Spring 1994

The effects of different types of noise on human heart rate

Jose R. Fabregas
New Jersey Institute of Technology

ABSTRACT

THE EFFECTS OF DIFFERENT TYPES OF NOISE ON HUMAN HEART RATE

by

Jose R. Fabregas

In an industrial environment, chronic noise exposure is assumed to affect human heart rate. If this is true, people who are more sensitive to noise will run a higher risk of incurring cardiovascular diseases.

Sixteen healthy experimental subjects, all with normal hearing, eight males and eight females, were exposed to five different types of pink and white noise at 60, 70, 80, and 85 dBA in order to determine if any relationship exists between the heart rate and sex. Each individual was exposed for a maximum of thirty seconds for each type and level of noise. Audiometric tests were given to subjects in order to measure their hearing sensitivity (threshold) before and after the experiment.

This study provides valuable information towards understanding if autonomic responses are higher in people who consider themselves sensitive to noise, and in determining if sex plays a role on any effects noise may exert on heart rate.

THE EFFECTS OF DIFFERENT TYPES OF NOISE ON HUMAN HEART RATE

by
Jose R. Fabregas

A Thesis
Submitted to the Faculty of
New Jersey Institute of Technology
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Occupational Safety and Health Engineering

Department of Mechanical and Industrial Engineering

May 1994

APPROVAL PAGE

THE EFFECTS OF DIFFERENT TYPES OF NOISE ON HUMAN HEART RATE

Jose R. Fabregas

Dr. Howard Gage, Thesis Advisor — Date
Associate Professor of Industrial Engineering and Director of the Occupational Safety and Health Program, NJIT

Dr. Min-Yong Park, Committee Member — Date
Assistant Professor of Industrial Engineering, NJIT

Dr. Layek Abdel-Malek, Committee Member — Date
Professor of Industrial and Management Engineering and Associate Chairperson of Industrial Engineering

BIOGRAPHICAL SKETCH

Author: Jose R. Fabregas

Degree: Master of Science in Occupational Safety and Health Engineering

Date: May 1994

Undergraduate and Graduate Education:

- Master of Science in Occupational Safety and Health Engineering,
  New Jersey Institute of Technology, Newark, NJ, 1994

- Bachelor of Science in Industrial Engineering,
  Polytechnic University of Puerto Rico, Hato Rey, PR, 1989

Major: Occupational Safety and Health Engineering

This thesis is dedicated to
my wife Eilyn and my parents, Jose A. and Hilda T.

ACKNOWLEDGMENT

The author wishes to express his sincere gratitude to his thesis advisors, Dr. Min Yong-Park and Dr. Howard Gage for their guidance, friendship, patience, and moral support throughout this research.

Special thanks to Dr. Layek Abdel-Malek for serving as a member of the committee.

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

Table **Page**

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Noise has often been referred to as an unwanted by-product of urbanization and industrialization and, as such, noise is a pervasive aspect of many modern communities and work environments. It is generally believed that continued exposure to noise in real life can be a source of physiological stress possibly capable of causing health disorders beyond that of direct damages to the auditory system.

The autonomic nervous system is concerned with not only maintaining the homeostatic and life-continuing process of the body but also is involved when a person is startled or experiences feelings or emotions, such as becoming frightened or angry. As is well known, on these occasions the reactions may include changes in heart rate, peripheral blood pressure and volume, changes in respiration, sweating, etc.; reactions that are believed to be indicative of a state of physiological stress. Stress factors in working environments have recently been discussed as risk factors for cardiovascular disease. The best known of the acute effects that are mediated via the sympathetic nervous system are associated with peripheral circulation and heart activation via their sympathetic innervation, as well as that mediated by circulating adrenaline and noradrenaline produced by the adrenal medulla in response to sympathetic nervous stimulation. There appears to be general agreement that noise exposure operates as a stressor for human beings, resulting in contraction of peripheral arteries caused by the activation of the sympathetic nervous system to raise blood pressure. Although noise can act as a nonspecific biological stressor, it is not known whether the effects produced are transitory or whether prolonged exposure can result in cumulative pathology.

One of the researchers in this area has suggested, however, that physiological stress responses may be more related to indirect, physiological factors pertaining to the noise than to the noise per se, or are normal physiological responses that are not indicative of a true condition of physiological stress (Kryter, 1984). In any event, the possible role of the environmental noise in causing conditions of physiological stress to man is a matter of both scientific and practical importance.

Evidence accumulated from human and animal studies suggests that noise exposure is a factor in the development of hypertension. However, there is a contradiction in research in the area as to whether it raises blood pressure. A review of the literature reveals that much more clinical and epidemiological evidence must be gathered before any valid conclusions can be made. The following sections present some history, comparisons, and contrast between some pioneers that made it possible for us to understand the relationship between noise and the heart activity through epidemiological, animal, and human studies.

Finally, the main goal of this study is to determine if there is a relationship between the heart rate, sex, and noise; and if these factors play a key role in determining cardiovascular problems.

CHAPTER 2

THEORETICAL APPROACH

2.1 Epidemiological Studies

Epidemiological studies have not conclusively demonstrated that noise exposure is one of the contributory factors inducing hypertension (Talbott, Helmkamp, Matthews, Kuller, Cuttington, and Redmond, 1985). Several studies suggested that workers exposed to long-term industrial noise suffer from high blood pressure or increase risk of hypertension. On the other hand, there are some investigations which show no significant difference in blood pressure between noise exposed workers (Brown III, 1975, and Parvizpoor, 1976).

2.2 Laboratory Studies in People

2.2.1 Early Studies on Humans

In the early 1950's, researchers Davis, Buchwald, and Frankman reported the results of a rather extensive experiment on observable changes produced by exposure to sound in a now-classic monograph. Specifically, they measured the effects of repetitive exposure to 1000 Hz tones of various intensities on blood pressure, pulse time, volume pulse, breathing amplitude and depth, and the temporal pattern of breathing, galvanic skin response (GSR) amplitude and latency, and finger and chin volumes. Noise produced an initial rise in pressure pulse amplitude; then there was a pronounced decrease, followed by a sustained rise. Volume pulse increased briefly and then fell drastically. GSR amplitude and latency decreased, and pulse rate slowed. Finger volume decreased, indicating peripheral vasoconstriction, but chin volume increased. Generally, all of these effects tended to extinguish or adapt with stimulus repetition, except for the increase in the depth of breathing, which increased with repetition. The adaptations in breathing rate, volume pulse, and finger and pulse volume fell short of statistical significance. Changes in the extent of reactions between 70 and 90 dBA were less pronounced than changes between 90 and 120 dBA.

2.2.2 Later Human Studies

Human studies, such as the research presented by Miller (1974), tried to communicate the general sense of the effects of noise on people. He categorized three classes of transient general physiological responses to sound: (1) the fast responses of the voluntary musculature mediated by the somatic nervous system; (2) the slightly slower responses of the smooth muscles and glands mediated by the visceral nervous system; and (3) the even slower responses of the neuroendocrine system. It is relevant to discuss the importance of item two, where Miller mentioned, that in response to brief sounds there is general constriction in the peripheral blood vessels with a reduction in peripheral blood flow. There may be acceleration or deceleration of heart rate, reduction in the resistance of the skin to electrical current (an indication of the peripheral visceral nervous system), changes in breathing patterns, changes in the motility of the gastro-intestinal tract, changes in the size of pupils of the eyes, and changes in the secretion of saliva and gastric secretions. These responses to brief sounds are obvious for A-weighted sound levels over 70 dB, yet it is doubtful whether the recording techniques are sufficiently sensitive to detect whether these responses occur. In any case, they are either small or nonexistent.

There is evidence that workers exposed to high levels of noise have a higher incidence of cardiovascular disorders; ear, nose, throat problems; and equilibrium disorders than workers exposed to lower levels of noise (Miller 1974 and Kryter 1984). The results of these studies are summarized in Figure 1. The fact that those who are exposed to high noise levels show greater evidence of medical problems that those exposed to lower noise levels is not conclusive evidence that noise is the crucial factor. In each case it is possible that the observed effects can be explained by other factors such as:

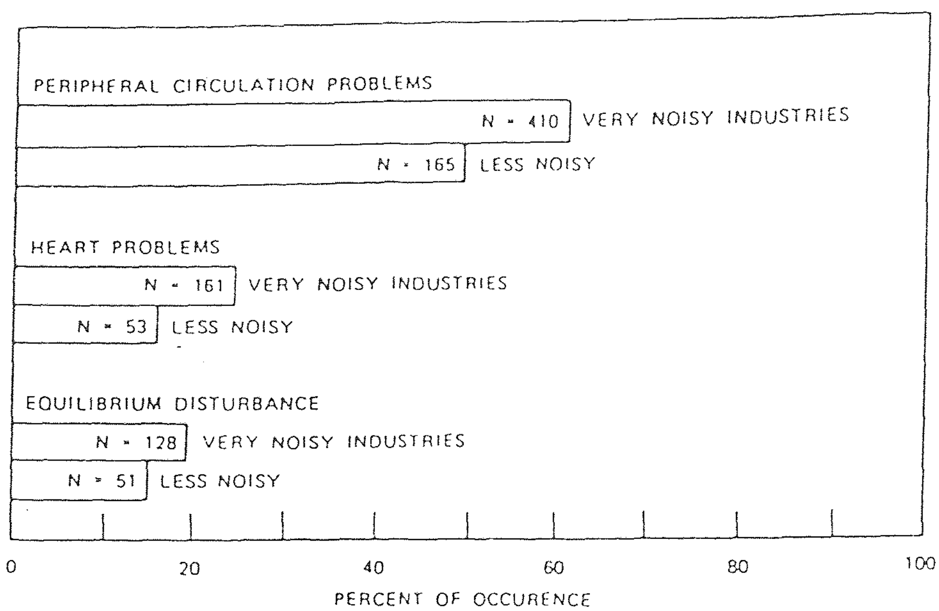

Figure 1 Differences between the percentages of physiological problems of those who work in two different levels of noise. These data are from 1005 German industrial workers. Peripheral circulation problems include pale and taut skin, mouth and pharynx symptoms, abnormal sensations in the extremities, paleness of the mucous membrane, and other vascular disturbances. [From Kryter et al., 1971.]

age, dust levels, occupational danger, life habits, and other non-noise hazards. Miller, as well as other researchers (i.e. Kryter 1980), agree that there is no substantial evidence that noise can cause cardiovascular diseases or significant changes in heart rate.

Jansen (1977) presented a paper describing experiments in which he measured the blood volume of the finger during exposure to eight minutes of 105 dBA noise and a temporary threshold shift (TTS) at 4 kHz. Volume was significantly decreased, more so after a second exposure. Strangely, there was a significantly negative correlation between finger pulse amplitude and TTS. Relatively high correlations of this kind, between physiological indices and either sensory or performance measures, are rarely encountered. It probably would be unwise to accept this finding uncritically until it is replicated.

In other studies, Glass and Singer (1972) found that physiological adaptation (GSR and vasoconstriction) invariably occurred in their laboratory studies regardless of the intensity or the unpredictability of the noise presented to their subjects. Generally, loud noise (such as 108 dBA mixed unintelligible speech and machine noise) did produce vasoconstriction, increased muscle tension, and lower skin resistance, subjects so exposed seemed to adapt completely within 23-25 minutes. However, they found about four percent of college students screened for some of their experiments seemed unable to adapt physiologically to any experimental procedures. This experiment suggested that it is important to recognize that physiological stress responses become manifest during exposures of longer duration.

In an interesting research study conducted by Osada (1972), subjects were exposed continuously for two or four hours to recordings of road traffic noise at levels of 40, 50, and 60 dBA. The subjects were exposed to the noise from a small cassette tape players. The subjects moved around the laboratory, went out to lunch, and so forth, while wearing the cassette player and earphones. For most of the noise conditions, blood and urinary samples revealed a significant increase in blood cells and hormones, especially the corticosteroids, which would indicate autonomic system stress reactions. Osada concluded that autonomic system stress activity is caused by noise levels above 50 dBA. However, it is suggested that these effects are perhaps related to stress caused by the noise masking the hearing of speech and other wanted environmental sounds useful to the subjects while moving about, and not from some direct autonomic system arousal by the noise.

In 1980, Brown, investigated physiological effects on pilots. He chose 22 professional pilots and recorded measurements of heart rate, systolic and diastolic blood pressure, serum cholesterol, and glucose. These data were compared to records of the same measurements from 29 non-flying FAA personnel of the same ages. Every year the parameters were recorded, along with audiometric histories. The data were tabulated and compared within the noise levels found inside the aircraft. The results of measuring heart rate of the pilots were found to fluctuate considerably without establishing an increasing or decreasing trend. This finding led the author to conclude that changes observed in the heart rate over the study period (seven years), though statistically significant within population and between populations, did not show a decline in rate resulting from noise exposure, nor were these changes of sufficient magnitude to be considered biologically important.

During the same year, Andrén, Hansson, Bjorkman, and Johnson (1980), after conducting their research, explained the mechanisms by which noise may raise blood pressure in people. They studied if there was any relationship between the stroke volume (SV), cardiac output, and the total peripheral resistance with exposure to industrial noise. This study suggested that exposure to such noise at levels prevailing during several industrial processes may cause acute elevations of arterial blood pressure due to peripheral vascular resistance. In animal studies, repeated elevations of blood pressure due to exposure to noise have been shown to cause a permanent elevation of blood pressure.

Therefore, Andrén et al (1980) suggested that noise may be one of several external stimuli contributing to the development of arterial hypertension in humans. They selected eighteen males between ages 23 and 31 years old, and measured their respective blood pressure at rest, their stoke volume and cardiac output. Then, with those parameters, they measured in a laboratory the effects of different A-weighted noise levels and their frequency spectra. Measurements were made after twenty minutes of recumbent rest at 40 dBA and again after exposure to noise at 95 dBA for twenty minutes. In eight subjects, recordings were also made after stimulation for ten minutes at 75 and 85 dBA. Finally, recordings were made at five, ten, and fifteen minutes after cessation of noise stimulation. The results of this experiment found that no significant changes in heart rate occurred during stimulation with noise at either 75, 85, or 95 dBA, whereas significant reduction of stroke volume was seen at two highest levels of stimulation. The reduction of SV also caused a significant reduction of cardiac output at the highest level of stimulation. It was also found that statistically significant increments of mean arterial pressure and total peripheral resistance occurred during stimulation with noise at the 95 dBA level.

During the same decade, Kryter and Poza (1980), performed two types of experiments. The first tried to replicate some results of Jansen (1964). In the second experiment, they tried to determined the effects of slow versus rapid onset of noise interruption rate; measuring in both experiments the heart rate, pulse amplitude, blood volume, and peripheral body temperature. The first experiment consisted of four groups of six subjects who were exposed to four different noise characteristics : (1) wide-band pink noise at 92 dB, (2) narrow-band noise, a 1/3-octave band centered at 3150 HZ at 92 dB SPL, (3) wide-band pink noise at 76 dB SPL, (4) wide-band pink noise at 67 dB SPL. The wide-band noise was band limited only by the acoustic characteristics of the speaker. Within these characteristics, each subject group was tested for three different stimuli : (a) quiet, (b) noise lasting for two minutes, or (c) noise lasting for four minutes. The second experiment consisted of three groups of four subjects. There were six stimulus types, as compared to three in the first experiment : (1) quiet, (2) continuous noise, rapid onset and offset, (3) same as item (2), but noise with slow, (4) noise bursts of three seconds each, separated by twenty seconds of silence, (5) noise burst at twenty seconds each, separated by twenty seconds of silence (rapid onset and offset), (6) same as 5 but with slow onset and offset time. The results of these experiments, regarding the heart rate, indicates that there is no systematic change in heart rate because of the noise, even though an increase in vasoconstriction did occur. But, Kryter (1980) states that some studies reported that heart rate is possibly a meaningful indicator of a "stress" response to noise.

