SONOROUS BREATHING: A THEORETICAL AND TREATMENT OUTCOME STUDY

by

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Dissertation submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY
in
Psychology

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August, 1982

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Acknowledgements

This dissertation was not the result of my individual effort, but rather the contribution of many persons. The names of my friends who provided support are too numerous to mention, but I would like to thank all of them for their support and help. I must also mention and thank the individuals who participated as subjects in this study. Their contribution of time and effort, and willingness to try something new, made this study possible.

I also acknowledge the important contribution made by my dissertation committee members. George A. Clum, Charles D. Noblin, Thomas H. Ollendick, and Brian E. Warren provided valuable input to the project and insured the final product was well-designed and written. James D. Fritzen and Robert L. Hodes also provided input into the original formulation of the project.

My dissertation committe chairman, Dr. Albert M. Prestrude, deserves special acknowledgement. Dr. Prestrude has been an excellent mentor and friend. His advice, encouragement and support will always be remembered.

Finally, I wish to acknowledge the most important contribution of and dedicate this dissertation to my parents, Mark and Mary Butler. Their unconditional support and confidence provided me with the motivation to begin and stamina to complete this project and degree.

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Chapter 1

Introduction

Sonorous breathing or snoring as it is more commonly called, has been the subject of ridicule, jokes and comedy routines. Boulware (1974) has collected lay articles on snoring bearing such titles as "Noises in the Night" or "Bedlam in Boudoir." However the anonymous author was correct who said "Laugh and the world laughs with you; snore and you sleep alone." Levity has diverted attention from the serious physical and interpersonal impact snoring has upon millions of people. Estimates of the incidence of snoring in humans range from 10 to 20% (Boulware, 1974). Snoring is cross-cultural as well as cross-species occurring in both dogs and cats. Snoring occurs in both males and females and is no respecter of age; both babies and the elderly snore.

Snoring is generally not a problem for snorers as very aptly illustrated in Mark Twain's quote of "There ain't no way to find out why a snorer can't hear himself snore." A problem occurs when the snorer sleeps in close proximity to nonsnorers in a motel, dormitory, barracks, or at home. The snoring can seriously disrupt the sleep of others and lead to strained interpersonal and marital relations (Shapiro, 1971). The infamous gunfighter John Wesley Hardin was once so disturbed by another hotel guest's snoring that Hardin shot and killed the unfortunate snorer (Trachtman, 1975).

The lack of research on snoring is surprising considering the commonness of the disorder. Several articles have been published

suggesting causes or mechanisms of snoring and several articles have reviewed the snoring literature, or the lack thereof. However the majority of the literature on snoring is anecdotal, based upon medical research or clinical impression, and only one treatment outcome study has appeared which has any research credibility.

A variety of anatomical tissues, structures and organs have been hypothesized as being involved in the production of a snore. Some of the structures or organs are the faucial pillars, glosso-pharyngeal arch, larynx, nasal passages, palate, tongue and velum. (Appendix A for definitions).

Definitions

A single definition of snoring has not been generally accepted despite the commonness of the disorder. Arnold (cited in Boulware, 1974) argued that snoring is a disorder only to the individual who cannot tolerate it. Such a definition suggests that treatment of snoring should not be directed at the snorer, but at the spouse or roommate. Koebel and Crist (1977) accepted this definition and reported success in the use of fading to decrease a woman's aversion to her fiancee's snoring.

Boulware (1974) surveyed 100 eye, nose and throat specialists to arrive at a definition of snoring. His definition of snoring is "any intense audible noise in the upper respiratory passage of the sleeper." Boulware's definition thus includes sounds produced by the cheeks, tongue, lips and nasal passages but does not suggest a mechanism for the cause of the snore.

Robin (1968) defined snoring as "noisy respiration while asleep...and produced...during both inspiration and expiration. It is limited to sounds made by various kinds of vibrations of the soft palate and posterior faucial pillars during sleep." Robin's definition excludes any conscious reproduction of a snore as being a true snore and specifies vibration of the soft palate and faucial pillars as being the origin of a snore. All other structures and organs are excluded.

Luchsinger and Arnold (1965) have defined snoring as "intermittent explosions of the slight closure between the relaxed velum and the posterior walls or between the sluggish tongue base and the pharyngeal walls." This definition is similar to Robin's (1968) definition in that it specifies involvement of the velum of the soft palate and the posterior walls (faucial pillars). Both definitions suggest that some type of vibration is involved. The Luchsinger and Arnold definition is broader in that the tongue base could also be involved.

Hinderer (cited in Boulware, 1974) proposed a broad definition of snoring. Hinderer's definition states that snoring is "vibrations brought about by more than a quivering of the faucial and velar tissues, but may be caused by anything which alters the normal contour of the free air." This definition specifies the same structures as Robin (1968) as being involved in snoring but then loses specificity by including components of Boulware's (1974) definition by involving any upper respiratory tract structure.

Snoring can be classified on clinical and theoretical bases into three primary divisions: pathological causation, physiological causation and motivational causation (Boulware, 1974; Shapiro, 1971). Pathological or symptomatic snoring is caused by some abnormality in the structures involved in snoring. Examples of pathologically induced snoring include high arched palate, nasal polyps, septal deviations and vasomotor rhinitis.

Physiological or ideopathic snoring is snoring in which no pathology can be determined. The snoring is caused by a disturbance in the operation of a normal tissue or structure rather than in a change in the tissue or structure. Tsukamoto, Nagami, and Tsunematsu (1938) suggested a subdivision of physiologic snoring on the basis of how long into the sleep period the snoring continues. The largest group of physiologic snorers begin snoring immediately upon sleep onset but stop before the person awakens. The smaller second group of physiologic snorers begin snoring immediately upon sleep onset and continue throughout the sleep period until arousal. A third subdivision of physiologic snoring is laryngeal snoring. Laryngeal snoring originates at the level of the larynx and is similar in production to voice. This type of snoring occurs when an individual is under general anesthesia. The anesthesia relaxes the vocal cords which then vibrate during respiration.

Motivational snoring is snoring in which neither pathology nor physiological disturbance is present. Motivational snoring is divided into two subdivisions: pseudosnoring and neurotic snoring.

Pseudosnoring is fake or conscious snoring by an individual to achieve some personal gratification or goal. An example of pseudosnoring would be an individual who pretends to snore to make a fake sleeping episode more realistic. Definitions of snoring generally state the individual who snores is asleep. Thus the sounds produced in pseudosnoring do not qualify as a snore.

The second subdivision of motivationally induced snoring is neurotic snoring which originates from deep-seated intra-psychic conflicts or other psychologic factors. The snore can serve some unconscious need such as expressing aggression or gaining attention.

Treatments for Snoring

The literature reports little in the way of effective treatment for snoring.(Albert & Ballas, 1973; Shapiro, 1971). Treatment techniques for snoring have generally fallen into one of three categories: surgery to modify or remove velar tissue, devices and instruments which change the body position during sleep, and auto-suggestion and hypnotism to increase the snorer's awareness of breathing patterns. Boulware (1974) reports that only 30% of snorers are cured, 50% are improved and 20% show no change. However no criteria were provided to define the categories of "cure" and "improved" nor was any information given on how the snoring was assessed.

Surgery is the preferred treatment when specific pathological origins of the snoring can be determined. Pathology could include nasal polyps, nasopharyngeal fibromas, hypertrophy of the nasal

turbinates (bones), deflected nasal cartilage and diverse septal anomalies. Unfortunately surgery is sometimes used when no organic pathology is clearly evident. The surgical procedure involved in such cases can involve amputation or excision of the uvula, injection of paraffin into the soft palate or injection of a sclerosing agent into the velum tissue of the soft palate. These surgical methods have been found to be ineffective for most individuals (Kleitman, 1963).

Approximately 180 anti-snoring devices and instruments have been patented (Boulware, 1974). These range from devices that force the individual to lie in a specific position to devices which require breathing through a tube. No study has yet been reported on the effectiveness of these anti-snoring devices. These and similar devices have two major drawbacks. The first is that the devices are generally cumbersome and uncomfortable for the user. Secondly, the devices serve as a crutch; the individual does not acquire self-control over the snoring.

Hypnosis and autosuggestion have been used in the treatment of snoring. The goal of these therapies is to increase muscle tone, increase awareness of breathing patterns, and to sleep with the mouth shut. These treatment methods have not been found to be very effective in the opinion of Albert and Ballas (1973), can be expensive and can require many hours of practice.

A fourth treatment approach using behavioral methodology was recently reported by Josephson and Rosen (1980). Subjects were

divided into three conditions: waiting list control (WL), contingent awakening (CA), and self-control (SC). The CA subjects were awakened by a loud sound at the onset of each snore. The subject had to push a response lever to terminate the sound. The SC subjects were given two 15 minute tapes to listen to prior to bedtime. The tapes contained instructions for progressive relaxation as well as phonetic, jaw, and breathing exercises to increase the awareness of breathing patterns and to increase pharyngeal muscle tonus. In addition, autosuggestion and personal habit restrictions such as reduction of alcohol intake were imposed on the SC subjects.

The results of the study showed that the effect of the treatment conditions was marginally significant ($p=.058$). A combination of the SC and CA groups was significantly different from the WL control group. The SC and CA groups did not differ significantly from each other nor did they differ individually from the WL control group.

In general, current treatment techniques have not been shown to be effective in reducing snoring. The use of surgical methods is applicable in only a few well-defined cases. Devices and instruments are generally effective only when the snorer wears the device while hypnotism and autosuggestion can be both time consuming and expensive. The behaviorally oriented treatments were not found to be individually significant in reducing snoring, but perhaps could have clinical utility.

Theories of Snoring

A variety of theories have been advanced to explain the occurrence of snoring. In general, the theories are of limited scope and

are imprecise. Often the theory is no more than an elaborate definition of snoring. Only two of the theories are relevant to the present study and will be reviewed. In addition, a behavioral interpretation of snoring will be proposed by the author.

The first theory to be reviewed is a dynamic interpretation of snoring by Altschuler (1964). This theory suggested that a dynamic causation may underlie some cases of snoring. Altschuler's hypothesis states that a snorer must maintain a sustained attitude during sleep that the sound produced is unimportant or nonexistent to prevent being awakened. The sustained attitude of disregarding the snore is unconsciously motivated. The origin of the snoring may be initiated by a specific intra-psychic conflict unique to the individual. An example of an intra-psychic conflict could involve hostility toward a loved bedmate. The snoring could be the overt manifestation of the unconscious hostility. Alternatively, the snoring may be secondarily involved as an expressive vehicle. An example could be using snoring to keep the bedmate awake and "on guard" to protect the snorer from some feared object or event. Altschuler does not provide any research to support his hypothesis but does present a single case in which snoring was allegedly caused by psychologic factors. The appropriate treatment for snoring based upon this theory would be intense psychotherapy to resolve the intra-psychic conflict underlieing the snoring.

The second theory to be reviewed is by Tsukamoto et al. (1938) and theorized snoring to occur through an interaction of relaxation, pulmonary alveoli CO_2 levels, and respiratory passage width. Relaxation

of the skeletal musculature occurs upon sleep onset; the lower jaw drops and the mouth opens. Concurrent with the lower jaw dropping, the tongue drops back and the soft palate lowers causing a constriction in the faucial isthmus. The narrowed isthmus causes an increase in pulmonary alveoli CO_2 levels. The CO_2 level is reduced by mouth breathing which increases the air flow to the lungs. The increased air flow could cause the soft palate to vibrate causing a sound. However in nonsnorers, the muscular relaxation which begins at sleep onset is accompanied by increased blood circulation in the extremities and decreased blood volume in the mucous membranes of the nasal passages. The decreased blood circulation in the nasal mucous membranes results in a widening of the upper respiratory tract and the movement of greater air volume through the nose. The increased air volume through the nose decreases the necessity for mouth breathing and thus the liklihood of snoring.

Individuals who snore throughout the sleep period are hypothesized by Tsukamoto et al. (1938) as failing to relax sufficiently to allow the necessary vascularization changes that prevent snoring. Individuals who snore only through part of the sleep period are hypothesized as relaxing the skeletal musculature only during the segments of the sleep period in which snoring does not occur. Non-relaxed periods result in snoring. Pathologic conditions which restrict nasal breathing will cause snoring regardless of the state of relaxation.

The level of sleep at which snoring occurs could provide infor-

mation on the degree of body relaxation and the validity of the Tsukamoto et al. (1938) theory. However there has been considerable controversy about muscle tonicity during snoring and about when snoring occurs in the sleep period. Fischgold and Schwartz (1961) reported that snoring rarely occurred in REM sleep and suggested that a temporary increase in the muscle tonus of the soft palate must occur during REM to prevent the snoring. They suggest that an increase in the muscle tonus of the oropharyngeal muscle tissue might occur in conjunction with the rapid movement of the eyeball in REM sleep. However, Cohen (1979) reported that REM sleep is characterized by a rather flat EMG indicative of reduced muscle tonus, and the reduced muscle tonus included the muscles of the oropharyngeal cavity and the geniglossi muscles of the tongue. Berger (1961) has also recorded a decrease in the extrinsic laryngeal muscle tonus during REM. However Robin discounts laryngeal musculature as a major factor in snoring.

Albert and Ballas (1973) examined the EEG and temporal correlates of snoring which could provide data on the validity of the Tsukamoto et al. (1938) theory. The results of the study showed that snoring occurred with the greatest frequency in Stage 2 sleep (64.6% of total snoring time). However, the proportion of time spent snoring relative to the period of time the person remained in a sleep stage did not differ across stages. Thus REM sleep snoring was not found to differ in proportion from the other stages. The results of the study do indicate that significantly more snoring occurred in the first two fifths of the sleep period than in the last one fifth. The researchers

suggested this may be caused by autonomic changes causing a reduction in mouth breathing as noted by Tsukamoto et al. (1938).

The Tsukamoto et al. (1938) theory is sufficiently precise in formulation to suggest a treatment for snoring. Briefly, the theory states that relaxation of the skeletal musculature causes vascular dilation in the body extremities and constriction of the nasal vascular bed supplying the mucous membranes. Mouth breathing is then utilized to increase air intake and snoring may result.

A treatment approach in which the snorer is trained to relax prior to sleep onset should be successful in increasing the relaxation of the skeletal musculature while the snorer is asleep. The increased muscle relaxation would then induce the constriction of the nasal vascular bed causing shrinkage of the mucous membranes. The volume of air that can pass through the nasal passages is increased and the necessity for mouth breathing decreased. The likelihood of a snore occurring decreases as the mouth breathing decreases.

Surprisingly, a behavioral conceptualization of the snoring phenomenon has not been advanced to date. The author proposes a behavioral conceptualization as the third interpretation of the snoring phenomenon. An adequate behavioral interpretation of snoring should account for the etiology and maintenance of the snoring. The theory or hypothesis should be sufficiently precise to suggest treatment techniques that would reduce or eliminate the snoring. Finally the conceptualization or theory should account for the few

facts which are known about snoring. Specifically, the theory should account for the vibration of the velar tissues and faucial pillars observed by Robin (1968) as causing the snore and account for the occurrence of snoring across sexes, cultures, and species.

The behavioral theory of snoring proposed by the author views respiration as a series or a constellation of responses elicted by the organism's need for oxygen. Respiration requires a coordination and chaining of responses in the somatic and visceral systems. Usually the respiration response is autonomic; the organism is not aware of the process or of changes in the response. However the respiration can be affected by emotional stimuli and can also be controlled voluntarily.

The individual responses comprising respiration vary dependent upon the stimulus of O_2 and CO_2 gaseous tension levels. Carotid bodies in the common carotid arteries and the respiratory centers in the central nervous system are sensitive to gaseous tensions in the blood. The carotid bodies and respiratory center can alter the rapidity and strength of inhalation and exhalation to maintain normal gaseous tension levels in the blood (Comroe, 1974).

The general respiration response involves muscle responses in the larynx, pharynx, trachea and upper airway passages. Sufficient muscle tonus must be maintained in these structures during respiration to provide a passage through which air can travel. Lack of muscle tonus would cause these structures to collapse. The collapse of these structures while the individual is asleep is labeled peripheral

sleep apnea.

The proposed behavioral theory of snoring posits the body has a predisposition for, or has learned what respiration responses are necessary for a specific O_2-CO_2-environmental stimulus configuration. For example, the stimulus configuration caused by strenuous exercise is readily compensated for by changes in the rate and depth of respiration. However some events might occur in which the body must attempt new response patterns to maintain normal gaseous tension levels. Such events could include respiratory infections or allergies.

