75-21,194

MAXWELL, Donald Edward, 1941-
A STUDY OF THE EFFECT OF WHITE NOISE
MASKING ON TRAINED SINGERS.

The University of Oklahoma, D.Mus.Ed., 1975
Education, music

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

A STUDY OF THE EFFECT OF WHITE NOISE MASKING ON TRAINED SINGERS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF MUSIC EDUCATION

BY

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Norman, Oklahoma

1975

A STUDY OF THE EFFECT OF WHITE NOISE MASKING

ON TRAINED SINGERS

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ACKNOWLEDGMENTS

Deepest appreciation is expressed to Dr. Bruce Govich, who has served as advisor on this project--for his guidance, advice, continued interest, and most of all, for his patience in reading each draft of this dissertation and offering suggestions for its improvement.

A special thanks of gratitude goes to Dr. Ralph Verrastro for clarifying the experimental design and procedures, and for offering helpful suggestions in each of the preliminary drafts; and to Drs. Russell Mathis, Ernest Trumble and Gail de Stwolinski for their suggestions which contributed greatly to completion of the dissertation.

Sincere appreciation is expressed to Mr. Alan Loether for constructing and donating the white noise generator to the experiment; to Dr. Albert Krienke for his invaluable help in analysis of the experimental data; to Dr. Gene Brooks, Chairman of the Department of Music, Midwestern University, for allowing many free hours to work on this project; to students who participated as subjects in the experiment; and, to Mr. Glenn Schell who assisted in conducting the experiment.

Deepest gratitude is expressed to my wife, Nancy, who helped with the seemingly endless number of things that had to be done to complete this work, including the lending of moral support.

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CHAPTER I

INTRODUCTION

Voice teachers often become frustrated at the inability of their students to understand concepts which lead to acceptable vocal production. While some students progress easily and rapidly, many are unable to overcome basic vocal deficiencies. The pattern of success appears to be dependent upon a combination and interaction of processes which are not fully understood.

There is available a large body of information which could be of great value to voice teachers. A teacher's lack of readily available knowledge of the physiology, acoustics, and learning theories which pertain to singing, however, leads to the propagation and perpetuation of many fallacious concepts about singing. Physicists, psychologists, and speech therapists rarely apply their expertise to the problems of trained singers. Therefore, voice teachers must take it upon themselves to assimilate and apply findings generated from related avenues of research. Concerning this matter in a general sense, Gage says that "research has lost touch with behavioral sciences. It has not drawn nourishment from the theoretical and methodological developments in psychology, sociology and anthropology."[1] Because the act of singing requires a number of interrelated and interdependent mental and physical skills, there is a genuine need for interdisciplinary inquiry.

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[1]N. L. Gage (ed.), Handbook of Research on Teaching (Chicago: Rand McNally and Company, 1967), p. vi.

Methods used by speech therapists may be applicable to the solving of some of the problems of singers. Speech and singing are overlaid functions which have been superimposed upon a primitive mechanism whose primary purpose is to aid man in such acts as swallowing and keeping food from entering the respiratory tract.[1] There is no difference in the physiological and mental mechanisms which govern the speaking and singing voice.[2,3,4] Therefore, it is reasonable to assume that many of the problems of speakers and singers are related.

Audiologists and speech therapists, however, are more concerned with speaking and hearing disorders rather than the problems of singers. Van Riper describes treatments employed in the correction of speech disorders which also could be applied to the problems of singers.[5]

One area of research that could be relevant to the concerns of voice teachers is the study of auditory deprivation. In order to achieve auditory deprivation, a noise, most commonly white noise, is applied to a subject's ears. The noise makes it difficult, if not impossible, for the subject to hear any other sound input including the feedback of his own voice. Although researchers have recorded the effects of auditory deprivation on the human speaking voice, and speech therapists use

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[1]D. Ralph Appelman, The Science of Vocal Pedagogy (Bloomington: Indiana University Press, 1967), pp. 41-3.

[2]Douglas Stanley, The Science of Voice (5th ed.; New York: Carl Fischer, Inc., 1958), p. 129.

[3]E. Herbert-Caesari, Vocal Truth (Boston: Crescendo Publishing Company, 1969), p. 35.

[4]Charles Van Riper, Speech Correction--Principles and Methods (5th ed.; Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1972), pp. 130-1.

[5]Van Riper, pp. 138-66.

masking techniques in hearing loss disclosure and rehabilitation, no literature is available in dealing with the effects of auditory deprivation on the singing voice. Dr. John P. Zubeck, Research Professor at the University of Manitoba, Winnipeg, Canada, indicated in a letter (Appendix A) that a study of auditory deprivation on singers would be welcomed by researchers working in this general field. Such a study might be of potential value to teachers of singing, since little is known about the effect of altered feedback on a singer's performance.

Research in learning theories, especially those dealing with perception and the interaction of the senses, may be important to teachers of singing. Unless singing teachers play a part in testing learning theories themselves, however, little progress can be expected in the development of voice teaching techniques.

Need for the Study

For the singer, there are at least two aspects of the hearing process which need to be differentiated: (1) the sensations created by external hearing, and (2) the tonal-mental image.