2.2.3 Recent Studies on Humans

Di Nisi (1987), tried to indicate a cardiovascular response to noise by looking at the effects of self estimated sensitivity of noise, sex, and time of the day. He issued a 31 item questionnaire to a select group of 80 subjects. The selection was based on self-estimates of sensitivity to noise ranging from a scale of one (not sensitive to noise) to twelve (very sensitive to noise). Hearing was tested by an automatic audiometer for ten frequencies between 250 and 8000 Hz. Noises used in this study were five: (1) jet airplane, (2) truck, (3) motor cycle, (4) train, and (5) telephone. (Refer to Table 1).

Table 1 Maximum Intensity, Spectral Frequencies, and Time Duration of the Five Types of Noises

Type of noise	Maximum intensity (dBA)	Spectral frequencies (min-max)(Hz)	Duration (s)
Airplane	86	30-7000	21.4
Truck	81	30-6000	20.4
Motor cycle	71	40-5000	10.2
Train	76.6	20-5000	16.8
Telephone	74.5	1000-2000	10.0

Heart rate intervals were continuously recorded on a digital computer and time-related exposures of the different noises and the amplitude of the heart rate response to each noise were then calculated. Statistical analyses were made by three-three level analysis of variance ANOVA and student's t-test. The results showed that for an average heart rate, the only significant difference was related to the sex factor. In other words, female subjects exhibited a higher heart beat than observed in male subjects. This is because men have a larger heart capacity than women. Another finding in this study was that the average amplitude of the heart rate response (HRR) depends on both the amplitude of the heart rate modifications and the percentage of noises producing that effect. The average amplitude of the HRR represents the "heart rate cost" over the entire exposure of noise (Di Nisi 1987). The only result found here was that the group that was highly sensitive presented significantly more responses to noise than did a lower sensitivity group. In this study, there was a large difference between frequency of vasoconstrictions and the frequency of heart rate responses produced by noise. Seventy-two percent of noises presented provoked a vasoconstriction while 22 percent provoked a heart rate response.

Another recent research, presented by Chen, Hiramatsu, Ooue, Takagi, and Yamamoto (1991), attempted to determine whether the blood pressure rises as a result of noise exposure. They conducted a short-term experiment using the method of synchronized averaging of blood pressure. The authors defined noise-evoked blood pressure as the rise of systolic blood pressure owing to sound presentation. This quantity was clearly shown as a synchronized averaging signal. They identified twenty-five healthy male and female Japanese students with normal heart activity, aged between 18 and 28 years. They were exposed to white noise, as the stimulus, with sound pressure levels of from 60 to 100 dB. The signal outputs of systolic blood pressure and pulse rate from the measuring device as well as the ongoing signal of the sound presentation were stored in the computer. The results of this study can be summarized as follows :

1. A noise-evoked blood pressure rise was detected by using the synchronized method.
2. A linear relation was found, with a high correlation between blood pressure rise and the sound pressure levels of white noise.

3. A peak of the blood pressure rise was found at 10 seconds after onset of the stimulus without regard to the sound pressure level.

Finally, the most recent study in this field conducted by Griefahn, and Di Nisi (1992), stated that chronic noise exposure is assumed to contribute to cardiovascular diseases (i.e. stress) by means of the autonomic responses produced during acute stimulation. However, if this is true, the autonomic responses are higher in people who feel sensitive to noise, indicating that these people are at higher risk. The main goal of this study was to determine the influence of personal self-estimated sensitivity on the extent of noise-induced responses, on mood and cardiovascular function. The experiment consisted of selecting 150 healthy normal subjects with ages ranging from 30 to 60 years old who were distributed according to gender and these three categories : (1) resistant, (2) indifferent, and (3) sensitive to noise. The criterion used to select these categories was based upon the basis of self-estimated sensitivity to noise. The selection of this subjects was based on a questionnaire given to 3000 employees at the University of Dnsseldorf. The experiments were executed in a soundproof room, using three types of noises : (1) pink noise, (2) traffic noise, and (3) gunfire, with repetitions of two shots per second. Results were presented for 19 seconds with equivalent noise levels of 62, 68, 74, and 80 dBA (gunfire used a sound pressure level {SPL} of 71 dBA). Peripheral blood flow, heart rate and mood were measured as a result of the noises. Specific statistical comparisons were used (i.e. analysis of variance and t-test). The results of this study suggested that heart rate responses are not determined by mood during noise, and that both the physiological responses are independent of each other. The small differences observed between the responses of so-called sensitive and resistant subjects do not support the hypothesis that sensitive people run a higher risk of developing cardiovascular diseases if permanently exposed to noise.

2.3 Animal Studies

In addition to the studies mentioned above, researchers have done many well-documented animal studies relating cardiovascular effects to noise exposure. The most common subjects used by researchers were rodents and primates.

2.3.1 Experimental Subject: Rodents

Rodents are not ideal subjects for studying the physiological effects of noise (Loeb, 1986). Thus, conjectures and extrapolations about the effects of noise stress in humans from these mice and rats studies have been controversial. Nevertheless, there have been a number of experiments in which rodents were chronically exposed to noise and the effects on health observed. Buckley and Smookler (1970) reported that exposing rats to high noise produced elevated blood pressure. But, since environmental factors were not independently manipulated, it is hard to evaluate their significance for human health.

One study, which failed to demonstrate a relationship between noise exposure and rats were more susceptible to noise induced hearing loss. Ising and Melchert (1980) exposed rats to random four second bursts of noise each night. Instead of using A-weighting which is based on human hearing, the researchers used a weighting curve based on the hearing level of rats, expressing levels in dB_{rat}. Changes in cardiac structure were observed after periods of noise exposure up to 28 weeks.

2.3.2 Experimental Subjects: Primates

It would appear safer to extrapolate from experiments with primates (monkeys or apes) than from rodents, both because they are more closely related to humans and because they do not suffer audiogenic seizures. Unfortunately there are conflicting results from such experiments.

Peterson and his colleagues (Peterson et al, 1981) performed a number of experiments with rhesus monkeys at the University of Miami. In one, they employed 112 dBA traffic noise as an unconditioned (traumatic) stimulus and measured blood pressure and heart rate in a restrained subject over a thirty day period. Heart rate was initially elevated but soon significantly adapted. The baseline blood pressure significantly increased over the thirty day period. A second monkey was exposed for twelve hours per day for thirty days to a noise which was variable, exceeding 68 dBA 90 percent of the time, 76 dBA 50 percent of the time, and 84 dBA 10 percent of the time. Overall, the levels were such that it would be annoying to most humans but not injurious to hearing. Both systolic and diastolic pressure were elevated on days in which there was noise exposure. During the night they fell to near normal values but rose again during the next day. After days of exposure, this change began to occur an hour before each daily exposure, presumably in anticipation. Restraint alone produced no such effects. This study suggested that with continued daily exposures, there may be permanent elevations of blood pressure and heart rate.

Turkkan, Hienz, and Harris (1983) used baboons rather than rhesus monkeys. They reported that although there were initial elevations, the chronic effect of noise on their subjects was to lower blood pressure rather than elevate it. They also noted chronic depression of heart rate. Both research groups, Peterson et al and Turkkan et al, considered that differences in reactions of the two species might be important. If so, then extrapolation from animal studies will necessarily be more difficult. This is unfortunate, as good controlled studies of this kind can only be performed with animal subjects.

Finally, another primate research, performed by DeJoy (1984), only mentions animal studies that reflected physiological disorders when animals were exposed to noise. He notes a study using primates exposed for a nine month period of continuous daily noise at L_{eq24} = 85 dB; here sustained elevations in blood pressure of 23 to 28 percent in rhesus monkeys.

2.4 Industrial Studies

Industrial studies have been reviewed by a few researchers such as Kryter (1970), Gulian (1974), and others. Jansen (1961) found that there were more circulatory, cardiac, and equilibratory problems in workers in noisy industries (i.e. iron and steel) than workers in quieter industries. Similar effects have been reported by Strakhov(1964) and Shatalov, Sanitanov, and Glotova (1962). Lehman (1964) considers that it has been demonstrated that prolonged and chronic noise exposure has a detrimental effect on cardiovascular function.

Nevertheless, it is clear that there is no convincing evidence from industrial studies conclusively proving that noise impairs health, though there is considerable suggestive evidence (Loeb, 1986).

CHAPTER 3

METHODOLOGY OF THE EXPERIMENT

3.1 Research Objectives

It is clear from the previous review of the literature that researchers in the noise and heart field, have not yet found enough evidence to prove that different types of chronic noise exposure contribute to cardiovascular diseases, or even irregular heart beat. On the other hand, Kryter (1985) and Griefhan (1992) found that heart rate experiences an increase with exposure to white noise.

This study compared the effects of different types of noise at different sound pressure levels in order to determine if there is any relationship between human heart beat and the gender, and type of noise and sound level of the subjects under the investigation. An audiometric test was given to the subjects in order to measure their hearing sensitivity (threshold) before and after the experiment. A questionnaire was given to each subject in order to record their sensitivity while exposed to noise.

This study provides information to future researchers in the health and safety fields to confirm if autonomic responses are higher in people who feel they are more sensitive to noise. The study also helps to determine the roles which sex, type of noise, and sound pressure level may play in regulating heart beat in high noise environments.

3.2 Selection of Subjects

Sixteen individuals, eight males and eight females, volunteered as experimental subjects for this experiment conducted at the New Jersey Institute of Technology. Subjects were briefed about their role in the experiment and how to follow directions from the experimenter. The description given to subjects is shown in Appendix A. Every participant received a pre-experimental questionnaire (see Figure 2), in order to categorize each individual according to their sex, age, and sensitivity to noise.

QUESTIONNAIRE

Purpose : The purpose of this questionnaire is to determine how the results of your heart beat compare with your physical condition when you are expose to different types of noise levels.

Answer the best selection and fill in the blanks :

1. ___Male ___Female

2. Age : ______

3. Do you consider yourself sensitive to noise: ___Yes ___No

4. Are you exposed, in a daily basis, to high noise levels at work (i.e. traffic noise, radio, etc.) ___Yes ___No
If yes, what type(s) of noise are you exposed to :___________

5. Have you ever had an illness or problem of any sort related to your heart or blood vessels ? ___Yes ___No
If yes, what kind of illness ___________

6. Do you exercise :
___once a week ___twice a week ___none other : ___________

7. Do you experience shortness of breath during exercise ?___Yes ___No

8. Do you smoke ?___Yes ___No

Figure 2 Pre-Experimental Questionnaire

Subjects filled a participant's informed consent form in order to understand their role in agreeing to participate in the experiment. This form is shown in Appendix B.

Audiometric tests were given to each of the subjects prior to and after the experiment in order to check for auditory threshold shifts (ATS) and temporary threshold shifts (TTS). If any hearing-related or heart-related chronic diseases were found, those individuals were excluded from the experiment.

Requirements for participation for this experiment were : (1) no individual working in a high noise level environment, (2) no previous participation in audiometric testing, (3) no individuals having cardiovascular problems at time of the experiment, and (4) the ability to experience high noise levels.

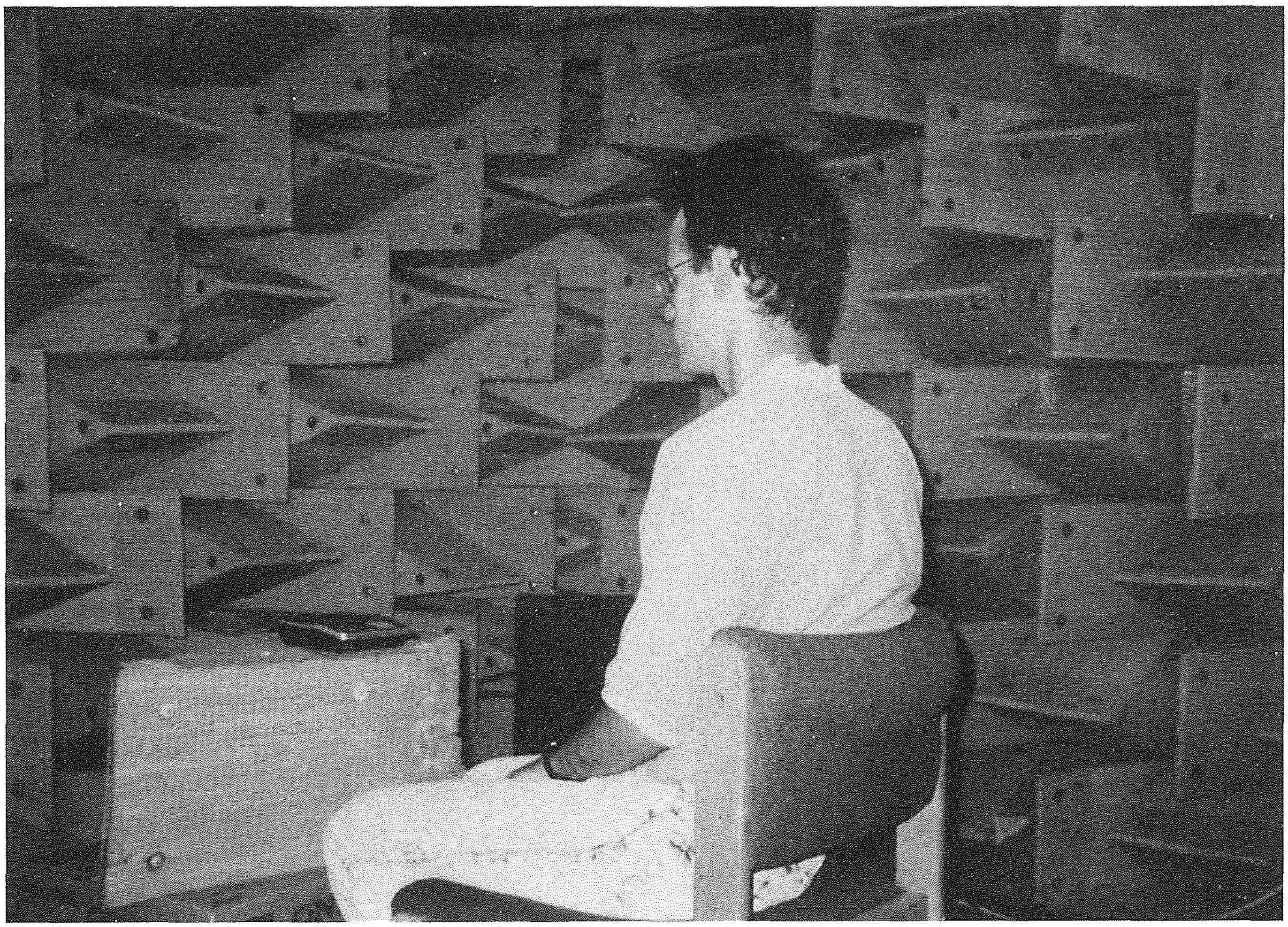

Figure 3 Anechoic Chamber (New Jersey Institute of Technology)

3.3 Types of Noise and Sound Pressure Levels

Five different types of noise were used in this experiment. The types of noise used were : (1) boiler room, (2) exhaust fan for power saw, (3) pump room, (4) screw gun, and (5) gas compressor. The types of noise selected were recorded on metal recording tape for higher fidelity. Noise types were recorded with a SONY® boom box two-way recorder at the Princeton Plasma Physics Laboratory in Princeton, New Jersey.