Disorders such as respiratory infections can cause abnormal gaseous tension levels. The behavioral theory of snoring suggests the body adapts accordingly by altering the respiration response to obtain increased O_2 and to remove CO_2. The abnormal gaseous tension level might not return to normal in disorders involving alveoli such as emphysema or silicosis. These individuals develop alternate responses of reduced motor activity and increased sleep.

The proposed behavioral interpretation of snoring assumes that an individual initially has a respiration response pattern in which snoring does not occur. However a respiratory allergy or infection, such as the common cold, caused a blocking or restriction of the nasal passages. The restriction in the nasal passages produces a mild O_2 deficit thus disrupting the normal gaseous tension level in the blood. The body responds to the abnormal gaseous tensions by altering the constellation or chain of responses involved in breathing.

Two changes in the response constellation are proposed for

snoring to occur. The first response change is a reduction in muscle tonus, if possible, to reduce the O_2 requirement of the body. A change in muscle tonus is most likely to occur while an individual is asleep and motor movements are minimal. The proposed reduction in muscle tonus might be modified by other variables such as adrenal levels or the stage of sleep.

The second response change required for snoring to occur is for the individual to use mouth breathing to obtain air. Respiration through the mouth would bypass the restricted nasal passages. Air flow to the lungs would be increased and the O_2 debt reduced. The reduction or elimination of the O_2 debt serves as reinforcement for the altered respiration response. Additional trials and reinforcements of the above process would increase the probability of the modified respiration response occurring in the abscence of an infection. The interaction of reduced muscle tonus in the respiratory passages including the faucial pillars and uvula, with increased air flow over these structures from mouth breathing increases the probability of their vibrating and causing a snore.

Alternatively, the O_2 debt might function as an aversive stimulus to the body. The body would attempt alternate respiration responses to eliminate the aversive stimulus of the O_2 debt. A combination of reduced muscle tonus and mouth breathing might eliminate the O_2 debt. Removal of the aversive stimulus or O_2 debt would act as negative reinforcement for the altered respiration response of reduced muscle tonus and mouth breathing. The interaction of

reduced muscle tonus in the respiratory passages including the faucial pillars and uvula, with increased air flow over these structures from mouth breathing increases the probability of their vibrating and causing a snore.

The proposed behavioral theory of snoring provides a rationale for several treatment techniques. The snoring response could be eliminated by creating an O_2 debt in the body. Creating an O_2 debt would change the gaseous tension level and force the individuals to modify their respiration responses. Sufficient O_2 could be provided when a respiration response pattern was obtained in which snoring did not occur. Reduction of the O_2 debt would reinforce the nonsnoring respiration pattern. This technique would require the services of a sleep laboratory and therefore would be inaccessible to the majority of snorers.

A second treatment technique would be to interrupt the respiration response only when a snore occurred. A nonsnoring response pattern would then be provided which would replace the snoring response pattern. One method of causing an interruption in the snore would be to cause a muscle contraction in the neck at the beginning of a snore. The induced muscle contraction would cause increased muscle tension and tonus. The increased muscle tension response would gradually replace the low muscle tonus response in the general respiration response.

Purpose

The current study was designed to evaluate the effectiveness

of the second treatment approach suggested by the proposed behavioral theory and the relaxation treatment for the Tsukamoto et al. (1938) theory of snoring. The behavioral treatment requires conditioning of interoceptive stimuli from muscle relaxation to a muscle contraction response. A sound-activated microphone was used to deliver a low voltage, low amperage current to the neck and throat muscles of one group of subjects at the onset of a snore. The current functioned as an unconditioned stimulus (UCS) and elicited an unconditioned contraction response (UCR) of the throat muscles (Figure 1a). The UCR disrupted the relaxed state of the upper respiratory tract muscles thus preventing vibration of the velar tissues and stopping the snore. With sufficient pairings, the interoceptive stimuli associated with upper respiratory muscle relaxation that precedes a snore become conditioned stimuli (CS) as shown in Figure 1b and then conditioned anticipatory stimuli (CAS) associated with disruption of the relaxed state and subsequent muscle tension (Figure 1c). The low muscle tonus response in the general respiration response is replaced with a high muscle tonus response. The snoring ceases because the velar tissues and the faucial pillars cannot vibrate. This group of subjects was labeled the Snore Collar condition for the device they wore about their neck that delivered the shock that caused the conditioning.

The Tsukamoto et al. (1938) theory predicts that inducing skeletal muscle relaxation would be effective in reducing snoring. Relaxation training was provided to a second group of subjects.

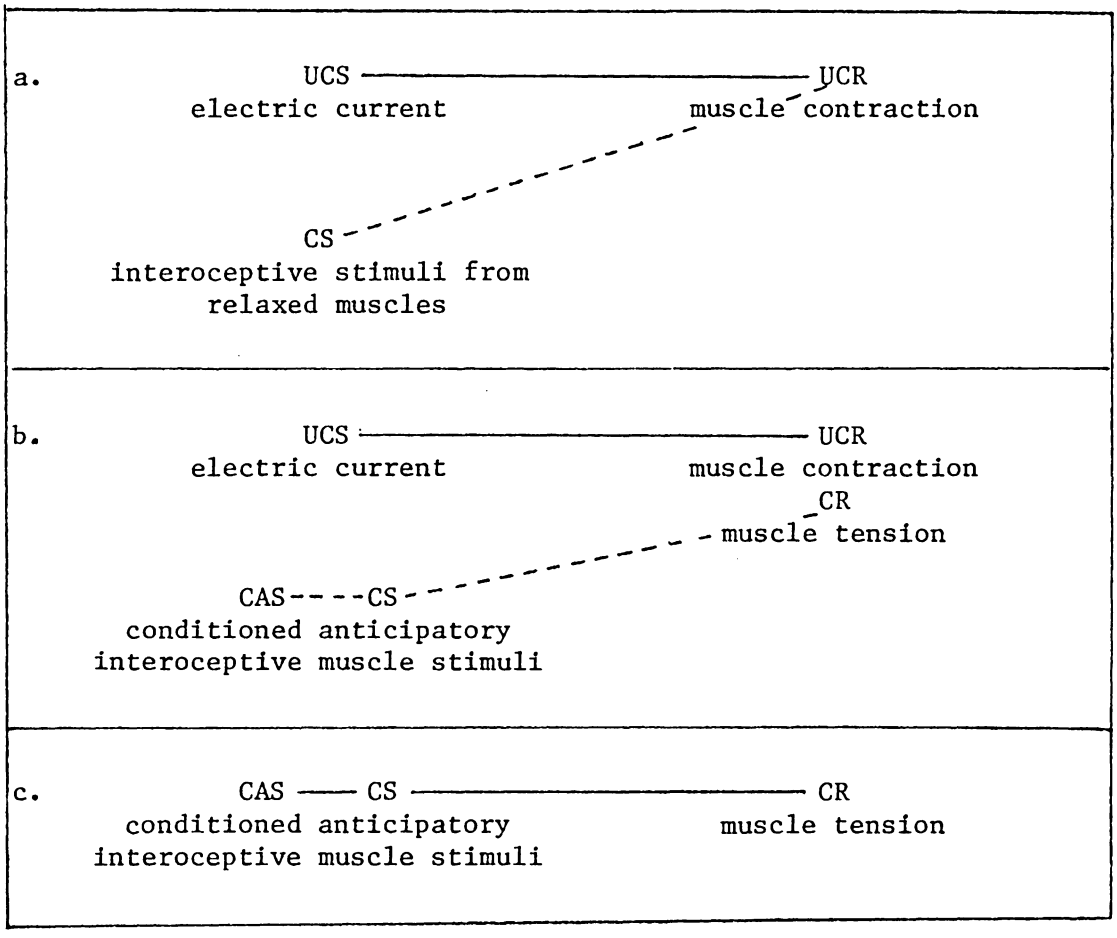

Figure 1. Hypothesized Classical Conditioning Sequence in a Behavioral Treatment of Snoring.

The relaxation training would increase the relaxation of the skeletal musculature of the subjects. The increased muscle relaxation should cause changes in the vascularization of the nasal mucous membranes as previously outlined. Snoring should be reduced as skill in relaxaing increases and nasal breathing replaces mouth breathing. This condition was labeled the Relaxation (RX) condition.

Control groups were included to evaluate the effectiveness of the two treatments. The first control was a No Treatment (NT) control group. Subjects in this condition received no treatment for their snoring. No reduction of snoring was predicted to occur during the study for these subjects. Measures of their snoring such as frequency and duration of snoring were used in comparison with similar measures from the other groups.

A Placebo Control (PC) group was included and used to evaluate the placebo or attention value of the equipment provided to the SC subjects. The PC subjects used the same equipment as the SC subjects, however the equipment that produced the conditioning was made non-functional.

The evaluation of the behavioral theory and the Tsukamoto et al. (1938) theory were of primary relevance in the current study. However, the evaluation of a treatment which could be used only in a sleep laboratory would be of little or no benefit to the majority of snorers. The current study was designed to provide and evaluate treatments which could be used by snorers in their homes with little or no supervision. The administration of the treatments in the

subjects' homes could introduce greater variability in the data from differences in subject compliance with instructions or interruptions of the subjects' sleep from roommates, children and others. However the appearance of treatment effects despite the increased error variance would serve to underscore the robustness of the treatment.

The evaluation of personality characteristics was undertaken as a logical addendum to the theoretical and practical purposes of the study. There have been no studies assessing personality variables in snorers. Assessment of personality variables could provide ideas for future research in snoring and suggest explanations for the results of the present study. Measures of hostility, locus of control, and anxiety were obtained for descriptive and general information purposes.

The perception of snoring by the snorer and roommate was briefly examined as an addendum to the primary theoretical and practical purposes of the study. Examination of snorer and roommate perceptions of snoring would add to the general body of knowledge on the interpersonal effects of snoring. It was expected that because the snorers would be asleep and generally unaware of their snoring, their perception of the snoring would not be similar to the roommates' perception of the snoring.

Hypotheses

The behavioral theory predicts that conditioning of the muscle contraction would result in a decrease of snoring in the SC subjects

relative to the RX, PC, and WL subjects. A decrease in the snoring of the SC subjects below the levels of the latter three groups would support a behavioral interpretation of snoring.

The Tsukamoto et al. (1938) theory would predict that the RX subjects would show a significant decrease in snoring duration and frequency relative to the SC and control subject.

A reduction in snoring by both of the active treatment groups, SC and RX, was not predicted to occur. The contraction of the neck and throat muscles from the electrical stimulation in the SC condition would be antithetical to relaxation unless some type of muscle relaxation rebound effect occurred in response to the muscle contraction. The increased muscular activity from the muscle contractions might cause an increase in blood flow to the neck and throat. An increase in blood flow to the neck and throat area could further dilate the nasal vasculature and increase the probability of snoring according to the Tsukamoto et al. (1938) theory. Conversely, the relaxation produced by the relaxation exercises for the RX subjects produces an effect opposite to that elicited by the snore collar in the SC group.

A reduction in snoring for the PC condition relative to the other groups was not predicted to occur. A reduction in the snoring of the PC subjects would demonstrate the potency of a treatment expectancy mental set and provide tenuous support for Altschuler's (1964) theory (see page 8). Altschuler's theory would gain credibility in that a significant reduction in snoring of the PC subjects would

indicate that neither a behavioral nor physiological intervention was necessary to reduce the snoring. Dynamic factors would appear to be involved. For example, if snoring represents unconscious hostility toward a loved bedmate, then continued snoring in the presence of a treatment believed to be effective would make the hostility expressed by the snoring more overt and perhaps achieve consciousness as a hostile act. The snoring would be reduced to prevent conscious recognition of its aggressive purpose. The hostility previously expressed by the snoring would be expressed in a new, less overt manner.

Chapter 2

Methods

Apparatus

The apparatus consisted of: 4 General Electric cassette recorders, Model 3-5152, 10 Panasonic cassette recorders with microphones, Model RQ-2785; 10 voice-activated (VOX) relay switches; 6 Snore Suppressor collars, Crossley Electronics: blank cassette tapes; relaxation cassette tapes; telegraph key switch; and a Lafayette Stop Clock, Model 5708.

Each of the Panasonic cassette recorders was modified to record and play at 0.375 inches per second (ips) which is one-fifth the normal speed of 1.875 ips. Thus a 120 minute cassette tape was capable of recording or playing back 600 minutes or 10 hours of material.

A voice-activated control switch (VOX) was connected to each of the Panasonic cassette recorders. The VOX controlled the operation of the recorder by providing power for the recorder to operate only when a sound of a pre-determined level occurred. The VOX has a sensitivity switch allowing for exclusion of background or the ambient noise level.

The snore collar is a light weight, self-contained unit designed to deliver a low voltage/amperage current to the throat through two silicone rubber electrodes. The collar fits snugly around the front of the neck and is fastened behind the neck by an adjustable Velcro strip. The collar is flexible, does not interfere with the wearer's mobility or movement, and causes minimal if any discomfort.

The electrical components of the snore collar consist of a small 15 volt battery, transformer, circuit board and condensor microphone. All of the components are concealed under a flexible vinyl casing which forms the body of the snore collar. An on-off switch combined with a potentiometer regulates the current to the electrodes. A sensitivity switch regulates the sensitivity of the microphone to sounds. Electrode gel is smeared on the silicone rubber electrodes to decrease electrical resistance between the electrodes and skin.

Subjects and Design

The subjects were 9 male and 7 female volunteers from Virginia and 13 male and 3 female volunteers from Mississippi. The following a priori criteria were applied to all potential subjects.

1. All subjects were required to be between the ages of 18 to 65.
2. All subjects were required to have a roommate who was willing to participate in the study.
3. All subjects were required to have a chronic snoring problem. Chronic was defined as nightly snoring for four weeks.
4. No subject could have a pathological causation or origin of their snoring.
5. Sleep apnic individuals were ineligible because the treatments were not expected to be effective in reducing sleep apnic snoring.
6. All subjects were required to be in good cardiovascular condition.
7. The potential of treatment induced seizures prevented individuals with epilepsy from participation in the study.

Subjects were recruited via physician referrals, public service announcements on radio and in newspapers, and through radio interviews and newspaper articles.

The study was a one factor with repeated measures design. The factor Treatment Condition had four levels; Snore Collar (SC), Relaxation (RX), Placebo Control (PC), and No Treatment (NT). The subjects were randomly assigned to one of the four levels of Treatment condition. The dependent variables of snoring duration and snoring frequency were the repeated measures assessed over 31 nights or trials.

Thirty-one nights of snoring data were recorded from each subject. The first five nights of data were labeled the baseline period. Each subject's baseline rate of snoring was recorded to insure that all conditions were similar in snoring prior to the administration of the treatments. The baseline period also allowed the subjects to adapt to the presence of the recording equipment in their home.

The intervention period immediately followed the baseline period and continued for 20 consecutive nights. The snore treatments applicable to each treatment condition level were administered throughout the intervention period.

Two 3 night follow-up periods were recorded. No snore treatments were administered during the follow-up periods. The first follow-up period, the immediate follow-up, began the night following the last night of the intervention period. The purpose of the immediate follow-up was to determine if there was a short-term reduction in snoring caused by the snore treatments administered in the preceding

intervention period. The second follow-up, the extended follow-up, began 4 to 12 weeks following the immediate follow-up period. The purpose of the extended follow-up period was to determine if there was a long-term or stable reduction in snoring from the treatments.

Measures

Duration. Snore duration was defined as the number of seconds in one night during which a subject produced a snoring sound. The duration data were transcribed from the cassette tapes by the researcher. A Lafayette Stop Clock and telegraph key switch were used to manually time the duration of each snore. A sampling procedure was utilized on tapes exceeding 4 hours in length such that a minimum of 50% of the tape was transcribed. The tape recorder that was used in transcribing the tapes contained a counter for measuring the tape length. Samples of the tapes were collected through the use of the counter. A tape which had a length of 900 "counts" was sampled in 50 unit increments, with the first 50 and last 50 units of the tape always transcribed. Thus a tape would be transcribed at counts of 0 to 50, 100 to 150, 200 to 250, ..., and the last 50 counts on the tape, 850 to 900. Sounds such as coughing or talking were not included in the duration measure.

Frequency. The total number of separate snores produced by a subject in one night defined the frequency measure. The frequency data were transcribed from the cassette tapes by the researcher at the same time that the duration data was transcribed. The sampling procedure that was applied to the duration data was also applied to

the frequency data. Sounds such as coughing or talking were not included in the frequency measure.

