six intensities, designated "Intensity 1, 2, 3, 4, 5, 6." As can be seen by inspection of Table II and Fig. 4, the most intense aircraft sound in intensity 1 is 70 dBA peak and the other peak levels within that session decrease to 55 dBA in 5 dB increments. Likewise, in intensity 2, the most intense aircraft sound is 75 dBA and the quietest is 60 dBA, and so on.

Speech stimuli. The experiment involved the presentation of speech as well as aircraft flyover sound stimuli. The same flyover stimuli were presented during all three activities, i.e., reverie, TV viewing, and telephone listening. Controlled speech stimuli were presented only during the telephone listening phase of the experiment. The two sets of stimuli (aircraft and speech) were recorded on two tracks of a single tape. This provided synchrony between the speech and flyover stimuli. The speech stimuli were recorded in a commercially available sound treated room by a speaker of general American English. Speech stimuli were recorded at the rate of approximately one word every 6 seconds. The test word was appended to the phrase; "number _____ is _____," where the last blank corresponds to the position of the test word. The talker monitored his voice level with a VU meter during recording of speech stimuli. Speech stimuli were recorded on one tape track on a high quality audio tape recorder with a commercially available dynamic microphone. The recorded speech material is shown in Appendix VII. Speech stimuli were played to listeners at constant level such that the speech peaks were approximately 50 dBA in the telephone handsets as measured in a 6 cc coupler.

The aircraft flyover stimuli were recorded on the second track of the tape. The two tracks were juxtaposed so that the first word of the speech stimuli and the beginning of the first flyover occurred at about the same time. Flyover levels were calibrated in the test room using a sound level meter. A corresponding voltage for a calibration tone on the tape was observed and recorded. These voltages were used in subsequent sessions to set the correct flyover levels. These calibrations were checked periodically during the experiment to insure consistency of stimuli presentation. A diagram showing the level of stimuli presented to subjects and the activity they were performing is shown in Table III.

Stimuli analysis. The aircraft flyover sounds were recorded as they occurred in the test room using commercially available acoustic analysis recording equipment. The sounds were recorded at the extreme levels of 95 and 70 dBA at several seat positions normally used by subjects. In addition, a recording of the speech signal was made with one of the handsets coupled to the microphone while the aircraft flyover sounds emanated simultaneously from the loudspeaker. These recorded stimuli will be analyzed at a computer facility and results will be available sometime in the near future for a more detailed analysis of the relationships between actual speech interference and the physical description of the noise.

RESULTS

The median annoyance scores as a function of intensity level for each activity are shown in Fig. 5. The slopes of the three lines differed significantly from each other. Median tests of differences in annoyance at each session intensity show that annoyance from noise interruption of TV viewing at intensity 1 was significantly ($p < .05$) more than for either of the other conditions, while for intensity level 5, the relation was reversed for TV viewing and telephone listening, i.e., in the session where the loudest noise was 70 dBA peak, S's watching TV were more annoyed than those listening to speech on the telephone or doing nothing (reverie). As the aircraft noise intensity increased to where 90 dBA peak was the highest level, annoyance of those listening to the telephone increased until it was significantly more than that for either of the other two conditions.

The frequency distribution of annoyance scores for all intensities and activities is presented in Table IV. It should be noted that 17 S's (over 5% of those in the study) said that aircraft sounds were "pleasant" to listen to.

DISCUSSION

The results suggest that the "telephone listening" task provides a much more sensitive indicator of subjects overall annoyance response to aircraft noise than either "TV viewing" or "reverie" situations. While on the surface the results might at first seem to be at variance with past studies which show fairly high correlations between noise level and the resulting annoyance reaction in the no-task situation, careful consideration of the procedures and conditions of this experiment makes the results of this study more understandable. To begin with, it is widely known that laboratory subjects judging the loudness or noisiness of individual noises covering a given intensity range will quite neatly order the stimuli as an increasing monotonic function of the intensity level, clearly demonstrating that they can discriminate intensity levels, if nothing else. Note, however, that the subjects in these experiments made only one judgment of the effect of a ½-hour exposure to aircraft noises presented at various intensity levels at the rate of about one flight every 2 minutes. The experimental situation was contrived such that the subjects were not required to discriminate one intensity from another, but rather that they were to report their reactions to one specific exposure condition. This is not to say that the subjects did not use a standard against which to compare their reactions to the experimental stimuli. They could, conceivably, have an existing internal standard developed from real life experiences against which to compare the integrated effects of the laboratory noise exposure. The practice of obtaining only one response from each subject has much in common with the assessment of individual reactions of airport community residents to their own neighborhood noise environment. It is common practice in social surveys dealing with community response to aircraft noise to ask individuals to rate their own noise environment on various numerical category scales. In such studies, the respondents are not usually asked to rate more than one noise environment, their own. It is not surprising, therefore, that most such studies have found rather poor correlations between noise levels in the environment and reported annoyance reactions.

It is clear from our data that the growth and absolute level of annoyance differ depending on which specific activity is interrupted by the intruding aircraft noise. With reference to the stress-reduction model of Appendix III, the data support the hypothesis that reaction to noise is modified by the nature of the activity engaged in at the time of the noise. A viable predictor of annoyance reaction to aircraft noise must then account for the "dominant" activity in a given community during each noise exposure period. It would not be surprising to find in future experiments still another (and totally different) psychophysical function relating annoyance and noise level which occurs during and possibly interrupts sleep. The same could be said for the reactions of people engaged in various other activities. While both our TV viewing task and telephone listening task involved aural communications, the telephone listening task differed in a number of important ways. Firstly, there was no redundancy built into the speech test presented over the telephone while there is a certain amount inherent in the usual TV show. Secondly, the importance of speech intelligibility was artifically increased in the telephone listening task by offering a bonus for superior speech reception scores. The differences in annoyance during TV viewing and reverie suggest a possible different basis for the annoyance reaction in each situation. One might speculate that the significantly greater annoyance reported by the TV viewers in intensity level 1 (where the loudest overflight was only 70 dBA peak) may have been due to distraction, rather than communication interference from masking, per se.

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TABLE I - TEST SEQUENCE

15 MINUTES	30 MINUTES	5 MINUTES	5 MINUTES
Reverie (no task)			
S's sit and talk freely, Instruction "A" read to S's	S sits; talking not permitted	S's complete Data Sheet 1	
TV Viewing			
TV audio adjusted and instructions "B" and "A" read to S's	S views TV program previously selected	S's complete Data Sheet 1	S's complete Data Sheet 2
Telephone Listening			
Instruction "C" and practice given to S's; then instruction "A"	S listens to telephone for speech reception test	S's complete Data Sheet 1	

TABLE II - PEAK AIRCRAFT FLYOVER LEVEL IN dBA

Stimulus Designator	Session Intensity Level					
	1	2	3	4	5	6
A	70	75	80	85	90	95
B	65	70	75	80	85	90
C	60	65	70	75	80	85
D	55	60	65	70	75	80

TABLE III - SUBJECT ASSIGNMENTS

	Session Noise Intensity Level					
	1	2	3	4	5	6
Peak Level of Most Intense Aircraft Noise During Exposure, in dBA	70	75	80	85	90	95
Activity						
No Task	S1-S18	S19-S36	S37-S54	S55-S72	S73-S90	S91-S108
TV Viewing	S109-S126	S127-S144	S145-S162	S163-S180	S181-S198	S199-S216
Telephone Listening	S217-S234	S235-S252	S253-S270	S271-S288	S289-S306	S307-S324

TABLE IV - FREQUENCY DISTRIBUTION OF SCORES

Very Pleasant					Neutral					Extremely Annoying	Subject Response Scale	
-5	-4	-3	-2	-1	0	1	2	3	4	5	Median	Condition
				3	5	6		2	2		.67	70 Rev
					4	4	2	6	1	1	2.0	75 Rev
		1		1	2	1	2	2	2	1	1.2	80 Rev
1			2		1	6		2	5	1	1.3	85 Rev
	1	1			3	3	5	5			1.7	90 Rev
				1	4	1	1	4	1		1.93	95 Rev
					2	3	4	7	2		2.50	70 TV
				1			3	8	4	2	3.12	75 TV
					3	1	3	4	3	4	3.0	80 TV
				1	2	4	4	2	3	2	2.0	85 TV
						4	2	5	3	3	2.9	90 TV
						2	2	7	3	4	3.21	95 TV
		1	1		9	1	2	2	1		0.2	70 Tel
		1			1	5	5	2	1	3	1.9	75 Tel
					1	1	4	8	3	1	2.87	80 Tel
						2	4	7	1	4	2.93	85 Tel
						1	1	3	6	7	4.17	90 Tel
						1	4	4	4	5	3.5	95 Tel

NAME________________________ SUBJECT NO.

PLEASE INDICATE YOUR GENERAL REACTION TO THE AIRCRAFT SOUNDS WHICH WERE PRESENTED DURING THE SESSION BY PLACING A CHECK MARK NEXT TO THE APPROPRIATE POINT ON THE SCALE SHOWN BELOW.

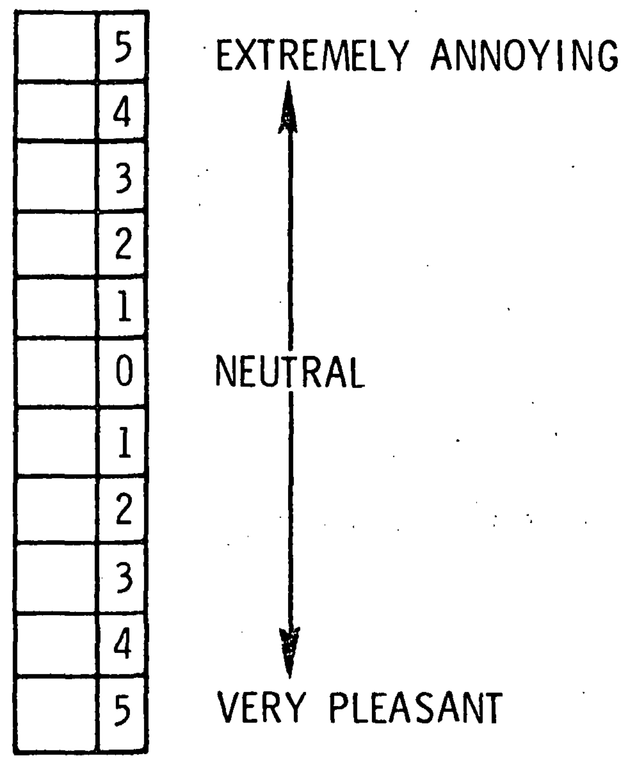

Figure 1.- Subject response sheet 1.

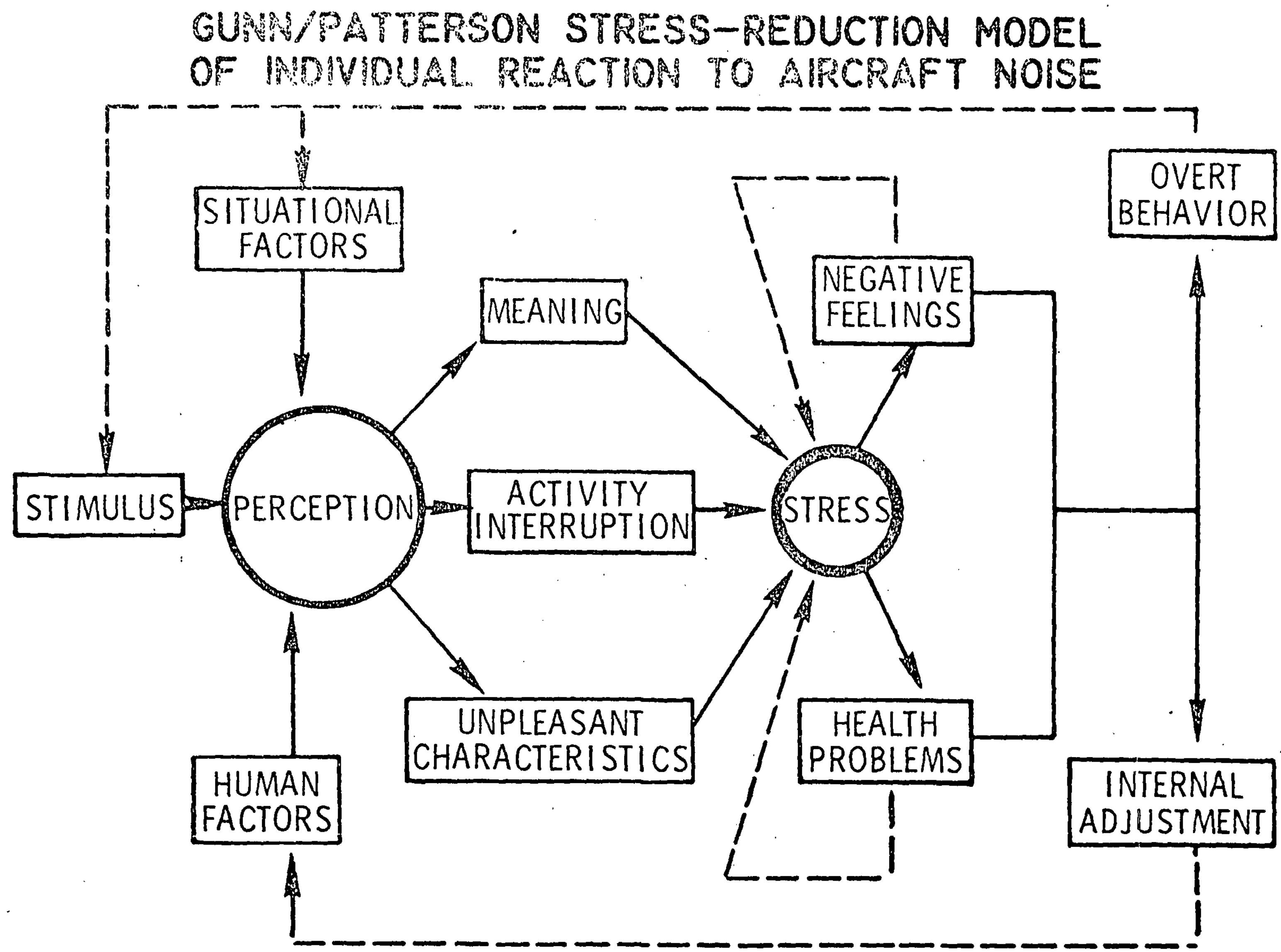

Figure A1.- Gunn/Patterson stress reduction model of individual reaction to aircraft noise.

PLEASE ANSWER THE FOLLOWING QUESTIONS BY CHECKING THE APPROPRIATE BOX.