For every type of noise, a sound pressure level was applied throughout the entire experiment. The four sound pressure levels used were 60, 70, 80, and 85 dBA.

3.4 Testing Facilities

The facility used for this experiment is housed in the Acoustics Laboratory the Department of Mechanical and Industrial Engineering at New Jersey Institute of Technology. An IAC chamber and a test booth (anechoic chamber) were used in order to obtain the best attenuation possible. Photographs of the anechoic chamber and IAC booth used are shown in figures 3 and 4.

Different types of pre-recorded noise were generated by using loudspeakers located inside the anechoic chamber.

3.5 Instrumentation

A wireless heart beat monitor was used throughout the experiment. This heart beat monitor is the *UNIC CIC HEARTWATCH* model 8799, as shown in Figure 5; it is manufactured by Computer Instruments Corporation. This heartwatch is an exercise computer instrument that senses the electrical signals generated by an individual's heart beat following the same technique used by physicians when obtaining an electrocardiogram (EKG). The heart rate in beats per minute is digitally displayed in real time on a wrist watch worn by each subject. The other component used with the

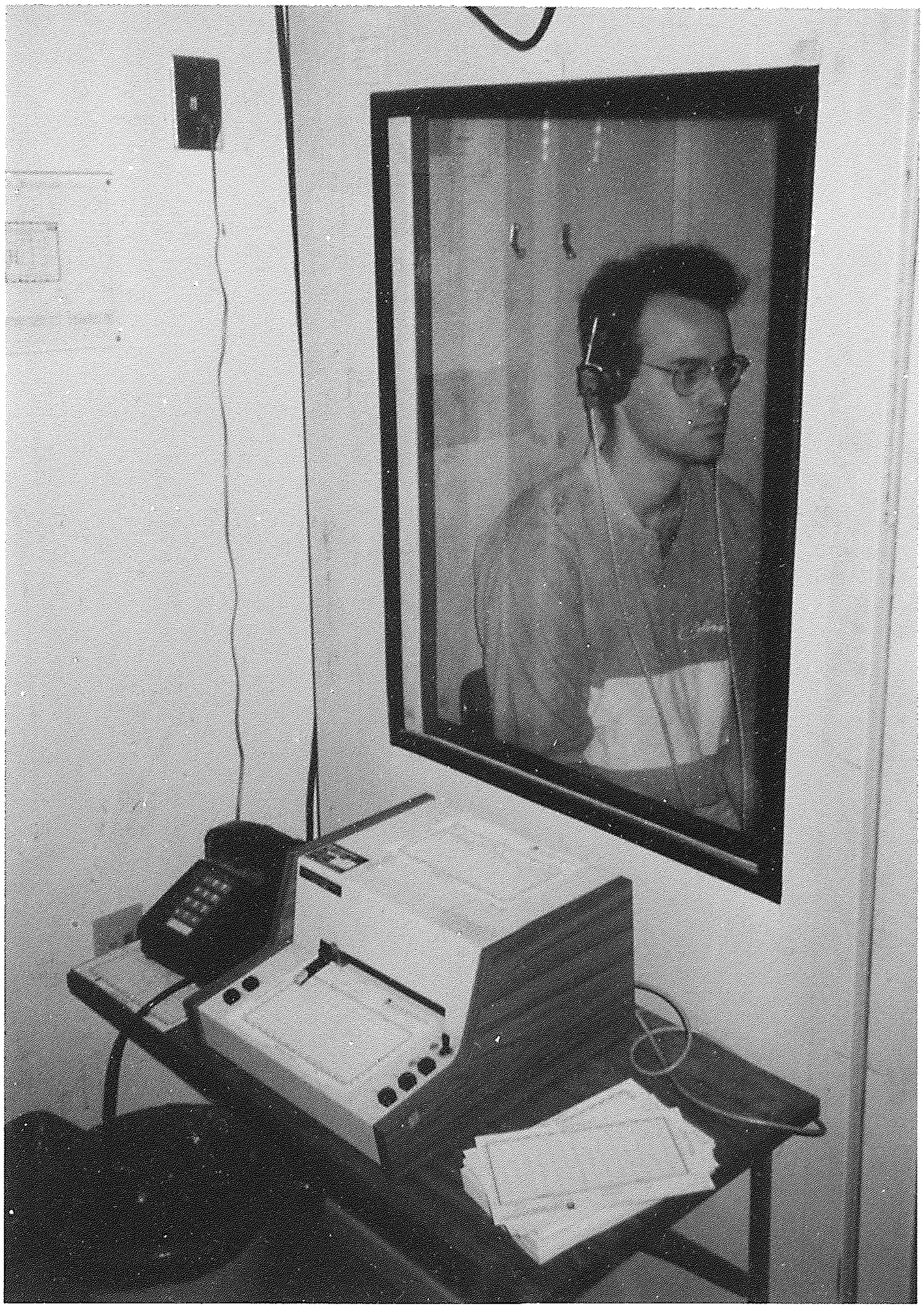

Figure 4 IAC Booth (New Jersey Institute of Technology)

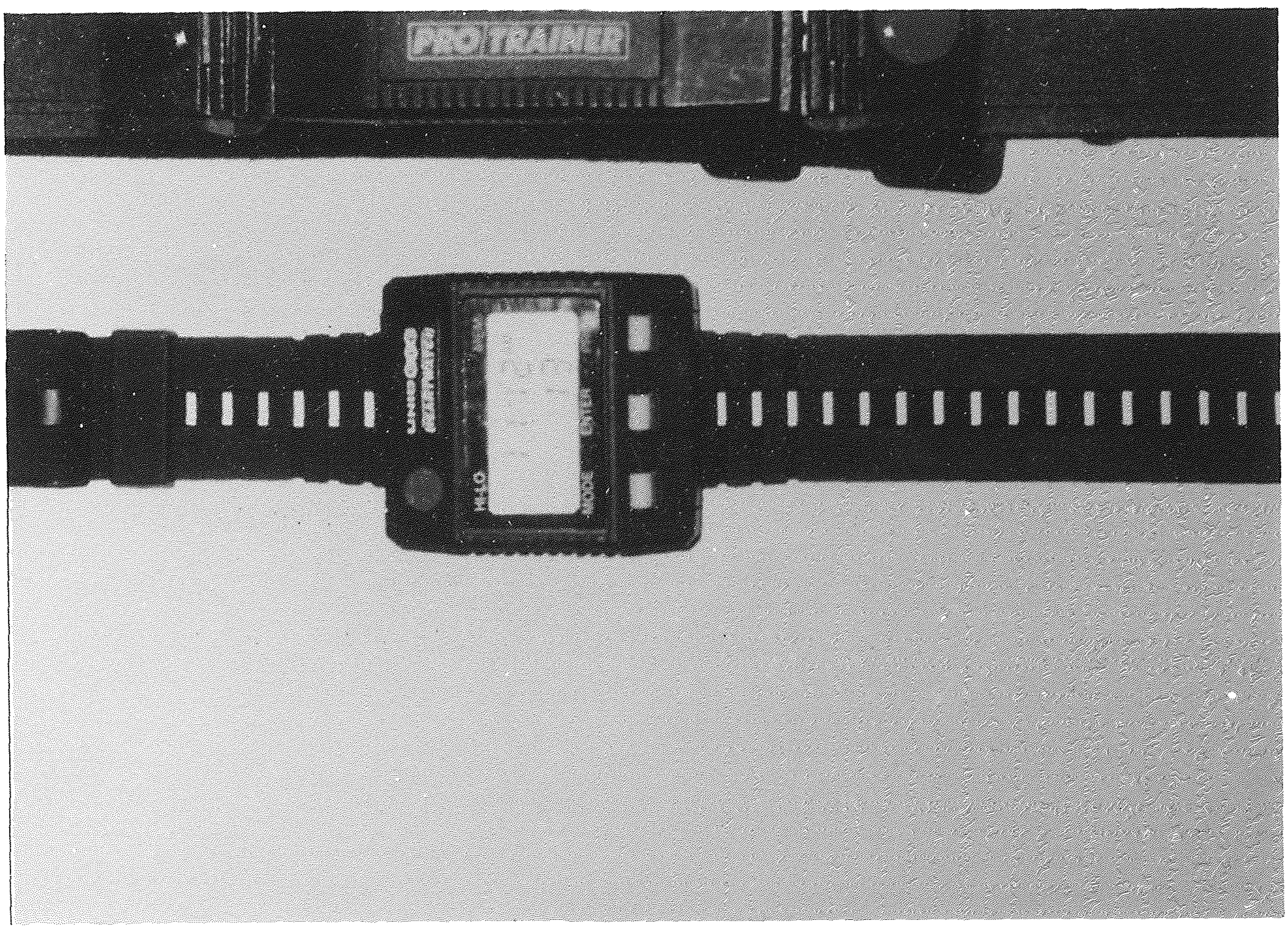

Figure 5 UNIC CIC Heartwatch Model 8799

heartwatch was the electrode strap. This strap consists of two transmitter connectors and two rubber electrodes, which send electronic signals to the heartwatch. This electrode strap was attached at the chest of each tested individual.

The different types of noise and sound pressure levels were amplified by an ONKYO P-301 Infrared wireless remote controlled stereo preamplifier. In order to measure the appropriate sound pressure level, a QUEST dosimeter was used when subjects were exposed to different types of noise. This equipment is shown in Figure 6.

3.6 Software

The software used for statistical data analysis was a computer package called Statistical Analysis System (SAS®). This software is used by engineering students at New Jersey Institute of Technology. The SAS® System, developed by SAS Institute Inc., is an integrated system of software. It provides a comprehensive approach for data management, analysis, and presentation. The SAS® System's analysis tools range from simple descriptive statistics to more advanced or specialized analyses for econometrics and forecasting, statistical design, computer performance evaluation, graphics, and operations research.

3.7 Experimental Design

The statistical matrix, shown on Table 2, was used for data collection and analysis. The matrix has S representing the types of noise and $y_{a,b,c}$ representing the dependent and independent variables used in this experiment. This experimental design focuses on any relationship or interaction which may exist between the independent and dependent variables. The experimental protocol followed the order shown in Appendix C. This protocol was strictly followed by the experimenter throughout this research project.

Figure 6 Equipment Used to Reproduce Noise

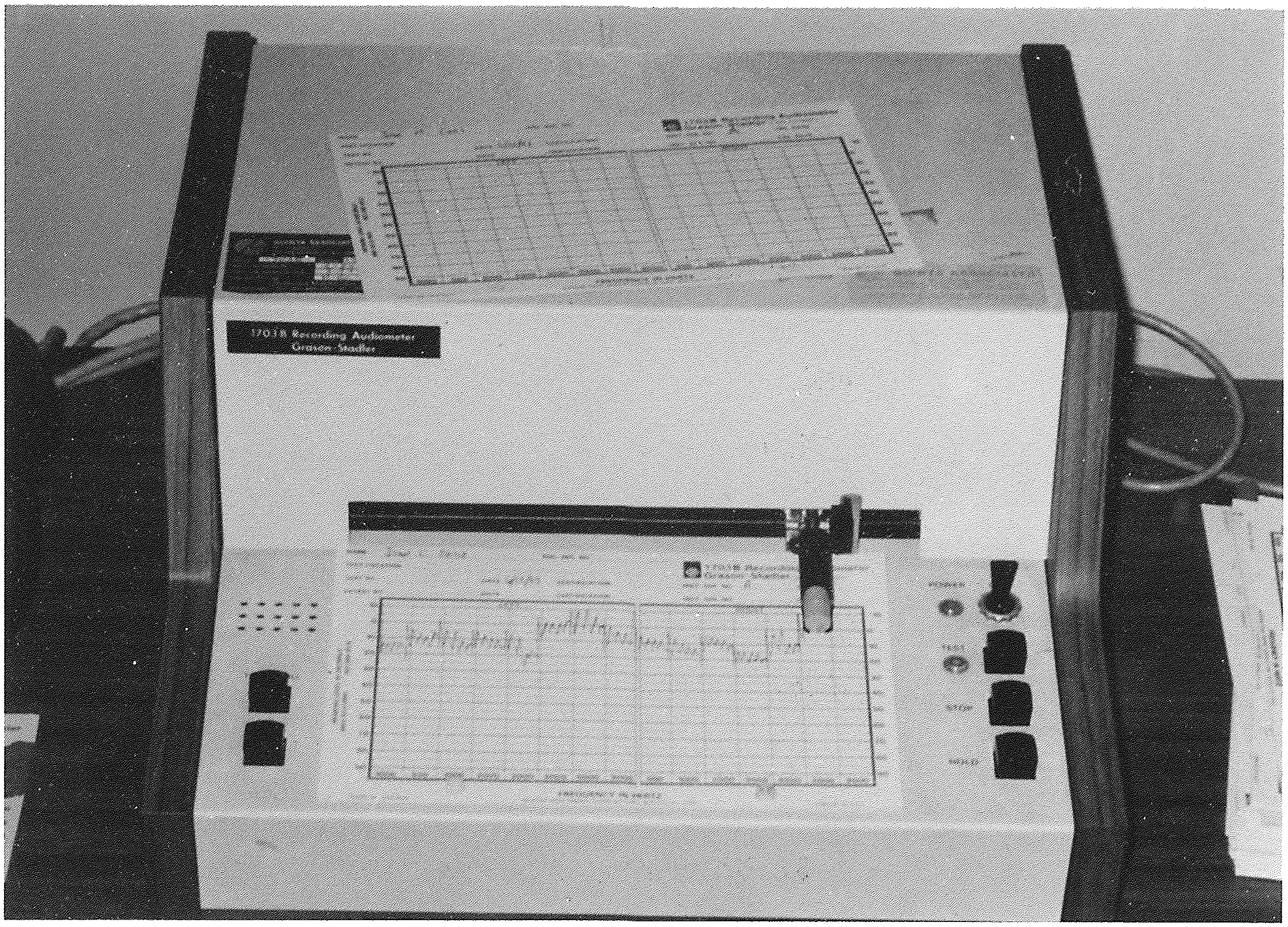

Figure 7 A Grayson Stadler Audiometer Model #1703B

Table 2 Experimental Design Matrix

Types of Noise	Noise Level			
	60 dBA	70 dBA	80 dBA	85 dBA
S1	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$
S2	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$
S3	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$
S4	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$
S5	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$	$y_{a,b,c,d,e}$

3.7.1 Independent Variables

The factors used for the experimental design were : (1) sex, (2) type of noise, and (3) noise level.

3.7.2 Dependent Variables

The main dependent variable obtained in this experiment was heart rate, as measured in beats per minute.

3.8 Experimental Procedure

Each subject filled out a questionnaire in order to gather information about their physical condition and cardiac history. An audiometric test was given to the participants in order to check for temporary threshold shifts (TTS). A Grayson Stadler audiometer, model #1703B was used here, with typical results shown in Figure 7. After this test, the participant entered the anechoic chamber. The subject experienced five types of noise (i.e. white noise, pink noise, etc.) as shown in Table 3 , at sound pressure levels of 60, 70, 80, and 85 dBA. These types of noise lasted for thirty seconds, while the subject remained in the anechoic chamber wearing the heartwatch.