Sleep Apnea Questionnaire. The Sleep Apnea Questionnaire (SAQ), forms A and B, is an author derived questionnaire (Appendix B). This self-report questionnaire was used as a screening instrument to detect individuals whose snoring might be caused by sleep apnea. The SAQ was given to all subjects and roommates prior to the subjects participation in the intervention period of the study. Form A of the SAQ was completed by the snorer and consisted of 11 items plus a space to describe unusual snoring or sleeping characteristics. Seven items are of the "yes-no" format and four of the items are multiple choice.

Form B of the SAQ was completed by the roommate of the snorer and consisted of 10 items plus a space to describe unusual snoring or sleeping characteristics of the snorer. Seven items are of the "yes-no" format and 3 items are multiple choice.

A "yes" response on items 1 through 3 and 5 through 7 or a "d" response on item 4 indicated the potential for sleep apnea was present and further verbal questioning was necessary. A "yes" response on item 8 was an admission of or observation of sleep apnea. Item 9 of form A and items 9 and 10 of form B assessed the severity of the sleep apnea when item 8 was answered "yes." Items 10 and 11 of form A examined the incidence of sleep apnea in the subject's family. The construction of the questionnaire does not readily permit use of a cutoff or criterion score for sleep apnea. Subjective

evaluation of the questionnaire by the researcher indicated whether the subject should be questioned further about sleeping and breathing patterns. No subjects were found to have sleep apnea on the basis of the SAQ.

Sonorous Breathing Questionnaire. The Sonorous Breathing Questionnaire (SBQ), forms A and B, is an author derived questionnaire (Appendix B). This self-report questionnaire was used as a correlational measure to determine the congruence between snorer and roommate perception of the snoring. Form A of the SBQ was completed by the snorer and consists of 6 multiple choice items and 6 "yes-no" format items. The multiple choice items describe general antecedents and general characteristics of snoring as well as the effect of the snoring on the roommate. The 6 "yes-no" format items are on specific antecedents of snoring, such as alcohol consumption.

Form B of the SBQ was completed by the roommate of the snorer and consists of 6 multiple choice and 6 "yes-no" format items. The form B items are similar to the form A items, but request information from the roommate's perspective rather than the snorer's.

State-Trait Anxiety Inventory (Spielberger, Gorsuch & Luschene, 1970). The trait component (A-2) of the State-Trait Anxiety Inventory (STAI) is a self-report measure that assesses enduring anxiety independent of situationally induced anxiety (Appendix B). The scale is composed of 20 statements describing emotional states. The respondent was asked to respond to each item using a 4 point scale which includes "1" or almost never, "2" or sometimes, "3" or often,

and "4" or almost always. The trait anxiety level was computed by summing the points for all items with the higher scores reflecting higher levels of trait anxiety. The STAI-A2 was used as a descriptive measure in providing general information about personality characteristics of snorers.

Rotter I-E Scale (Rotter, 1966). The Rotter I-E Scale is a self-report questionnaire that purportedly assesses the extent that an individual believes reinforcements are self-controlled or controlled by others and luck. The scale is composed of 23 scorable and 6 distractor items with two statements per item. Each of the scorable items contains one "internal" and one "external" statement. The respondents select the statement that is most similar to their beliefs. The scale is scored by summing the number of "external" items selected by the respondent. A high score suggest an external locus of control and a low score suggests an internal locus of control. The I-E Scale was used as a descriptive measure in providing general information about personality characteristics of snorers.

S-R Inventory of Hostility (Endler & Hunt, 1968a). The S-R Inventory of Hostility is a self-report questionnaire that purportedly assesses a general trait of hostility (Appendix B). Aggression, anger and hostility are considered synonymous in the questionnaire. The inventory is composed of 14 sample situations in which anger, aggression or hostility are likely to occur. Ten response modes are used to assess the anger or hostility felt in each stimulus situation. The respondent rates the amount of anger or hostility expressed in a

response mode with a 5 step scale ranging from "not at all" to "very much." The inventory is scored by summing the response mode scores for each situation and then computing the mean of the 14 situations. Low mean scores represent low trait hostility. The S-R Inventory of Hostility was used as a descriptive measure in providing general information about personality characteristics of snorers.

Anxiety Thermometer. The Anxiety Thermometer (AT), forms A and B, is an author derived scale (Appendix B). The AT is a self-report measure designed to determine the level of anxiety a person is experiencing or has experienced recently. Form A of the AT asks the respondent to rate the average amount of anxiety, stress or tension felt or experienced that day on a 10 point scale. Form B asks the respondent to rate the amount of anxiety, stress or pressure that is being experienced at the time of the rating. The AT was used as a descriptive measure in examining the relationship between state anxiety and snoring.

Procedure

Each subject was initially contacted via telephone. The purpose of the study, eligibility requirements and the subject's contribution in time and effort were discussed. Individuals who indicated they had signs of sleep apnea were advised to consult a physician for treatment. Individuals who met the a priori eligibility criteria were asked to visit a physician for an examination. A meeting with the researcher was also scheduled during the telephone interview.

The purpose of the physician's examination was to screen out

subjects who might have been at cardiovascular risk or who had a pathological causation of their snoring. The electrical current delivered to the throat could have a negative effect upon an individual with a severe cardiovascular disorder. The physician also examined the individuals for any indications of a pathological cause of the snoring. The proposed treatments were not expected to be effective in reducing pathological snoring.

A physician serving as the medical consultant to the Psychological Services Center operated by the Psychology Department performed the examinations upon the Virginia subjects. The physician's fee for the Virginia subjects was paid by the research project. The Mississippi subjects were required to obtain a physician's examination at their expense. The Mississippi subjects were encouraged to obtain their examination from their family physician or a physician familiar with the subject's snoring.

The purpose of the meeting with the researcher was to explain the study in detail, provide a rationale for the assigned treatment condition, and to begin the subject's participation in the study. All subjects were asked to sign a Consent to Participate form (Appendix B) and were provided with the SAQ, SBQ, STAI-A2, Rotter I-E Scale, and the S-R Inventory of Hostility. Each subject was provided with a Panasonic tape recorder, microphone, VOX, cassette tapes and operating instructions. Each subject was asked to place the equipment at the side of their bed with the microphone no more than 24 inches from the normal position of their head when asleep. Daytime naps were not

recorded.

The instructions for the equipment and rationale for the intervention differed among the four treatment conditions. The SC subjects were informed of the conditioning process that was expected to occur. Each SC subject was provided with a snore collar. The collar was to be worn but not turned on during the baseline period. The collar was to be turned on during the intervention period. The shock level was adjusted to provide a visible muscle contraction in the neck. The SC subjects were instructed to wear the collar during all sleep periods, including naps although data were not recorded during naps.

The PC subjects were provided with a snore collar similar to that of the SC subjects. However the battery was disconnected and the microphone removed in the PC subjects' collars. The subjects were told that the collar produced a minute pulsating electrical stimulation to the neck and throat muscles. This electrical stimulation would allegedly gradually increase the muscle tone of the throat muscles and related structures causing a decrease and then cessation of the snoring. The PC subjects were instructed to wear the collar only during the intervention period.

The use of deception in psychological research is never desirable, but is sometimes necessary. The present study used deception with the PC subjects to increase compliance in wearing the snore collar. The subjects' belief of a treatment effect from the collar was expected to increase the PC subjects' motivation to wear the collar each night.

The RX subjects were informed of the Tsukamoto et al. (1938) theory and of the hypothesized interaction between skeletal relaxation and nasal vasodilation. A GE cassette player and a cassette tape of progressive relaxation exercises (Jacobson, 1934) were provided to each RX subject. The subjects were instructed to play the relaxation tape once per day during the intervention period. They were asked to relax as completely as possible upon retiring to bed at night. The subjects were not allowed to use the relaxation tape during the follow-up periods but were encouraged to continue to relax upon retiring to bed.

The NT subjects were informed that one purpose of the study was to examine the relationship between anxiety and snoring. These subjects were told that 31 nights of data would be necessary to determine if their snoring was related to the anxiety or stress they experienced during the day. These subjects were told they would be assigned to either the SC or RX treatment condition based upon the extent to which their tension levels affected their snoring. The NT subjects were also informed that their group would serve as a control group for comparison to the other treatment conditions.

The researcher visited each subject following the 5th, 10th, 20th and 25th nights of recording. The visit was to collect recorded data, provide blank cassettes, and to check for malfunctioning equipment. The equipment was collected following the completion of the immediate follow-up period. The recording equipment was returned 4 to 12 weeks later for recording of the 3 night extended follow-up period. The length of time between the immediate and extended

follow-up periods varied depending upon each subject's availability for participation in the extended follow-up period.

All subjects were instructed to record the date, time of going to bed, and the AT forms A and B ratings on the tape cassette prior to going to sleep. The time of awakening was recorded by the subjects in the morning.

The subjects in all groups were debriefed following their completion of the study. Every subject was given a relaxation cassette and the option of receiving the snore collar treatment.

Chapter 3

Results

The two basic dependent variables, Frequency (F) and Duration (D), provided cumulative records of the snoring for an entire night. The variable F represents the total number of snores that occurred in a night. The variable D represents the total number of seconds of snores that occurred in a night. Division of the two basic dependent variables by hours of sleep (H), yielded two additional dependent variables, D/H and F/H. These variables represent the average amount of snoring per hour of sleep in any one night. Duration divided by frequency yielded a fifth dependent variable (D/F) which is the average length of a snore per night.

Subject error or malfunctioning equipment occasionally resulted in data not being recorded for a night. The repeated measures analysis of variance used in subsequent analyses does not permit missing data values. The missing data values were replaced by computing the mean of the immediately preceding and succeeding nights. The range of missing data values per subject was one to six nights.

A significance level of $\leq .05$ was set for all comparisons of treatment effects unless specifically stated otherwise for an analysis. A significance level of $< .20$ was set for all comparisons of the baseline data. This significance level provides a more conservative equivalence of groups test for the baseline period than would a smaller alpha level. Baseline data analysis requires acceptance rather than rejection of the null hypothesis to assume

equivalence of groups. However experimental designs and significance levels are generally established to minimize Type I error or falsely rejecting the null hypothesis. Thus the groups can show considerable variation during the baseline period yet not be statistically different with a traditional alpha level. Increasing the alpha level increases the probability of a Type I error and decreases the probability that the null hypothesis will be falsely rejected.

Tests for homogeneity of variance between treatment conditions were routinely performed. Homogeneity of variance, or homoscedasticity, is required for repeated measures analysis of variance and covariance. No significant differences in homoscedasticity were found between any treatment conditions in any of the following analyses.

D, D/H, F, and F/H. The baseline data for the variables D, D/H, F, and F/H were analyzed to determine if the treatment conditions were equivalent on these measures prior to the intervention period. Separate repeated measures analyses of variance were performed on the baseline data for D, D/H, F, and F/H. Treatment Condition (TC) was the Between-Subjects factor and Nights was the Within-Subjects factor. No significant differences were found for the main effects of TC, Nights, or the TC X Nights interaction. These analyses demonstrate that the treatment conditions did not significantly differ on the dependent variables nor appreciably vary over the baseline nights.

The repeated measures of Nights was blocked for subsequent analyses to increase computational efficiency. The 25 nights comprising the baseline and intervention periods were converted into

five blocks of five successive nights each. The baseline formed one block (B1) and the intervention period yielded four blocks (B2-B5). Each of the follow-up periods was converted into a separate block of three successive nights (B6, B7). The block means, B1-B7, for the dependent variables D, D/H, F, and F/H are plotted in Figures 2, 3, 4, and 5, respectively.

An examination of Figures 2 through 5 indicates that the baseline block, B1 is rather variable. The baseline block was covaried from subsequent blocks in the following analyses to assist in delineating the treatment effects. Representative adjusted block means for the dependent variables D, D/H, F, and F/H are plotted in Figures 6, 7, 8, and 9, respectively, to illustrate the effect of the covariate on subsequent blocks.

The intervention D, D/H, F, and F/H data were analyzed to determine if any treatment effects were apparent during the intervention period. Separate repeated measures analyses of covariance were performed on the D, D/H, F, and F/H intervention data using the baseline block as the covariate. Treatment Condition was the Between-Subjects factor and Blocks the Within subjects factor. No significant differences were found in any analysis for the main effects of TC, Blocks or the TC X Blocks interaction. These analyses demonstrate that the treatment conditions did not significantly differ on the variables of D, D/H, F, or F/H during the intervention period.

An examination of the immediate follow-up block, B6, in Figures 6 through 9 indicates that the level of D, D/H, F, and F/H decreased

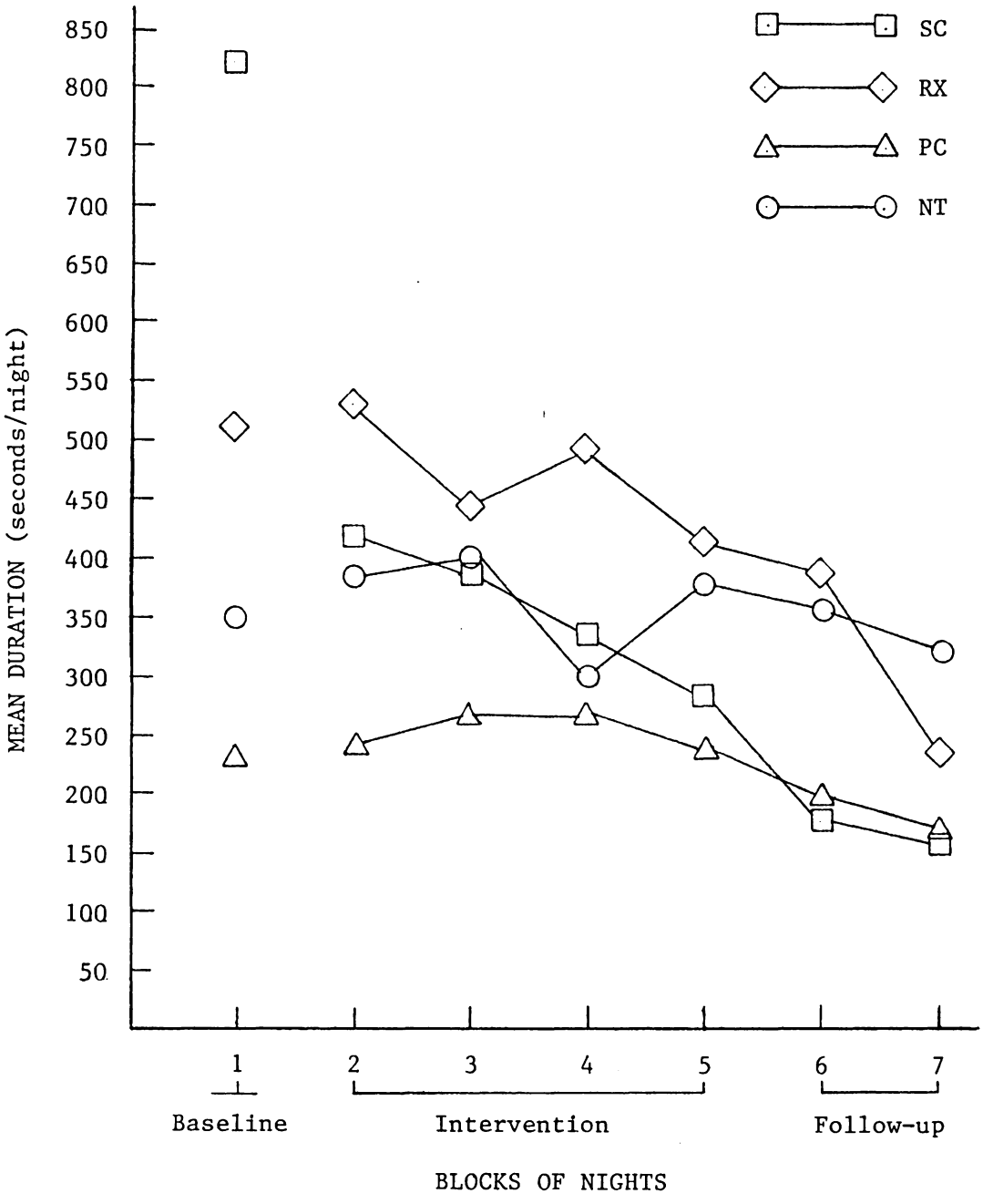

Figure 2. Mean Total Snoring Duration for the Baseline, Intervention and Follow-Up Blocks.