- HOW WOULD YOU RATE THE TV SHOW YOU WATCHED?

  ☐ EXCELLENT ☐ GOOD ☐ FAIR ☐ POOR

- HOW WOULD YOU RATE THE TV SOUND LEVEL?

  ☐ TOO QUIET ☐ JUST RIGHT ☐ TOO LOUD

- WHAT BOTHERED YOU THE MOST ABOUT THE AIRCRAFT SOUNDS? (WRITE A FEW WORDS TO DESCRIBE YOUR FEELINGS.)

Figure 2.- Subject response sheet 2.

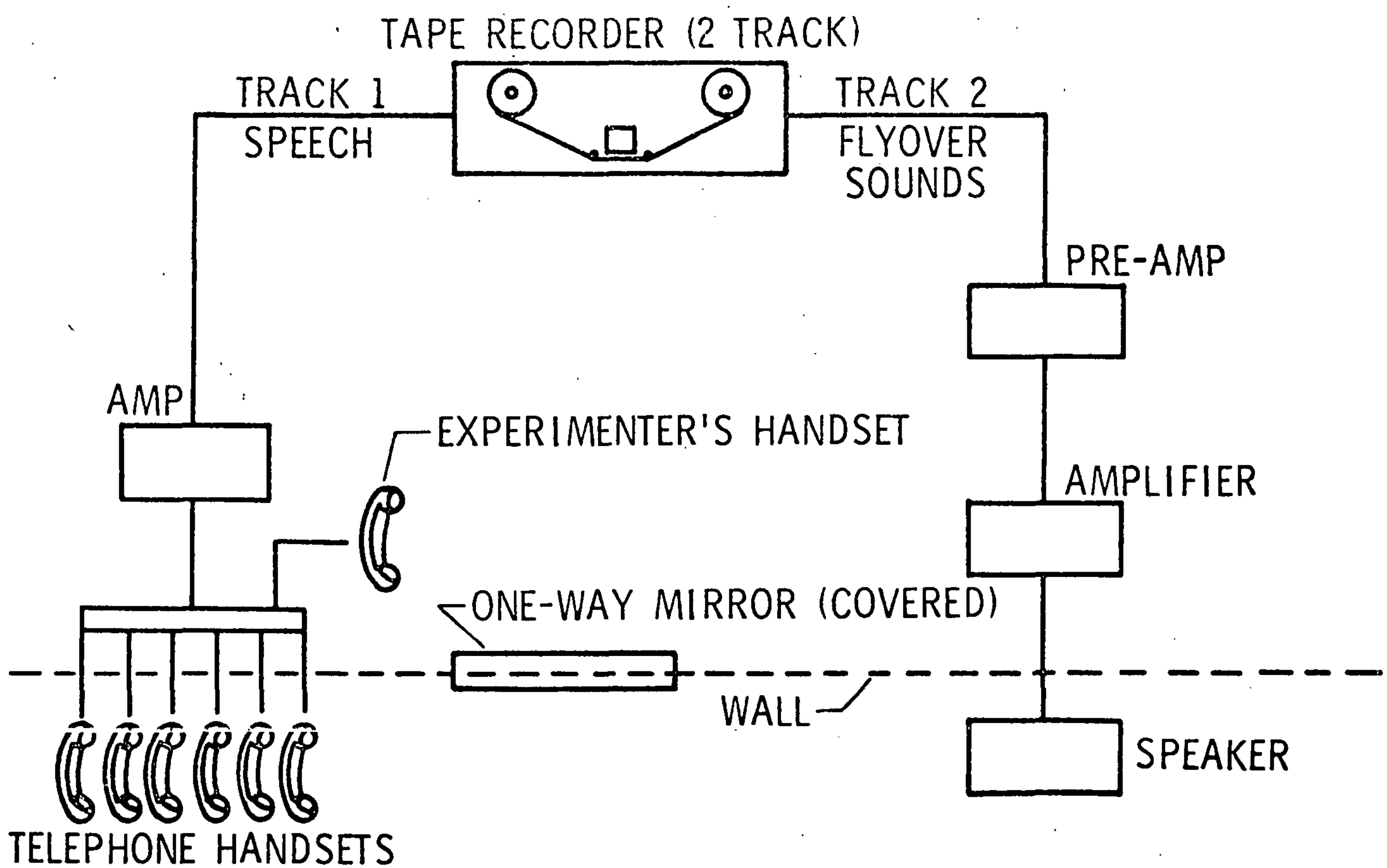

Figure 3.- Apparatus.

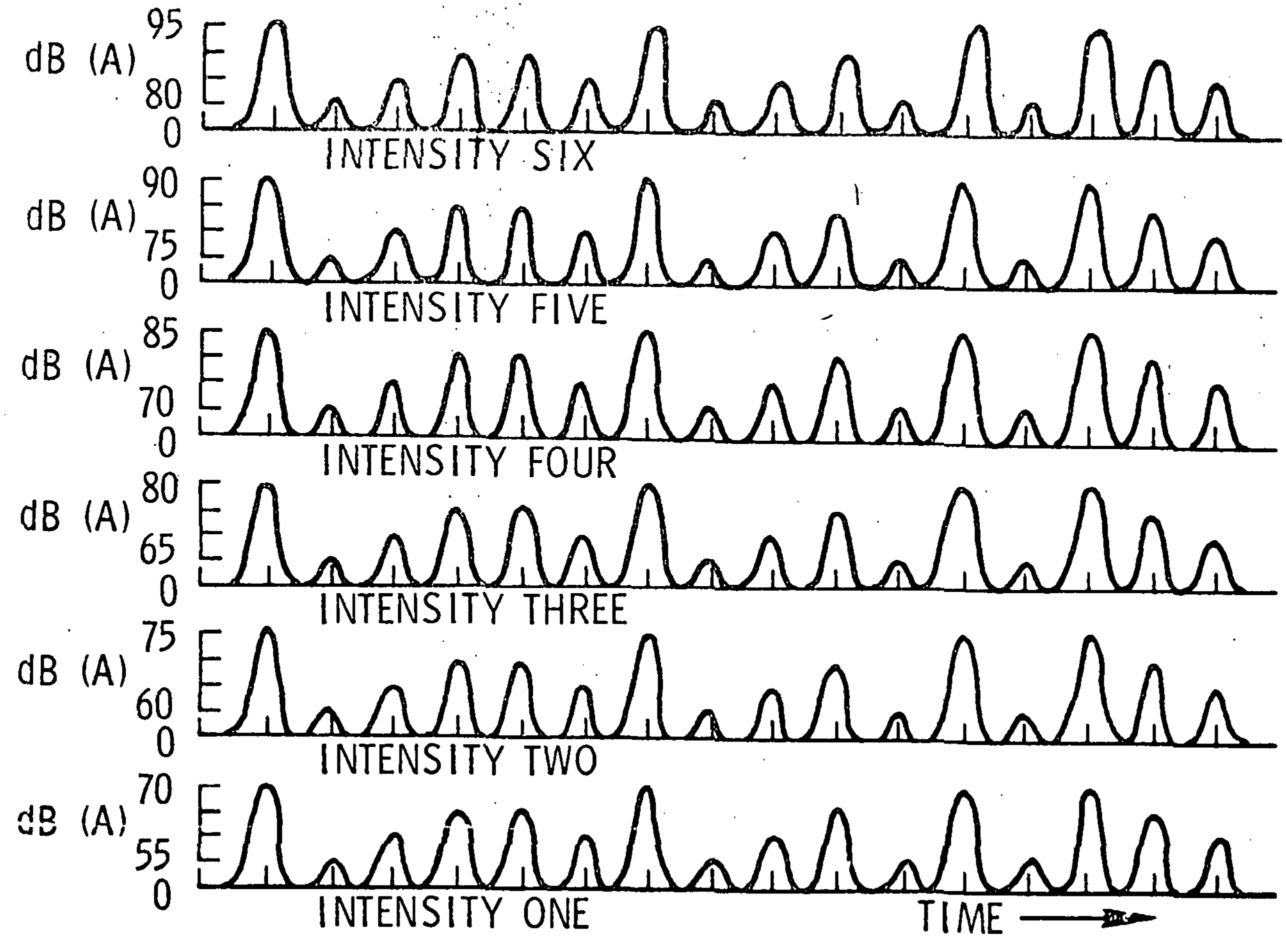

Figure 4.- Aircraft flyover noises.

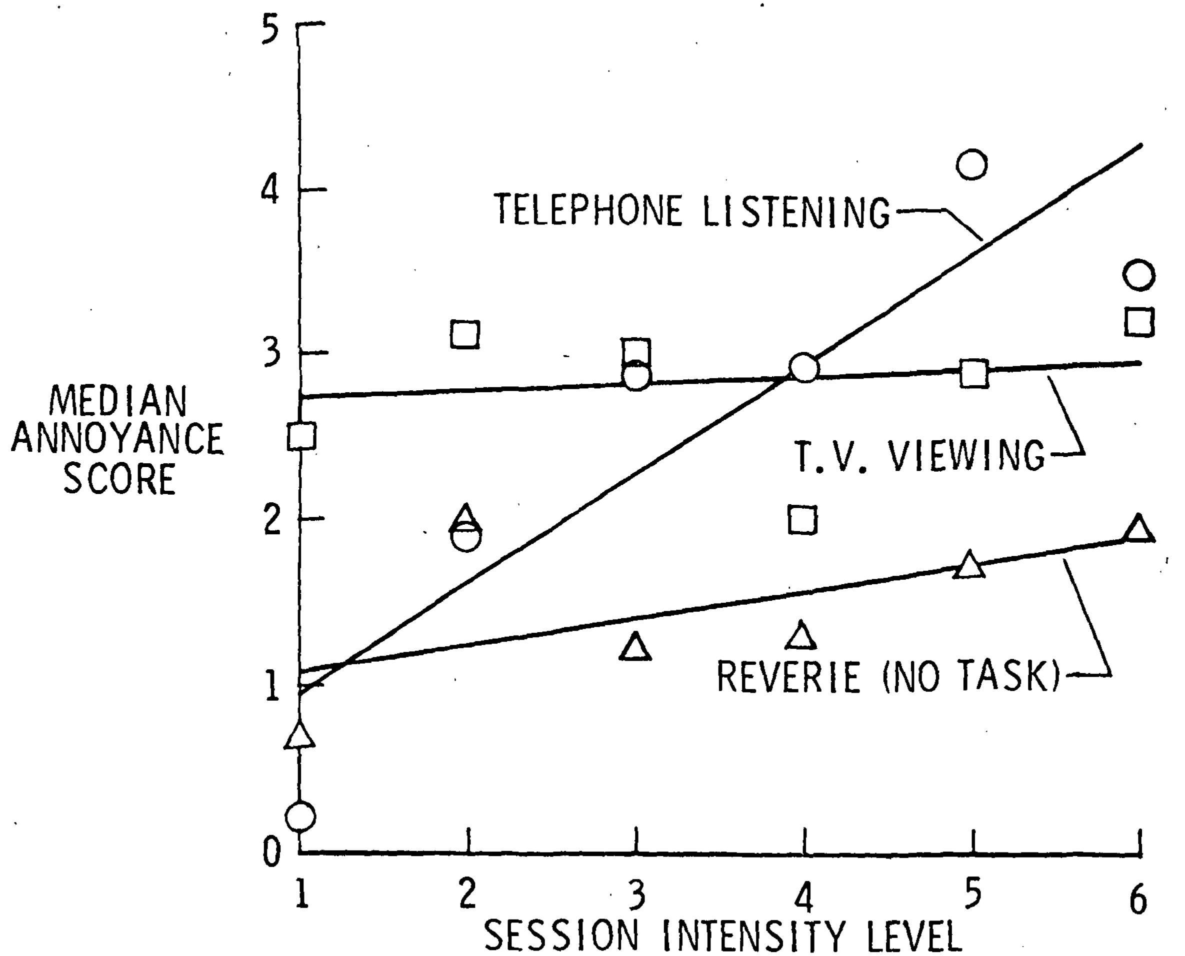

Figure 5.- Effects of activity interruption

APPENDIX I

ANNOYANCE OF AIRCRAFT FLYOVER NOISE AS A FUNCTION OF THE PRESENCE OF STRANGERS

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FINAL TECHNICAL REPORT
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Many researchers (1), (2), use test procedures in which groups of subjects listen to recordings of aircraft flyovers and record their annoyance response for each flight, using various psychophysical procedures. The results are then used in an attempt to predict individual response to noise. It seemed possible that if the presence of others tends to alter one's response to aircraft noise, the practice of testing groups of subjects simultaneously, while efficient, might introduce needless errors into attempts to predict individual response to aircraft noise. In order to determine the comparability of results derived by testing individuals alone or individuals when in groups, the following experiment was designed.

Subjects were tested in groups of six, in one condition, or as individuals in the other condition. Each subject was asked to evaluate the annoyance value of various recorded aircraft sounds, using either a magnitude estimation method or a thermometer-like numerical category scale, after Connor and Patterson (3).

Method

The subjects (S's) used in this study were obtained from Memphis State University and were either students or staff and ranged in age from 20 to 43 with the average age 27.3 yrs. There were 8 male and 16 female S's. They were paid $10.00 for their participation in the study. All S's were screened for conventional hearing (500-6,000 Hz) with no one accepted as a S with hearing levels at any of those frequencies of 20 dB or higher. Hearing was also tested for high frequency tones (8,000-18,000 Hz) but no criterion level was set for high frequency hearing. All testing was done in an Industrial Acoustics Co. Model 1203 sound treated room by a graduate student in audiology from the Memphis Speech and Hearing Center. Conventional hearing was tested using a Rudmose ARJ-4A audiometer while high frequency hearing was tested using a Rudmose ARJ-4HF audiometer. Both audiometers were within acceptable calibration limits.

All S's were also administered the Taylor Manifest Anxiety Scale (TMAS) as part of their pre-experiment screening.

The research was conducted in a quiet room 15' x 24', set up to be similar to a living room, with wall-to-wall carpeting, drapes on three of the four walls, and acoustical tile on the ceiling. (See Appendix A for pictures of the test room.) Average ambient sound pressure level in the room was 43 dB(A).

A Bruel and Kjaer Model 2203 sound level meter, set on the slow meter reading, A scale, was used to adjust the SPL of the stimuli on the tapes at the S's ear. The meter was placed at ear level at the S's chair position with the S not present, the tape was run to the 1,000 Hz calibration tone, and the preamplifier gain control was adjusted until the meter read 95 dB(A). The voltage across the speaker necessary to obtain 95 dB(A) was found to be 4 volts. Thereafter, each time a tape was run, voltage to the speaker was checked on the VTVM, set at exactly 4 volts if it was not, and the tape run. In practice, little or no change in voltage was noted from tape to tape or session to session. A block diagram of the apparatus may be seen in Fig. 1.