Table 3 Five Types of Noise Used for Experimentation

TYPES OF NOISE USED
boiler room (t1)
exhaust fan for power saw (t2)
pump room (t3)
screw gun (t4)
compressor room (t5)

These five noises and four sound levels were presented in random order, so that each subject was exposed to a total of twenty varieties of combined noise. The only restriction was that for each type of noise selected, the sound level was presented randomly. After each noise exposure, a two minute rest, was given to each individual before the next type of noise was presented to them.

Subjects were required to fill out a response form, in order to measure their heart rate and their level of annoyance (or sensitivity to noise) for each type of noise and sound pressure level.. This form is shown in Appendix D.

3.9 Data Analysis

A rigorous statistical analysis was performed to determine if there was any type of interaction between the variables (dependent and independent) used for this experiment. An analysis of variance (ANOVA) was performed using the SAS computer package. Another statistical tool used was a student t-test since the sample size was less than thirty subjects. A regression analysis was also performed in order to analyze iterations between the variables mentioned in sections 3.7.1 and 3.7.2.

CHAPTER 4

STATISTICAL RESULTS

A total of 1600 observations were taken throughout the span of this research (200 observations per subject). It is important to define each variable used for the ANOVA (refer to Table 2 and Table 4):

1. *subject*; person used for experimental purpose (1 to 16),
2. *type* (t_1, t_2, t_3, t_4, t_5) ; represents the different types of noise (refer to Table 4),
3. *slevel* (l_1, l_2, l_3, l_4); represents the different sound pressure levels (refer to section 3.3),
4. sex (m, f); represents the subject's gender (male or female), and
5. *hrate*; represents the heart beat of person during experimentation.

Table 4 Class Level Information From ANOVA Analysis

Class	Levels	Values
Type	5	t_1, t_2, t_3, t_4, t_5
Slevel	4	l_1, l_2, l_3, l_4
Sex	2	m, f

After the data were entered , a statistical tool used by SAS®, procedure ANOVA, allows us to determine if the model used by the experimenter shows any relationship between human heart beat and gender, and the type of noise and sound level encountered. The ANOVA model (see Appendices E and F), showed that the overall F value was 25.46, meaning that there is no significant interaction at a value greater than five percent. Also, the output of SAS showed that the F values for the independent variables (type of noise, sound level, sex, and some of their interactions between them) were not significant at 5 percent. But, it is important to demonstrate that even though the F values are not significant, they are close to one, which makes this a good statistical model.

The analysis of the results of this experiment do not show if sex plays a role on any effects noise may exert on heart rate. This is because the F value exceeds five percent, but this value alone does not reveal if the F value is realistic or conclusive. On the other hand, the interactions between the type of noise and sex, and sound level and sex variables showed that there is a strong chance that this possibility may be responsible for some of the effects to the heart rate.

Finally, the hypothesis to be proven :

H_O : Sex does not affect human heart rate.

H_1 : Sex does affect human heart rate

has been demonstrated. Using a t-test with n=16 and a confidence level of 95 percent, it was shown that the hypothesis H_O should be accepted as noted in Appendix F. Therefore, the statistical analysis proves that gender does not affect human heart rate.

CHAPTER 5

CONCLUSIONS

Many sounds and/or noises can indirectly cause autonomic system reactions that are deemed physiologically stressful. These are sounds which create feelings of emotion (i.e. startle, fear, anger, etc.) in the listener because of their unexpectedness or other meanings they can convey, or because of the annoyance caused by interference with rest, and/or job performance. The only conclusively established effect of noise on health remains that of noise-induced hearing loss. In addition, noise can permanently damage the inner ear, interfere with speech and communication, disturb sleep, be a source of annoyance, influence mood and disturb relaxation, and interfere with job performance or other complicated tasks (Miller, 1974).

Experimental evidence demonstrated that sex does not play a role with respect to any effects which noise may exert on heart rate. But, it showed that there is a close relationship between the interaction of noise and sex, and sex and sound level. Both interactions suggest the possibility that noise may cause some effects on heart rate, but the data is inconclusive. Perhaps the stress of continued exposure to high levels of noise can produce disease or make one more susceptible to disease, but again the evidence is not conclusive. Thus, noise could be one of several external factors contributing to the development of hypertension in humans, particularly in susceptible individuals. This will be difficult to evaluate but it is important to conduct research in this field because cardiovascular diseases accounted for almost a million deaths in the United States, only a few years ago. A review of existing information on the relationship between certain workplace factors (such as industrial noise) and cardiovascular disease indicates that millions of workers are currently exposed to selected work-related factors which are associated with an increased risk of cardiovascular diseases.

Although positive findings exist concerning the relationship of chronic noise exposure to heart rate, the consensus today is that existing literature does not permit inferences of cause and effect or derivations of dose-response relationships for noise and heart rate or any other medically significant cardiovascular response or health outcome.

Finally, it is recommended that further research be conducted in this field. This research could be expanded by using other variables such as blood pressure, pulse rate, cardiac output, and span of noise, etc. to look for other specific interactions.

APPENDIX A

DESCRIPTION OF THE EXPERIMENT TO THE SUBJECTS

This experiment will investigate the effects on human heart rate by exposing you to different types of noise and sound levels. A pre-experimental questionnaire and an audiometric test will be given to you. If you are qualified, an informed consent form must be signed by you.

You will hear five different types of sound (noise), each for the period of 30 seconds. Whenever you are bothered by the noise, you have a right to terminate this experiment. The experimental session will last about one and a half hours. It is imperative that you do not expose yourself to high level noises, such as rock concerts or loud equipment (e.g. power saw, "walk-man stereo", etc.), over the period of time that you are participating in this study. Otherwise, the experiment performed may not yield accurate results.

You will wear sophisticated equipment before you enter the auditory and anechoic chambers. An intercom system will be provided for communication with the experimenter while you are in either chamber. After exposure to the different types of noise and sound levels, you will experience a second audiometric test to measure temporary threshold shifts (TTS).

No risks will be posed by this experiment except possible stress and/or fatigue due to the length of the experiment. However, you will be able to rest after each noise exposure.

APPENDIX B

PARTICIPANT'S INFORMED CONSENT FORM

Your heart beat will be measured when exposed to different types of noise and different sound pressure levels. During your exposure to noise, your heart rate will be recorded on a form provided by the experimenter.

No hazardous sounds or other danger will occur during the experiment. The test will be conducted in a sound-proof chamber with the experimenter sitting outside. The door to the chamber will be shut but not locked during the test. You may open it from the inside, or the experimenter may open it from the outside in case of an emergency. An intercom system will be provided for communication with the experimenter.

No risk to your well-being will be posed by this experiment, although you may experience fatigue due to the length of the experiment (approximately 1.5 hours). After each type of noise and sound level ends, you are able to rest for a minute. You may elect to discontinue participation at any time.

As a participant in this experiment, you have certain rights, as stated below. This form is intended to describe these rights to you and to obtain your written consent to participate in this experiment at the New Jersey Institute of Technology.

Your rights as a participant :

1. You have the right to discontinue participating in this experiment at any time for any reason by simply informing to the experimenter.
2. You have the right to inspect your data and to withdraw it from the experiment. In general, data are processed and analyzed after all subjects have completed the experiment. Subsequently, all the data are treated anonymously and confidentially in all analyses, reports, and publications resulting from the experiment. Therefore, if you

wish to withdraw your data, you must do so immediately after your participation is completed; otherwise, your name cannot be associate with your data.

3. You have the right to be informed as to general results of the experiment. If you wish to receive a synopsis of the results, include your address with your signature at the space provided below this form. If, after receiving the synopsis, you would like further information, please contact the Mechanical and Industrial Engineering Department, and a more detailed report will be made available to you. To avoid biasing other potential subjects, you must not discuss the study with anyone until a year from now.
4. You may ask questions of the experimenter at any time prior to data collection. All questions will be answered to your satisfaction subject only to the constraint that an answer will not prebias the outcome of the experiment. If bias would occur, with your permission an answer will be delayed until after data collection, at which time a full answer will be given.
5. Your name, address, or phone number will not be disclosed by any means. This information will be considered confidential.

The experimenter sincerely appreciates your participation and hopes that you find the experiment an interesting experience. At least, you will have the satisfaction of knowing your audiometric test results and how sensitive you are to noise.

Before you sign this form, please make sure that you understand, to your complete satisfaction, the nature of the study and your rights as a participant. If you have any questions, please do so at this time. Then if you decide to participate, please sign your name and provide your phone number in case the experimenter has to communicate with you.

The researcher, Jose R. Fabregas, a graduate student from NJIT, and his thesis advisor, Dr. Min-Yong Park can be contacted at the address and phone number below :

Mechanical and Industrial Engineering Department
New Jersey Institute of Technology
Newark, NJ 07102
(201) 596-3658

Tear along the dotted line

I have read description of this study and understand the nature of the research and my rights as a participant. I hereby consent to participate, with the understanding that I may discontinue participation at any time if I choose to do so.

Signature : ______________________________

Printed Name : ______________________________

Date : __________ Phone : ______________

Address : ______________________________

____

____

I will like to receive a synopsis of the experiment : _____ Yes _____ No

APPENDIX C

EXPERIMENTAL PROTOCOL

1. Subject reads instructions about the experiment (5 minutes)
2. If subject agrees, subject fills out a consent form and a pre-experimental questionnaire (2 minutes).
3. Experimenter explains to subject the audiometric testing procedure (2 minutes).
4. Start audiometer (3 minutes).
5. Move audiometer cursor from left to right until a "click" is heard (10 seconds).
6. Take the red plastic cap from head pin of the audiometer (10 seconds).
7. Subject would wear and adjust earphones with the assistance of the experimenter (1 minute).
8. Subject enters the IAC audiometric chamber, and both ears are audiometrically tested to check for temporary threshold shifts (TTS) by pressing the test button (10 minutes).
9. If subject passes the test, continue to step (10).
10. The subject should wear and adjust the heartwatch and electrode strap before entering the anechoic chamber (5 minutes).
11. Before subject enters the chamber, he/she is asked to fill a form in order to record sensitivity to noise and heart beat (displayed by the Heartwatch).
12. Subject enters the anechoic chamber and a practice trial is run (3 minutes).
13. Noise exposure begins.
14. Subject will be standing up at time of exposure and every 10 second, for each type and level of noise, subject will record his heart beat (displayed by the Heartwatch) on the form noted in step (11).

15. A type of noise and sound level will be chosen randomly by the experimenter.
16. Experimenter reproduces the type of noise and sound pressure level on loudspeakers inside the chamber .
17. After the subject is exposed to the type of noise and sound pressure level for thirty seconds, he/she can take a two minute rest by sitting down in a chair provided inside the chamber.
18. Repeat step (13) through step (16) until the experimental subject is exposed to a total of twenty combinations of noise.
19. Subject is given a second audiometric test to measure his/her temporary threshold shift (TTS). Repeat from step (6) to step (8). This will last approximately eleven minutes.
20. Subject is debriefed and thanked for his/her contribution to this experiment.

APPENDIX D

PARTICIPANT'S RESPONSE FORM

Participant's Response Form

Answer the following question during and/or before you been exposed to noise. In the space provided below, record your heart beat, as shown while wearing the heartwatch. Then select the best answer to the following question :

Rate your sensitivity to this type of noise and sound pressure level. Select (1) not irritating at all, (2) slightly irritating, (3) average, (4) more irritating, or (5) most irritating

1. Heart Rate for sound 1 : _______ Sensitivity : _____
2. Heart Rate for sound 2 : _______ Sensitivity : _____
3. Heart Rate for sound 3 : _______ Sensitivity : _____
4. Heart Rate for sound 4 : _______ Sensitivity : _____
5. Heart Rate for sound 5 : _______ Sensitivity : _____
6. Heart Rate for sound 6 : _______ Sensitivity : _____
7. Heart Rate for sound 7 : _______ Sensitivity : _____
8. Heart Rate for sound 8 : _______ Sensitivity : _____
9. Heart Rate for sound 9 : _______ Sensitivity : _____
10. Heart Rate for sound 10 : _______ Sensitivity : _____
11. Heart Rate for sound 11 : _______ Sensitivity : _____
12. Heart Rate for sound 12 : _______ Sensitivity : _____
13. Heart Rate for sound 13 : _______ Sensitivity : _____
14. Heart Rate for sound 14 : _______ Sensitivity : _____
15. Heart Rate for sound 15 : _______ Sensitivity : _____
16. Heart Rate for sound 16 : _______ Sensitivity : _____
17. Heart Rate for sound 17 : _______ Sensitivity : _____
18. Heart Rate for sound 18 : _______ Sensitivity : _____
19. Heart Rate for sound 19 : _______ Sensitivity : _____
20. Heart Rate for sound 20 : _______ Sensitivity : _____

APPENDIX E

EXPERIMENTAL DATA

The data is tabulated by the statistical software as discussed on page 23. The experiment consists of a total of 1600 observations, that is, 100 observations per person (refer to Table 2).

Experimental Data

17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1	1	m	t1	l1	62
2	1	m	t1	l1	64
3	1	m	t1	l1	63
4	1	m	t1	l1	63
5	1	m	t1	l1	65
6	1	m	t1	l2	68
7	1	m	t1	l2	71
8	1	m	t1	l2	66
9	1	m	t1	l2	65
10	1	m	t1	l2	69
11	1	m	t1	l3	71
12	1	m	t1	l3	71
13	1	m	t1	l3	68
14	1	m	t1	l3	66
15	1	m	t1	l3	66
16	1	m	t1	l4	70
17	1	m	t1	l4	69
18	1	m	t1	l4	66
19	1	m	t1	l4	65
20	1	m	t1	l4	65
21	1	m	t2	l1	65

Experimental Data 2
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
22	1	m	t2	l1	68
23	1	m	t2	l1	70
24	1	m	t2	l1	69
25	1	m	t2	l1	68
26	1	m	t2	l2	70
27	1	m	t2	l2	70
28	1	m	t2	l2	63
29	1	m	t2	l2	64
30	1	m	t2	l2	66
31	1	m	t2	l3	60
32	1	m	t2	l3	65
33	1	m	t2	l3	67
34	1	m	t2	l3	67
35	1	m	t2	l3	65
36	1	m	t2	l4	72
37	1	m	t2	l4	71
38	1	m	t2	l4	70
39	1	m	t2	l4	67
40	1	m	t2	l4	67
41	1	m	t3	l1	65
42	1	m	t3	l1	66

Experimental Data 3
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
43	1	m	t3	l1	67
44	1	m	t3	l1	66
45	1	m	t3	l1	64
46	1	m	t3	l2	65
47	1	m	t3	l2	67
48	1	m	t3	l2	69
49	1	m	t3	l2	68
50	1	m	t3	l2	66
51	1	m	t3	l3	67
52	1	m	t3	l3	67
53	1	m	t3	l3	71
54	1	m	t3	l3	70
55	1	m	t3	l3	71
56	1	m	t3	l4	67
57	1	m	t3	l4	69
58	1	m	t3	l4	67
59	1	m	t3	l4	69
60	1	m	t3	l4	68
61	1	m	t4	l1	70
62	1	m	t4	l1	68
63	1	m	t4	l1	66