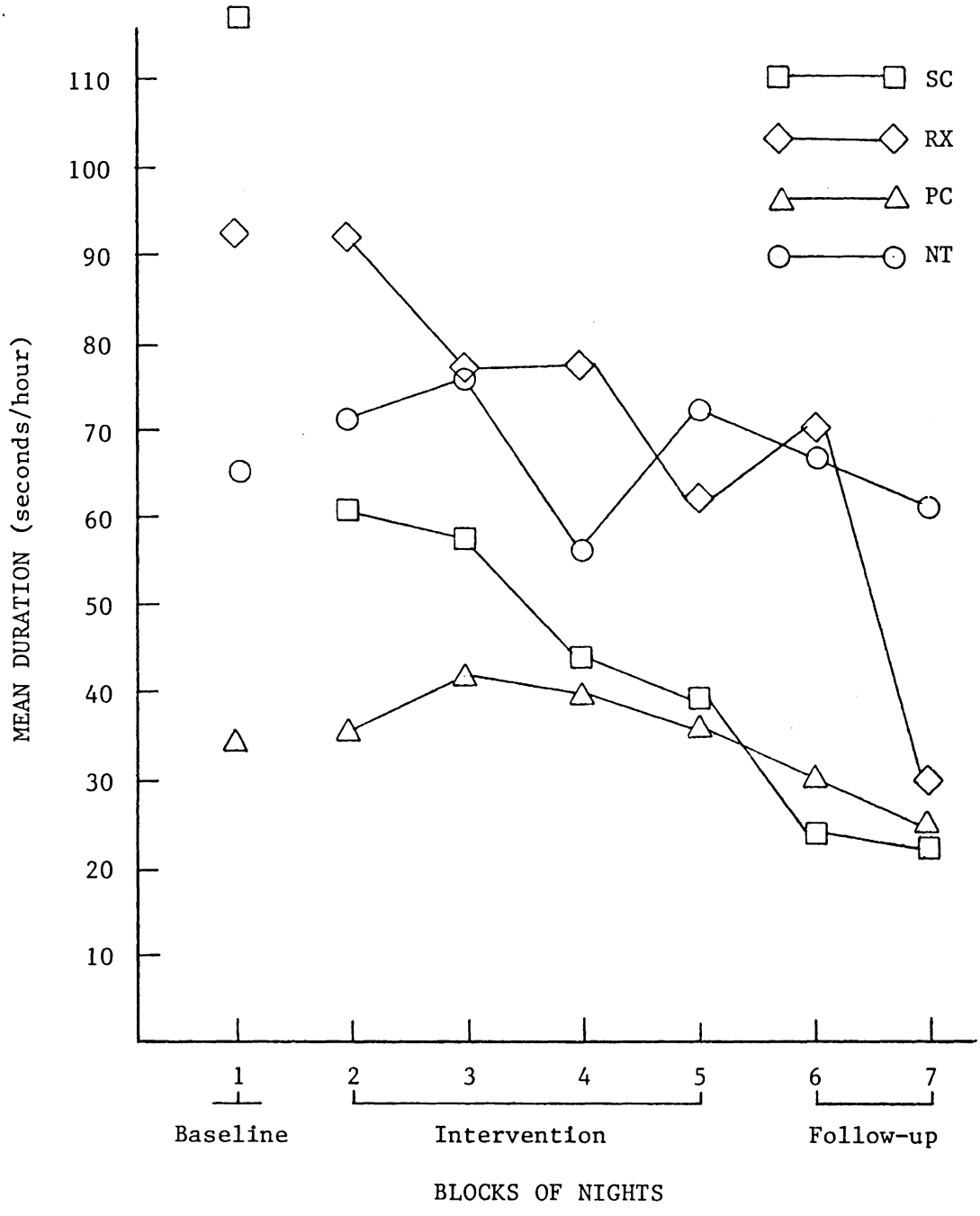

Figure 3. Mean Snoring Duration per Hour for the Baseline, Intervention and Follow-Up Blocks.

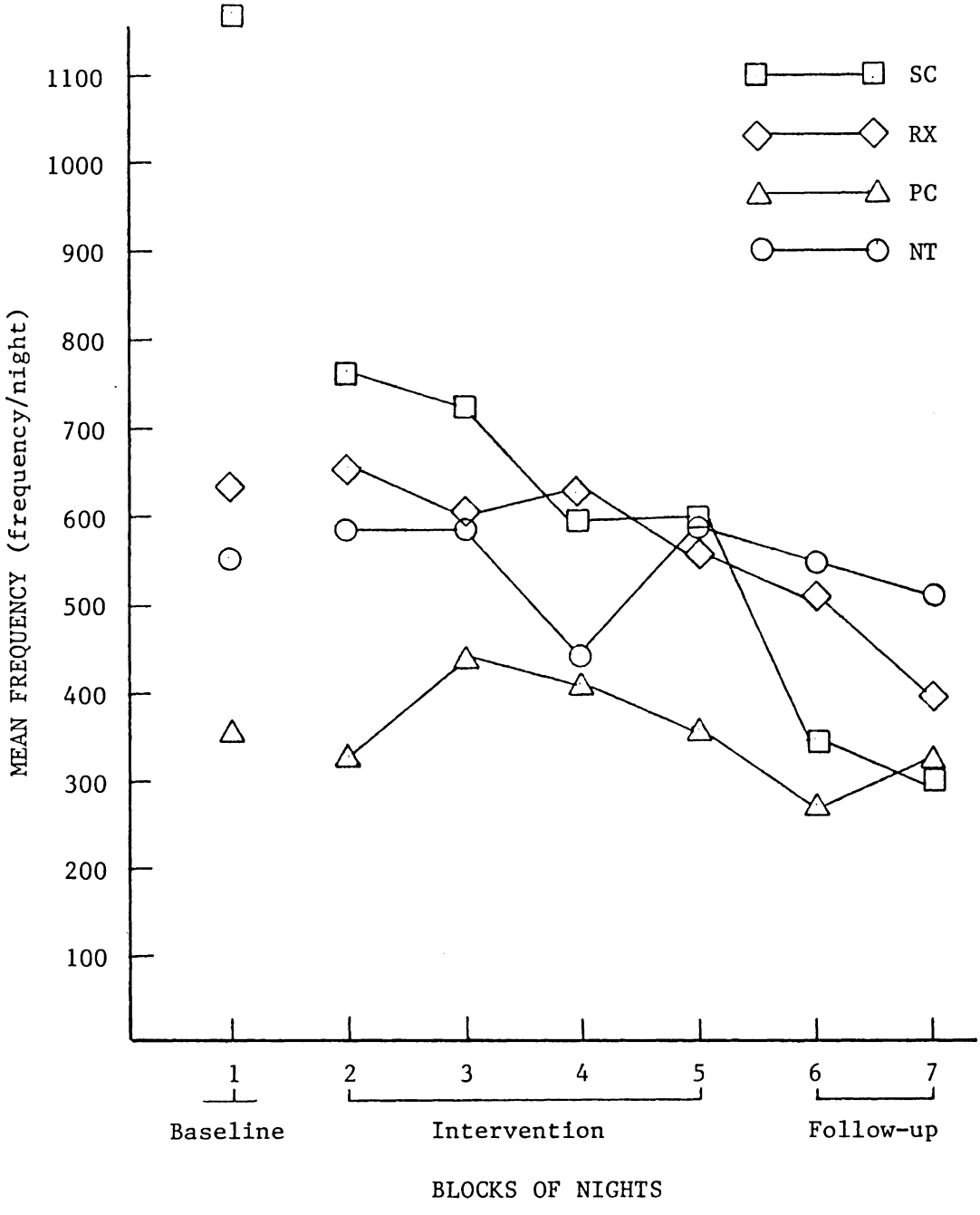

Figure 4. Mean Total Snoring Frequency for the Baseline, Intervention and Follow-Up Blocks.

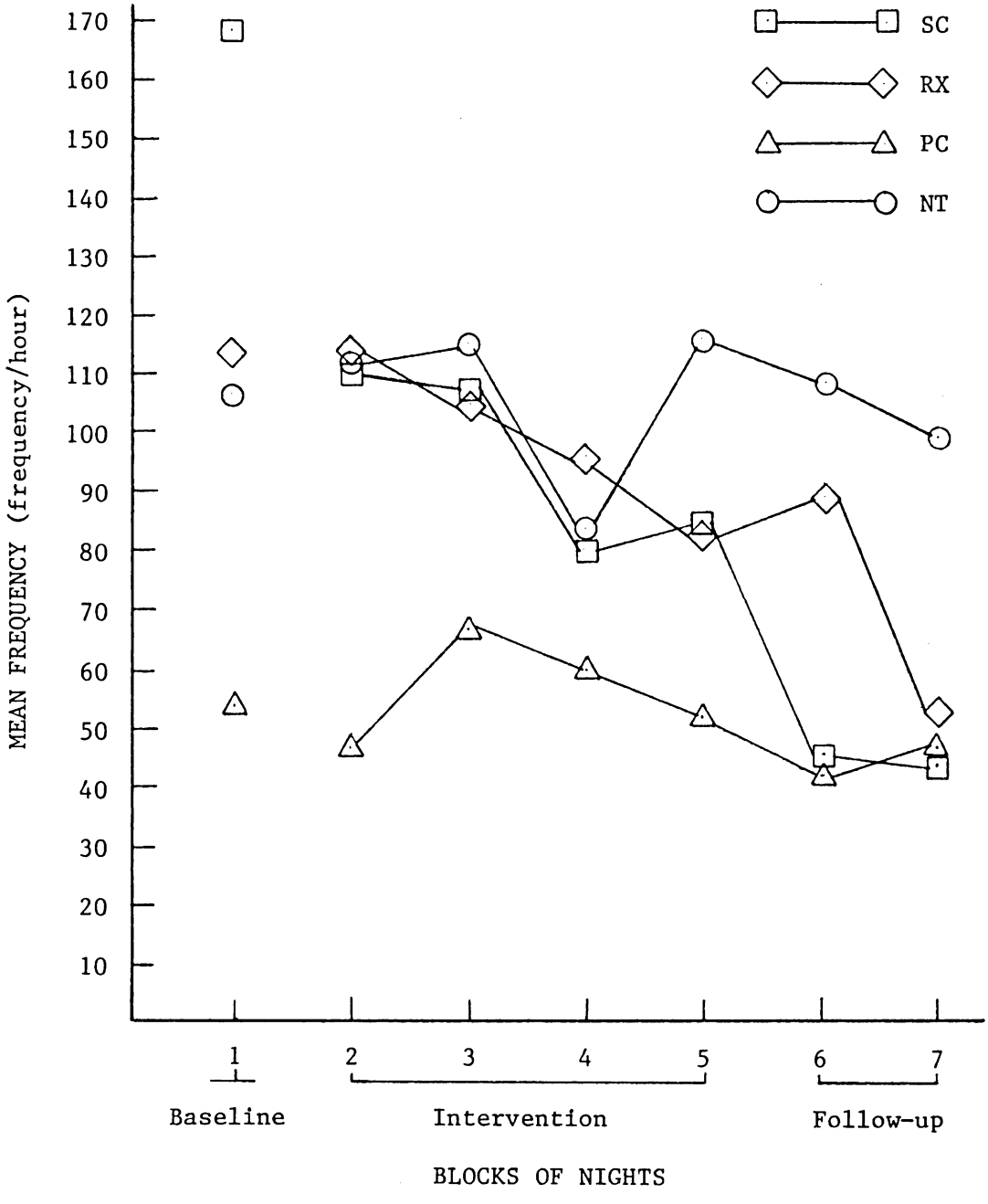

Figure 5. Mean Snoring Frequency per Hour for the Baseline, Intervention and Follow-Up Blocks.

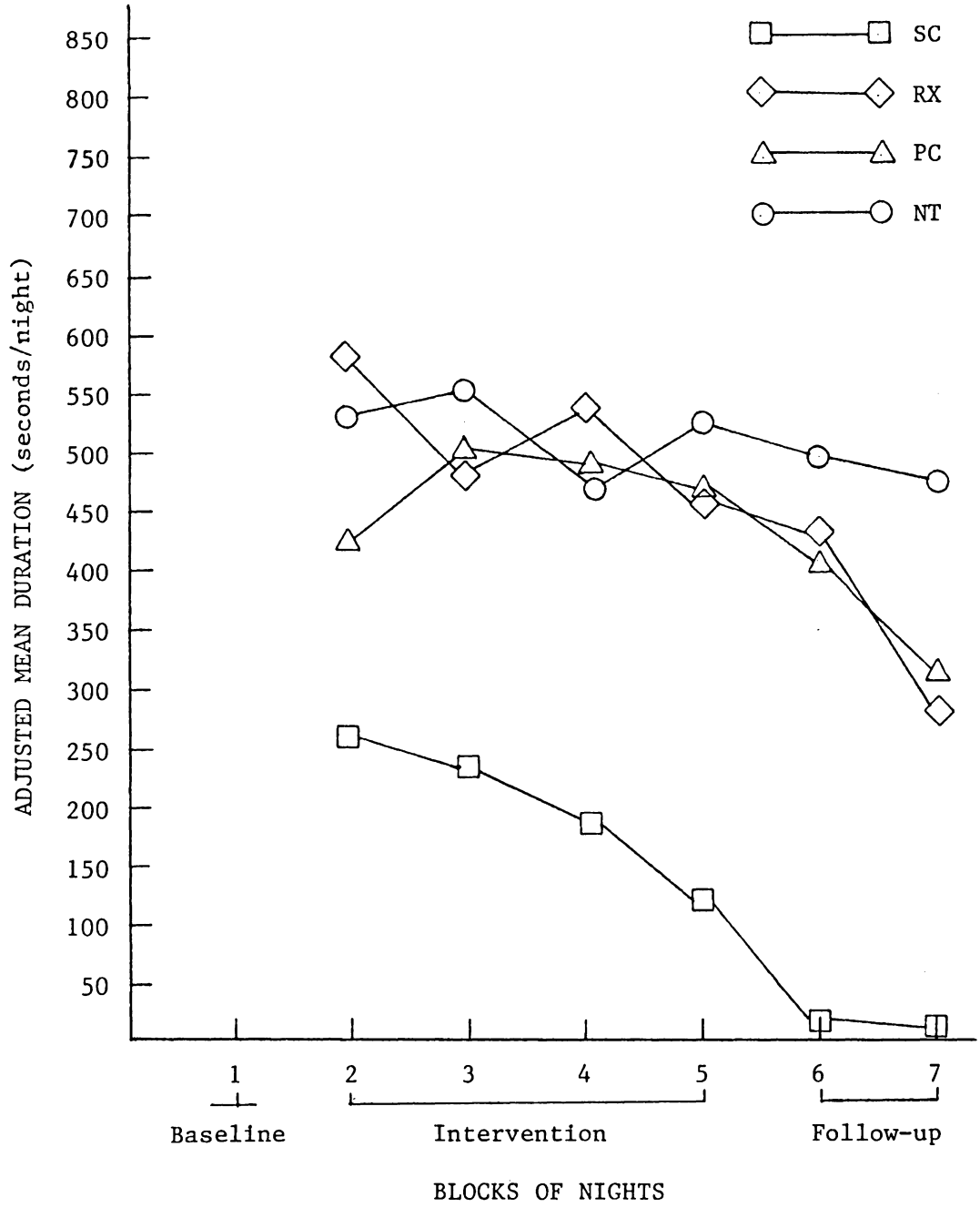

Figure 6. Mean Total Snoring Duration over Blocks Adjusted for the Baseline Block Covariate.