The S's were divided into four groups of six persons per group as they were screened and found qualified for the experiment. The S's were then tested, first either individually or in a group in counterbalanced order. They also, in counterbalanced order, judged annoyance to the aircraft flyover noise either using the "thermometer-like" numerical category scale or the magnitude estimation method (see Appendix C)(5). When tested (Appendix B) as individuals, the S's were called in and given their instructions, and the study began. In similar fashion when they were tested in groups they were called into the room, seated, given their instructions, any questions about task or procedure were answered, and the study begun.

The stimuli on Tape I, 16 in number, were presented and the S rated annoyance to the sound on the "thermometer" scale. There was a 2 min. interval between onset of each stimulus and onset of the next stimulus. Thus, the S's made an annoyance judgement every 2 min. Likewise, on Tape II, there were also 16 aircraft noises, 2 min. apart, and four "standard" noises interspersed, with a magnitude estimation judgement required after each stimulus. On that particular tape, the standard appeared four times or before the first experimental stimulus, and preceeding every group of four stimuli thereafter. (See Table I.)

Results

Fig. 2 shows mean specific annoyance responses for each of the four peak levels of flyover noise for subjects tested as individuals, in one condition, and the same subjects when tested in groups of six. The differences between responses of individuals when tested alone or in groups of six did not reach the 0.05 level of significance. It is therefore concluded that the presence of others does not significantly influence one's annoyance reaction to recorded aircraft noise, in this particular test situation, and when this particular category scale (thermometer scale) is used as an index of annoyance.

Figure 3 presents mean specific annoyance responses utilizing the magnitude estimation technique for each of the four peak levels of flyover noise for S's tested as individuals, then again in a group of six. Again, as with the "thermometer" scale, the differences between annoyance scores when tested as individuals did not differ significantly (.05 level of significance) from those found for S's tested in groups of six. This suggests strongly that the presence of others does not influence the annoyance reaction to recorded aircraft noise.

Fig. 4 depicts mean specific annoyance as measured by the thermometer scale versus anxiety for each subject in this experiment. No significant correlation was found to exist between annoyance and anxiety, as had been found in a previous study (4). These results were not totally unexpected since the range of anxiety of subjects in this experiment was severely restricted relative to the anxiety levels found in the previous study. Since the subjects in this experiment listened to exactly the same tape as the subjects in the previous experiment and rated the annoyance value of the same aircraft noises using the same thermometer-like numerical category scale, it seems justifiable to combine the data from both experiments into one composite plot. Fig. 5 shows the combined data of both experiments. In this Figure, mean specific annoyance is plotted versus anxiety for each of the 43 subjects for whom data were available. The Pearson Product moment correlation coefficient was found to be -0.39 which was significant beyond the 0.01 level.

Discussion

The findings indicate that at least for similar test situations (where the subjects sit and evaluate each recorded flyover noise) and for the two psychophysical methods used, the presence of others does not appear to influence one's annoyance response to aircraft noise. The implications for future laboratory research are that groups of subjects can be tested simultaneously for maximum procedural efficiency with confidence that the procedures do not alter the individual responses significantly.

Although the limited range of anxiety scores may have obscured any possible correlation of anxiety and annoyance in this experiment, the data of this experiment when combined with similar data from a previous study (4) do indicate a significant ($p < .05$) negative correlation between anxiety scores and annoyance ratings for individuals. As suggested in the Gunn and Fletcher study (4), this result may be a laboratory artifact resulting from the laboratory-induced stress of the test situation having a "saturating" effect on one's emotional response to noxious stimuli and therefore not valid in a real life situation, or it may in fact be an important factor governing one's annoyance to aircraft noise. Further research in this area seems indicated in order to verify this effect in the laboratory and in airport communities.

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TABLE I

SUBJECT GROUP	TAPE PRESENTATION ORDER				
1	2	5	3	1	4
2	3	1	4	2	5
3	4	2	5	3	1
4	5	3	1	4	2
5	1	4	2	5	3

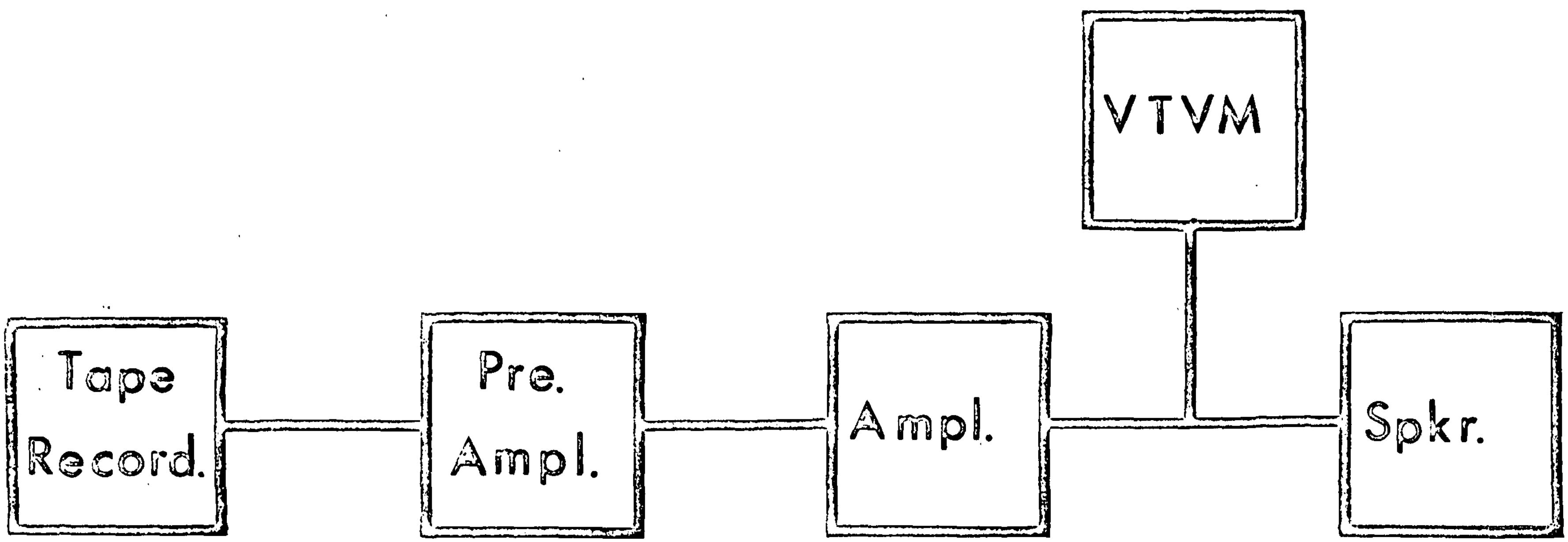
TAPE	STIMULUS PRESENTATION ORDER															
1	A_b	D_b	C_b	B_b	B_b	C_b	A_b	D_b	C_b	B_b	D_b	A_b	D_b	A_b	B_b	C_b
2	A	D_b	C	B_b	B	C_b	A	D_b	C	B_b	D	A_b	D	A_b	B	C_b
3	A	D	C	B_b	B	C	A	D_b	C	B	D	A_b	D	A	B	C_b
4	A	D	C	B	B	C	A	D_b	C	B	D	A	D	A	B	C_b
5	A	D	C	B	B	C	A	D	C	B	D	A	D	A	B	C_b

"b" - beep immediately following last flight

A = 95 dB(A) PEAK
B = 90 dB(A) PEAK
C = 85 dB(A) PEAK
D = 80 dB(A) PEAK

Figure 1.

Block Diagram of Apparatus



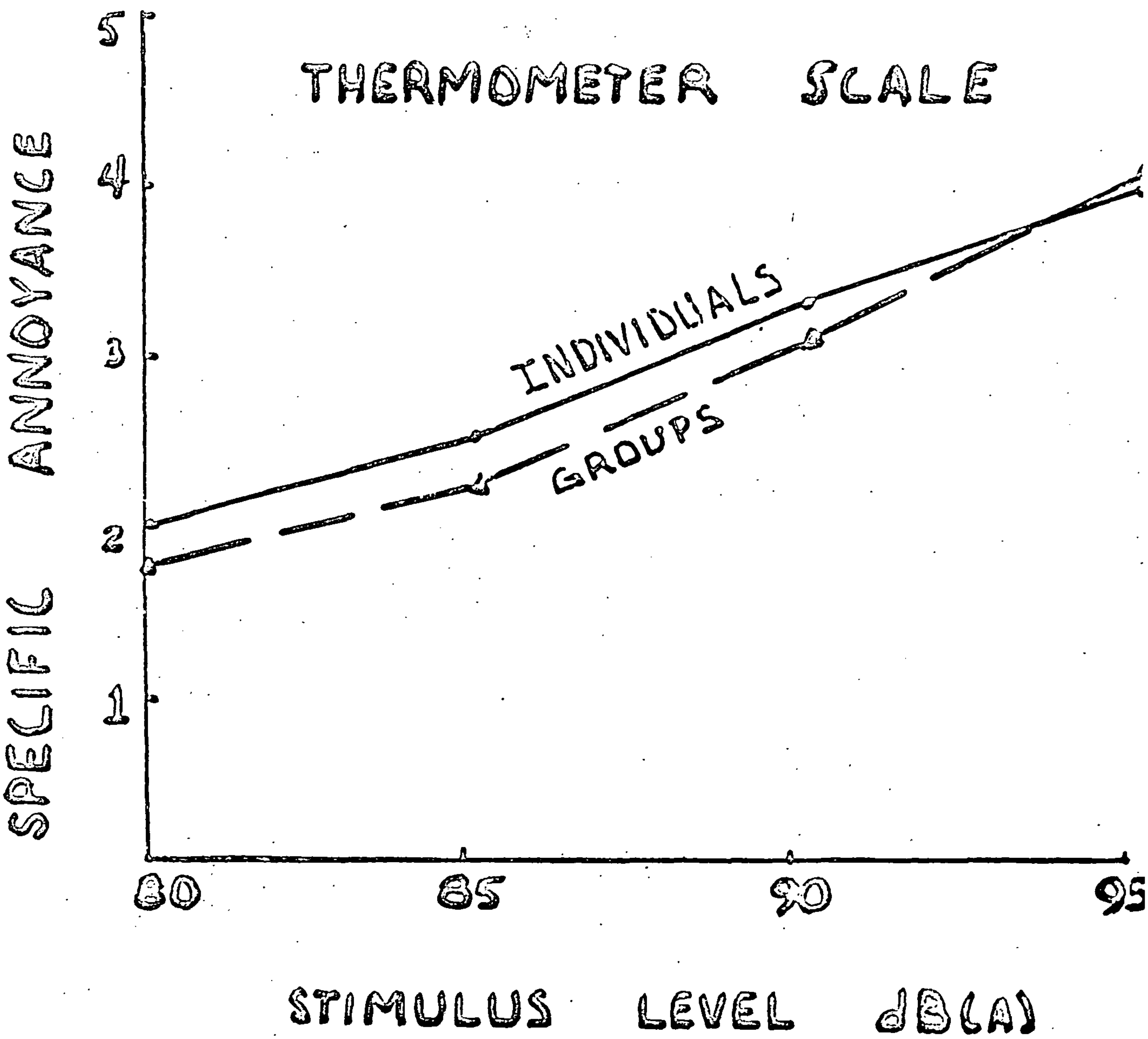
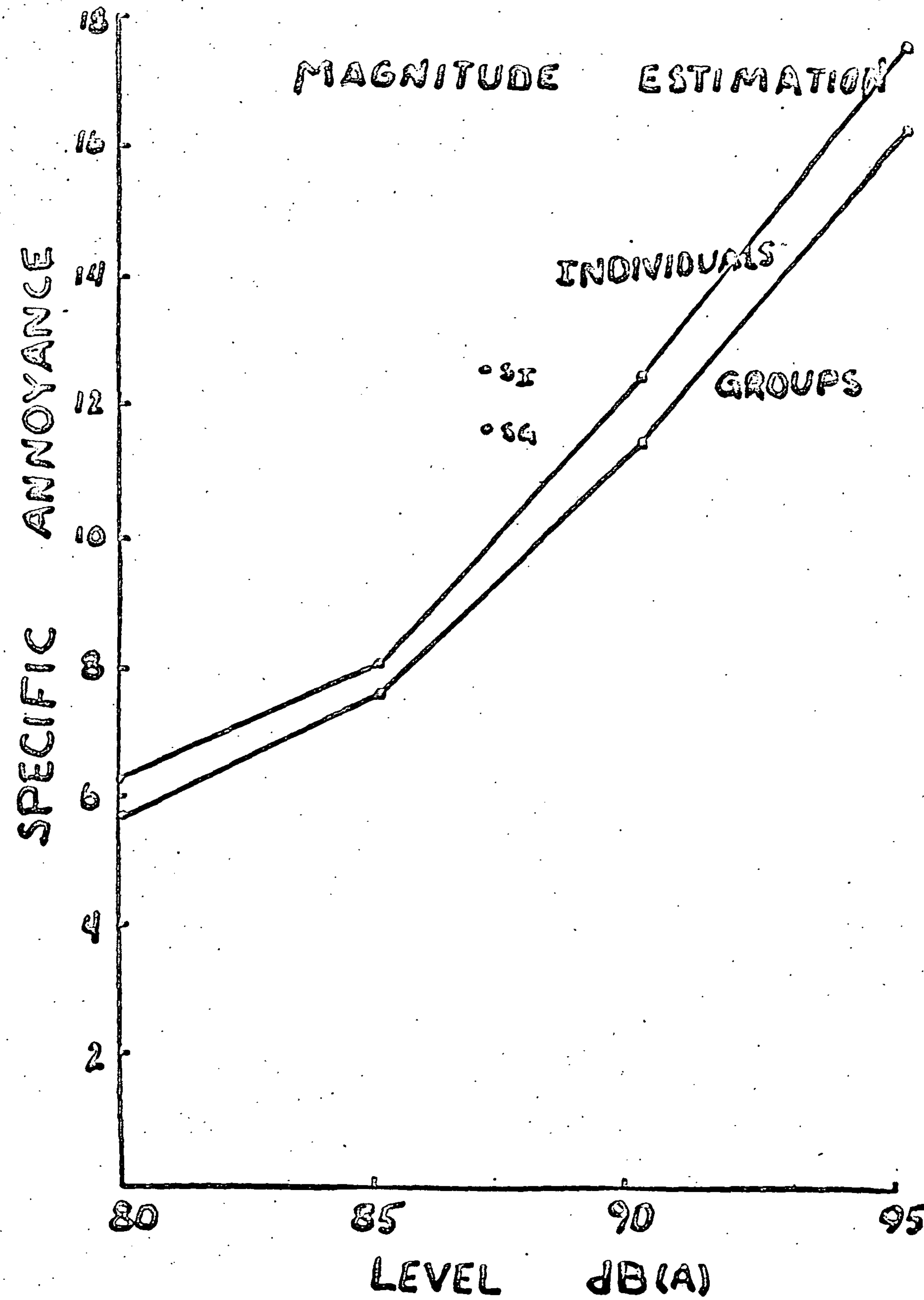