Experimental Data 4
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
64	1	m	t4	l1	66
65	1	m	t4	l1	67
66	1	m	t4	l2	66
67	1	m	t4	l2	64
68	1	m	t4	l2	64
69	1	m	t4	l2	63
70	1	m	t4	l2	63
71	1	m	t4	l3	66
72	1	m	t4	l3	70
73	1	m	t4	l3	69
74	1	m	t4	l3	70
75	1	m	t4	l3	69
76	1	m	t4	l4	67
77	1	m	t4	l4	67
78	1	m	t4	l4	68
79	1	m	t4	l4	67
80	1	m	t4	l4	67
81	1	m	t5	l1	64
82	1	m	t5	l1	66
83	1	m	t5	l1	67
84	1	m	t5	l1	67

Experimental Data 5
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
85	1	m	t5	l1	65
86	1	m	t5	l2	73
87	1	m	t5	l2	73
88	1	m	t5	l2	70
89	1	m	t5	l2	68
90	1	m	t5	l2	66
91	1	m	t5	l3	76
92	1	m	t5	l3	76
93	1	m	t5	l3	72
94	1	m	t5	l3	69
95	1	m	t5	l3	66
96	1	m	t5	l4	71
97	1	m	t5	l4	70
98	1	m	t5	l4	72
99	1	m	t5	l4	72
100	1	m	t5	l4	65
101	2	m	t1	l1	64
102	2	m	t1	l1	64
103	2	m	t1	l1	67
104	2	m	t1	l1	64
105	2	m	t1	l1	65

Experimental Data 6
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
106	2	m	t1	l2	57
107	2	m	t1	l2	59
108	2	m	t1	l2	67
109	2	m	t1	l2	65
110	2	m	t1	l2	61
111	2	m	t1	l3	64
112	2	m	t1	l3	64
113	2	m	t1	l3	64
114	2	m	t1	l3	65
115	2	m	t1	l3	64
116	2	m	t1	l4	70
117	2	m	t1	l4	70
118	2	m	t1	l4	70
119	2	m	t1	l4	68
120	2	m	t1	l4	65
121	2	m	t2	l1	61
122	2	m	t2	l1	60
123	2	m	t2	l1	57
124	2	m	t2	l1	58
125	2	m	t2	l1	59
126	2	m	t2	l2	63

Experimental Data 7
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
127	2	m	t2	l2	69
128	2	m	t2	l2	66
129	2	m	t2	l2	62
130	2	m	t2	l2	63
131	2	m	t2	l3	57
132	2	m	t2	l3	62
133	2	m	t2	l3	60
134	2	m	t2	l3	63
135	2	m	t2	l3	64
136	2	m	t2	l4	64
137	2	m	t2	l4	66
138	2	m	t2	l4	77
139	2	m	t2	l4	75
140	2	m	t2	l4	70
141	2	m	t3	l1	58
142	2	m	t3	l1	59
143	2	m	t3	l1	63
144	2	m	t3	l1	60
145	2	m	t3	l1	59
146	2	m	t3	l2	55
147	2	m	t3	l2	65

Experimental Data 8
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
148	2	m	t3	l2	65
149	2	m	t3	l2	64
150	2	m	t3	l2	62
151	2	m	t3	l3	60
152	2	m	t3	l3	63
153	2	m	t3	l3	65
154	2	m	t3	l3	68
155	2	m	t3	l3	67
156	2	m	t3	l4	62
157	2	m	t3	l4	66
158	2	m	t3	l4	67
159	2	m	t3	l4	66
160	2	m	t3	l4	64
161	2	m	t4	l1	57
162	2	m	t4	l1	58
163	2	m	t4	l1	58
164	2	m	t4	l1	58
165	2	m	t4	l1	59
166	2	m	t4	l2	62
167	2	m	t4	l2	63
168	2	m	t4	l2	61

Experimental Data 9
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
169	2	m	t4	12	61
170	2	m	t4	12	63
171	2	m	t4	13	59
172	2	m	t4	13	60
173	2	m	t4	13	62
174	2	m	t4	13	63
175	2	m	t4	13	62
176	2	m	t4	14	62
177	2	m	t4	14	62
178	2	m	t4	14	62
179	2	m	t4	14	62
180	2	m	t4	14	67
181	2	m	t5	11	63
182	2	m	t5	11	65
183	2	m	t5	11	64
184	2	m	t5	11	63
185	2	m	t5	11	64
186	2	m	t5	12	65
187	2	m	t5	12	63
188	2	m	t5	12	64
189	2	m	t5	12	69

Experimental Data 10
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
190	2	m	t5	12	63
191	2	m	t5	13	70
192	2	m	t5	13	71
193	2	m	t5	13	68
194	2	m	t5	13	64
195	2	m	t5	13	57
196	2	m	t5	14	63
197	2	m	t5	14	63
198	2	m	t5	14	64
199	2	m	t5	14	64
200	2	m	t5	14	67
201	3	f	t1	11	72
202	3	f	t1	11	72
203	3	f	t1	11	69
204	3	f	t1	11	68
205	3	f	t1	11	68
206	3	f	t1	12	63
207	3	f	t1	12	74
208	3	f	t1	12	72
209	3	f	t1	12	69
210	3	f	t1	12	68

Experimental Data 11
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
211	3	f	t1	l3	81
212	3	f	t1	l3	78
213	3	f	t1	l3	74
214	3	f	t1	l3	72
215	3	f	t1	l3	75
216	3	f	t1	l4	71
217	3	f	t1	l4	67
218	3	f	t1	l4	69
219	3	f	t1	l4	71
220	3	f	t1	l4	68
221	3	f	t2	l1	66
222	3	f	t2	l1	69
223	3	f	t2	l1	65
224	3	f	t2	l1	66
225	3	f	t2	l1	69
226	3	f	t2	l2	68
227	3	f	t2	l2	70
228	3	f	t2	l2	70
229	3	f	t2	l2	69
230	3	f	t2	l2	69
231	3	f	t2	l3	71

Experimental Data 12
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
232	3	f	t2	l3	71
233	3	f	t2	l3	70
234	3	f	t2	l3	71
235	3	f	t2	l3	71
236	3	f	t2	l4	63
237	3	f	t2	l4	63
238	3	f	t2	l4	65
239	3	f	t2	l4	69
240	3	f	t2	l4	69
241	3	f	t3	l1	64
242	3	f	t3	l1	65
243	3	f	t3	l1	66
244	3	f	t3	l1	65
245	3	f	t3	l1	64
246	3	f	t3	l2	78
247	3	f	t3	l2	80
248	3	f	t3	l2	76
249	3	f	t3	l2	72
250	3	f	t3	l2	74
251	3	f	t3	l3	68
252	3	f	t3	l3	70

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
253	3	f	t3	l3	68
254	3	f	t3	l3	66
255	3	f	t3	l3	65
256	3	f	t3	l4	67
257	3	f	t3	l4	67
258	3	f	t3	l4	74
259	3	f	t3	l4	73
260	3	f	t3	l4	63
261	3	f	t4	l1	84
262	3	f	t4	l1	84
263	3	f	t4	l1	76
264	3	f	t4	l1	75
265	3	f	t4	l1	77
266	3	f	t4	l2	75
267	3	f	t4	l2	75
268	3	f	t4	l2	77
269	3	f	t4	l2	79
270	3	f	t4	l2	75
271	3	f	t4	l3	71
272	3	f	t4	l3	69
273	3	f	t4	l3	68

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
274	3	f	t4	l3	69
275	3	f	t4	l3	67
276	3	f	t4	l4	72
277	3	f	t4	l4	72
278	3	f	t4	l4	71
279	3	f	t4	l4	71
280	3	f	t4	l4	73
281	3	f	t5	l1	74
282	3	f	t5	l1	74
283	3	f	t5	l1	73
284	3	f	t5	l1	71
285	3	f	t5	l1	73
286	3	f	t5	l2	65
287	3	f	t5	l2	66
288	3	f	t5	l2	66
289	3	f	t5	l2	67
290	3	f	t5	l2	66
291	3	f	t5	l3	76
292	3	f	t5	l3	77
293	3	f	t5	l3	73
294	3	f	t5	l3	71

Experimental Data 15
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
295	3	f	t5	13	70
296	3	f	t5	14	83
297	3	f	t5	14	82
298	3	f	t5	14	80
299	3	f	t5	14	78
300	3	f	t5	14	85
301	4	f	t1	11	69
302	4	f	t1	11	66
303	4	f	t1	11	65
304	4	f	t1	11	70
305	4	f	t1	11	68
306	4	f	t1	12	71
307	4	f	t1	12	72
308	4	f	t1	12	69
309	4	f	t1	12	70
310	4	f	t1	12	69
311	4	f	t1	13	82
312	4	f	t1	13	84
313	4	f	t1	13	84
314	4	f	t1	13	82
315	4	f	t1	13	78

Experimental Data 16
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
316	4	f	t1	14	73
317	4	f	t1	14	76
318	4	f	t1	14	72
319	4	f	t1	14	73
320	4	f	t1	14	72
321	4	f	t2	11	67
322	4	f	t2	11	66
323	4	f	t2	11	67
324	4	f	t2	11	63
325	4	f	t2	11	64
326	4	f	t2	12	65
327	4	f	t2	12	65
328	4	f	t2	12	67
329	4	f	t2	12	67
330	4	f	t2	12	70
331	4	f	t2	13	70
332	4	f	t2	13	67
333	4	f	t2	13	69
334	4	f	t2	13	69
335	4	f	t2	13	69
336	4	f	t2	14	68

Experimental Data 17
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
337	4	f	t2	l4	70
338	4	f	t2	l4	70
339	4	f	t2	l4	72
340	4	f	t2	l4	71
341	4	f	t3	l1	63
342	4	f	t3	l1	65
343	4	f	t3	l1	65
344	4	f	t3	l1	67
345	4	f	t3	l1	64
346	4	f	t3	l2	69
347	4	f	t3	l2	72
348	4	f	t3	l2	75
349	4	f	t3	l2	73
350	4	f	t3	l2	72
351	4	f	t3	l3	66
352	4	f	t3	l3	65
353	4	f	t3	l3	67
354	4	f	t3	l3	67
355	4	f	t3	l3	68
356	4	f	t3	l4	70
357	4	f	t3	l4	70

Experimental Data 18
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
358	4	f	t3	l4	70
359	4	f	t3	l4	70
360	4	f	t3	l4	70
361	4	f	t4	l1	73
362	4	f	t4	l1	75
363	4	f	t4	l1	78
364	4	f	t4	l1	80
365	4	f	t4	l1	71
366	4	f	t4	l2	77
367	4	f	t4	l2	78
368	4	f	t4	l2	78
369	4	f	t4	l2	78
370	4	f	t4	l2	78
371	4	f	t4	l3	61
372	4	f	t4	l3	62
373	4	f	t4	l3	63
374	4	f	t4	l3	62
375	4	f	t4	l3	61
376	4	f	t4	l4	69
377	4	f	t4	l4	65
378	4	f	t4	l4	65

Experimental Data 19
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
379	4	f	t4	14	67
380	4	f	t4	14	67
381	4	f	t5	11	71
382	4	f	t5	11	69
383	4	f	t5	11	73
384	4	f	t5	11	71
385	4	f	t5	11	72
386	4	f	t5	12	64
387	4	f	t5	12	64
388	4	f	t5	12	64
389	4	f	t5	12	66
390	4	f	t5	12	65
391	4	f	t5	13	67
392	4	f	t5	13	66
393	4	f	t5	13	66
394	4	f	t5	13	67
395	4	f	t5	13	69
396	4	f	t5	14	81
397	4	f	t5	14	81
398	4	f	t5	14	81
399	4	f	t5	14	80

Experimental Data 20
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
400	4	f	t5	14	83
401	5	f	t1	11	69
402	5	f	t1	11	70
403	3	f	t1	11	70
404	5	f	t1	11	71
405	5	f	t1	11	69
406	5	f	t1	12	68
407	5	f	t1	12	69
408	3	f	t1	12	69
409	5	f	t1	12	69
410	5	f	t1	12	68
411	5	f	t1	13	84
412	5	f	t1	13	83
413	3	f	t1	13	77
414	5	f	t1	13	82
415	5	f	t1	13	85
416	5	f	t1	14	79
417	5	f	t1	14	77
418	3	f	t1	14	79
419	5	f	t1	14	71
420	5	f	t1	14	78

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
463	3	f	t4	l1	77
464	5	f	t4	l1	77
465	5	f	t4	l1	79
466	5	f	t4	l2	70
467	5	f	t4	l2	70
468	3	f	t4	l2	71
469	5	f	t4	l2	71
470	5	f	t4	l2	69
471	5	f	t4	l3	65
472	5	f	t4	l3	65
473	3	f	t4	l3	65
474	5	f	t4	l3	65
475	5	f	t4	l3	64
476	5	f	t4	l4	69
477	5	f	t4	l4	72
478	3	f	t4	l4	68
479	5	f	t4	l4	68
480	5	f	t4	l4	64
481	5	f	t5	l1	66
482	5	f	t5	l1	67
483	3	f	t5	l1	67

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
484	5	f	t5	l1	69
485	5	f	t5	l1	69
486	5	f	t5	l2	63
487	5	f	t5	l2	63
488	3	f	t5	l2	64
489	5	f	t5	l2	64
490	5	f	t5	l2	63
491	5	f	t5	l3	80
492	5	f	t5	l3	79
493	3	f	t5	l3	77
494	5	f	t5	l3	77
495	5	f	t5	l3	76
496	5	f	t5	l4	81
497	5	f	t5	l4	81
498	3	f	t5	l4	83
499	5	f	t5	l4	83
500	5	f	t5	l4	80
501	6	f	t1	l1	68
502	6	f	t1	l1	67
503	6	f	t1	l1	69
504	6	f	t1	l1	69

Experimental Data 21
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
421	5	f	t2	l1	59
422	5	f	t2	l1	59
423	3	f	t2	l1	60
424	5	f	t2	l1	60
425	5	f	t2	l1	62
426	5	f	t2	l2	68
427	5	f	t2	l2	70
428	3	f	t2	l2	69
429	5	f	t2	l2	69
430	5	f	t2	l2	66
431	5	f	t2	l3	82
432	5	f	t2	l3	79
433	3	f	t2	l3	77
434	5	f	t2	l3	77
435	5	f	t2	l3	79
436	5	f	t2	l4	60
437	5	f	t2	l4	60
438	3	f	t2	l4	61
439	5	f	t2	l4	62
440	5	f	t2	l4	62
441	5	f	t3	l1	66

Experimental Data 22
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
442	5	f	t3	l1	67
443	3	f	t3	l1	67
444	5	f	t3	l1	69
445	5	f	t3	l1	69
446	5	f	t3	l2	88
447	5	f	t3	l2	85
448	3	f	t3	l2	76
449	5	f	t3	l2	79
450	5	f	t3	l2	79
451	5	f	t3	l3	63
452	5	f	t3	l3	70
453	3	f	t3	l3	64
454	5	f	t3	l3	69
455	5	f	t3	l3	66
456	5	f	t3	l4	67
457	5	f	t3	l4	68
458	3	f	t3	l4	68
459	5	f	t3	l4	69
460	5	f	t3	l4	67
461	5	f	t4	l1	75
462	5	f	t4	l1	75

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
505	6	f	t1	l1	67
506	6	f	t1	l2	70
507	6	f	t1	l2	70
508	6	f	t1	l2	71
509	6	f	t1	l2	71
510	6	f	t1	l2	70
511	6	f	t1	l3	59
512	6	f	t1	l3	63
513	6	f	t1	l3	64
514	6	f	t1	l3	63
515	6	f	t1	l3	64
516	6	f	t1	l4	66
517	6	f	t1	l4	67
518	6	f	t1	l4	66
519	6	f	t1	l4	69
520	6	f	t1	l4	68
521	6	f	t2	l1	58
522	6	f	t2	l1	59
523	6	f	t2	l1	55
524	6	f	t2	l1	63
525	6	f	t2	l1	62