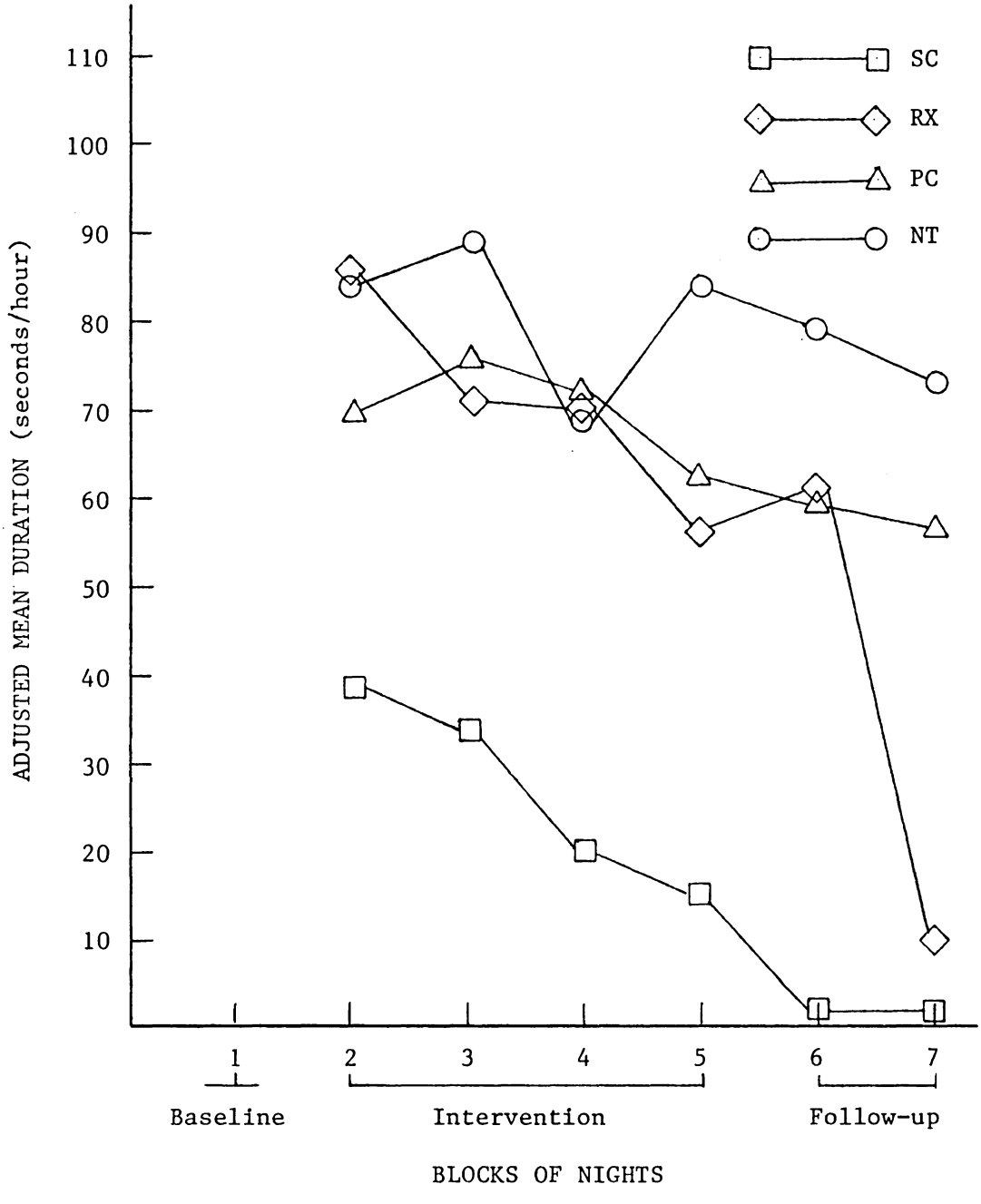

Figure 7. Mean Snoring Duration per Hour over Blocks Adjusted for the Baseline Block Covariate.

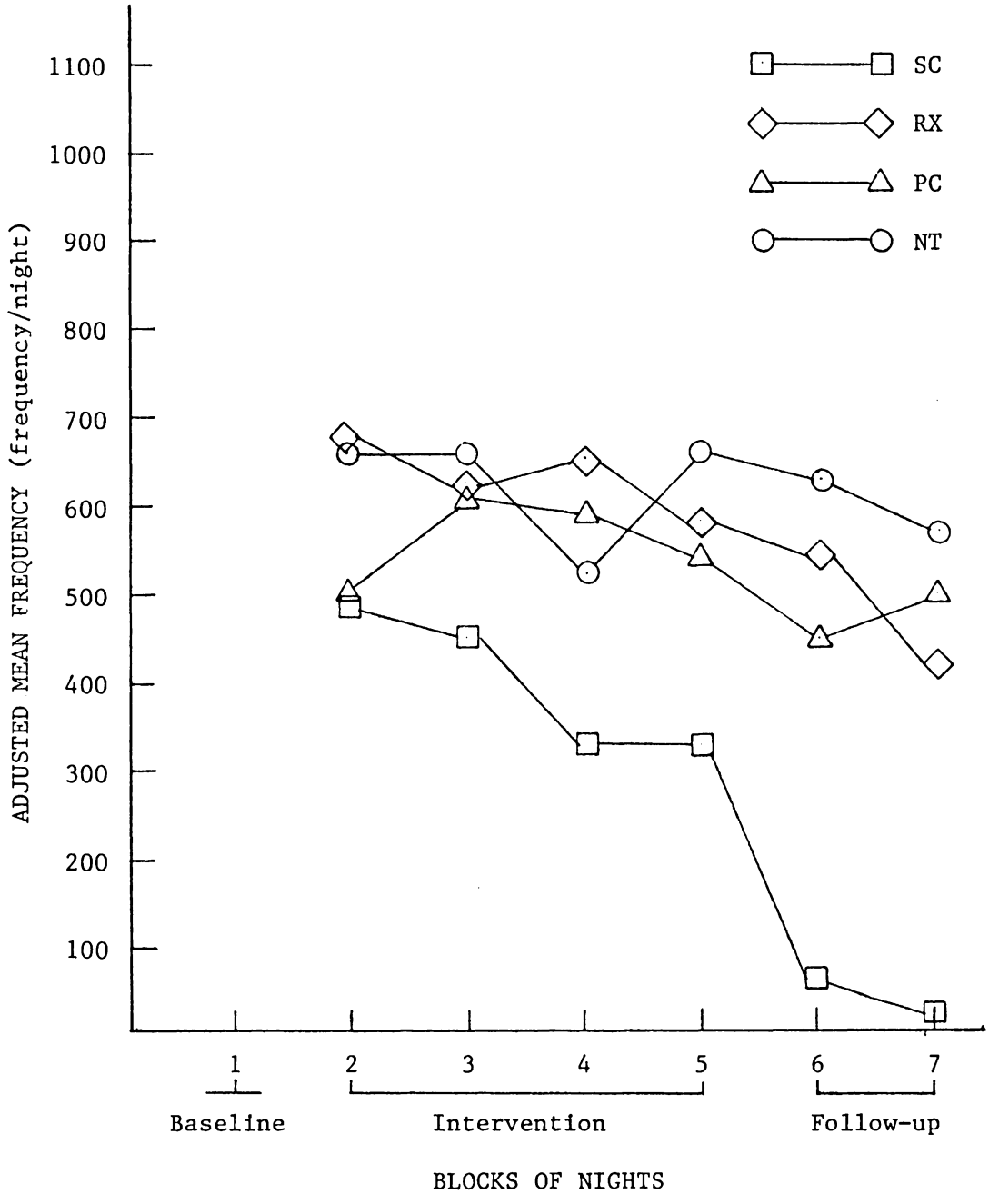

Figure 8. Mean Total Snoring Frequency over Blocks Adjusted for the Baseline Block Covariate.

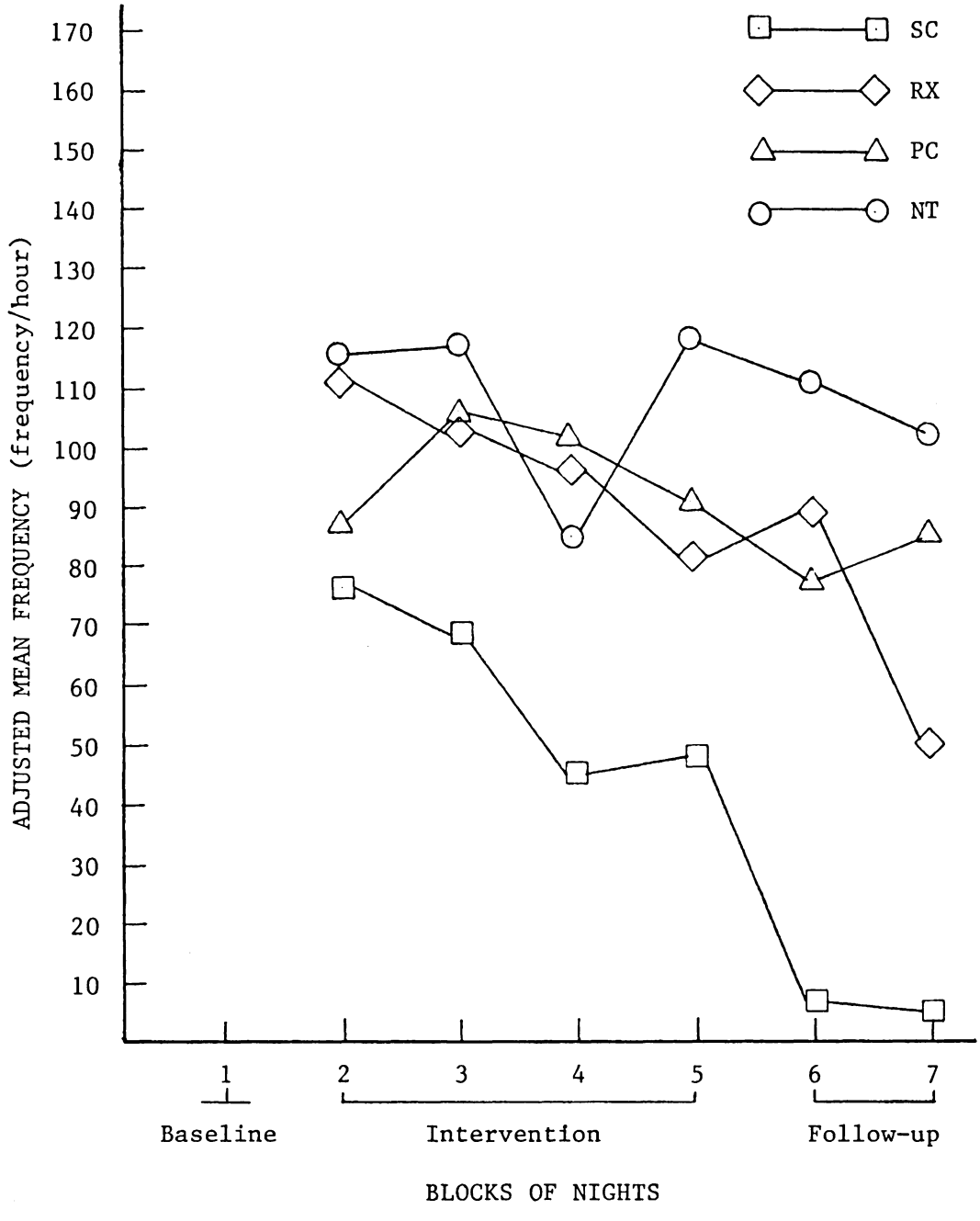

Figure 9. Mean Snoring Frequency per Hour over Blocks Adjusted for the Baseline Block Covariate.

for the SC condition below that found in the intervention. Separate one-way analyses of covariance using the baseline block as the covariate were performed on the immediate follow-up block. The main effect of Treatment Condition was significant for D ($p \leq .028$) and for D/H ($p \leq .008$). The analysis of covariance for D is summarized in Table 1 and for D/H in Table 2.

A Tukey Multiple Comparisons test was applied to the D immediate follow-up data and is summarized in Table 3. The SC condition ($p \leq .05$) significantly differed from the NT condition. No other comparisons were significant. This analysis demonstrates that the SC condition subjects exhibited significantly fewer seconds of snoring per night than the subjects in the NT control group.

A Tukey Multiple Comparisons test was applied to the D/H immediate follow-up data and is summarized in Table 4. The SC condition significantly differed from the NT condition ($p \leq .01$), the PC condition ($p \leq .05$), and the RX condition ($p \leq .05$). No other comparisons were significant. This analysis demonstrates that the SC subjects exhibited significantly fewer seconds of snoring per hour than any of the other subjects.

The extended follow-up blocks (B7) were examined to determine if the treatment effects in the B6 block were stable. Separate one-way analyses of covariance using the baseline block as the covariate were performed on the extended follow-up block for D, D/H, F, and F/H. The main effect of Treatment Condition was significant for D ($p \leq .034$) and D/H ($p \leq .023$). The analysis of covariance for D is summarized

Table 1

Summary of Analysis of Covariance of Mean Total Snoring Duration for the Immediate Follow-Up Block

Source	df	MS	F	p
Between Subjects	3			
Treatment Condition	3	350491.0	3.53	<.028
Covariate	1	4050033.0	40.79	<.0001
Within Subjects				
error w	27	99280.8		
Total	31			

Table 2

Summary of Analysis of Covariance of Mean Snoring Duration per Hour for the Immediate Follow-Up Block

Source	df	MS	F	p
Between Subjects				
Treatment Condition	3	10511.4	4.82	<.0082
Covariate	1	206150.9	94.55	<.0001
Within Subjects				
error w	27	2180.4		
Total	31			

Table 3

Summary of the Tukey Multiple Comparison Test

in Mean Total Snoring Duration for the

Immediate Follow-Up Block

	NT	SC	RX	PC
NT	436.6*	**		
SC		-52.8*		
RX			366.4*	
PC				350.4*

* Adjusted group means

** $p \leq .05$ Critical Difference$_{(4,24)} \geq 434.5$

Table 4

Summary of the Tukey Multiple Comparison Test in Mean Snoring Duration per Hour for the Immediate Follow-Up Block

	NT	SC	RX	PC
NT	75.81*	**		
SC		-7.28*	***	***
RX			57.97*	
PC				61.9*

* Adjusted group means

** $p \leq .01$ Critical Difference$_{(4,24)} \geq 80.89$

*** $p \leq .05$ Critical Difference$_{(4,24)} \geq 64.38$

in Table 5 and for D/H in Table 6.

A Tukey Multiple Comparisons test was applied to the D extended follow-up data and is summarized in Table 7. The SC condition ($p \leq .05$) significantly differed from the NT condition. No other comparisons were significant. This analysis demonstrates that the SC condition subjects exhibited significantly fewer seconds of snoring per night than the NT control subjects in the extended follow-up period.

A Tukey Multiple Comparisons test was applied to the D/H extended follow-up data and is summarized in Table 8. The SC condition ($p \leq .05$) significantly differed from the NT condition. No other comparisons were significant. This analysis demonstrates that the SC condition subjects exhibited significantly fewer seconds of snoring per hour than the NT control subjects over an extended time period.

Duration/Frequency. The average or mean snore length per night was computed by dividing the duration data by its corresponding frequency data. The resulting variable was labeled Duration/Frequency (D/F). The baseline D/F data for the SC, RX, PC and NT conditions were analyzed to determine if the conditions were equivalent in D/F prior to the intervention period. A repeated measures analysis of variance was performed on the baseline D/F data. Treatment Condition was the Between-Subjects factor and Nights was the Within-Subjects factor. No significant differences were found for the main effects of TC, N Nights or the TC X Nights interaction. This analysis demonstrates that the mean snore duration did not significantly differ across treatment conditions nor did it appreciably vary over the baseline nights.

Table 5

Summary of Analysis of Covariance of Mean Total Snoring Duration for the Extended Follow-Up Block

Source	df	MS	F	p
Between Subjects				
Treatment Condition	3	213969.3	3.34	<.034
Covariate	1	2561450.0	40.01	<.0001
Within Subjects				
error w	27	64016.6		
Total	31			

Table 6

Summary of Analysis of Covariance of Mean Snoring Duration per Hour for the Extended Follow-Up Block

Source	df	MS	F	p
Between Subjects				
Treatment Condition	3	5321.9	3.73	<.023
Covariate	1	71690.8	50.27	<.0001
Within Subjects				
error w	27	1426.1		
Total	31			

Table 7

Summary of the Tukey Multiple Comparison Test

in Mean Total Snoring Duration for the

Extended Follow-Up Block

	NT	SC	RX	PC
NT	389.1*	**		
SC		-19.1*		
RX			222.1*	
PC				291.7*

* Adjusted group means

** $p \leq .05$ Critical Difference$_{(4,24)} \geq 348.9$

Table 8

Summary of the Tukey Multiple Comparison Test of Mean Snoring Duration per Hour for the Extended Follow-Up Block

	NT	SC	RX	PC
NT	66.1*	**		
SC		4.8*		
RX			23.2*	
PC				43.4*

* Adjusted group means

** $p \leq .05$ Critical Difference$_{(4,24)} \geq 52.07$

The repeated measures of Nights was blocked for subsequent analyses to increase computational efficiency. The blocking of the D/F data was identical to that of the D, D/H, F and F/H data. The block means, B1-B7, for the D/F data are plotted in Figure 10. An examination of Figure 10 indicates that the baseline block, B1, shows little variation among the treatment conditions. Covarying the baseline from subsequent blocks would not be necessary to delineate treatment effects in this situation.