THERMOMETER SCALE
SPECIFIC ANNOYANCE
5
4
3
2
1
INDIVIDUALS
GROUPS
80
85
90
95
STIMULUS LEVEL dB(A)

FIGURE 2



MAGNITUDE ESTIMATION
INDIVIDUALS
GROUPS
SI
SG
SPECIFIC ANNOYANCE
18
16
14
12
10
8
6
4
2
80
85
90
95
LEVEL dB(A)

FIGURE 3

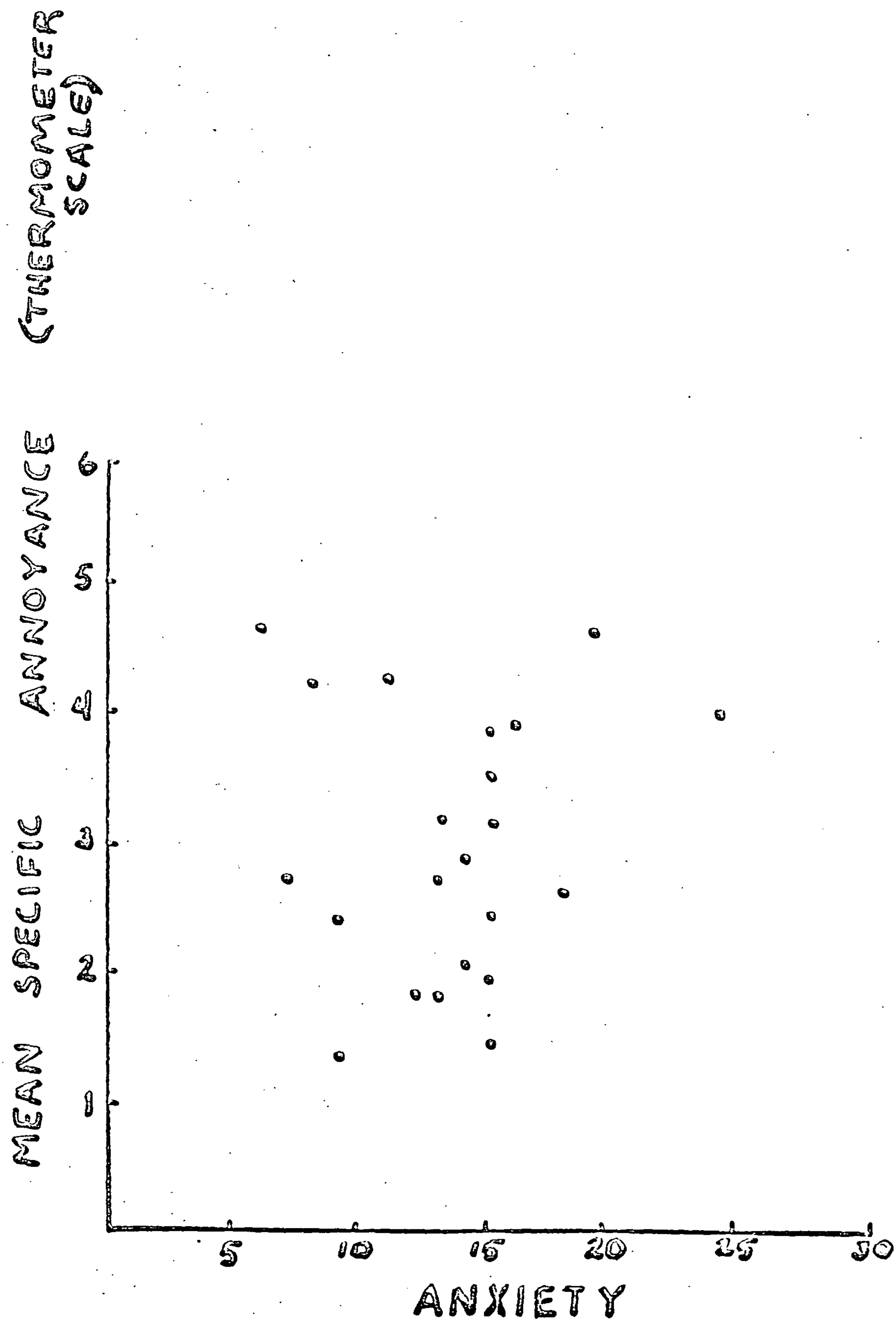

MEAN SPECIFIC ANNOYANCE (THERMOMETER SCALE)
6
5
4
3
2
1
5
10
15
20
25
30
ANXIETY

FIGURE 4

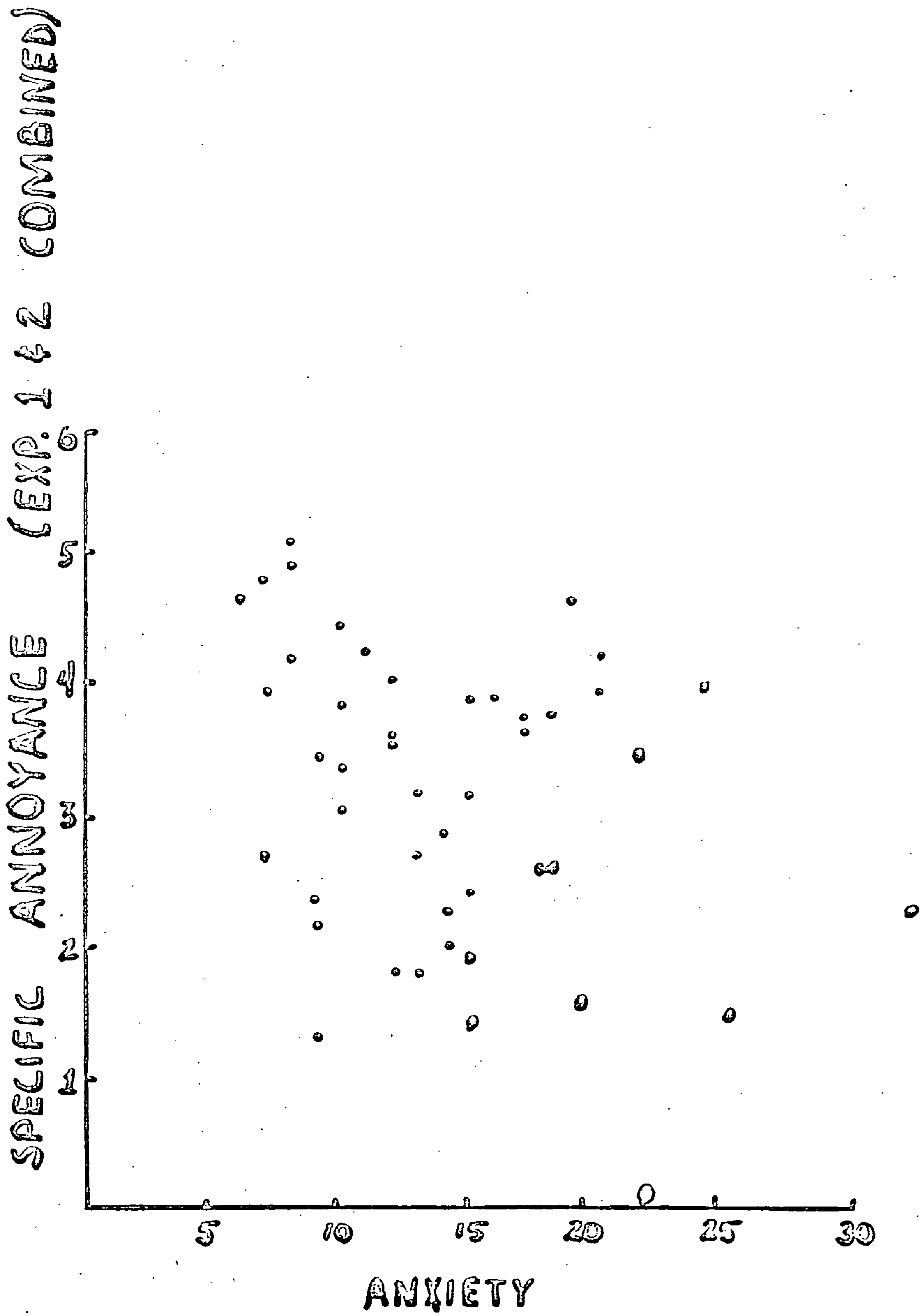

SPECIFIC ANNOYANCE (EXP. 1 & 2 COMBINED)
6
5
4
3
2
1
5
10
15
20
25
30
ANXIETY

FIGURE 5

APPENDIX A

APPENDIX B

ANSWER SHEET

Name ______________________________ Date ____________________________

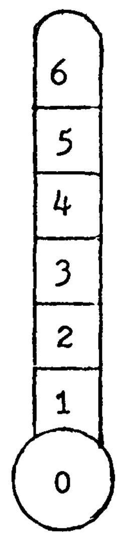
Sex___ Age ___ Session ____________ Listening Position______________

INSTRUCTIONS FOR THERMOMETER SCALE JUDGEMENTS

We are going to ask you to help in an experiment about aircraft noise. You will hear a series of aircraft noises and we would like to know your feelings about how noisy, annoying, unwanted, or objectionable certain sounds are. Try to imagine that you are hearing these sounds at home in your living room and that the planes fly this way on most days.

We would like you to record your response to each flight in the left column and your general response to all of the flights up to that point in the right column. Use the thermometer-like scale on the right as a guide to rating the sounds.

FLIGHT	IMMEDIATELY PRECEDING NOISE	NOISE IN GENERAL
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		



6 Intolerable
5 Highly Annoying
4 Very Annoying
3 Annoying
2 Moderately Annoying
1 Slightly Annoying
0 Not Annoying

APPENDIX C

EXPERIMENT #   METHOD #

ANSWER SHEET

Name________________________________ Date__________________

Sex__________ Age______ Session _______ Listening Position______

INSTRUCTIONS

We are asking you to help us solve a problem concerned with noise: How annoying or disturbing are various kinds of sound when heard in your home? You will be asked to give a score to each sound.

First, we will produce a sound whose noisiness score is 10. Use that sound as a standard, and judge each succeeding sound in relation to that standard. For example, if a sound seems twice as noisy as the standard, you will write 20 in the appropriate box on the answer sheet. If it seems only one-quarter as noisy, write 2.5. If it seems three times as noisy, write 30, and so on.

Please try to judge each sound carefully, and give it a score that tells how strong the annoyance seems to you. There are no right or wrong answers. The important thing is to say how you rate each of the sounds.

1. ____________ 11. ____________
2. ____________ 12. ____________
3. ____________ 13. ____________
4. ____________ 14. ____________
5. ____________ 15. ____________
6. ____________ 16. ____________
7. ____________ 17. ____________
8. ____________ 18. ____________
9. ____________ 19. ____________
10. ____________ 20. ____________

APPENDIX II

THE EFFECT OF NUMBER OF FLIGHTS PRIOR TO JUDGEMENT ON ANNOYANCE TO AIRCRAFT FLYOVER NOISE

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MEMPHIS, TENNESSEE

SEMI-ANNUAL STATUS REPORT
NASA CONTRACT NO. NGR 43-008-008
JOINT MSU AND NASA RESEARCH PROJECT

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by

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Past laboratory studies dealing with the subjective feelings of annoyance towards recorded aircraft sounds have traditionally been conducted in relatively unrealistic test situations. While subjects are usually asked to report their annoyance reactions toward each and every flyover heard (1), some individuals (2) prefer to allow subjects to listen to several flights prior to making annoyance judgements. A reasonable question, in light of the different procedures employed by various researchers, would be whether the results from the different laboratories can be compared directly. That is to say, does a subject report the same level of annoyance to a specific aircraft sound when he is making judgements of each and every flight as when he is judging only selected flights, i.e., every other flight, every 4th flight, 8th flight, or 16th flight?

While it is important to establish comparability of laboratory results, it is also important from the standpoint of efficiency of laboratory procedure to establish the minimum number of unjudged flights required before stabilization of annoyance responses to specific stimuli. This is especially important because of the limited period of time subjects are willing to serve in laboratory experiments of this nature, usually one to two hours at best. If stable responses can be obtained when subjects judge every flight, rather than every three, four, or more, then the length of the test session can be reduced proportionally without losing or distorting data.

Therefore, this study is concerned with the effect of the rate of making annoyance judgements on one's reaction to specific flyover noises. The subjects in this experiment are required to participate in five specific sessions. In one session, they judge the annoyance value of each aircraft flight they hear, while in other sessions they make judgements of every second, fourth, eighth, or sixteenth flight. Their annoyance responses to each specific level of noise can then be compared under the five different rates of making judgements.

In a recent study of community reaction to aircraft noise (3) it was reported that the most important psychological variable influencing one's annoyance reaction to aircraft noise was "Fear of airplane crashes in the neighborhood." A recent study of the most important community response reports (4) suggests that this finding is weakened by at least three features of the questionnaires used in the survey:

(1) there were only two fear questions
(2) there were no non-aircraft fear questions, and
(3) the questions made obvious the fact that the study was concerned with community responses to aircraft noise.

It may be possible that there may be a tendency within individuals to report general emotional reactions to any stressful stimulus. In order to test this notion, subjects in this experiment were required to answer questions on the Taylor Manifest Anxiety Scale (5), which provides a measure of individual anxiety level. In this way, individual annoyance responses can be compared with individual anxiety scores to determine the extent to which individual anxiety level effects one's annoyance reaction to aircraft noises, at least in a laboratory situation.

Method

The subjects (S's) used in this study were obtained through Memphis State University and were either students or staff and ranged in age from 20-50 with the average age 25.7 yrs. There were 14 male and 11 female S's. They were paid $10.00 for their participation in the study. All S's were screened for conventional hearing (500-6,000 Hz) with no one accepted as a S with hearing levels at any of those frequencies of 20 dB or higher. Hearing was also tested for high frequency tones (8,000-18,000 Hz) but no criterion level was set for high frequency hearing. All testing was done in an Industrial Acoustics Co. model 1203 sound treated room by a graduate student in audiology from the Memphis Speech and Hearing Center. Conventional hearing was tested using a Rudmose ARJ-4A audiometer while high frequency hearing was tested using a Rudmose ARJ-4HF audiometer. Both audiometers were within acceptable calibration limits.