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
526	6	f	t2	l2	62
527	6	f	t2	l2	64
528	6	f	t2	l2	64
529	6	f	t2	l2	65
530	6	f	t2	l2	65
531	6	f	t2	l3	73
532	6	f	t2	l3	73
533	6	f	t2	l3	69
534	6	f	t2	l3	69
535	6	f	t2	l3	72
536	6	f	t2	l4	67
537	6	f	t2	l4	68
538	6	f	t2	l4	68
539	6	f	t2	l4	69
540	6	f	t2	l4	68
541	6	f	t3	l1	64
542	6	f	t3	l1	64
543	6	f	t3	l1	66
544	6	f	t3	l1	64
545	6	f	t3	l1	64
546	6	f	t3	l2	73

Experimental Data 27
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
547	6	f	t3	12	72
548	6	f	t3	12	72
549	6	f	t3	12	71
550	6	f	t3	12	71
551	6	f	t3	13	70
552	6	f	t3	13	70
553	6	f	t3	13	69
554	6	f	t3	13	69
555	6	f	t3	13	69
556	6	f	t3	14	69
557	6	f	t3	14	68
558	6	f	t3	14	69
559	6	f	t3	14	67
560	6	f	t3	14	69
561	6	f	t4	11	81
562	6	f	t4	11	79
563	6	f	t4	11	79
564	6	f	t4	11	81
565	6	f	t4	11	74
566	6	f	t4	12	69

Experimental Data 28
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
568	6	f	t4	12	66
569	6	f	t4	12	69
570	6	f	t4	12	66
571	6	f	t4	13	75
572	6	f	t4	13	74
573	6	f	t4	13	71
574	6	f	t4	13	74
575	6	f	t4	13	70
576	6	f	t4	14	72
577	6	f	t4	14	70
578	6	f	t4	14	70
579	6	f	t4	14	70
580	6	f	t4	14	72
581	6	f	t5	11	77
582	6	f	t5	11	76
583	6	f	t5	11	76
584	6	f	t5	11	78
585	6	f	t5	11	78
586	6	f	t5	12	60
587	6	f	t5	12	60
588	6	f	t5	12	59

Experimental Data 29
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
589	6	f	t5	12	63
590	6	f	t5	12	63
591	6	f	t5	13	87
592	6	f	t5	13	87
593	6	f	t5	13	83
594	6	f	t5	13	81
595	6	f	t5	13	81
596	6	f	t5	14	73
597	6	f	t5	14	72
598	6	f	t5	14	69
599	6	f	t5	14	72
600	6	f	t5	14	72
601	7	m	t1	11	70
602	8	m	t1	11	70
603	7	m	t1	11	69
604	7	m	t1	11	69
605	7	m	t1	11	67
606	7	m	t1	12	75
607	8	m	t1	12	73
608	7	m	t1	12	66
609	7	m	t1	12	69

Experimental Data 30
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
610	7	m	t1	12	69
611	7	m	t1	13	59
612	8	m	t1	13	61
613	7	m	t1	13	64
614	7	m	t1	13	61
615	7	m	t1	13	63
616	7	m	t1	14	80
617	8	m	t1	14	79
618	7	m	t1	14	66
619	7	m	t1	14	75
620	7	m	t1	14	75
621	7	m	t2	11	63
622	8	m	t2	11	62
623	7	m	t2	11	63
624	7	m	t2	11	62
625	7	m	t2	11	63
626	7	m	t2	12	71
627	8	m	t2	12	71
628	7	m	t2	12	73
629	7	m	t2	12	69
630	7	m	t2	12	71

Experimental Data 31
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
631	7	m	t2	13	62
632	8	m	t2	13	62
633	7	m	t2	13	59
634	7	m	t2	13	60
635	7	m	t2	13	60
636	7	m	t2	14	69
637	8	m	t2	14	67
638	7	m	t2	14	67
639	7	m	t2	14	67
640	7	m	t2	14	68
641	7	m	t3	11	64
642	8	m	t3	11	64
643	7	m	t3	11	64
644	7	m	t3	11	65
645	7	m	t3	11	65
646	7	m	t3	12	70
647	8	m	t3	12	69
648	7	m	t3	12	69
649	7	m	t3	12	68
650	7	m	t3	12	67
651	7	m	t3	13	69

Experimental Data 32
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
652	8	m	t3	13	67
653	7	m	t3	13	68
654	7	m	t3	13	71
655	7	m	t3	13	70
656	7	m	t3	14	63
657	8	m	t3	14	62
658	7	m	t3	14	64
659	7	m	t3	14	63
660	7	m	t3	14	62
661	7	m	t4	11	73
662	8	m	t4	11	72
663	7	m	t4	11	76
664	7	m	t4	11	76
665	7	m	t4	11	77
666	7	m	t4	12	60
667	8	m	t4	12	59
668	7	m	t4	12	63
669	7	m	t4	12	63
670	7	m	t4	12	63
671	7	m	t4	13	69
672	8	m	t4	13	70

Experimental Data 33
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
673	7	m	t4	13	69
674	7	m	t4	13	69
675	7	m	t4	13	69
676	7	m	t4	14	66
677	8	m	t4	14	65
678	7	m	t4	14	65
679	7	m	t4	14	66
680	7	m	t4	14	67
681	7	m	t5	11	59
682	8	m	t5	11	55
683	7	m	t5	11	57
684	7	m	t5	11	59
685	7	m	t5	11	58
686	7	m	t5	12	77
687	8	m	t5	12	77
688	7	m	t5	12	75
689	7	m	t5	12	75
690	7	m	t5	12	75
691	7	m	t5	13	69
692	8	m	t5	13	70
693	7	m	t5	13	71

Experimental Data 34
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
694	7	m	t5	13	72
695	7	m	t5	13	71
696	7	m	t5	14	67
697	8	m	t5	14	67
698	7	m	t5	14	70
699	7	m	t5	14	70
700	7	m	t5	14	65
701	8	m	t1	11	64
702	8	m	t1	11	64
703	8	m	t1	11	67
704	8	m	t1	11	64
705	8	m	t1	11	65
706	8	m	t1	12	57
707	8	m	t1	12	59
708	8	m	t1	12	67
709	8	m	t1	12	65
710	8	m	t1	12	61
711	8	m	t1	13	64
712	8	m	t1	13	64
713	8	m	t1	13	64
714	8	m	t1	13	65

Experimental Data 35
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
715	8	m	t1	13	64
716	8	m	t1	14	70
717	8	m	t1	14	70
718	8	m	t1	14	70
719	8	m	t1	14	68
720	8	m	t1	14	65
721	8	m	t2	11	61
722	8	m	t2	11	60
723	8	m	t2	11	57
724	8	m	t2	11	58
725	8	m	t2	11	59
726	8	m	t2	12	63
727	8	m	t2	12	69
728	8	m	t2	12	66
729	8	m	t2	12	62
730	8	m	t2	12	63
731	8	m	t2	13	57
732	8	m	t2	13	62
733	8	m	t2	13	60
734	8	m	t2	13	63
735	8	m	t2	13	64

Experimental Data 36
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
736	8	m	t2	14	64
737	8	m	t2	14	66
738	8	m	t2	14	77
739	8	m	t2	14	75
740	8	m	t2	14	70
741	8	m	t3	11	58
742	8	m	t3	11	59
743	8	m	t3	11	63
744	8	m	t3	11	60
745	8	m	t3	11	59
746	8	m	t3	12	55
747	8	m	t3	12	65
748	8	m	t3	12	65
749	8	m	t3	12	64
750	8	m	t3	12	62
751	8	m	t3	13	60
752	8	m	t3	13	63
753	8	m	t3	13	65
754	8	m	t3	13	68
755	8	m	t3	13	67
756	8	m	t3	14	62

Experimental Data 37
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
757	8	m	t3	l4	66
758	8	m	t3	l4	67
759	8	m	t3	l4	66
760	8	m	t3	l4	64
761	8	m	t4	l1	57
762	8	m	t4	l1	58
763	8	m	t4	l1	58
764	8	m	t4	l1	58
765	8	m	t4	l1	59
766	8	m	t4	l2	62
767	8	m	t4	l2	63
768	8	m	t4	l2	61
769	8	m	t4	l2	61
770	8	m	t4	l2	63
771	8	m	t4	l3	59
772	8	m	t4	l3	60
773	8	m	t4	l3	62
774	8	m	t4	l3	63
775	8	m	t4	l3	62
776	8	m	t4	l4	62
777	8	m	t4	l4	62

Experimental Data 38
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
778	8	m	t4	l4	62
779	8	m	t4	l4	62
780	8	m	t4	l4	67
781	8	m	t5	l1	63
782	8	m	t5	l1	65
783	8	m	t5	l1	64
784	8	m	t5	l1	63
785	8	m	t5	l1	64
786	8	m	t5	l2	65
787	8	m	t5	l2	63
788	8	m	t5	l2	64
789	8	m	t5	l2	69
790	8	m	t5	l2	63
791	8	m	t5	l3	70
792	8	m	t5	l3	71
793	8	m	t5	l3	68
794	8	m	t5	l3	64
795	8	m	t5	l3	57
796	8	m	t5	l4	55
797	8	m	t5	l4	56
798	8	m	t5	l4	61

Experimental Data 39
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
799	8	m	t5	l4	61
800	8	m	t5	l4	60
801	9	m	t1	l1	61
802	9	m	t1	l1	62
803	9	m	t1	l1	61
804	9	m	t1	l1	62
805	9	m	t1	l1	59
806	9	m	t1	l2	66
807	9	m	t1	l2	70
808	9	m	t1	l2	69
809	9	m	t1	l2	67
810	9	m	t1	l2	68
811	9	m	t1	l3	69
812	9	m	t1	l3	71
813	9	m	t1	l3	67
814	9	m	t1	l3	69
815	9	m	t1	l3	69
816	9	m	t1	l4	70
817	9	m	t1	l4	69
818	9	m	t1	l4	69
819	9	m	t1	l4	68

Experimental Data 40
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
820	9	m	t1	l4	68
821	9	m	t2	l1	64
822	9	m	t2	l1	67
823	9	m	t2	l1	71
824	9	m	t2	l1	66
825	9	m	t2	l1	66
826	9	m	t2	l2	72
827	9	m	t2	l2	74
828	9	m	t2	l2	73
829	9	m	t2	l2	74
830	9	m	t2	l2	73
831	9	m	t2	l3	62
832	9	m	t2	l3	62
833	9	m	t2	l3	63
834	9	m	t2	l3	63
835	9	m	t2	l3	62
836	9	m	t2	l4	70
837	9	m	t2	l4	70
838	9	m	t2	l4	71
839	9	m	t2	l4	67
840	9	m	t2	l4	69

Experimental Data 41
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
841	9	m	t3	l1	67
842	9	m	t3	l1	66
843	9	m	t3	l1	67
844	9	m	t3	l1	66
845	9	m	t3	l1	64
846	9	m	t3	l2	66
847	9	m	t3	l2	67
848	9	m	t3	l2	69
849	9	m	t3	l2	68
850	9	m	t3	l2	66
851	9	m	t3	l3	67
852	9	m	t3	l3	67
853	9	m	t3	l3	71
854	9	m	t3	l3	70
855	9	m	t3	l3	70
856	9	m	t3	l4	67
857	9	m	t3	l4	69
858	9	m	t3	l4	67
859	9	m	t3	l4	69
860	9	m	t3	l4	68
861	9	m	t4	l1	70

Experimental Data 42
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
862	9	m	t4	l1	68
863	9	m	t4	l1	66
864	9	m	t4	l1	66
865	9	m	t4	l1	67
866	9	m	t4	l2	66
867	9	m	t4	l2	64
868	9	m	t4	l2	64
869	9	m	t4	l2	63
870	9	m	t4	l2	63
871	9	m	t4	l3	66
872	9	m	t4	l3	70
873	9	m	t4	l3	69
874	9	m	t4	l3	70
875	9	m	t4	l3	69
876	9	m	t4	l4	67
877	9	m	t4	l4	67
878	9	m	t4	l4	68
879	9	m	t4	l4	67
880	9	m	t4	l4	67
881	9	m	t5	l1	64
882	9	m	t5	l1	66

Experimental Data 43
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
883	9	m	t5	l1	67
884	9	m	t5	l1	67
885	9	m	t5	l1	65
886	9	m	t5	l2	73
887	9	m	t5	l2	73
888	9	m	t5	l2	70
889	9	m	t5	l2	68
890	9	m	t5	l2	66
891	9	m	t5	l3	72
892	9	m	t5	l3	73
893	9	m	t5	l3	72
894	9	m	t5	l3	71
895	9	m	t5	l3	71
896	9	m	t5	l4	71
897	9	m	t5	l4	70
898	9	m	t5	l4	72
899	9	m	t5	l4	72
900	9	m	t5	l4	65
901	10	m	t1	l1	65
902	10	m	t1	l1	65
903	10	m	t1	l1	63

Experimental Data 44
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
904	10	m	t1	l1	61
905	10	m	t1	l1	62
906	10	m	t1	l2	66
907	10	m	t1	l2	68
908	10	m	t1	l2	70
909	10	m	t1	l2	71
910	10	m	t1	l2	69
911	10	m	t1	l3	77
912	10	m	t1	l3	77
913	10	m	t1	l3	67
914	10	m	t1	l3	70
915	10	m	t1	l3	70
916	10	m	t1	l4	70
917	10	m	t1	l4	68
918	10	m	t1	l4	68
919	10	m	t1	l4	71
920	10	m	t1	l4	69
921	10	m	t2	l1	63
922	10	m	t2	l1	63
923	10	m	t2	l1	59
924	10	m	t2	l1	61

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
925	10	m	t2	l1	60
926	10	m	t2	l2	69
927	10	m	t2	l2	69
928	10	m	t2	l2	68
929	10	m	t2	l2	68
930	10	m	t2	l2	68
931	10	m	t2	l3	61
932	10	m	t2	l3	60
933	10	m	t2	l3	63
934	10	m	t2	l3	62
935	10	m	t2	l3	62
936	10	m	t2	l4	70
937	10	m	t2	l4	68
938	10	m	t2	l4	67
939	10	m	t2	l4	67
940	10	m	t2	l4	68
941	10	m	t3	l1	64
942	10	m	t3	l1	66
943	10	m	t3	l1	65
944	10	m	t3	l1	64
945	10	m	t3	l1	61

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
946	10	m	t3	l2	66
947	10	m	t3	l2	66
948	10	m	t3	l2	65
949	10	m	t3	l2	65
950	10	m	t3	l2	66
951	10	m	t3	l3	71
952	10	m	t3	l3	72
953	10	m	t3	l3	75
954	10	m	t3	l3	71
955	10	m	t3	l3	72
956	10	m	t3	l4	73
957	10	m	t3	l4	75
958	10	m	t3	l4	70
959	10	m	t3	l4	77
960	10	m	t3	l4	74
961	10	m	t4	l1	66
962	10	m	t4	l1	67
963	10	m	t4	l1	65
964	10	m	t4	l1	65
965	10	m	t4	l1	66
966	10	m	t4	l2	62