The intervention D/F for the SC, RX, PC and NT conditions was analyzed to determine if any treatment effects were apparent during the intervention period. A repeated measures analysis of variance was performed on the D/F data and is summarized in Table 9. Treatment Condition was the Between-Subjects factor and Blocks the Within-Subjects factor. The main effect of Treatment Condition was significant at the $p \leq .063$ level and Blocks was significant at the $p \leq .12$ level. Consideration of the significance levels attained in this analysis and an examination of the variation among the treatment conditions in Figure 10 suggest that a treatment effect for the SC and RX conditions may be masked. Therefore simple effects analyses of variance were performed on the SC, RX, PC and NT conditions and are summarized in Table 10. The SC condition ($p \leq .001$) exhibited a significant decline in D/F as did the RX condition ($p \leq .014$). The NT and PC conditions did not show a significant decline in D/F. The results of these analyses indicate that the SC and RX conditions decreased in mean snore duration during the intervention period.

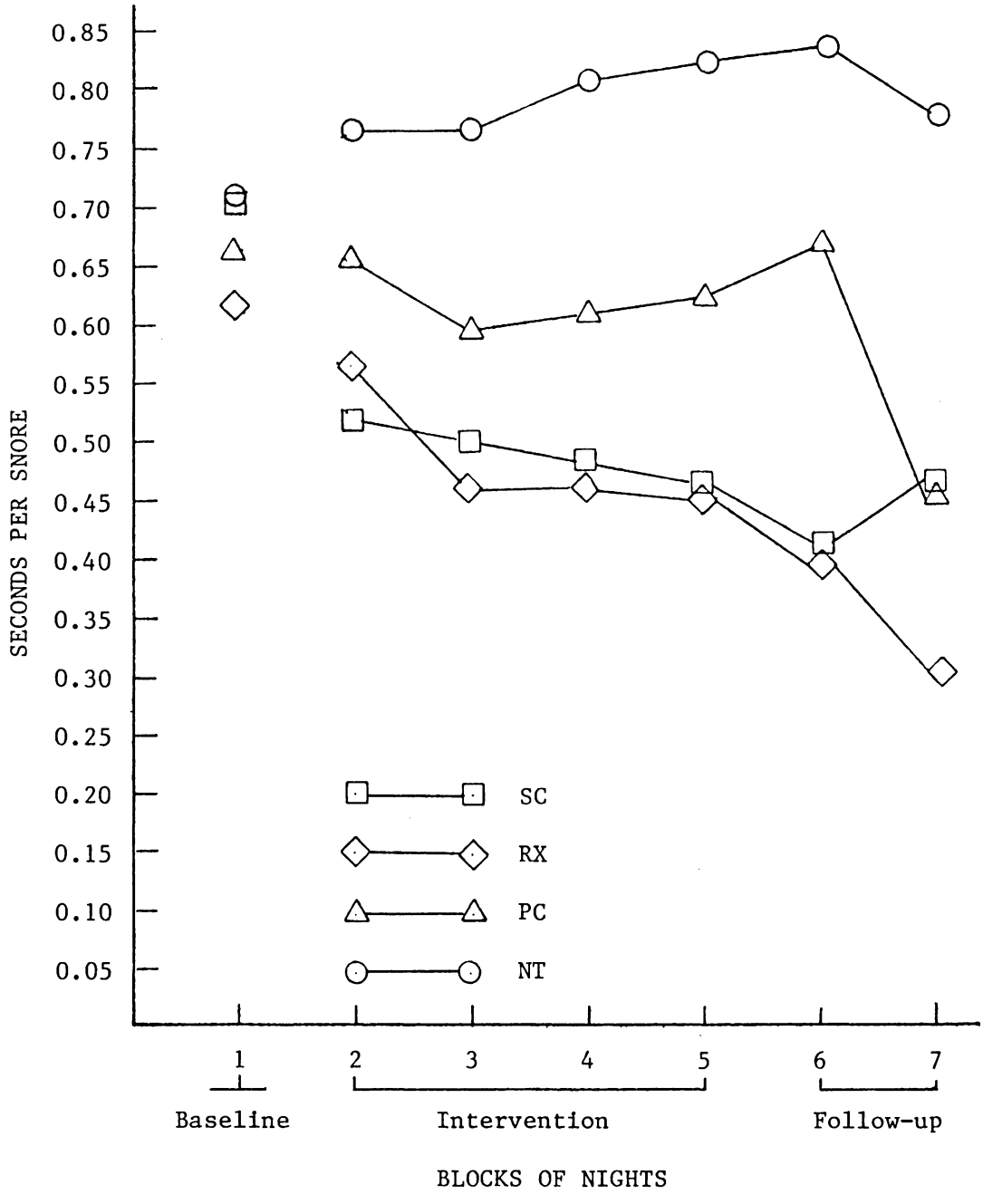

Figure 10. Duration of the Mean Snore for the Baseline, Intervention and Follow-Up Blocks.

Table 9

Summary of Repeated Measures Analysis of Variance of Mean Snore Duration for the Intervention Period

Source	df	MS	F	p
Between Subjects				
Treatment Condition	3	0.6193	2.72	<.063
error b	28	0.2277		
Within Subjects				
Blocks	3	0.01413	2.00	<.120
TC*Blocks	9	0.00825	1.17	<.325
error w	84	0.00705		
Total	127			

Table 10

Summary of the Simple Effects Analyses of Variance of Mean Snore Duration for the Intervention Period

Treatment Condition	Source	df	MS	F	p
SC	Blocks	3	0.09683	13.46	<.001
	error	21	0.00720		
RX	Blocks	3	0.04933	4.44	<.014
	error	21	0.01111		
PC	Blocks	3	0.01197	0.87	<.471
	error	21	0.01371		
NT	Blocks	3	0.01242	1.23	<.325
	error	21	0.01014		

An examination of the follow-up blocks, B6 and B7, suggest that D/F varies between the treatment conditions. A one-way analysis of variance was performed on the immediate follow-up block (B6) and is summarized in Table 11. The main effect of Treatment Condition ($p \leq .0193$) was significant. A Tukey Multiple Comparisons test was applied to the data and is summarized in Table 12. The SC and RX conditions ($p \leq .05$) were significantly different from the NT condition. No other comparisons were significant. These analyses demonstrate the decline in mean snore duration during the intervention period for the SC and RX subjects was maintained into the immediate follow-up period.

The extended follow-up block (B7) was examined to determine the long-term stability of the decrease in mean snore duration found for the SC and RX subjects in the intervention and immediate follow-up periods. A one-way analysis of variance was performed on the data and is summarized in Table 13. The main effect of Treatment Condition ($p \leq .0177$) was significant. A Tukey Multiple Comparisons test was applied to the data and is summarized in Table 14. The RX condition ($p \leq .05$) significantly differed from the NT condition. No other comparisons were significant. These analyses demonstrate that the decline in mean snore duration for the RX subjects was stable over an extended time period.

Correlational Data. The relationship between snoring and state anxiety as assessed by the Anxiety Thermometer, forms A and B, was examined. Kendall Rank Order correlational analyses were applied to

Table 11

Summary of Analysis of Variance of Mean

Snore Duration for the Immediate Follow-Up

Source	df	MS	F	p
Between Subjects				
Treatment Condition	3	0.34011	3.89	<.0193
Within Subjects				
error w	28	0.08752		
Total	31			

Table 12

Summary of the Tukey Multiple Comparison Test

in Mean Snore Duration for the Immediate Follow-Up

	NT	SC	RX	PC
NT	0.8301*	**	**	
SC		0.4229*		
RX			0.3914*	
PC				0.6500*

* Group means

** $p \leq .05$ Critical Difference$_{(4,24)} \geq 0.4027$

Table 13

Summary of Analysis of Variance of Mean

Snore Duration for the Extended Follow-Up

Source	df	MS	F	p
Between Subjects				
Treatment Condition	3	0.3147	3.98	<.0177
Within Subjects				
error w	28	0.0791		
Total	31			

Table 14

Summary of the Tukey Multiple Comparison Test

in Mean Snore Duration for the Extended Follow-Up

	NT	SC	RX	PC
NT	0.7756*		**	
SC		0.4720*		
RX			0.3024*	
PC				0.4530*

* Group means

** $p \leq .05$ Critical Difference$_{(4,24)} \geq 0.3829$

the baseline snoring frequency and duration data versus the Anxiety Thermometer data. No significant correlations were found between state anxiety and snoring frequency or duration for the five baseline nights. The results of these analyses demonstrate that there is no simple direct relationship between state anciety and snoring.

The perception of the snoring by the snorer and roommate was examined. Chi square statistics were computed for the corresponding item pairs on the Sonorous Breathing Questionnaire (SBQ), forms A and B. The chi square provides a measure of the significance level of the relationship between corresponding items but does not provide a measure of the strength of the relationship. The contingency coefficient was calculated for each item pair to provide an index of the strength of the relationship. The contingency coefficients are summarized with the chi square analyses in Table 15.

A majority of the respondents checked the "do not know" response on items 7 through 12 of the SBQ. Additional chi square analyses were performed on items 7 through 12 using only respondents who answered either "yes" or "no." No significant chi squares were obtained for these analyses. The results of these analyses demonstrate that the significant chi square values obtained for items 7 through 12 in Table 15 may reflect the respondents' lack of information about antecedents to the snoring.

Descriptive Data. Brief descriptive statistics were computed on three personality inventories. Means and standard deviations for the STAI-Trait, Rotter I-E Scale, and S-R Inventory of Hostility are

Table 15

Chi Square and Contingency Coeffieients

for the Sonorous Breathing Questionnaires

Item Number	Chi Square (X^2)	Significance	Contingency Coefficient
1	$X^2_{(4)}$=3.044	p<0.551	0.299
2	$X^2_{(8)}$=3.582	p<0.8928	0.3218
3	$X^2_{(6)}$=8.503	p<0.2035	0.46395
4	$X^2_{(6)}$=4.412	p<0.6212	0.35296
5	$X^2_{(16)}$=30.06	p<0.0177	0.70163
6	$X^2_{(6)}$=31.362	p<0.0001	0.70196
7	$X^2_{(4)}$=32.196	p<0.0001	0.71377
8	$X^2_{(4)}$=5.891	p<0.2075	0.39960
9	$X^2_{(4)}$=12.677	p<0.0130	0.53874
10	$X^2_{(4)}$=16.437	p<0.0025	0.58864
11	$X^2_{(4)}$=19.790	p<0.0005	0.62422
12	$X^2_{(4)}$=9.864	p<0.0428	0.49130

presented in Table 16. Undergraduate norms on these personality variables are also presented in Table 16 for comparative purposes.

Table 16.

Mean Scores and Standard Deviations for Measures of Trait Anxiety, Locus of Control, and Hostility

State-Trait Anxiety Inventory-A2

	Snorers			Undergraduates[1]		
	Male	Female	Total	Male	Female	Total
N	21	9	30	253	231	-
Mean	32.96	41.36	36.35	37.68	38.25	-
SD	7.69	9.38	9.70	9.69	9.14	-

Rotter I-E Scale

	Snorers			Undergraduates[2]		
	Male	Female	Total	Male	Female	Total
N	21	10	31	575	605	1180
Mean	7.81	6.90	7.51	8.15	8.42	8.29
SD	2.02	2.96	2.35	3.88	4.06	3.97

S-R Inventory of Hostility

	Snorers			Undergraduates[3]		
	Male	Female	Total	Male	Female	Total
N	21	10	31	45	73	-
Mean	22.60	22.41	22.54	21.75	22.86	-
SD	3.99	5.39	4.40	7.47	7.45	-

1. Spielberger, Gorsuch and Lushene (1970, Table 3).

2. Rotter (1966, Table 3).

3. Endler and Hunt (1968b).

Chapter 4

Discussion

The current study was primarily designed to investigate the theoretical basis and treatment outcome of a behavioral interpretation of snoring versus a treatment and interpretation advocated by Tsukamoto et al. (1938). A ancillary purpose was to obtain general information on snoring. One facet of providing general information about snoring was to determine if a snorer and their roommate had a common perception of the snoring. A general information questionnaire, the SBQ, was completed by the snorer and the roommate. The snorer's responses on the questionnaire were in general, not expected to significantly correlate with the roommate's responses. The snorer would be asleep and unaware of the snoring patterns and of variables that could affect the snoring.

The results of the SBQ demonstrated that the snorers were aware of how often the snoring awakened the roommate. Similarly, the snorer was aware of how disturbing the snoring was to the roommate. There was no significant correlation between the snorer and roommate on questions of how often the snoring occurred, how fatigue affected the snoring, or how stress affected the snoring. The snorers were also unaware of when their snoring occurred in the sleep cycle. Thus the snorer was generally aware of how his snoring directly affected the roommate but not of patterns or antecedents to the snoring.

The SBQ also attempted to determine what activities could cause or increase snoring. Activities listed on the questionnaire included

consumption of alcoholic beverage, food, marijuanna, cigarettes, and sexual activity. Generally, neither the subject nor roommate were aware of how these activities affected, if at all, the snoring. This finding may be related to the duration and intensity of the relationship between the snorer and roommate. Roommates included spouses, apartment and dormitory roommates. The roommates varied on whether they were of the same or opposite sex of the snorer and on the length of the relationship. Spouses or roommates of long duration would likely have more knowledge about the snoring than a dormitory or apartment roommate of short acquaintance.

Generally the prediction that the roommate and snorer perceptions of the snoring would not be similar was supported. Four of the six items examining snoring patterns or effect upon the roommate were not significantly correlated. Neither the snorer or roommate possessed substantial knowledge of what activites increased the snoring. Future studies investigating this aspect of snoring should control for the duration and type of relationship as well as the sex of the snorer and roommate.

A second facet of obtaining general information about snoring was to briefly examine the relationship between state anxiety and snoring. No direct relationship between state anxiety as measured by the Anxiety Thermometer and snoring was found. Future studies examining the effect of anxiety or stress upon snoring should survey the incidence of snoring in a population identified as high stress and a population identified as low stress. A survey would be a

more efficient initial step than a group design in determining if a relationship exists between state anxiety and snoring.

A third facet of the study in providing general information about snoring was to obtain brief descriptive statistics on the personality variables in snorers of trait anxiety, locus of control, and hostility. The STAI-Trait, Rotter I-E Scale, and S-R Inventory of Hostility were used to assess these personality characteristics. The means and standard deviations for the snorers on these variables and norms based on undergraduate college students are presented in Table 16. No predictions were made on the personality characteristics of the snorers.

The primary focus of the present study was to evaluate the Tsukamoto et al. (1938) theory of snoring and to propose a behavioral theory of snoring. The theories were evaluated by deriving a single treatment for snoring from each theory. The treatments were designed to provide differential predictions of treatment efficacy by each theory. The treatments were also designed for clinical utility and for general availability to the public.

Two treatments were derived and evaluated from the theories. The Tsukamoto et al. (1938) theory predicted that a treatment based upon inducing skeletal relaxation would be effective in reducing snoring. The behavioral theory predicted that a treatment based upon increasing the muscle tension component of the general respiration response would be effective in reducing snoring. The results of the present study generally but not unequivocally support the efficacy

of a behaviorally derived treatment over the relaxation treatment derived from the Tsukamoto et al. (1938) theory.

The analyses of the intervention period yielded only two significant reductions in snoring among the four treatment conditions. Significant reductions in the mean duration per snore were found for two treatment conditions during the intervention period. Both the SC and RX subjects obtained a significant decrease in mean duration per snore relative to the NT and PC subjects.

The analyses of the immediate follow-up period yielded the greatest number of significant reductions in snoring. The NT and PC conditions did not exhibit a significant decline in snoring nor did they significantly differ from each other on any of the measures. However the RX subjects' significant decrease in mean duration per snore exhibited in the intervention period relative to the NT and PC subjects was continued into the immediate follow-up period.

The SC subjects obtained a significant reduction in snoring on three of the five analyses of the immediate follow-up period. The SC subjects exhibited a significant reduction in snoring relative to the NT subjects in analyses of seconds of snoring per night and in mean duration per snore. The SC subjects were significantly less in seconds of snoring per hour than the RX, PC and NT subjects.

The extended follow-up period yielded fewer significant differences in snoring among the four treatment conditions than the immediate follow-up period. The PC and NT subjects again did not exhibit a significant decline in snoring on any analysis of the

extended follow-up period. However the RX subjects maintained the reduction in mean duration per snore relative to the NT subjects that was first apparent in the intervention period.

The SC subjects maintained a reduction in snoring on several measures through the extended follow-up period. The SC subjects exhibited less snoring than the NT subjects in seconds of snoring per hour and per night. The significant reduction in mean duration per snore for the SC subjects relative to the NT subjects was not maintained from the immediate follow-up.

To summarize the results, the SC subjects exhibited a significant reduction in snoring relative to the NT subjects on all but one duration measure of snoring. This reduction in duration was generally stable over an extended time period. The SC subjects were also found to exhibit less snoring than the RX and PC subjects on the immediate follow-up measure of seconds of snoring per hour. The RX subjects exhibited a stable reduction in mean duration per snore. The RX subjects did not exhibit significantly less snoring than the SC subjects on any of the dependent measures.