All S's were also administered the Taylor Manifest Anxiety Scale (TMAS)as part of their pre-experiment screening.

The research was conducted in a quiet room 15' x 24', set up to be similar to a living room, with wall-to-wall carpeting, drapes on three of the four walls, and acoustic tile on the ceiling. (See Appendix A for picture of the test room.) Ambient sound pressure level in the room was 43 dBA.

The S's were divided into five groups of five as they were screened and found qualified for the experiment. The groups were then called in one group at a time, given the instructions necessary to perform in the experiment, and the study was begun. Subjects were not allowed to smoke or to talk to each other during actual running of the experiment. During the course of the experiment the S's were presented five different tape recordings of aircraft flyovers recorded with four different maximum levels of noise, 80, 85, 90, and 95 dB. Tape #1 called for an annoyance judgement after every flight, #2 after every other flight, #3 after every fourth flight, #4 after every eighth flight, and #5 after the sixteenth (and last) flight. Each tape took approximately 30 min. to run. Table I shows the order of tape presentations while Table II shows the stimulus order within tapes.

The order of running of the five tapes was counterbalanced and the sequence of presentation of the four levels of flyover noise was determined by a Latin square order of presentation.

A Bruel and Kjaer model 2203 sound level meter, set on the slow meter reading, A scale, was used to adjust the SPL of the stimuli on the tapes at the S's chair position with the S not present, the tape was run to the 1,000 Hz calibration tone, and the pre-amplifier gain control was adjusted until the meter read 95 dB(A). The voltage across the speaker necessary to obtain 95 dB(A) was found to be 4 volts. Thereafter, each time a tape was run, voltage to the speaker was checked on the VTVM, set at exactly 4 volts if it was not, and the tape run. In practice, little or no change in voltage was noted from tape to tape or session to session. A block diagram of the apparatus may be seen in Fig. 1.

Each group of S's was brought into the testing room, seated, then handed the aircraft flyover noise annoyance rating sheet (see Fig. 2). They were told to read the instructions on the sheet carefully and follow them exactly throughout the experiment. If there were any questions about the procedure or the task required of them, they were answered at that time. As soon as the Experimenter (E) could see that all the S's understood the job they were to do, he left the room and put on the first tape recorded stimuli they were to listen to and started the experiment. There was a 5 min. break between playing of each of the five tapes to enable the E to rewind the tape presented and put the next tape on the recorder. The S's were allowed to get up, talk, smoke, and move around until the next tape was ready. Thus the overall length of each experimental group session was about 3 hrs.

Results

Results of the study of the effect of number of flights prior to judgements and the ratio of judgements to number of overflights on annoyance are depicted in Fig. 3. Essentially, judgements made of individual stimuli within a tape appear not to be based upon number of flights heard prior to that particular stimulus. Additionally, annoyance judgements of individual stimuli do not appear to be affected by the ratio of judgement to number of stimuli presented, i.e., the judgements of the overflight with a 95 dB(A) peak as presented in Tape 1 where every flight is rated by the S's are not significantly different from ratings of the same flights from Tape 2 where judgements are made every other flight. Likewise, judgements of annoyance at a peak level of 85 dB(A) do not differ significantly whether judged every time, every other time, after every fourth, eighth, or sixteenth flight.

As expected, specific annoyance increases with level of noise. In fact, a doubling of annoyance, i.e., increasing the annoyance score from about 2 to 4, results where the SPL of the overflight goes from 80 dB(A) to 90 dB(A). This is consistent with Stevens' (6) finding that doubling or halving of loudness occurs with a change in stimulus level of about 10 dB and also with Kryter's (7) finding with respect to annoyance.

Fig. 4 shows the relationship between mean general annoyance screened across all stimuli and anxiety, as measured by scores on the TMAS for each S. Surprisingly, there appears to be a strong negative correlation between general annoyance to the aircraft noise used in this experiment and anxiety level. The Pearson product-moment correlation coefficient (r) was found to be -.56, significant beyond the .01 level. The r for specific annoyance was also calculated (see Fig. 5) and found to be -.53, also significant beyond the .01 level, substantiating the results found for general annoyance. These results, then, apparently indicate that anxious people, defined as those scoring high on the TMAS, tend not to be as annoyed by recorded aircraft flyover noise in the laboratory as less anxious (lower scoring on the TMAS) persons.

Figure 6 shows the relation between specific annoyance and general annoyance over trials. It appears that general annoyance does not grow over the 16 flight session but does reflect the level of the specific flight preceding the general annoyance judgement.

Discussion

The fact that number of flights heard prior to judging the annoyance of the flights was not significantly related to annoyance is important in the design of future laboratory studies of annoyance to aircraft flyover noise. Individual flyovers can be presented and directly compared to results of other researchers who may use different procedures.

The finding in this study that a doubling of annoyance occurred with a 10 dBA increase in the peak level of the overflight substantiates findings of other researchers regarding loudness changes as a function of changes in intensity and indicate that loudness and annoyance are rather directly linked.

Additionally, a considerable shortening of test session length can be achieved by having S's judge each flight, rather than every third flight without degrading the results.

At first the negative correlation of the TMAS scores and aircraft flyover noise annoyance scores would seem to be startling.

Without thinking about the problem too deeply the first thought would probably be that anxious people would also be easily annoyed because they are probably more aroused and driven by their anxieties. From one point of view, perhaps the anxieties - whatever they are - distract the person and occupy his thoughts such that at least minor, non-threatening stimuli in the laboratory environment are not as noticed and annoying as they might be if he were not so distracted. On the other hand, the result may be an artifact induced by the artificial laboratory setting, and therefore not valid in a real-life setting such as at the subject's home.

Another possibility should be considered. A study by Glickstein (8) of the response to stress of S's rated as either high or low anxious persons found that the various physiological indices studied changed less in high anxious than in low anxious S's. These findings would appear to support the findings of the present study and suggest that the low anxious S's respond to their subjective feelings (blood pressure, heart rate, etc.) which in turn change more and would be more noticeable than they do for high anxious S's.

The implications of this finding are rather clear. Results of annoyance studies using anxious S's may show artificially low annoyance to stimuli. Therefore, S's should be screened for annoyance so that those with high anxiety levels do not unduly influence the results of the study. It would appear to be more than worthwhile to investigate further the relations between anxiety and annoyance to aircraft flyover noise both in the laboratory and in the community.

References

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4. U.S. National Bur. Standards study of the fear component in reactions to aircraft noise. Unpubl. Interim Report, NASA Order L-88318, Aug., 1973, 10 pp.

5. Taylor, Janet A. A personality scale of manifest anxiety. J. Abn. and Soc. Psych., 1953, 48, 285-290.

6. Stevens, S. S. Concerning the form of the loudness function. J. Acoust. Soc. Amer., 1957, 29, 603-606.

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8. Glickstein, M., Chevalier, J. A., Karchen, S. J., Basowitz, H., Sabshin, M., Hamburg, D. A., and Grinker, R. R., Temporal heart rate patterns in anxious patients. AMA, Arch. Neur. Psychist., 78, 101-106, 1957.

TABLE I

SUBJECT GROUP	TAPE PRESENTATION ORDER				
1	2	5	3	1	4
2	3	1	4	2	5
3	4	2	5	3	1
4	5	3	1	4	2
5	1	4	2	5	3

TAPE	STIMULUS PRESENTATION ORDER															
1	A_b	D_b	C_b	B_b	B_b	C_b	A_b	D_b	C_b	B_b	D_b	A_b	D_b	A_b	B_b	C_b
2	A	D_b	C	B_b	B	C_b	A	D_b	C	B_b	D	A_b	D	A_b	B	C_b
3	A	D	C	B_b	B	C	A	D_b	C	B	D	A_b	D	A	B	C_b
4	A	D	C	B	B	C	A	D_b	C	B	D	A	D	A	B	C_b
5	A	D	C	B	B	C	A	D	C	B	D	A	D	A	B	C_b

"b" - beep immediately following last flight

A = 95 dB(A) PEAK
B = 90 dB(A) PEAK
C = 85 dB(A) PEAK
D = 80 dB(A) PEAK

TABLE II

STIMULUS LEVELS AND ORDER

The tape for Method II consists of a series of recorded aircraft (747) flyovers (landings). There are 4 presentations of each of four levels of noise.

Stimulus	Peak Level /dB (A)7
A	95
B	90
C	85
D	80

The flyovers were recorded in the following sequence (according to a Lat. Sq. design) with two minute intervals from onset to onset:

Tape I

Flight numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Stimulus	A	D	C	B	B	C	A	D	C	B	D	A	D	A	B	C

The tape for Method I consists of the same series of flights as recorded on tape I, but with a "Standard" noise(S) /pink noise at 87 dB(A) for 15 seconds with 5 second rise and decay times/ inserted between flights as shown:

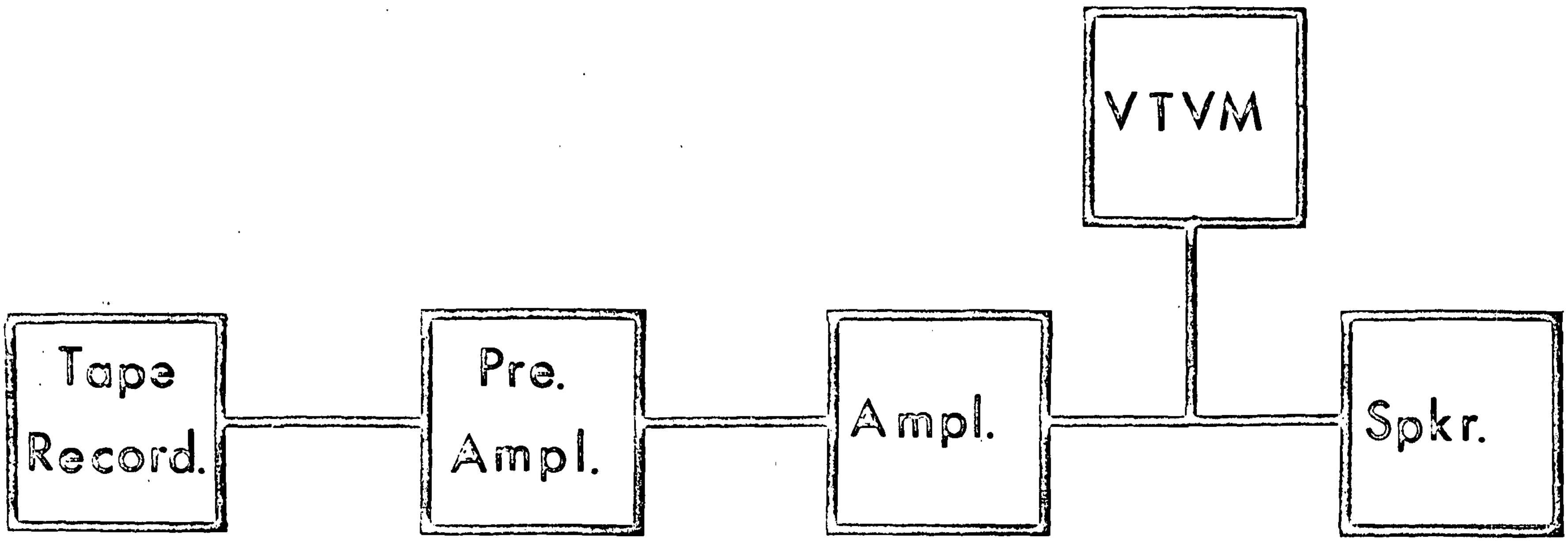
Tape II

Stimulus No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	2(
Stimulus	S	A	D	C	B	S	B	C	A	D	S	C	B	D	A	S	D	A	B	C

Since Tape II is a copy of Tape I with standards inserted as shown above, the length of the recordings is approximately equal.

Figure 1.

Block Diagram of Apparatus



EXPERIMENT #   METHOD#

FIGURE 2

(Subjects Instruction and Data Sheet)

ANSWER SHEET

Name________________________________ Date__________________

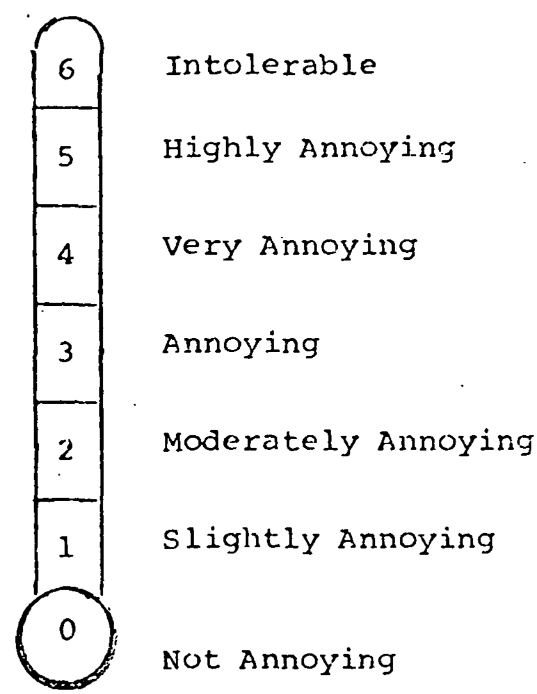
Sex____ Age____ Session____________ Listening Position______________

INSTRUCTIONS

We are going to ask you to help in an experiment about aircraft noise. You will hear a series of aircraft noises and we would like to know your feelings about how noisy, annoying, unwanted, or objectionable certain sounds are. Try to imagine that you are hearing these sounds at home in your living room and that the planes fly this way on most days.

We would like you to record your response each time you hear a "beep" after certain flights. When you hear the beep, record your response to (a) the flight immediately before the beep, and (b) your overall reaction to all of the flights in general up to this point. Use the thermometer-like scale at the right as a guide to rating the sounds.