Experimental Data 47
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
967	10	m	t4	12	62
968	10	m	t4	12	65
969	10	m	t4	12	63
970	10	m	t4	12	63
971	10	m	t4	13	70
972	10	m	t4	13	70
973	10	m	t4	13	71
974	10	m	t4	13	71
975	10	m	t4	13	70
976	10	m	t4	14	64
977	10	m	t4	14	64
978	10	m	t4	14	64
979	10	m	t4	14	64
980	10	m	t4	14	65
981	10	m	t5	11	72
982	10	m	t5	11	63
983	10	m	t5	11	64
984	10	m	t5	11	63
985	10	m	t5	11	63
986	10	m	t5	12	66
987	10	m	t5	12	65

Experimental Data 48
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
988	10	m	t5	12	66
989	10	m	t5	12	64
990	10	m	t5	12	66
991	10	m	t5	13	77
992	10	m	t5	13	76
993	10	m	t5	13	69
994	10	m	t5	13	69
995	10	m	t5	13	71
996	10	m	t5	14	70
997	10	m	t5	14	70
998	10	m	t5	14	71
999	10	m	t5	14	72
1000	10	m	t5	14	69
1001	11	f	t1	11	66
1002	11	f	t1	11	65
1003	11	f	t1	11	63
1004	11	f	t1	11	61
1005	11	f	t1	11	66
1006	11	f	t1	12	66
1007	11	f	t1	12	68
1008	11	f	t1	12	70

Experimental Data 49
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1009	11	f	t1	12	71
1010	11	f	t1	12	71
1011	11	f	t1	13	77
1012	11	f	t1	13	77
1013	11	f	t1	13	67
1014	11	f	t1	13	70
1015	11	f	t1	13	70
1016	11	f	t1	14	70
1017	11	f	t1	14	68
1018	11	f	t1	14	68
1019	11	f	t1	14	71
1020	11	f	t1	14	69
1021	11	f	t2	11	63
1022	11	f	t2	11	63
1023	11	f	t2	11	59
1024	11	f	t2	11	61
1025	11	f	t2	11	60
1026	11	f	t2	12	69
1027	11	f	t2	12	69
1028	11	f	t2	12	68
1029	11	f	t2	12	68

Experimental Data 50
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1030	11	f	t2	12	68
1031	11	f	t2	13	61
1032	11	f	t2	13	60
1033	11	f	t2	13	63
1034	11	f	t2	13	62
1035	11	f	t2	13	62
1036	11	f	t2	14	70
1037	11	f	t2	14	68
1038	11	f	t2	14	67
1039	11	f	t2	14	67
1040	11	f	t2	14	68
1041	11	f	t3	11	64
1042	11	f	t3	11	66
1043	11	f	t3	11	65
1044	11	f	t3	11	64
1045	11	f	t3	11	61
1046	11	f	t3	12	66
1047	11	f	t3	12	66
1048	11	f	t3	12	65
1049	11	f	t3	12	65
1050	11	f	t3	12	66

Experimental Data 51
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1051	11	f	t3	13	71
1052	11	f	t3	13	72
1053	11	f	t3	13	75
1054	11	f	t3	13	71
1055	11	f	t3	13	72
1056	11	f	t3	14	73
1057	11	f	t3	14	75
1058	11	f	t3	14	70
1059	11	f	t3	14	77
1060	11	f	t3	14	74
1061	11	f	t4	11	66
1062	11	f	t4	11	67
1063	11	f	t4	11	65
1064	11	f	t4	11	65
1065	11	f	t4	11	65
1066	11	f	t4	12	62
1067	11	f	t4	12	62
1068	11	f	t4	12	65
1069	11	f	t4	12	63
1070	11	f	t4	12	63
1071	11	f	t4	13	70

Experimental Data 52
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1072	11	f	t4	13	69
1073	11	f	t4	13	71
1074	11	f	t4	13	71
1075	11	f	t4	13	70
1076	11	f	t4	14	64
1077	11	f	t4	14	64
1078	11	f	t4	14	64
1079	11	f	t4	14	64
1080	11	f	t4	14	65
1081	11	f	t5	11	72
1082	11	f	t5	11	63
1083	11	f	t5	11	64
1084	11	f	t5	11	63
1085	11	f	t5	11	63
1086	11	f	t5	12	66
1087	11	f	t5	12	65
1088	11	f	t5	12	66
1089	11	f	t5	12	64
1090	11	f	t5	12	66
1091	11	f	t5	13	77
1092	11	f	t5	13	76

Experimental Data 53
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1093	11	f	t5	13	69
1094	11	f	t5	13	69
1095	11	f	t5	13	71
1096	11	f	t5	14	70
1097	11	f	t5	14	70
1098	11	f	t5	14	71
1099	11	f	t5	14	72
1100	11	f	t5	14	70
1101	12	f	t1	11	66
1102	12	f	t1	11	64
1103	12	f	t1	11	64
1104	12	f	t1	11	64
1105	12	f	t1	11	64
1106	12	f	t1	12	66
1107	12	f	t1	12	68
1108	12	f	t1	12	70
1109	12	f	t1	12	71
1110	12	f	t1	12	67
1111	12	f	t1	13	71
1112	12	f	t1	13	72
1113	12	f	t1	13	67

Experimental Data 54
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1114	12	f	t1	13	70
1115	12	f	t1	13	70
1116	12	f	t1	14	70
1117	12	f	t1	14	68
1118	12	f	t1	14	68
1119	12	f	t1	14	71
1120	12	f	t1	14	69
1121	12	f	t2	11	63
1122	12	f	t2	11	63
1123	12	f	t2	11	59
1124	12	f	t2	11	61
1125	12	f	t2	11	60
1126	12	f	t2	12	66
1127	12	f	t2	12	69
1128	12	f	t2	12	68
1129	12	f	t2	12	68
1130	12	f	t2	12	68
1131	12	f	t2	13	61
1132	12	f	t2	13	60
1133	12	f	t2	13	63
1134	12	f	t2	13	62

Experimental Data 55
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1135	12	f	t2	l3	62
1136	12	f	t2	l4	70
1137	12	f	t2	l4	68
1138	12	f	t2	l4	67
1139	12	f	t2	l4	67
1140	12	f	t2	l4	68
1141	12	f	t3	l1	64
1142	12	f	t3	l1	66
1143	12	f	t3	l1	65
1144	12	f	t3	l1	64
1145	12	f	t3	l1	61
1146	12	f	t3	l2	66
1147	12	f	t3	l2	66
1148	12	f	t3	l2	65
1149	12	f	t3	l2	65
1150	12	f	t3	l2	66
1151	12	f	t3	l3	71
1152	12	f	t3	l3	72
1153	12	f	t3	l3	75
1154	12	f	t3	l3	71
1155	12	f	t3	l3	72

Experimental Data 56
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1156	12	f	t3	l4	73
1157	12	f	t3	l4	75
1158	12	f	t3	l4	70
1159	12	f	t3	l4	77
1160	12	f	t3	l4	74
1161	12	f	t4	l1	66
1162	12	f	t4	l1	67
1163	12	f	t4	l1	65
1164	12	f	t4	l1	65
1165	12	f	t4	l1	66
1166	12	f	t4	l2	62
1167	12	f	t4	l2	62
1168	12	f	t4	l2	65
1169	12	f	t4	l2	63
1170	12	f	t4	l2	63
1171	12	f	t4	l3	70
1172	12	f	t4	l3	70
1173	12	f	t4	l3	71
1174	12	f	t4	l3	71
1175	12	f	t4	l3	70
1176	12	f	t4	l4	64

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1177	12	f	t4	l4	64
1178	12	f	t4	l4	64
1179	12	f	t4	l4	64
1180	12	f	t4	l4	65
1181	12	f	t5	l1	72
1182	12	f	t5	l1	63
1183	12	f	t5	l1	64
1184	12	f	t5	l1	63
1185	12	f	t5	l1	63
1186	12	f	t5	l2	66
1187	12	f	t5	l2	65
1188	12	f	t5	l2	66
1189	12	f	t5	l2	64
1190	12	f	t5	l2	66
1191	12	f	t5	l3	77
1192	12	f	t5	l3	76
1193	12	f	t5	l3	69
1194	12	f	t5	l3	69
1195	12	f	t5	l3	71
1196	12	f	t5	l4	70
1197	12	f	t5	l4	70

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1198	12	f	t5	l4	71
1199	12	f	t5	l4	72
1200	12	f	t5	l4	69
1201	13	f	t1	l1	59
1202	13	f	t1	l1	55
1203	13	f	t1	l1	53
1204	13	f	t1	l1	55
1205	13	f	t1	l1	57
1206	13	f	t1	l2	70
1207	13	f	t1	l2	68
1208	13	f	t1	l2	70
1209	13	f	t1	l2	71
1210	13	f	t1	l2	69
1211	13	f	t1	l3	77
1212	13	f	t1	l3	77
1213	13	f	t1	l3	67
1214	13	f	t1	l3	70
1215	13	f	t1	l3	70
1216	13	f	t1	l4	70
1217	13	f	t1	l4	68
1218	13	f	t1	l4	71

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1219	13	f	t1	l4	70
1220	13	f	t1	l4	69
1221	13	f	t2	l1	63
1222	13	f	t2	l1	63
1223	13	f	t2	l1	60
1224	13	f	t2	l1	61
1225	13	f	t2	l1	60
1226	13	f	t2	l2	69
1227	13	f	t2	l2	69
1228	13	f	t2	l2	68
1229	13	f	t2	l2	68
1230	13	f	t2	l2	68
1231	13	f	t2	l3	61
1232	13	f	t2	l3	60
1233	13	f	t2	l3	63
1234	13	f	t2	l3	62
1235	13	f	t2	l3	62
1236	13	f	t2	l4	70
1237	13	f	t2	l4	68
1238	13	f	t2	l4	67
1239	13	f	t2	l4	67

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1240	13	f	t2	l4	68
1241	13	f	t3	l1	64
1242	13	f	t3	l1	66
1243	13	f	t3	l1	65
1244	13	f	t3	l1	64
1245	13	f	t3	l1	61
1246	13	f	t3	l2	66
1247	13	f	t3	l2	66
1248	13	f	t3	l2	65
1249	13	f	t3	l2	65
1250	13	f	t3	l2	66
1251	13	f	t3	l3	71
1252	13	f	t3	l3	72
1253	13	f	t3	l3	75
1254	13	f	t3	l3	71
1255	13	f	t3	l3	72
1256	13	f	t3	l4	73
1257	13	f	t3	l4	75
1258	13	f	t3	l4	70
1259	13	f	t3	l4	77
1260	13	f	t3	l4	74

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1261	13	f	t4	l1	66
1262	13	f	t4	l1	67
1263	13	f	t4	l1	65
1264	13	f	t4	l1	65
1265	13	f	t4	l1	66
1266	13	f	t4	l2	62
1267	13	f	t4	l2	62
1268	13	f	t4	l2	65
1269	13	f	t4	l2	63
1270	13	f	t4	l2	63
1271	13	f	t4	l3	70
1272	13	f	t4	l3	70
1273	13	f	t4	l3	71
1274	13	f	t4	l3	71
1275	13	f	t4	l3	70
1276	13	f	t4	l4	64
1277	13	f	t4	l4	64
1278	13	f	t4	l4	64
1279	13	f	t4	l4	64
1280	13	f	t4	l4	65
1281	13	f	t5	l1	82

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1282	13	f	t5	l1	83
1283	13	f	t5	l1	84
1284	13	f	t5	l1	83
1285	13	f	t5	l1	83
1286	13	f	t5	l2	66
1287	13	f	t5	l2	65
1288	13	f	t5	l2	66
1289	13	f	t5	l2	64
1290	13	f	t5	l2	66
1291	13	f	t5	l3	87
1292	13	f	t5	l3	86
1293	13	f	t5	l3	89
1294	13	f	t5	l3	89
1295	13	f	t5	l3	81
1296	13	f	t5	l4	70
1297	13	f	t5	l4	70
1298	13	f	t5	l4	71
1299	13	f	t5	l4	72
1300	13	f	t5	l4	69
1301	14	f	t1	l1	72
1302	14	f	t1	l1	73

Experimental Data 63
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1303	14	f	t1	l1	73
1304	14	f	t1	l1	71
1305	14	f	t1	l1	73
1306	14	f	t1	l2	68
1307	14	f	t1	l2	68
1308	14	f	t1	l2	70
1309	14	f	t1	l2	71
1310	14	f	t1	l2	69
1311	14	f	t1	l3	67
1312	14	f	t1	l3	68
1313	14	f	t1	l3	67
1314	14	f	t1	l3	70
1315	14	f	t1	l3	70
1316	14	f	t1	l4	71
1317	14	f	t1	l4	70
1318	14	f	t1	l4	68
1319	14	f	t1	l4	71
1320	14	f	t1	l4	71
1321	14	f	t2	l1	73
1322	14	f	t2	l1	73
1323	14	f	t2	l1	79

Experimental Data 64
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1324	14	f	t2	l1	71
1325	14	f	t2	l1	70
1326	14	f	t2	l2	79
1327	14	f	t2	l2	79
1328	14	f	t2	l2	78
1329	14	f	t2	l2	78
1330	14	f	t2	l2	78
1331	14	f	t2	l3	71
1332	14	f	t2	l3	70
1333	14	f	t2	l3	73
1334	14	f	t2	l3	72
1335	14	f	t2	l3	72
1336	14	f	t2	l4	72
1337	14	f	t2	l4	68
1338	14	f	t2	l4	67
1339	14	f	t2	l4	67
1340	14	f	t2	l4	68
1341	14	f	t3	l1	65
1342	14	f	t3	l1	66
1343	14	f	t3	l1	65
1344	14	f	t3	l1	64

Experimental Data 65
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1345	14	f	t3	l1	65
1346	14	f	t3	l2	66
1347	14	f	t3	l2	66
1348	14	f	t3	l2	65
1349	14	f	t3	l2	65
1350	14	f	t3	l2	66
1351	14	f	t3	l3	71
1352	14	f	t3	l3	72
1353	14	f	t3	l3	75
1354	14	f	t3	l3	71
1355	14	f	t3	l3	72
1356	14	f	t3	l4	73
1357	14	f	t3	l4	75
1358	14	f	t3	l4	70
1359	14	f	t3	l4	77
1360	14	f	t3	l4	74
1361	14	f	t4	l1	66
1362	14	f	t4	l1	67
1363	14	f	t4	l1	65
1364	14	f	t4	l1	65
1365	14	f	t4	l1	66

Experimental Data 66
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1366	14	f	t4	l2	62
1367	14	f	t4	l2	62
1368	14	f	t4	l2	65
1369	14	f	t4	l2	63
1370	14	f	t4	l2	63
1371	14	f	t4	l3	70
1372	14	f	t4	l3	70
1373	14	f	t4	l3	71
1374	14	f	t4	l3	71
1375	14	f	t4	l3	70
1376	14	f	t4	l4	64
1377	14	f	t4	l4	64
1378	14	f	t4	l4	64
1379	14	f	t4	l4	64
1380	14	f	t4	l4	65
1381	14	f	t5	l1	72
1382	14	f	t5	l1	63
1383	14	f	t5	l1	64
1384	14	f	t5	l1	63
1385	14	f	t5	l1	63
1386	14	f	t5	l2	66