The Tsukamoto et al. (1938) theory cannot adequately account for the statistical results of the current study. This theory predicted that the snoring of the RX subjects would decrease relative to the other conditions as relaxation was achieved by the subjects. The only significant decline in snoring for the RX subjects was in mean duration per snore. The RX subjects achieved a reduction in mean duration per snore from a baseline of .62 seconds per snore to

an extended follow-up of .31 seconds per snore.

The Tsukamoto et al. (1938) theory cannot adequately account for the SC subjects' reduction in snoring duration. There is no reasonable basis for assuming the conditioning process undergone by the SC subjects would induce relaxation of the entire skeletal musculature. Relaxation of the muscles directly involved in the conditioning process might occur through muscle fatigue caused by repeated muscle contraction. However the increased muscle tension that was being conditioned in the SC subjects was the opposite effect of that desired by Tsukamoto et al. (1938). In addition, the increased muscle tension might cause dilation of the vasculature in the affected muscles because of the greater metabolic requirements of the contracting muscles. However vasodilation in this body region would be the opposite of that desired by the Tsukamoto et al. (1938) theory.

A visual examination of Figures 6, 7, 8 and 9 indicates that the RX subjects reduced their snoring duration and frequency over time. The decline in snoring duration and frequency was gradual and could be of clinical rather than statistical significance. The decline in snoring was supported by two RX subjects who stated that their snoring had decreased during the course of their participation in the study. These two subjects and their roommates reported that the snoring declined when the subjects were very relaxed but would increase if some event prevented the subjects from relaxing.

Altschuler's (1964) dynamic interpretation of snoring was not of primary interest in the current study. However a reduction in

snoring of the PC subjects would have provided some support for a dynamic interpretation of snoring. A reduction in snoring by the PC subjects would indicate that snoring could be reduced through psychologic factors alone. A continuation of snoring at baseline levels could be explained as failing to specifically determine and treat the psychologic factors involved in each subject's snoring. The snoring of the PC subjects did not decline on any measure. Thus neither support for or against Altshuler's dynamic interpretation was provided by the results of this study.

The SC subjects, in general, performed as predicted by the behavioral theory of snoring. The SC subjects obtained a significant reduction in snoring relative to the NT and PC subjects on duration measures of snoring during the two follow-up periods. A reduction in snoring relative to the RX subjects was found on one measure.

The reduction in snoring obtained in the immediate follow-up period for the SC subjects demonstrated that the theorized conditioning process was the active component of the treatment. A reduction in snoring during the intervention period only would have indicated that the collar and electrical shock were causing the treatment effect and not the conditioning process.

The continuation of the reduction in snoring duration into the extended follow-up indicates the conditioning of the SC subjects was relatively stable. The maintenance of the reduction in snoring provides additional support for the conditioning process being the active component of the treatment. In addition, the continued

reduction in snoring indicates the conditioning process has clinical utility. One of the drawbacks of previous anti-snoring devices and treatments was they served as a crutch; once removed, the snoring returned.

The reduction in snoring by the RX subjects in mean duration per snore was not predicted by the behavioral hypothesis. However, the reduction in snoring by the RX subjects can be accounted for in a manner compatible with the behavioral hypothesis. The Jacobson (1934) relaxation exercises received by the RX subjects teach an individual to differentiate between tense and relaxed muscles by alternately tensing and relaxing muscle groups while concentrating upon the attendant interoceptive sensations. The alternate tensing and and relaxing of muscle groups, including muscles of the chest and throat areas, could function as exercise for some individuals resulting in an increase in muscle tone. The increased muscle tone would alter the interoceptive stimuli from the muscles thereby changing the stimulus configuration that elicits the respiration response. The respiration response elicited by the altered stimulus configuration may not include snoring for some individuals. Thus a weak treatment effect would appear for the RX subjects as a result of reduced snoring in a few individuals.

A second explanation for the reduction in mean duration per snore for the RX subjects involves a functional change in body tissues. A relaxation exercise induced increase in muscle tonus of the throat and upper respiratory tract could produce a functional alteration in

the response of the muscle tissue to neural stimulation. The characteristics of the muscle tissue such as its density or elasticity could be altered by the relaxation exercises. The pre- and post-relaxation exercise tissues could respond differently to identical neural stimulation. The change in post-exercise tissue response could prevent a snore from occurring or reduce the mean duration per snore.

The proposed behavioral theory of snoring can adequately account for the treatment effects of the RX subjects. The proposed theory is also versatile in its ability to account for a number of phenomena related to snoring. The theory can account for the etiology and widespread occurrence of snoring through the proposed modification of the respiratory response caused by upper respiratory infection or allergy. Epidemiologically, these respiratory disorders are common and occur throughout the world in all age ranges and both sexes. In terms of species, domestic animals are particularly susceptible to upper respiratory infections and are also found to be subject to snoring.

The behavioral theory can account for individuals who breathe through the mouth while asleep yet do not snore. It is hypothesized that these individuals' muscle tonus is not lowered to reduce O_2 requirements during infection or allergy. Such individuals may have first resorted to mouth breathing rather than a reduction in muscle tonus; sufficient O_2 being obtained through mouth breathing alone to return the gaseous tension levels to normal. The reduction in

gaseous blood tensions then serves to reinforce the mouth breathing response. Muscle tonus would be maintained normally during sleep so that the velar tissues and faucial pillars could not vibrate and cause a snore even though the air flow over them had been increased.

The proposed behavioral theory can account for individual variation in snoring. The extent to which muscle tonus is decreased in the respiratory tract during infection could account for the individual variation. The lessened muscle tonus as a response to the infection may summate with variations in muscle tonus that occur during sleep. A nonsnorer is hypothesized as maintaining sufficient muscle tonus to prevent vibration of the velar tissues despite fluctuations in muscle tonus while asleep. However a slight reduction in muscle tonus could occur as a result of an infection as previously proposed and then become part of the respiration response. This slight reduction in muscle tonus could summate with fluctuations in muscle tonus during sleep to produce intermittent episodes of snoring. An individual who adapted to the infection induced O_2 debt with a large decrease in muscle tonus might snore continuously, regardless of the sleep stage or adrenal levels.

Despite the apparent effectiveness of the behavioral treatment and utility of the proposed theory, no statement can be made regarding the correctness of the theory based upon the treatment outcome of the study. The behavioral theory was not disproved on the basis of the outcome, and was demonstrated to be sufficiently versatile to account for the results of the RX subjects. The Tsukamoto et al. (1938) theory

was unable to adequately account for the reduction in snoring of the SC subjects. The behavioral treatment and theory of snoring would therefore appear to be of greater utility in accounting for the snoring phenomenon than the Tsukamoto et al. (1938) theory.

A number of variables could have influenced the internal and external validity of the present study. The most serious threats to the internal validity of the study relate to potential researcher bias in assessing the dependent measures and to a lack of independent confirmation that the subjects were complying with the treatment instructions. The researcher transcribed all the data tapes and was aware of the treatment condition of each subject. Unintentional bias could have caused systematic error to occur in the measurement of snoring duration and frequency for one or more of the groups. Reliability checks on the transcription of the data tapes would have been of assistance in reducing a bias in the data. However the use of a discrete, observable behavior as the dependent measure reduced the subjective judgement and bias that could affect the data and subsequent analyses.

The lack of independent checks on subject compliance with treatment instructions could have adversely affected the treatment results. The RX subjects were required to listen to a relaxation exercise tape and practice the relaxation technique prior to going to sleep. A subject who failed to do as instructed would not learn how to relax sufficiently to trigger the vascular change. Such a subject(s) would weaken the outcome of the relaxation condition and weaken the

apparent utility of the Tsukamoto et al. (1938) theory.

The SC and PC subjects required less individual effort to comply with the treatment instructions, and could be expected therefore to have a higher rate of compliance than the RX subjects. However other complications could have occurred, such as failure of the snore collar to work correctly. A defective snore collar would reduce the conditioning process necessary to reduce the snoring. Such an event(s) could have contributed to the lack of significant reductions on the frequency measures of snoring.

The selection of the subjects and assignment to the treatment conditions could have been biased in some undetected manner. Examination of the baseline data in Figures 2, 3, 4 and 5 shows wide inter-group variability. Although the subjects were randomly assigned to the groups, chance assignment of or an undetected bias in assignment could have caused an interaction effect between treatment effectiveness and the subjects yielding contaminated results.

The generalizability of the results, or the external validity, of the study must also be considered. The treatments were designed to have clinical utility and applicability in the home environment. However subjects in the study were volunteers who could conceivably differ from non-volunteers. The effectiveness of the treatments on non-volunteers was not considered and could yield different results.

The subjects differed on many variables, such as age and chronicity of the snoring. The abilility to generalize the results of the present study to particular or specific groups of snorers,

such as elderly snorers, is limited. Data were not collected examining the relative effectiveness of the treatments on individuals of different ages or chronicity of snoring.

Ethical issues must be addressed in any study in which deception is used. Deception in psychological research is never desirable, but is often necessary to achieve methodological integrity in the research design. The present study used deception primarily with the PC subjects. The subjects were told the placebo collar was operational and that they could expect their snoring to decrease if the collar worked. The deception was used to maximize compliance with the instructions of wearing the collar. The PC condition was necessary to assess the effects of wearing the snore collar without conditioning occurring. Failure to include the PC condition could have led to an alternate explanation for the results of the SC condition. The alternate explanation would be that the treatment effects observed in the SC subjects could be caused by the simple act of wearing the snore collar or by an expectancy of treatment success mental set.

Deception was used to a lesser extent on the NT subjects. These individuals were told that 31 nights of data collection were necessary to determine the relationship between their snoring and anxiety levels. These subjects were also informed of the control function of the NT group relative to the other conditions.

All subjects were debriefed following their completion of the study. All subjects were given the opportunity to receive the

treatment provided to the SC subjects and were offered a relaxation cassette tape. The relaxation cassette tape was offered because several subjects in the RX condition believed that the relaxation training had reduced their level of snoring.

Future research in snoring has several options. The first option is to attempt to further refine the conditioning procedure described in the present study. Subject variables such as age or chronicity of snoring were not examined for their effect upon treatment outcome. Procedural variables such as length of conditioning and level of electrical stimulation used to elicit the muscle contraction were not varied or examined. Single case methodology and design would be useful initially in delineating some of these varibles. The statistical precision and power of a group design could be more efficiently utilized after the single case methodology had identified sources of variability.

A second option for future research would be to attempt to identify different categories of snorers. The wide inter-subject variability in the present study suggest that snorers could be subdivided into more homogenous groups. The snorers might differ on the mechanism of snoring or different etiologies may be recognized.

A third option for snoring research involves theoretical variables. The present study has proposed a behavioral theory of snoring which is versatile but yet essentially untested. Studies examining muscle tension and tonus levels before and after respiratory infections would provide data regarding the accuracy of the theory. A laboratory

treatment with snorers in which the level of O_2 and CO_2 is manipulated by the researcher to elicit different respiration responses would provide valuable information regarding both a laboratory treatment for snoring and the utility of the behavioral theory of snoring.

In conclusion, the present study demonstrated that a behavioral approach to the problem of snoring can be of theoretical and clinical import. Use of a electrically induced muscle contraction in conditioning a higher level of muscle tension in the neck and throat significantly reduced duration measures of snoring. The behavioral theory was demonstrated to be sufficiently versatile to adequately account for the etiology, maintenance and treatment of snoring. The Tsukamoto et al. (1938) theory was incapable of accounting for the results of this study.

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Appendix A

Definitions are from Stedman's Medical Dictionary, 23rd edition, Baltimore: Williams & Wilkins Co., 1976.

Arcus: Arch.

Arcus palatine: Pillars of the fauces. See arcus palatoglossus and arcus palatopharyngeus.

Arcus palatoglossus: Palatoglossal arch; glossopalatine arch; anterior palatine arch; anterior pillar of the fauces; one of a pair of ridges or folds of mucous membrane passing from the soft palate to the side of the tongue. It encloses the palatoglosus muscle.

Arcus palatopharyngeus: Palatopharyngeal arch; posterior palatine arch; posterior pillar of the fauces; one of a pair of ridges or folds of mucous membrane which passes downward from the posterior margin of the soft palate to the lateral wall of the pharynx. It encloses the palatopharyngeus muscle.

Faucial: The space between the cavity of the mouth and the pharynx.

Glosso: Combining forms relating to the tongue.

Glossopharyngeal: Relating to the tongue and pharynx.

Gullet: Pharynx and esophagus, used in swallowing.

Larynx: The organ of voice production; the part of the respiratory tract between the pharynx and trachea; it consists of a framework of cartilages and elastic membranes housing the vocal folds and the muscles which control the position and tension of these elements.

Nasal: Rhinal; relating to the nose.

Palate: Palatum.

Palatum: Palate; the roof of the mouth; the bony and muscular partition between the oral and nasal cavities; popularly called the uvula.

Palatum molle: Soft palate; velum palatinum; velum pendulum palati; the posterior portion of the palate, forming an incomplete septum between the mouth and oropharynx, and between the oropharynx and nasopharynx.

Pharynx: The upper expanded portion of the digestive tube, between the esophagus below and the mouth cavities and nasal cavities above and in front.

Septal: Relating to septum.

Septum: A thin wall dividing two cavities or masses of softer tissue.

Soft palate: See palatum; See palatum molle.

Throat: 1. The gullet; the fauces and pharynx.

2. The anterior aspect of the neck.

Tongue: Lingua; glossa.

Uvula palatina: A conical projection from the posterior edge of the middle of the soft palate; it is composed of connective tissue containing a number of racemouse glands, and some muscular fibers (musculus uvulae).

Velar: Relating to any velum, especially the velum palati.

Velum: 1. Any structure resembling a veil or curtain.

2. Any serous membrane or membranous envelope or covering.

Velum palati: See palatum; See palatum molle.

Appendix B

SLEEP APNEA QUESTIONNAIRE A

Name:_____ Phone:_____

INSTRUCTIONS: Circle one response following each item.

1. Are you sometimes frightened or afraid when you wake up, but not know why?
   a. yes
   b. no

2. Are you tired even though you have had a full night of sleep?
   a. yes, or often
   b. no, or rarely
   c. sometimes, or about ½ the time

3. Are you a restless or fitfull sleeper?
   a. yes
   b. no

4. I wake up or remember waking up __?__ times per night.
   a. 0-2
   b. 3-5
   c. 6-12
   d. more than 12

5. Do you have dreams of not being able to breathe?
   a. yes
   b. no

6. Do you feel like you sleep too much but are still tired?
   a. yes
   b. no

7. Do you sometimes wake up gasping for air or choking?
   a. yes
   b. no

8. Have you ever been told you have sleep apnea or that you sometimes stop breathing while asleep?
   a. yes
   b. no

9. If your answer to 8 is yes, how often do the breathing stoppages occur?
   a. 2 or fewer times per week
   b. every other night
   c. 1-5 times per night
   d. 6 or more times per night

10. Has anyone in your family (grandparents, parents, brothers, sisters, children, cousins, aunts or uncles) been told they have sleep apnea or that they sometimes stop breathing while asleep?
   a. yes
   b. no
   c. do not know

11. If your answer to 10 is yes, what relationship are they to you? (Circle as many as appropriate)
   a. parent
   b. grandparent
   c. brother or sister
   d. child
   e. uncles or aunt
   f. cousin

12. Is there anything unusual about your sleeping or snoring? If so, please describe it in the space below.

SLEEP APNEA QUESTIONNAIRE B

Name:_____ Roommate's name:_____

Relationship:_____ How long known:_____

INSTRUCTIONS: Circle one response for each item.

1. Does your roommate sometimes seem frightened or afraid when they wake up, but not know why?
   a. yes
   b. no

2. Does your roommate appear tired even though they have had a full night of sleep?
   a. yes, or often
   b. no, or rarely
   c. sometimes, or about ½ the time

3. Is your roommate a restless or fitful sleeper?
   a. yes
   b. no

4. My roommate wakes up __?__ times per night.
   a. 0-2
   b. 3-5
   c. 6-12
   d. more than 12
   e. do not know

5. Has your roommate ever told you of having dreams in which they could not breathe?
   a. yes
   b. no

6. Do you believe your roommate sleeps too much but is still tired?
   a. yes
   b. no

7. Does your roommate choke or gasp for air while sleeping or snoring, or sometimes wake up gasping and choking?
   a. yes
   b. no
   c. do not know

8. Have you ever seen or heard your roommate stop breathing for 60 seconds or more while asleep?
   a. yes
   b. no

9. If your answer to 8 was yes, how often do the breathing stoppages occur?
   a. 2 or fewer times per week
   b. every other night
   c. 1-5 times per night
   d. 6 or more times per night

10. If your answer to 8 was yes, what happened when your roommate started breathing again?
   a. nothing, it was just like normal breathing started again
   b. they woke up, but did not make any noises
   c. they snored, gasped or choked, then began breathing normally; they did not wake up
   d. they snored, gasped or choked and also woke up

11. Is there anything unusual about your roommate's sleeping or snoring? If so, please describe it in the space below.

SONOROUS BREATHING QUESTIONNAIRE A

INSTRUCTIONS: Circle one response following each item.