BEEP	IMMEDIATELY PRECEDING NOISE	NOISE IN GENERAL
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		



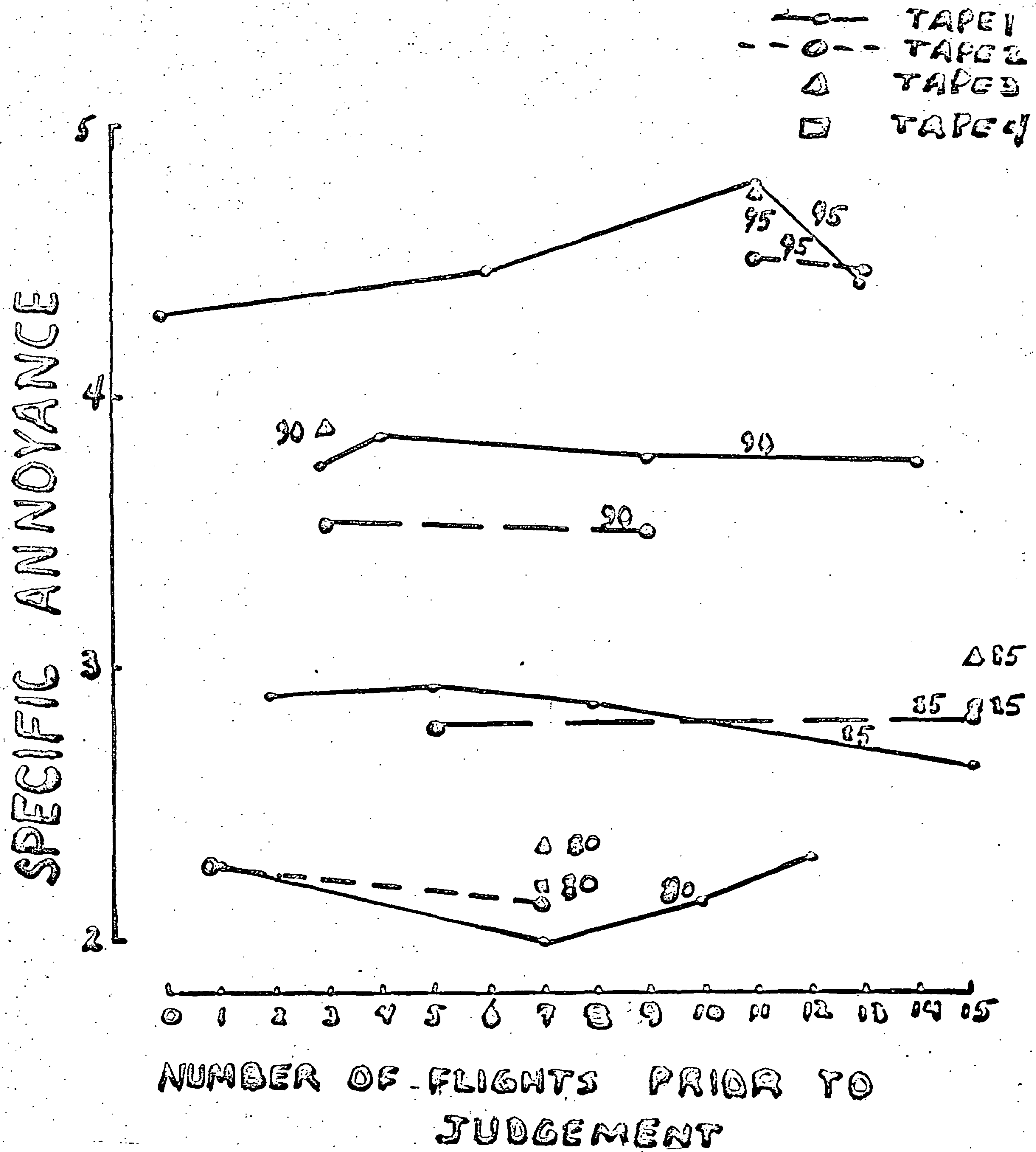

TAPE 1
TAPE 2
TAPE 3
TAPE 4
SPECIFIC ANNOYANCE
5
4
3
2
95
95
95
90
90
90
85
85
85
85
80
80
80
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
NUMBER OF FLIGHTS PRIOR TO JUDGEMENT

FIGURE 3

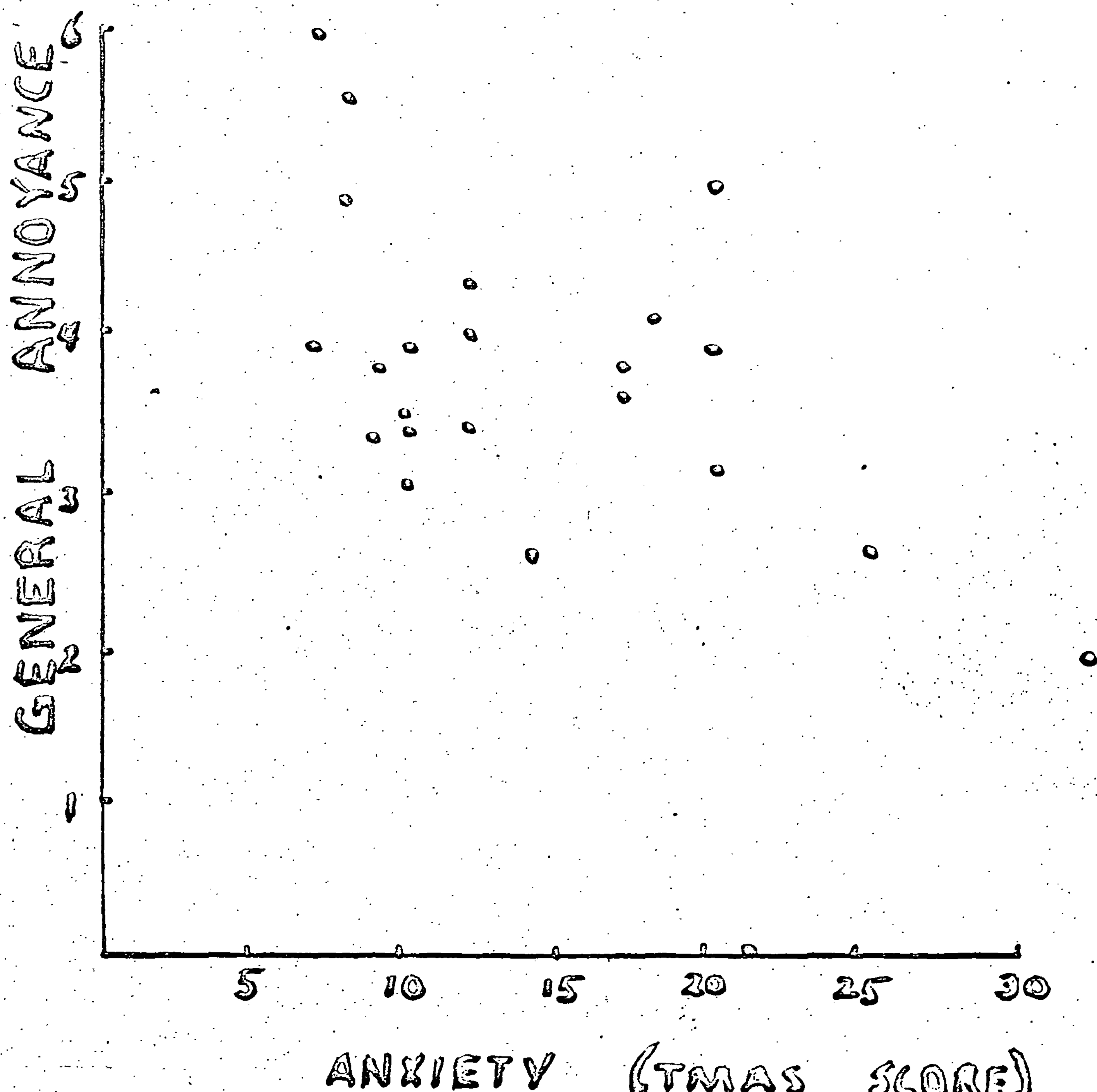


FIGURE 4

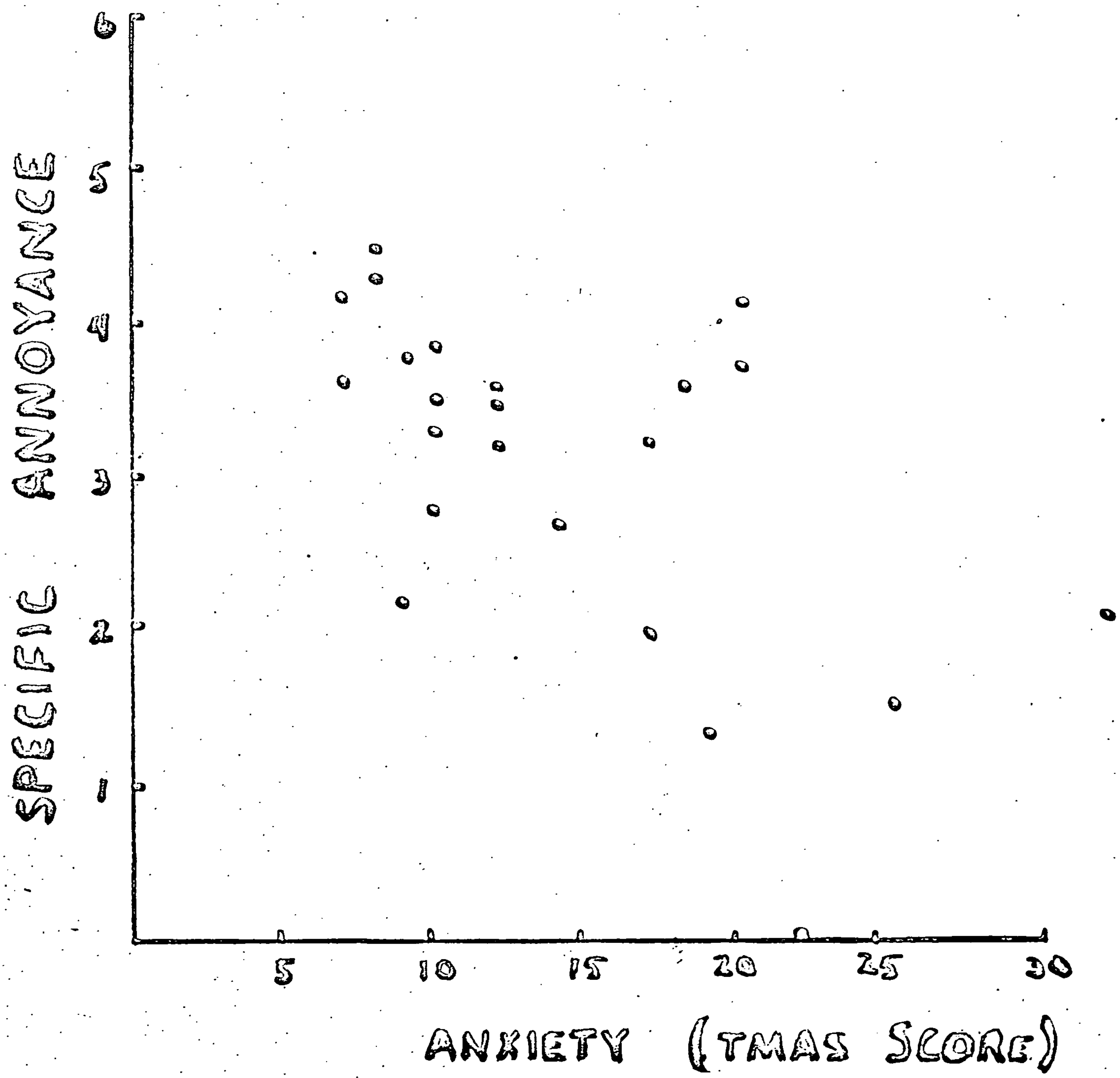

SPECIFIC ANNOYANCE
6
5
4
3
2
1
5
10
15
20
25
30
ANXIETY (TMAS SCORE)

FIGURE 5

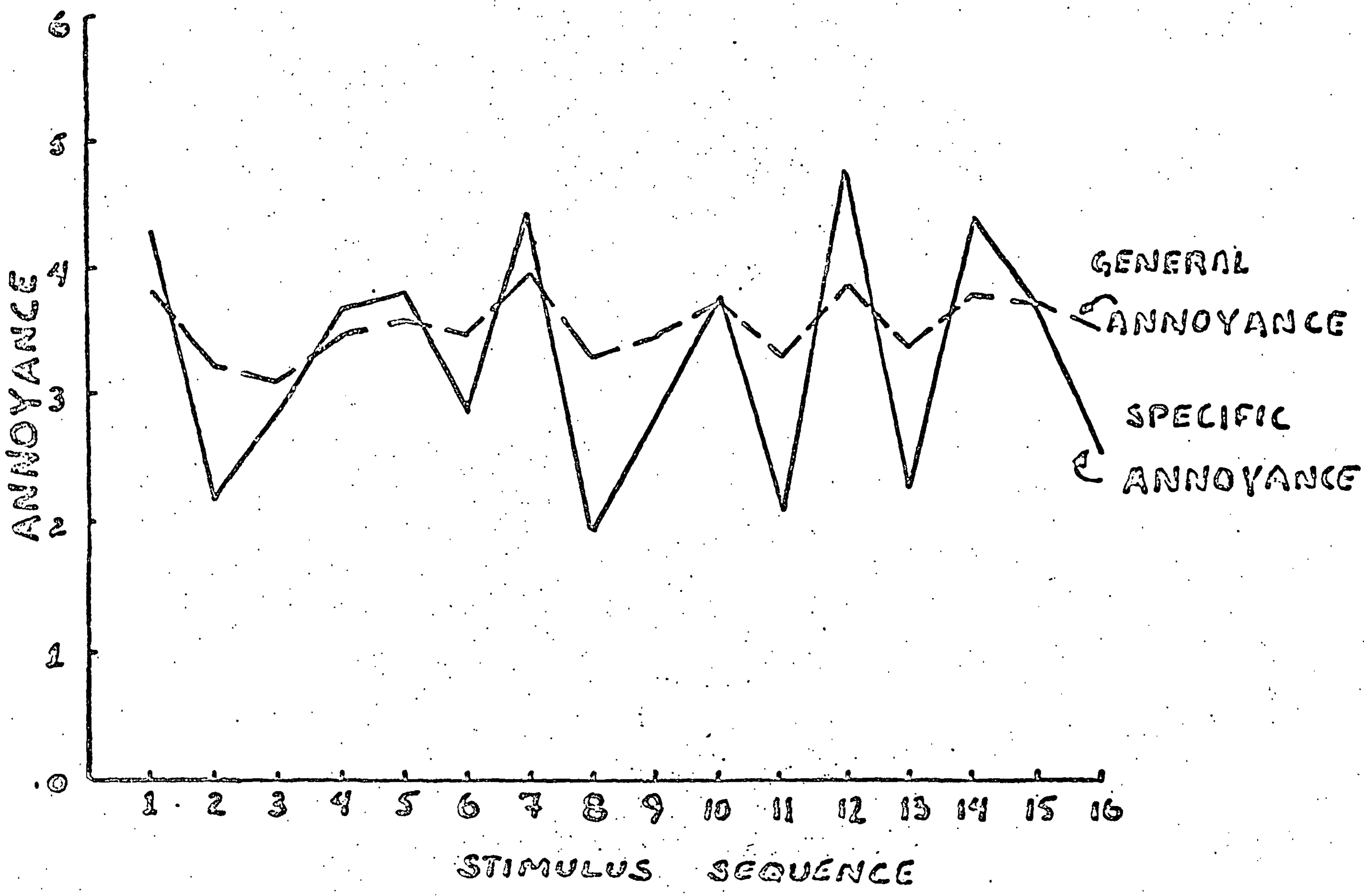

ANNOYANCE
6
5
4
3
2
1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
STIMULUS SEQUENCE
GENERAL ANNOYANCE
SPECIFIC ANNOYANCE

FIGURE 6

APPENDIX A

APPENDIX III

THE GUNN/PATTERSON STRESS REDUCTION MODEL

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Tracor, Inc.
Austin, Texas

In the development of a methodology for the assessment of community response to aircraft noise, an important concern is the identification of specific measurable changes exhibited by the exposed community. Following this, the psychophysical relationships between the cause (noise) and effect (community response) need to be determined. To increase the meaningfulness of the predicted response, relationships between response categories should also be determined. For example, if the mean annoyance of a given community is 4.8 (on a scale of 6) and this is designated as "very annoying," very little information regarding the actual state of mind of the average community resident is known. If, however, the relationship between annoyance, desire to move out of the neighborhood, health effects, sleep loss, hearing loss, activity interruption, and degradation of the perceived quality of life are predictable from knowledge of the degree of annoyance, for instance, then the information becomes considerably more meaningful to the various users, such as aircraft designers, airport operators, pilots, legislators, and public administrators.