Experimental Data 67
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1387	14	f	t5	12	65
1388	14	f	t5	12	66
1389	14	f	t5	12	64
1390	14	f	t5	12	66
1391	14	f	t5	13	77
1392	14	f	t5	13	76
1393	14	f	t5	13	69
1394	14	f	t5	13	69
1395	14	f	t5	13	71
1396	14	f	t5	14	71
1397	14	f	t5	14	71
1398	14	f	t5	14	71
1399	14	f	t5	14	72
1400	14	f	t5	14	69
1401	15	m	t1	11	65
1402	15	m	t1	11	65
1403	15	m	t1	11	63
1404	15	m	t1	11	61
1405	15	m	t1	11	62
1406	15	m	t1	12	66
1407	15	m	t1	12	68

Experimental Data 68
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1408	15	m	t1	12	70
1409	15	m	t1	12	71
1410	15	m	t1	12	69
1411	15	m	t1	13	77
1412	15	m	t1	13	77
1413	15	m	t1	13	67
1414	15	m	t1	13	70
1415	15	m	t1	13	70
1416	15	m	t1	14	70
1417	15	m	t1	14	68
1418	15	m	t1	14	68
1419	15	m	t1	14	71
1420	15	m	t1	14	69
1421	15	m	t2	11	63
1422	15	m	t2	11	63
1423	15	m	t2	11	59
1424	15	m	t2	11	61
1425	15	m	t2	11	60
1426	15	m	t2	12	69
1427	15	m	t2	12	69
1428	15	m	t2	12	68

Experimental Data

17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1429	15	m	t2	12	68
1430	15	m	t2	12	68
1431	15	m	t2	13	61
1432	15	m	t2	13	60
1433	15	m	t2	13	63
1434	15	m	t2	13	62
1435	15	m	t2	13	62
1436	15	m	t2	14	70
1437	15	m	t2	14	68
1438	15	m	t2	14	67
1439	15	m	t2	14	67
1440	15	m	t2	14	68
1441	15	m	t3	11	64
1442	15	m	t3	11	66
1443	15	m	t3	11	65
1444	15	m	t3	11	64
1445	15	m	t3	11	61
1446	15	m	t3	12	66
1447	15	m	t3	12	66
1448	15	m	t3	12	65
1449	15	m	t3	12	65

Experimental Data 70
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1450	15	m	t3	12	66
1451	15	m	t3	13	71
1452	15	m	t3	13	72
1453	15	m	t3	13	75
1454	15	m	t3	13	71
1455	15	m	t3	13	72
1456	15	m	t3	14	73
1457	15	m	t3	14	75
1458	15	m	t3	14	70
1459	15	m	t3	14	77
1460	15	m	t3	14	74
1461	15	m	t4	11	66
1462	15	m	t4	11	67
1463	15	m	t4	11	65
1464	15	m	t4	11	65
1465	15	m	t4	11	66
1466	15	m	t4	12	62
1467	15	m	t4	12	62
1468	15	m	t4	12	65
1469	15	m	t4	12	63
1470	15	m	t4	12	63

Experimental Data 71
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1471	15	m	t4	13	70
1472	15	m	t4	13	70
1473	15	m	t4	13	71
1474	15	m	t4	13	71
1475	15	m	t4	13	70
1476	15	m	t4	14	64
1477	15	m	t4	14	64
1478	15	m	t4	14	64
1479	15	m	t4	14	64
1480	15	m	t4	14	65
1481	15	m	t5	11	72
1482	15	m	t5	11	63
1483	15	m	t5	11	64
1484	15	m	t5	11	63
1485	15	m	t5	11	63
1486	15	m	t5	12	66
1487	15	m	t5	12	65
1488	15	m	t5	12	66
1489	15	m	t5	12	64
1490	15	m	t5	12	66
1491	15	m	t5	13	77

Experimental Data 72
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1492	15	m	t5	13	76
1493	15	m	t5	13	69
1494	15	m	t5	13	69
1495	15	m	t5	13	71
1496	15	m	t5	14	70
1497	15	m	t5	14	70
1498	15	m	t5	14	71
1499	15	m	t5	14	72
1500	15	m	t5	14	69
1501	16	m	t1	11	67
1502	16	m	t1	11	67
1503	16	m	t1	11	67
1504	16	m	t1	11	65
1505	16	m	t1	11	65
1506	16	m	t1	12	68
1507	16	m	t1	12	68
1508	16	m	t1	12	70
1509	16	m	t1	12	71
1510	16	m	t1	12	70
1511	16	m	t1	13	66
1512	16	m	t1	13	65

Experimental Data 73
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1513	16	m	t1	l3	67
1514	16	m	t1	l3	70
1515	16	m	t1	l3	68
1516	16	m	t1	l4	71
1517	16	m	t1	l4	69
1518	16	m	t1	l4	68
1519	16	m	t1	l4	71
1520	16	m	t1	l4	69
1521	16	m	t2	l1	64
1522	16	m	t2	l1	63
1523	16	m	t2	l1	64
1524	16	m	t2	l1	62
1525	16	m	t2	l1	62
1526	16	m	t2	l2	82
1527	16	m	t2	l2	69
1528	16	m	t2	l2	68
1529	16	m	t2	l2	68
1530	16	m	t2	l2	78
1531	16	m	t2	l3	59
1532	16	m	t2	l3	60
1533	16	m	t2	l3	61

Experimental Data 74
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1534	16	m	t2	l3	62
1535	16	m	t2	l3	61
1536	16	m	t2	l4	72
1537	16	m	t2	l4	69
1538	16	m	t2	l4	69
1539	16	m	t2	l4	67
1540	16	m	t2	l4	68
1541	16	m	t3	l1	64
1542	16	m	t3	l1	66
1543	16	m	t3	l1	65
1544	16	m	t3	l1	64
1545	16	m	t3	l1	61
1546	16	m	t3	l2	66
1547	16	m	t3	l2	66
1548	16	m	t3	l2	65
1549	16	m	t3	l2	65
1550	16	m	t3	l2	66
1551	16	m	t3	l3	71
1552	16	m	t3	l3	72
1553	16	m	t3	l3	75
1554	16	m	t3	l3	71

Experimental Data 75
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1555	16	m	t3	l3	72
1556	16	m	t3	l4	73
1557	16	m	t3	l4	71
1558	16	m	t3	l4	70
1559	16	m	t3	l4	72
1560	16	m	t3	l4	74
1561	16	m	t4	l1	66
1562	16	m	t4	l1	67
1563	16	m	t4	l1	65
1564	16	m	t4	l1	65
1565	16	m	t4	l1	66
1566	16	m	t4	l2	62
1567	16	m	t4	l2	62
1568	16	m	t4	l2	65
1569	16	m	t4	l2	63
1570	16	m	t4	l2	63
1571	16	m	t4	l3	70
1572	16	m	t4	l3	70
1573	16	m	t4	l3	71
1574	16	m	t4	l3	71
1575	16	m	t4	l3	70

Experimental Data 76
17:22 Monday, December 13, 1993

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1576	16	m	t4	l4	64
1577	16	m	t4	l4	64
1578	16	m	t4	l4	64
1579	16	m	t4	l4	64
1580	16	m	t4	l4	65
1581	16	m	t5	l1	72
1582	16	m	t5	l1	63
1583	16	m	t5	l1	64
1584	16	m	t5	l1	63
1585	16	m	t5	l1	63
1586	16	m	t5	l2	66
1587	16	m	t5	l2	65
1588	16	m	t5	l2	66
1589	16	m	t5	l2	64
1590	16	m	t5	l2	66
1591	16	m	t5	l3	67
1592	16	m	t5	l3	68
1593	16	m	t5	l3	66
1594	16	m	t5	l3	69
1595	16	m	t5	l3	67
1596	16	m	t5	l4	69

OBS	SUBJECT	SEX	TYPE	SLEVEL	HRATE
1597	16	m	t5	14	70
1598	16	m	t5	14	71
1599	16	m	t5	14	72
1600	16	m	t5	14	69

APPENDIX F

ANALYSIS OF VARIANCE FOR THE EXPERIMENTAL DATA

The following shows an analysis of variance for the statistical model (computer output generated by SAS®).

Analysis of Variance Procedure
Class Level Information

Class	Levels	Values
TYPE	5	t1 t2 t3 t4 t5
SLEVEL	4	l1 l2 l3 l4
SEX	2	f m

Number of observations in data set = 1600

Analysis of Variance for Experimental Data 177
16:58 Sunday, December 12, 1993

Analysis of Variance Procedure

Dependent Variable: HRATE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	27	13489.260625	499.602245	25.46	0.0001
Error	1572	30846.908750	19.622715		
Corrected Total	1599	44336.169375			

R-Square	C.V.	Root MSE	HRATE Mean
0.304250	6.533981	4.4297534	67.795625

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TYPE	4	1956.9287500	489.2321875	24.93	0.0001
SLEVEL	3	3118.5218750	1039.5072917	52.97	0.0001
SEX	1	3361.1006250	3361.1006250	171.29	0.0001

Analysis of Variance for Experimental Data 178
16:58 Sunday, December 12, 1993

Analysis of Variance Procedure

Dependent Variable: HRATE

Source	DF	Anova SS	Mean Square	F Value	Pr > F
TYPE*SLEVEL	12	4382.7312500	365.2276042	18.61	0.0001
TYPE*SEX	4	353.9962500	88.4990625	4.51	0.0013
SLEVEL*SEX	3	315.9818750	105.3272917	5.37	0.0011

REFERENCES

Andrén, L. 1980. "Noise as a Contributory Factor in the Development of Elevated Arterial Pressure". *Acta Medica Scandinavica*. 207: 493-498.

Andrén, L., L. Hansson, M. Björkman, and A. Johnson. 1980. "Noise as a Contributory Factor in the Development of Elevated Arterial Pressure". *Acta Med. Scand.* 207: 493-498.

Asterita, M. F. 1985. *The Physiology of Stress*. New York: Human Sciences Press

Brown III, J. E. 1975. "Certain Non-Auditory Physiological Responses to Noise". *American Industrial Hygiene Association Journal*. 36: 285-291.

Buckley, J. P., and H. H. Smookler. 1970. "Cardiovascular and Biochemical Effects of Chronic Intermittent Neurogenic Stimulation". *Physiological Effects of Noise*. Plenum, New York. 53-71.

Chen, C. J. 1991. "Measurement of Noise-Evoked Blood Pressure by Means of Averaging Method: Relation Between Blood Pressure Rise and SPL". *J. of Sound and Vibrations*. 151(3): 383-394.

DeJoy, D. 1984. " The Non-Auditory Effects of Noise: Review and Perspectives for Research". *J. of Auditory Research*. 24: 123-150.

Davis, R. C., A. M. Buchwald, and R. W. Frankman. 1955. Autonomic and Muscular Stimuli and Their Relation to Simple Stimuli. *Psychological Monographs*. 69 (405).

Di Nisi, J. 1987. "Cardiovascular Responses to Noise: Effects of Self-Estimated Sensitivity to Noise, Sex, and Time of the Day". *J. of Sound and Vibrations*. 114(2): 271-279.

Everly, G.S., and S. A. Sodelman. 1987. *Assessment of the Human Stress Response*. New York: AMS Press, Inc.

Glass, D. C., and S. E. Singer. 1972. *Urban Stress: Experiments on Noise and Social Stressors*. New York: Academic Press.

Griefahn, B., and J. Di Nisi. 1992. "Mood and Cardiovascular Functions During Noise, Related to Sensitivity, Type of Noise and Sound Pressure Level". *J. of Sound and Vibrations*. 155(1): 111-123.

Gulian, E. 1974. *Noise as an Occupational Hazard: Effects on Performance Level*. National Institute of of Occupational Safety and Health. Cincinnati, Ohio.

REFERENCES
(Continued)

Henderson, D., R. P. Hamernik, D. S. Dosanjh, and J. H. Mills. 1976. *Effects of Noise on Hearing*. New York: Ravens Press.

Ising, H., and H. Melchert. 1980. Endocrine and Cardiovascular Effects of Noise. *Proceedings of the Third International Conference on Noise as a Public Health Hazard, American Speech and Hearing Association*. Washington D.C. Report 10.

Jansen, G. 1961. Adverse Effects of Noise on Iron and Steel Workers. *Stahl Eisen*. 81: 217-220.

—. 1964. "The Influence of Noise at Manual Work". International J. of Appl. Physiology. 20: 233-239.

—. 1977. *Review of Noise Criteria*. Proc. FASE 77 Symposium of Environmental Noise Legislation. London 13-17 Nov.

Jones, D.M., and A. J. Chapman. 1984. *Noise and Society*. New York: Wiley.

Kryter, K. 1984. *Physiological, Psychological and Social Effects of Noise*. California: Acousis Company.

—. 1985. *The Effects of Noise on Man*. California: Academic Press, Inc.

Kryter, K., and F. Poza. 1980. "Effects of Noise on Some Autonomic System Activities". *J. Acoustical Society of America*. 67(6): 2036-2044.

Lehman, A. G. 1964. Man and Noise. *Handbook of Physiology*. American Physiological Society. 65 (4): 1007-1014.

Loeb, M. 1986. *Noise and Human Efficiency*. New York: Wiley

Miller, J. 1974. "Effects of Noise on People". *J. Acoustics Society of America*. 56(3): 729-764.

Melius, J., C. Althafer, W. Perry, C. Robinson, L. Schleifer, R. Stanevich, M. Torrason, K. Weber, and M. Woebkenberg. 1986. Proposed National Strategy for the Prevention of Occupational Cardiovascular Diseases. *DHHS (NIOSH) Publication No. 89-132, U.S. Dept. of Health and Human Services*. Cincinnati, Ohio.

Osada, Y. 1972. "Physiological Effects of Long-Term Exposure to Low-Level Noise". *Bulletin of the Institute of Public Health*. Tokyo, Japan. 22(2): 61-67.

REFERENCES
(Continued)

Parvizpoor, D. 1976. "Noise Exposure and Prevalence of High Blood Pressure Among Weavers in Iran". *J. Occupational Med.* 18(11): 730-731.

Peterson, E. A., J. S. Augenstein, D. C. Tanis, R. Warner, and W. Heal. 1981. "Noise Raises Blood Pressure Without Impairing Auditory Sensitivity". *Science.* 211: 1450-1452.

Peterson, E. A., J. S. Augenstein, D.C. Tanis, R. Warner, and W. Heal. 1983. "Some Cardiovascular and Behavioral Effects of Noise in Monkeys". *Proceedings of the International Congress on Noise as a Public Health Hazard, Centro Richerche E. Studi Amplifon.* Milan, Italy. 1175-86.

Shatalov, N. N., A. O. Sanitanov, and K. V. Glotova. 1962. On the State of the Cardiovascular System Under Conditions of Exposures to Continuous Noise. *Defence Research Board Report No. T411-N65-5577.* Ottawa, Canada.

Strakhov, A. B. 1964. "The Effects of Intense Noise on Certain Functions of the Body". *Gigiena: Sanitariya.* 69: 1-25.

Talbott, E., J. Helmkamp, K. Matthews, L. Kuller, E. Cuttington, and G. Redmond. 1985. Occupational Noise Exposure, Noise-Induced Hearing Loss, and the Epidemiology of High Blood Pressure. *Am. J. of Epidemiology.* 121(4): 501-514.

Turkkan, J. S., R. D. Heinz, A. H. and Harris. 1983. "The Non-Auditory Effects of Noise on the Baboons". *Proceedings of the Fourth International Congress on Noise as a Public Health, Problem Centro Richerche E. Studi Amplifon.* Milan, Italy. 1187-1198.

Walpole, R., and R. H. Myers. 1985. *Probability and Statistics for Engineers and Scientists.* New York: MacMillan Publishing.

Wilson, C. E. 1989. *Noise Control.* New York: Harper & Row.