1. I snore:
   a. all night
   b. only at the beginning of the night
   c. only at the middle of the night
   d. only at the end of the night
   e. do not know

2. I snore:
   a. every night
   b. 3-6 nights per week
   c. 1-2 nights per week
   d. less than 1 night per week
   e. do not know

3. I snore:
   a. only when very tired or fatigued
   b. only when restless or not tired
   c. only when I am "average" tired
   d. all the time, no matter how tired or restless I am
   e. do not know

4. I snore:
   a. only after a restful, relaxing, pleasant day
   b. only after a physically tiring or fatigueing day
   c. only after a day with a lot of anxiety and stress
   d. after any kind of day
   e. do not know

5. My snoring wakes my roommate __?__ times per night.
   a. 0-1
   b. 2-6
   c. 7 or more
   d. it keeps my roommate from going to sleep; once asleep, they do not awaken
   e. do not know

6. My roommate finds my snoring:
   a. unbearable or intolerable
   b. annoying but tolerable
   c. no opinion or does not make any difference to them
   d. pleasant or reassuring
   e. do not know

SBQ-A

7. I usually snore following:	(circle one response)		
drinking alcohol	yes	no	do not know
smoking cigarettes	yes	no	do not know
smoking marijuana	yes	no	do not know
sex	yes	no	do not know
a heavy meal	yes	no	do not know
a light meal	yes	no	do not know

SONOROUS BREATHING QUESTIONNAIRE B

INSTRUCTIONS: Circle one response following each item.

1. My roommate snores:
   a. all night
   b. only at the beginning of the night
   c. only at the middle of the night
   d. only at the end of the night
   e. do not know

2. My roommate snores:
   a. every night
   b. 3-6 nights per week
   c. 1-2 nights per week
   d. less than 1 night per week
   e. do not know

3. My roommate snores:
   a. only when very tired or fatigued
   b. only when restless or not tired
   c. only when he/she is "average" tired
   d. all the time, no matter how tired or restless he/she is
   e. do not know

4. My roommate snores:
   a. only after a restful, relaxing, pleasant day
   b. only after a physically tiring or fatigueing day
   c. only after a day with a lot of anxiety and stress
   d. after any kind of day
   e. do not know

5. My roommate's snoring wakes me __?__ times per night.
   a. 0-1
   b. 2-6
   c. 7 or more
   d. it keeps me from going to sleep; once asleep, I do not awaken
   e. do not know

6. I find my roommate's snoring:
   a. unbearable or intolerable
   b. annoying but tolerable
   c. no opinion or does not make any difference to me
   d. pleasant or reassuring
   e. do not know

SBQ-B

7. My roommate usually snores following:	(circle one response)		
drinking alcohol	yes	no	do not know
smoking cigarettes	yes	no	do not know
smoking marijuana	yes	no	do not know
sex	yes	no	do not know
a heavy meal	yes	no	do not know
a light meal	yes	no	do not know

FORM A-2

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you generally feel.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

		almost never	sometimes	often	almost always
1.	I feel pleasant	1	2	3	4
2.	I tire quickly	1	2	3	4
3.	I feel like crying	1	2	3	4
4.	I wish I could be as happy as others seem to be	1	2	3	4
5.	I am losing out on things because I can't make up my mind soon enough	1	2	3	4
6.	I feel rested	1	2	3	4
7.	I am "calm, cool, and collected."	1	2	3	4
8.	I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
9.	I worry too much over something that really doesn't matter	1	2	3	4
10.	I am happy	1	2	3	4
11.	I am inclined to take things hard	1	2	3	4
12.	I lack self-confidence	1	2	3	4
13.	I feel secure	1	2	3	4
14.	I try to avoid facing a crisis or difficulty	1	2	3	4
15.	I feel blue	1	2	3	4
16.	I am content	1	2	3	4
17.	Some unimportant thought runs through my mind and bothers me	1	2	3	4
18.	I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
19.	I am a steady person	1	2	3	4
20.	I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

PERSONAL OPTION SURVEY

This is a questionnaire to find out the way in which certain events in our society affect different people. Each item consists of a pair of alternatives numbered 1 or 2. Please select the one statement of each pair (and only one) which you more strongly believe to be the case as far as you are concerned. Be sure to select the one you actually believe to be more true rather than the one you think you should choose or the one you would like to be true. This is a measure of personal belief; there are no right or wrong answers.

Please answer these items carefully, but do not spend too much time on any one item. Be sure to find an answer for every choice. In some instances you may discover that you believe both statements or neither one. In such cases, be sure to select the one you more strongly believe to be the case as far as you are concerned. Also try to respond to each item independently when making your choice; do not be influenced by your previous choices.

REMEMBER

Select that alternative which you personally believe to be true.

I more strongly believe that:

1. 1. Children get into trouble because their parents punish them too much.
   2. The trouble with most children nowadays is that their parents are too easy with them.

2. 1. Many of the unhappy things in people's lives are partly due to bad luck.
   2. People's misfortunes result from the mistakes they make.

3. 1. One of the major reasons why we have wars is because people don't take enough interest in politics.
   2. There will always be wars, no matter how hard people try to prevent them.

4. 1. In the long run, people get the respect they deserve in this world.
   2. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

5. 1. The idea that teachers are unfair to students is nonsense.
   2. Most students don't realize the extent to which their grades are influenced by accidental happenings.

6. 1. Without the right breaks, one cannot be an effective leader.
   2. Capable people who fail to become leaders have not taken advantage of their opportunities.

7. 1. No matter how hard you try, some people just don't like you.
   2. People who can't get others to like them, don't understand how to get along with others.

8. 1. Heredity plays the major role in determining one's personality.
   2. It is one's experiences in life which determine what they are like.

9. 1. I have often found that what is going to happen will happen.
   2. Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

10. 1. In the case of the well-prepared student, there is rarely if ever such a thing as an unfair test.
    2. Many times exam questions tend to be so unrelated to course work that studying is really useless.

11. 1. Becoming a success is a matter of hard work; luck has little or nothing to do with it.
    2. Getting a good job depends mainly on being in the right place at the right time.

12. 1. The average citizen can have an influence in government decisions.
    2. This world is run by the few people in power, and there is not much the little guy can do about it.

13. 1. When I make plans, I am almost certain that I can make them work.
    2. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyhow.

14. 1. There are certain people who are just no good.
    2. There is some good in everybody.

15. 1. In my case, getting what I want has little or nothing to do with luck.
    2. Many times we might just as well decide what to do by flipping a coin.

16. 1. Who gets to be the boss often depends on who was lucky enough to be in the right place.
    2. Getting people to do the right thing depends upon ability; luck has little or nothing to do with it.

17. 1. As far as world affairs are concerned, most of us are the victims of forces we can neither understand nor control.
    2. By taking an active part in political and social affairs, the people can control world events.

18. 1. Most people don't realize the extent to which their lives are controlled by accidental happenings.
    2. There really is no such thing as "luck."

19. 1. One should always be willing to admit his mistakes.
    2. It is usually best to cover up one's mistakes.

20. 1. It is hard to know whether or not a person really likes you.
    2. How many friends you have depends upon how nice a person you are.

21. 1. In the long run, the bad things that happen to us are balanced by the good things.
    2. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

22. 1. With enough effort we can wipe out political corruption.
    2. It is difficult for people to have much control over the things politicians do in office.

23. 1. Sometimes I can't understand how teachers (supervisors) arrive at the grades (evaluations) they give.
    2. There is a direct connection between how hard I study (work) and the grade (evaluation) I get.

24. 1. A good leader expects people to decide for themselves what they should do.
    2. A good leader makes it clear to everybody what their jobs are.

25. 1. Many times I feel that I have little influence over the things that happen to me.
    2. It is impossible for me to believe that chance or luck plays an important role in my life.

26. 1. People are lonely because they don't try to be friendly.
    2. There's not much use in trying too hard to please people; if they like you, they like you.

27. 1. There is too much emphasis on athletics in high school.
    2. Team sports are an excellent way to build character.

28. 1. What happens to me is ny own doing.
    2. Sometimes I feel that I don't have enough control over the direction my life is taking.

29. 1. Most of the time I can't understand why politicians behave the way they do.
    2. In the long run the people are responsible for bad government on a national as well as on a local level.

INVENTORY OF ATTITUDES TOWARD GENERAL SITUATIONS

This inventory represents a means of studying people's reactions to and attitudes towards various types of General situations. On the following pages are represented two general kinds of situations which most people have encountered. For each of these general kinds of situations certain common types of personal reactions and feelings are listed. Indicate the degree to which you would show these reactions and feelings in the situations listed on the five point scale shown with each reaction.

Here is an example:

"You are getting ready to start the day."

Feel tense	1	2	3	4	5
	Not at all				Very uncomfortable

If you feel very uncomfortable in this situation you would circle alternative 5 (see A below); if you feel somewhat uncomfortable you would circle either alternative 2, 3, or 4 depending on how uncomfortable: if in this situation you do not feel uncomfortable at all, you would circle alternative 1 (see B below).

EXAMPLES:						
	A	1	2	3	4	5
	B	1	2	3	4	5

Please turn to the items on the following pages.

1. You are talking to someone and he (she) does not answer you.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

2. You accidently bang your shins (leg) against a park bench.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

3. Your instructor unfairly accuses you of cheating on an examination.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

4. Someone has lost an important book (tool) of yours.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

5. You have just found out that someone has told lies about you.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

6. You are driving to a party (appointment) and suddenly your car has a flat tire.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

7. You arrange to meet someone and he (she) doesn't show up.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

8. You are trying to study and there is incessant noise.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

9. You are waiting at the bus stop and the bus fails to stop for you.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

10. You are in a restaurant and have been waiting a long time to be served.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

11. Someone has opened your personal mail.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

12. You wake up early to get to a special 8 A.M. class or appointment and the instructor doesn't show up.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

13. You are carrying a cup of coffee to the table and someone bumps into you.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

14. You are very tired and have just gone to sleep, when you are awakened by the arrival of some friends.

Heart beats faster	1 Not at all	2	3	4	5 Much faster
Want to strike something or someone	1 Not at all	2	3	4	5 Very much
Lose patience	1 Not at all	2	3	4	5 Very much
Feel irritated	1 Not at all	2	3	4	5 Very much
Perspire	1 Not at all	2	3	4	5 Very much
Emotions disrupt actions	1 Not at all	2	3	4	5 Very much
Curse	1 Not at all	2	3	4	5 Very much
Become tense	1 Not at all	2	3	4	5 Very much
Want to shout	1 Not at all	2	3	4	5 Very much
Frown	1 Not at all	2	3	4	5 Very much

AT-A

PLEASE RATE THE AVERAGE AMOUNT OF STRESS, PRESSURE OR ANXIETY THAT YOU HAVE FELT OR EXPERIENCED TODAY.

None		Low		Moderate		High		Very High
1	2	3	4	5	6	7	8	9

AT-B

PLEASE RATE THE AMOUNT OF STRESS, PRESSURE OR ANXIETY THAT YOU FEEL OR ARE EXPERIENCING NOW.

None		Low		Moderate		High		Very High
1	2	3	4	5	6	7	8	9

VIRGINIA POLYTECHNIC INSTITUTE

AND STATE UNIVERSITY

Name:_____ Date:_____

Soc. Sec. No.:_____

1. I, the undersigned, hereby agree to participate in the study entitled "Treatment of Snoring."

2. I certify that the nature of the experiment has been described to me by Dave Butler, and I understand that its purpose is as follows: to evaluate treatment strategies that may be of benefit in reducing the frequency and duration of snoring.

3. I understand that the study is experimental in nature and a successful reduction of my snoring cannot be guaranteed. Treatments that I may be involved in are:
   a. relaxation training.
   b. wearing a collar at night which delivers a very low voltage and amperage electrical current. The shock will cause a slight muscle contraction in the neck.

   I will be required to obtain an examination by a physician. The purpose of the examination is to determine if there is a physical cause of my snoring which the experimental treatments could not modify. The examination will also determine if I am at any cardiovascular risk from any electrical current that may be used in the treatment.

4. I understand that my participation will also involve:
   a. attending one (1) introductory meeting with the experimenter.
   b. using a voice-activated cassette recorder to tape any sounds I make while asleep for 28 concecutive nights.
   c. a follow-up data collection period of three nights that will occur four to twelve weeks following my last treatment night.

5. I further understand that I will be asked to complete a number of questionnaires and check lists concerning my moods, feelings, thoughts and activities during the course of the experiment.

6. I understand that any information disclosed about myself on the above-mentioned forms and tapes is confidential and will not be disclosed to anyone other than the individuals directly involved in the project. All tape recordings will be erased following coding of relevant data from them. My identity will not be divulged for purposed of data analysis as I will be assigned a subject number and the data will be analyzed in groups of subjects.

7. I understand that I can terminate my participation in this experiment at any time without consequences. Any questions I have concerning the treatment procedures will be answered.

8. I understand that no compensation or medical treatment is available if injury or damage should be suffered as a result of this study. I further understand that it is my responsibility to contact Dave Butler (555-7094), the faculty advisor Dr Al Prestrude (555-5637) or the chairman of the Institutional Review Board Dr Milton Stombler (555-5283) should any medical problems occur as a result of this study.

Signature:_____

1. I, _____, agree to assist _____ in the study entitled "Treatment of Snoring."

2. I understand that I will be asked to fill out several questionnaires about the sleeping and snoring habits or patterns of my roommate. The questionnaires may include questions about the effects of my roommate's snoring upon me.

3. I understand that any information disclosed about myself or my roommate is confidential and will not be disclosed to anyone other than the individuals directly involved in the project. My identity will not be divulged for purposes of data analysis as I will be assigned a subject number and the data will be analyzed in groups of subjects.

4. Any questions that I have about my participation in this study will be answered by Dave Butler (555-7094) or Dr Al Prestrude (555-5637).

Signature:_____

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SONOROUS BREATHING: A THEORETICAL AND TREATMENT OUTCOME STUDY

by

David Lee Butler

(ABSTRACT)

Numerous theories of snoring have been offered, however only a few, such as Tsukamoto, Nagami and Tsunematsu (1938), are sufficiently precise to allow derivation of clinically useful treatments. The purpose of this study was to propose a behavioral theory of snoring for comparison to the Tsukamoto et al. theory. The two theories were evaluated by deriving a treatment technique for reducing snoring from each theory. Prediction of treatment efficacy differed for the two theories.

The behavioral theory proposed that snoring is a learned adaptation to a blood gas tension imbalance caused initially by an upper airway restriction. The adaptation response of reduced muscle tonus and mouth breathing causes snoring. Altering the stimulus configuration which elicits the respiration response was predicted to be effective in reducing snoring. An electrically-induced muscle contraction in the throat was utilized to replace the low muscle tonus with a high muscle tension response thereby preventing velar tissue vibration.

Tsukamoto et al. theorized snoring is caused by insufficient skeletal muscle relaxation at sleep onset to trigger a change in the vascular system. The nasal vascular bed remains dilated thus

restricting air flow to the lungs. Snoring occurs as mouth breathing is utilized to obtain sufficient air flow. Relaxation training was predicted to reduce snoring by inducing constriction of the nasal vascular bed, thus increasing air flow through the nasal passages.

Thirtytwo subjects were assigned to one of four groups: Relaxation (RX), Snore Collar (SC), Placebo Control (PC) and No Treatment (NT). The SC subjects wore a collar that caused an electrically-induced muscle contraction at the onset of a snore. The increased muscle tension gradually replaced the low muscle tonus of the respiration response. The RX subjects received relaxation training predicted by Tsukamoto et al. to reduce snoring. The PC and NT subjects comprised the control conditions.

The SC subjects exhibited a significant, stable reduction on multiple duration snoring measures. The RX subjects exhibited a reduction on one snoring measure. The results of the study supported a behavioral interpretation and treatment of snoring. Personality concomitants and roommate perception of snoring were also briefly examined.