Some of the specific measurable changes exhibited by airport community residents resulting from aircraft noise can be determined by answers to questions in social surveys, while certain behavioral changes can be directly observed or traced through official records, such as those of the telephone company, real estate offices, and hospitals. However, a specific model of individual reaction to aircraft noise is needed in order to determine better which specific changes may be anticipated and how they can be measured.

The initial attempt at formulation of a model* is shown in figure A1. This model is based upon the premise that individuals will attempt to reduce,

*The Stress Reduction Model was developed by W. J. Gunn of NASA, Langley Research Center and H. P. Patterson of Tracor, Inc.

avoid, or eliminate stress in their lives. Stress may be defined here as a general state of physical or psychological unrest. The model suggests that aircraft noise is perceived within two general contexts: situational and human factors. That is, qualities of the individual's physical, social, and psychological environments are important in his perception of the noise.

Only when the perception is "filtered" through the various meanings associated with the noise, through the interruption of activities and/or through evaluations of the aversive nature of the noise per se, is stress produced. The stress is manifested primarily in the development of negative feelings about the noise and in health problems. However, the individual will make every attempt to relieve this stress. Two methods are shown: overt behavior and internal adjustment. Overt behavior may be of various types, including complaint, retreating indoors or out of the neighborhood, and soundproofing the home. Internal adjustment is seen in adaptation, habituation, rationalization, and resignation to the noise. It is important to note that individuals who do not or cannot take overt action or who do not or will not make internal adjustments will develop more stress since the development of negative feelings and health problems themselves produce stress.

A. Stimulus Factors - The stimulus factors considered important in the model are divided into two general categories: noise and vibration.

(1) Noise

1. Level
2. Spectral characteristics
    a. General shape
    b. Discrete frequency content
3. Temporal characteristics

a. Time of occurrence

b. Duration

c. Impulsiveness

d. Dwell (temporal concentration)

4. Other characteristics

a. Rate of change of above

b. Directionality and movement

(2) Vibration

1. Level

2. Spectral content

3. Onset/offset characteristics

4. Correlation with the aircraft noise

5. Generation of secondary sounds (rattles, buzzes, etc.)

B. Situational Factors - The situational factors include the following: activity engaged in, setting, temporal factors, and other environmental conditions.

(1) Activity engaged in

The various activities which may be interrupted by aircraft noise are:

1. Relaxation (reverie)

2. Aural communications, whether active or passive, with or without visual cues

3. Sleep

4. Higher order cognitive functioning such as concentration, learning, problem solving, or reading

5. Physical activities

(2) Setting

The settings at times of noise exposure which may influence individual reaction are as follows:

1. At home or away

2. With others or alone

3. Indoors or out

(3) Temporal factors

The temporal factors which must be taken into consideration are:

1. Season

2. Day of week

3. Time of day

(4) Other environmental conditions

Other environmental factors which might effect stimulus conditions are as follows:

1. Presence and characteristics of nonaircraft sounds

2. Climatological conditions

   a. Temperature

   b. Relative humidity

   c. Atmospheric pressure

   d. Wind

   e. Precipitation

3. Illumination

4. Esthetics of surroundings, auditory, visual, tactile, and olfactory

C. Human factors - The human factors which may be influential in determining one's response to aircraft noise are divided into three general categories as follows: psychological factors, biological-physiological factors, and demographic factors.

(1) Psychological factors

There are at least seven psychological factors to be considered:

1. Attitudes
2. Intelligence
3. Traits
4. Needs
5. Self-concept
6. Values
7. State

(2) Biological-physiological factors

Important biological-physiological factors are:

1. Auditory sensitivity
2. Kinesthetic sensitivity
3. Condition: rested versus fatigued
4. General health
5/ State: relaxed versus tense

(3) Demographic factors

Possibly important demographic factors are:

1. Age
2. Sex
3. Occupation
4. Income
5. Education
6. Race
7. Class
8. Owner/Renter

9. Length of residence

10. Previous noise exposure

11. Dependence on aviation

D. Meaning associated with the noise - Kerrick, et al. (ref. A1) found that while noises from a variety of sources were rated equally on the basis of loudness or noisiness, they were not equally acceptable. Gunn, et al. (unpublished results of a study conducted by Langley Research Center personnel at NASA Wallops Station, Virginia) found that aircraft perceived as flying over an individual were rated as more annoying than aircraft perceived as flying off to the side, even at the same PNL. Connor and Patterson (ref. A2) found that "fear" of aircraft crashes was an important determinent of annoyance with aircraft noises. Wilson (ref. A3) found that aircraft noises were more acceptable and less noisy than motor vehicles at the same level. This suggests that the meaning associated with the source of the sound may have an important bearing on the degree of annoyance we feel about various sounds.

E. Activity interruption - In addition to the way we may feel about exposure to unpleasant sounds or the aversive meaning we attach to them, annoyance may result if the noise interferes with an ongoing activity, such as TV viewing, radio listening, sleeping, or activities requiring concentration. The extent of activity interruption could be assessed by questions on a social survey or through prediction based on controlled laboratory tests. There is good reason to think that interruption of these activities may contribute heavily to one's overall annoyance with aircraft noise.

F. Unpleasant characteristics of aircraft noise, per se - The range of possible feelings about the characteristics of a sound, per se, run the gamut from very pleasant, such as enjoyable music, to very unpleasant, such as a circular saw cutting sheetmetal. Similarly, certain aircraft sounds, at some levels, may actually be pleasant to hear, while other sounds may be perceived as neutral or unpleasant. Molino (ref. A4) developed what he calls "an equal aversiveness curve" for various bands of sound. The shape of the curve most closely resembled that of the inverse of the standard A-weighting characteristic. It is suggested that sounds above the threshold of aversiveness are "punishing" to the ear. Since the Molino data confounds aversiveness of the sound, per se, and interruption of concentration (the subjects were learning Russian during the experiment), the contour might be different under the condition of reverie. Clearly, there is a need to determine the psychophysical relationship between noise parameters and pleasantness or unpleasantness for various sounds. If a sound is perceived as being unpleasant to the ear, then continued exposure may lead to the development of stress in the unwilling listener.

G. Reported feelings - Airport community residents are often polled in order to determine how they feel about aircraft noise, airport operations, the people who are responsible, or the aircraft industry in general. The most commonly asked questions have to do with reported annoyance with aircraft noise. Sometimes people are asked for their overall annoyance, while in other cases they are asked about the annoyance they feel about the interruption of specific activities. In the latter case, the annoyance ratings for the interruption of various activities are usually combined in some way to form a single scale of annoyance. Although such a scale is typically well correlated with the single-question self-rating of annoyance (McKennell, ref. A5), it obviously represents only one particular dimension of annoyance and thus might best be termed "annoyance through disturbance of activities."

Questions are sometimes asked about feelings of "misfeasance" (feelings that those in authority are not doing all they could do to alleviate problems). Feelings of "fear of aircraft crashes" are also probed. The scales used to assess the various feelings are many and varied. Validity of the scales is, for the most part, assumed.

H. Health problems - While the evidence is scanty and sometimes in conflict, certain health-related problems resulting from aircraft noise may be:

1. Permanent hearing loss
2. Gastro-intestinal disorders
3. Increased nervousness
4. Cardio-vascular problems
5. Loss of sleep

Hospital and doctor's records might be helpful in assessing these aircraft noise related health effects.

I. Overt behavior - Few substantive studies have been conducted regarding the overt reaction of people to aircraft noise. Some important forms of overt behavior might be:

1. Moving family out of the noisy area
2. Complaints to authorities
3. Decrease in outdoor activities
4. Decrease in activities involving aural communications
5. Increased time spent out of neighborhood
6. Organizing to reduce the noise

J. Internal adjustment - The increased stress and the development of negative feelings and health problems represent an imbalance of the individual's normal or preferred state. In an effort to return to the normal state (homeostasis), the individual either takes overt action or makes internal adjustments, both of which serve to reduce the stress. Four types of internal adjustment are identified:

1. Adaptation
2. Habituation
3. Rationalization
4. Resignation

Thus, the individual may adapt to the noise or become habituated to it. Or, the individual may also rationalize his experience and convince himself that his situation is not so bad after all and that others are much worse off than himself.

K. Feedback loops - Every action or nonaction of the individual has a consequence. If the individual cannot or will not take overt action to reduce the stress, or if he does not make internal adjustments, then the development of negative feelings and health problems will themselves increase the stress. These relationships are shown in figure A1 by dashed lines from negative feelings and health problems back to stress. They represent positive feedback loops.

However, if the individual does take some overt action or makes an internal adjustment, then the stress will be relieved through an indirect process. Taking direct action has implications for both the stimulus and the situational factors. For example, through lobbying efforts, the individual may persuade the noise maker to reduce the noise or to change its characteristics so as to make it more tolerable. Or, the individual may change the situation by insulating his home, by spending less time outdoors (thereby decreasing his outdoor exposure time), or by moving out of the noise impacted area. If the individual makes an internal adjustment, this has implications for the human factors context. For example, the individual, in response to stress, may develop qualities of an "imperturbable" person. Such a person would deny that the noise ever bothered him and, in fact, might report difficulty in even perceiving the noise. These consequences of overt behavior and internal adjustment are represented by dashed lines back to the stimulus and situational factors for the former and back to human factors for the latter. Both are negative feedback loops.

L. The nature of the "filter" variables - As shown in the model diagram, there are no feedback loops to the boxes representing "meaning," "activity interruption," and "unpleasant characteristics." This means only that later elements within the model are not thought to affect these elements. Certainly, events outside the model have an effect. For example, if an aircraft crashes in the near vicinity, the individual may very well associate the next flyover event with a feeling of fear of crash. In a like manner, outside events are thought to produce a certain condition within the individual which tends to "color" his perception of aircraft noise. At any one point in time, these conditions work to predispose individuals to react in certain ways. Over time, however, the conditions can change and the individual's predispositions take on a dynamic character.

M. Hypotheses - A number of specific hypotheses are suggested by the stress reduction model. These are as follows:

1. Increased stimulus from aircraft operations will result in:
    a. increased development of negative feelings about the noise and/or
    b. increased development of health problems.

These results will be obtained provided the following elements are held constant:

(1) Situational factors

(2) Human factors

(3) Meaning associated with the noise

(4) Activity interruption

(5) Unpleasant characteristics of the noise, per se

2. The greater the development of negative feelings about the noise

a. the greater the amount of overt behavior directed toward reducing or eliminating the noise, and/or

b. the greater the internal adjustment of the individual.

The model thus suggests that once the situational and human factors are "controlled," and once the individual's perceptions are "filtered," then the following typical outcomes would be expected:

(1) A reduction in outdoor activities

(2) An exodus of noise sensitive individuals from the noise impacted area (provided there is an opportunity to move)

(3) An increase in overt behavior to reduce the noise exposure, e.g., soundproofing

(4) An increase in health problems

(5) A rise in atypical living habits, e.g., less conversation

(6) An increase in positive attitudes toward the noise source for those who make an internal adjustment

(7) An increase in indicators of other types of stress, e.g., family arguments

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A4. Molino, John A.: Equal Aversion Levels for Pure Tones and 1/3-Octave Bands of Noise. J. Acoust. Soc. Am., Vol. 55, 1974, pp. 1285-1289.

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APPENDIX IV

INSTRUCTION A

"We would like you to help us in this experiment which has to do with how you feel about the airplane sounds you will hear during the next 30 minutes. During the experiment, you are not to talk to each other. You will be asked for your reaction to the airplance sounds at the end of the session, which, as I said, will last about 1/2-hour."

APPENDIX V

INSTRUCTION B

"We will need to set the listening level of the TV so that it is acceptable to your group. Let's try to find a level which is a good compromise and generally comfortable for all of you."

EXPERIMENTER - FIND ACCEPTABLE LEVEL BY CONSENSUS (IN QUIET).

THEN TURN OFF TV

"Do not readjust the level during the program, please. It is imperative for the purpose of the study that the sound level stay where it is presently set."

APPENDIX VI

INSTRUCTIONS TO SUBJECTS IN LISTENING PHASE OF THE EXPERIMENT

Instructions to Subjects in Telephone Listening Phase of the Experiment

"You are about to take a listening test in which you will be identifying words spoken over the telephone. The two best scoring subjects on the test will receive $7 each. The four lower scoring subjects will receive $4 each. If you will pick up your telephone, you will receive more detailed instructions. Remember, during the test, do not cover your open ear and do not switch the phone to the other ear. Listen for the item number that accompanies each word. Some words may be completely masked out in the background noise. Make sure you are checking off a word in the correct box."

Recorded Instructions

"Your attention, please.
You are going to hear some one syllable words presented along with different loudness levels of background noise, each word will be presented in a carrier phase giving its particular item number. For example, you will hear phrases like the following:

NUMBER ONE IS TREE
NUMBER 46 IS MILE

The word presented will be one of the six words printed in a block on your answer sheet for that particular item number. Your task is to identify the word by drawing a line through it on your answer sheet. Look now at the answer sheet marked practice.

Here are some practice words:

NUMBER THREE IS TOW

Within block no. 3 is the correct word tow.

If this is the word you thought you heard, you will have drawn a line through "tow" on the practice answer sheet.
Here is another word.

NUMBER 14 IS BAT

In this case, the correct word was "bat." If this is the word you thought you heard, you will have drawn a line through "bat" within block 14 on the practice answer sheet. In the following exercise, some words will be easier to hear than others.

If you are not sure what the word is--guess. Always draw a line through one of the six words for each item number. If there are any questions, please ask the person in charge now. (Pause)

Please turn now to the answer sheet marked number one and prepare to begin. Remember, always draw a line through a word even if you must guess. After drawing a line through a word, move down to the next numbered block and prepare for the next word. After completing each of the 50 items, turn to the next answer sheet and continue, starting again with item no. 1.

A total of 300 words will be given at the rate of approximately one word every 6 second. The exercise will begin in about 30 seconds."

APPENDIX VII

WORD LISTS

1	lick pick tick	wick sick kick
2	seat meat beat	heat neat feat
3	pus pup pun	puff puck pub
4	look hook cook	book took shook
5	tip lip rip	dip sip hip
6	rate rave raze	race ray rake
7	bang rang sang	gang hang fang
8	hill till bill	fill kill will
9	mat man mad	mass math map
10	tale pale male	bale gale sale
11	sake sale save	same safe sane
12	peat peak peace	peas peal peach
13	king kit kill	kin kid kick
14	sad sass sag	sat sap sack
15	sip sing sick	sin sill sit
16	sold told hold	cold gold fold
17	buck but bun	bus buff bug
18	lake lace lame	lane lay late
19	gun run nun	fun sun bun
20	rust dust just	must bust gust
21	pan path pad	pass pat pack
22	dim dig dill	did din dip
23	wit fit kit	bit sit hit
24	din tin pin	sin win fin
25	teal teach team	tease teak tear
26	tent bent went	sent rent dent
27	sung sup sun	sud sum sub
28	red wed shed	bed led fed
29	hot got not	tot lot pot
30	dud dub dun	dug dung duck
31	pip pit pick	pig pill pin
32	seem seethe seep	seen seed seek
33	day say way	may gay pay
34	rest best test	nest vest west
35	pane pay pave	pale pace page
36	bat bad back	bath ban bass
37	cop top mop	pop shop hop
38	fig pig rig	dig wig big
39	tap tack tang	tab tan tam
40	cave cane came	cape cake case
41	game tame name	fame same came
42	oil foil toil	boil soil coil
43	fin fit fig	fizz fill fib
44	cut cub cuff	cuss cud cup
45	feel eel reel	heel peel keel
46	dark lark bark	park mark hark
47	heap heat heave	hear heath heal
48	men then hen	ten pen den
49	raw paw law	saw thaw jaw
50	bead beat bean	beach beam beak

No.			
1	went	sent	bent
	dent	tent	rent
2	hold	cold	told
	fold	sold	gold
3	pat	pad	pan
	path	pack	pass
4	lane	lay	late
	lake	lace	lame
5	kit	bit	fit
	hit	wit	sit
6	must	bust	gust
	rust	dust	just
7	teak	team	teal
	teach	tear	tease
8	din	dill	dim
	dig	dip	did
9	bed	led	fed
	red	wed	shed
10	pin	sin	tin
	fin	din	win
11	dug	dung	duck
	dud	dub	dun
12	sum	sun	sung
	sup	sub	sud
13	seep	seen	seethe
	seek	seem	seed
14	not	tot	got
	pot	hot	lot
15	vest	test	rest
	best	west	nest
16	pig	pill	pin
	pip	pit	pick
17	back	bath	bad
	bass	bat	ban
18	way	may	say
	pay	day	gay
19	pig	big	dig
	wig	rig	fig
20	pale	pace	page
	pane	pay	pave
21	cane	case	cape
	cake	came	cave
22	shop	mop	cop
	top	hop	pop
23	coil	oil	soil
	toil	boil	foil
24	tan	tang	tap
	tack	tam	tab
25	fit	fib	fizz
	fill	fig	fin
26	same	name	game
	tame	came	fame
27	peel	reel	feel
	eel	keel	heel
28	hark	dark	mark
	bark	park	lark
29	heave	hear	heat
	heal	heap	heath
30	cup	cut	cud
	cuff	cuss	cub
31	thaw	law	raw
	paw	jaw	saw
32	pen	hen	men
	then	den	ten
33	puff	puck	pub
	pus	pup	pun
34	bean	beach	beat
	beak	bead	beam
35	heat	neat	feat
	seat	meat	beat
36	dip	sip	hip
	tip	lip	rip
37	kill	kin	kit
	kick	king	kid
38	hang	sang	bang
	rang	fang	gang
39	took	cook	look
	hook	shook	book
40	mass	math	map
	mat	man	mad
41	ray	raze	rate
	rave	rake	race
42	save	same	sale
	sane	sake	safe
43	fill	kill	will
	hill	till	bill
44	sill	sick	sip
	sing	sit	sin
45	bale	gale	sale
	tale	pale	male
46	wick	sick	kick
	lick	pick	tick
47	peace	peas	peak
	peach	peat	peal
48	bun	bus	but
	bug	buck	buff
49	sag	sat	sass
	sack	sad	sap
50	fun	sun	bun
	gun	run	nun

1	gold	hold	sold	told	fold	cold
2	lame	lane	lace	late	lake	lay
3	bust	just	rust	dust	gust	must
4	did	din	dip	dim	dig	dill
5	sin	win	fin	din	tin	pin
6	sun	sud	sup	sub	sung	sum
7	lot	not	hot	got	pot	tot
8	pill	pick	pip	pit	pin	pig
9	may	gay	pay	day	say	way
10	pave	pale	pay	page	pane	pace
11	pop	shop	hop	cop	top	mop
12	tang	tab	tack	tam	tap	tan
13	keel	feel	peel	reel	heel	eel
14	heal	heap	heath	heave	hear	heat
15	paw	jaw	saw	thaw	law	raw
16	pub	pus	puck	pun	puff	pup
17	meat	feat	heat	neat	beat	seat
18	kit	kick	kin	kid	kill	king
19	cook	book	hook	shook	look	took
20	race	ray	rake	rate	rave	raze
21	bill	fill	till	will	hill	kill
22	sap	sag	sad	sass	sack	sat
23	gale	male	tale	pale	sale	bale
24	peas	peal	peach	peat	peak	peace
25	rent	went	tent	bent	dent	sent
26	sun	nun	gun	run	bun	fun
27	bus	buff	bug	buck	but	bun
28	tick	wick	pick	kick	lick	sick
29	sin	sill	sit	sip	sing	sick
30	name	fame	tame	came	game	same
31	safe	save	sake	sale	sane	same
32	map	mat	math	mad	mass	man
33	gang	hang	fang	bang	rang	sang
34	sip	rip	tip	lip	hip	dip
35	beach	beam	beak	bead	beat	bean
36	hen	ten	then	den	men	pen
37	cuff	cuss	cub	cup	cut	cud
38	park	mark	hark	dark	lark	bark
39	fizz	fill	fib	fin	fit	fig
40	soil	toil	oil	foil	coil	boil
41	came	cape	cane	case	cave	cake
42	wig	rig	fig	pig	big	dig
43	ban	back	bat	bad	bass	bath
44	test	nest	best	west	rest	vest
45	seen	seed	seek	seem	seethe	seep
46	dun	dug	dub	duck	dud	dung
47	led	shed	red	wed	fed	bed
48	tease	teak	tear	teal	teach	team
49	bit	sit	hit	wit	fit	kit
50	pad	pass	path	pack	pan	pat

1	kick	lick	sick	tick	wick	pick
2	neat	beat	seat	meat	feat	heat
3	pun	puff	pup	pub	pus	puck
4	hook	shook	book	took	cook	look
5	lip	hip	dip	sip	rip	tip
6	rake	rate	ray	raze	race	rave
7	fang	bang	hang	sang	gang	rang
8	will	hill	kill	bill	fill	till
9	map	mat	math	mad	mass	man
10	pale	sale	bale	gale	male	tale
11	sane	sake	safe	save	same	sale
12	peak	peach	peas	peal	peace	peat
13	kin	kid	kick	king	kit	kill
14	sack	sad	sap	sag	sat	sass
15	sit	sip	sill	sick	sin	sing
16	fold	sold	gold	hold	cold	told
17	but	bug	bus	buff	bun	buck
18	late	lake	lay	lame	lane	lace
19	run	bun	fun	sun	nun	gun
20	dust	gust	must	bust	just	rust
21	path	pack	pass	pat	pad	pan
22	dip	dim	din	dill	did	dig
23	fit	hit	bit	sit	kit	wit
24	tin	fin	sin	win	pin	din
25	tear	teal	teak	team	tease	teach
26	dent	tent	rent	went	sent	bent
27	sup	sub	sud	sum	sun	sung
28	wed	fed	bed	led	shed	red
29	pot	hot	lot	not	tot	got
30	duck	dud	dung	dun	dug	dub
31	pit	pin	pig	pill	pick	pip
32	seethe	seek	seen	seed	seep	seem
33	say	pay	may	gay	way	day
34	best	rest	nest	vest	test	rest
35	page	pane	pace	pave	pale	pay
36	bass	bat	ban	back	bath	bad
37	hop	cop	shop	mop	pop	top
38	dig	wig	big	fig	pig	rig
39	tack	tam	tab	tan	tang	tap
40	cake	came	cave	cane	case	cape
41	tame	came	fame	same	name	game
42	toil	boil	foil	coil	oil	soil
43	fig	fizz	fit	fib	fin	fill
44	cuss	cud	cup	cut	cub	cuff
45	heel	peel	keel	feel	eel	reel
46	mark	bark	dark	lark	hark	park
47	heath	heave	heap	heat	heal	hear
48	then	den	ten	pen	hen	men
49	law	saw	paw	jaw	raw	thaw
50	beat	beak	beach	beam	bean	bead

1	sent	rent	dent
	tent	bent	went
2	told	fold	cold
	gold	hold	sold
3	pass	pat	pack
	pan	path	pad
4	lay	lame	lake
	lace	late	lane
5	sit	kit	wit
	fit	hit	bit
6	just	must	dust
	gust	rust	bust
7	team	tease	teach
	tear	teal	teak
8	dill	did	dig
	dip	dim	din
9	shed	bed	wed
	fed	red	led
10	win	pin	din
	tin	fin	sin
11	dung	dun	dud
	dub	duck	dug
12	sud	sum	sub
	sung	sup	sun
13	seed	seep	seem
	seethe	seek	seen
14	tot	lot	pot
	not	got	not
15	nest	vest	west
	rest	best	test
16	pick	pig	pit
	pin	pip	pill
17	bath	ban	bass
	bat	bad	back
18	gay	way	day
	say	pay	may
19	rig	dig	pig
	big	fig	wig
20	pace	pave	pane
	pay	page	pale
21	cape	cake	case
	cave	cane	came
22	mop	pop	top
	hop	cop	shop
23	boil	soil	coil
	oil	foil	toil
24	tab	tan	tam
	tap	tack	tang
25	fill	fig	fin
	fit	fib	fizz
26	fame	same	came
	game	tame	name
27	reel	heel	eel
	keel	feel	peel
28	bark	park	lark
	hark	dark	mark
29	hear	heath	heal
	heap	heat	heave
30	cud	cuff	cut
	cub	cup	cuss
31	saw	thaw	jaw
	raw	paw	law
32	den	men	pen
	hen	ten	then
33	puck	pun	pus
	pup	pub	puff
34	beak	bead	beam
	bean	beach	beat
35	beat	heat	meat
	feat	seat	neat
36	hip	tip	sip
	rip	dip	lip
37	kid	kill	king
	kit	kick	kin
38	rang	fang	gang
	hang	sang	bang
39	shook	look	took
	cook	book	hook
40	man	map	mass
	math	mad	mat
41	rave	rake	race
	ray	raze	rate
42	sale	sane	same
	safe	save	sake
43	till	will	fill
	kill	bill	hill
44	sick	sin	sing
	sit	sip	sill
45	sale	tale	gale
	male	bale	pale
46	sick	tick	lick
	pick	kick	wick
47	peach	peat	peal
	peace	peas	peak
48	buff	bun	buck
	but	bug	bus
49	sass	sack	sat
	sap	sag	sad
50	nun	fun	run
	bun	gun	sun

1	cold	gold	fold	sold	told	hold
2	lace	late	lane	lay	lame	lake
3	gust	rust	bust	just	must	dust
4	dig	dip	did	din	dill	dim
5	fin	din	win	pin	sin	tin
6	sub	sung	sum	sun	sud	sup
7	got	pot	tot	lot	not	hot
8	pin	pip	pill	pick	pig	pit
9	pay	day	gay	way	may	say
10	pay	page	pale	pace	pave	pane
11	top	hop	pop	shop	mop	cop
12	tam	tap	tan	tang	tab	tack
13	eel	keel	heel	peel	reel	feel
14	heat	heal	hear	heath	heave	heap
15	jaw	raw	thaw	law	saw	paw
16	pup	pub	puff	puck	pun	pus
17	feat	seat	neat	beat	heat	meat
18	kick	king	kid	kill	kin	kit
19	book	took	shook	look	hook	cook
20	raze	race	rave	rake	rate	ray
21	kill	bill	hill	till	will	fill
22	sat	sap	sack	sad	sass	sag
23	male	bale	pale	sale	tale	gale
24	peal	peace	peat	peak	peach	peas
25	bent	dent	sent	rent	went	tent
26	bun	gun	sun	nun	fun	run
27	bug	buck	buff	bun	bus	but
28	pick	kick	wick	sick	tick	lick
29	sing	sit	sin	sill	sick	sip
30	came	game	same	name	fame	tame
31	sake	sale	save	same	safe	sane
32	math	mad	mat	man	map	mass
33	sang	gang	rang	fang	bang	hang
34	rip	dip	lip	hip	tip	sip
35	beam	bean	bead	beat	beak	beach
36	ten	pen	den	men	then	hen
37	cub	cup	cuss	cud	cuff	cut
38	lark	hark	park	mark	bark	dark
39	fib	fin	fill	fig	fizz	fit
40	foil	coil	boil	soil	toil	oil
41	case	cave	cake	came	cape	cane
42	big	fig	wig	rig	dig	pig
43	bad	bass	bath	ban	back	bat
44	west	rest	vest	test	nest	best
45	seek	seem	seed	seep	seen	seethe
46	dub	duck	dug	dung	dun	dud
47	fed	red	led	shed	bed	wed
48	teach	tear	tease	teak	team	teal
49	hit	wit	sit	kit	bit	fit
50	pack	pan	pat	pad	pass	path