The mind perceives, as an auditory sensation, any sound wave which stimulates the physiological ear mechanism. While this includes air conducted sound waves which reach the individual by the outer ear canal, tissue conduction plays a much greater part in relation to the audition of one's own voice. Vibrations of the vocal folds, in addition to generating air conducted waves, are transmitted to the bones of the skull. Sound conducted by tissue, primarily bone tissue, undergoes frequency and phase distortion because of passing through the more dense medium, so its timbre is different from air conducted sound.[1] Therefore, when the individual produces a vocal sound he hears a product of the interaction between air conduction and bone conduction.[2] It is for this reason that a person hearing a sound recording of himself for the first time is usually surprised at the quality of his own voice. The recording allows a person to hear his voice, essentially, as it is heard by others.[3]

Another component of hearing, the tonal-mental image, is a conception of a previous auditory experience that can be recalled in the absence of the original sensory stimulation. Although other theories have been advanced, a commonly accepted theory maintains that the image is shaped and developed by new auditory experiences. The image travels from the mind to the speech organs in the form of electrical impulses. The vocal folds convert the nerve impulses into the molecular movement of air particles that constitute sound waves.[4]

Tonal-mental image hearing serves a purpose different from that produced by external stimulation, although both components of hearing are essential. The mental concept of a sound, including the frequency, intensity, and relative strength of overtones, must precede the act of

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[1] George R. Simon, <u>Bone Conduction Hearing</u>, Maico Audiological Library Series, Volume VI, Report Ten (Maico Hearing Instruments, 1968).

[2] Hayes A. Newby, <u>Audiology</u> (New York: Appleton-Century-Crofts, Inc., 1958), p. 31.

[3] Richard B. Rosewall, <u>Handbook of Singing</u> (Illinois: Summy-Birchard Company, 1961), p. 49.

[4] Derek A. Sanders, <u>Aural Rehabilitation</u> (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971), p. 14.

singing.[1] Prominent adherents to this theory are Reid,[2] Coffin,[3] and Herbert-Caesari.[4] They and others conclude that the mental image initiates and maintains the delicate laryngeal adjustments for frequency and intensity and the pharyngeal adjustments of resonance and relative strength of overtones.[5,6,7,8]

Each individual's concept of singing is dependent upon his ability to perceive and interpret the input of his own voice. The concept changes and develops from infancy and is a product of the individual's total listening experience.[9] Since one listens to other singers exclusively by means of air conduction, the concept of singing largely is based upon air conducted input. But the hearing sensation one receives from his own voice is both air and bone conducted. Therefore, there will always be a conflict between the individual's tonal-mental image and the perception of the sounds being made.

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[1]Stanley, pp. 94-6.

[2]Cornelius L. Reid, The Free Voice (New York: Coleman-Ross Company, Inc., 1965), pp. 28-30.

[3]Berton Coffin, The Tonal Art of Singing: Harmonic Pronunciation (Colorado: Berton Coffin, 1972), p. 4.

[4]Herbert-Caesari, 24-37.

[5]Robert Lawrence Weer, My Views on Voice Production (Boston, Massachusetts: Robert Lawrence Weer, 1941), pp. 7-9.

[6]Arnold Rose, The Singer and the Voice (New York: St. Martin's Press, 1971), pp. 248-9.

[7]Richard De Young, The Singer's Art (Chicago: De Paul University, 1958), p. 61.

[8]William C. Rice, Basic Principles of Singing (New York: Abingdon Press, 1961), p. 31.

[9]Reid, pp. 101-4.

Rosewall states:

> . . . no matter how hard the singer may try to imitate and match the tone quality that he hears in someone else, he will fail; although he seems to duplicate the sound, he does so only in his own double hearing of the tone.[1]

When a person begins to sing, one of two conditions may result: (1) concentration on the image, or (2) a shifting of concentration to the sound being produced. Reid maintains that concentration on the sound being produced will cause a breakdown in the pharyngeal and laryngeal co-ordination.[2] Stanley, in agreement with Reid, has this to say about the importance of concentration on the image:

> The memory-picture of sound in all its phases: pitch, vowel and vowel color, intensity, rhythm, time, time spot, and sequence-pictures of these phenomena, are received through the ears and stored up in the brain. IT IS FROM THESE MEMORY-PICTURES THAT THE SINGER PHONATES. If he attempts to use his "listening apparatus" for this purpose, he is inverting the psychological process and destroying the function of the ear (memory centers in the brain). The moment the singer uses his listening mechanism as a guide, he starts to break down these memory-pictures which are his most vital asset.[3]

According to Brown, "When self-analysis begins, it should be set in motion only after a tone or phrase is finished, not during the act of singing the word or phrase."[4] Brown adds that a student's "irritation will continue indefinitely until he decides to stop listening to the sound of his voice (his voice as it sounds to him),

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[1] Rosewall, p. 49.

[2] Reid, p. 1.

[3] Stanley, p. 324.

[4] Ralph Morse Brown, The Singing Voice (New York: The Macmillan Company, 1947), p. 112.

and concentrates on causes rather than effects."[1] He implies that initiation and maintenance of the tonal image is of prime importance in singing.

It seems possible that one of the major obstacles in teaching voice is the confusion and lack of understanding surrounding this built-in conflict. Understandably, many singers find it difficult, if not impossible to ignore the sensations created by the stimulus of external hearing when they sing.

According to Husson, it is common experience for singers and speakers to experience feedback sensations which appear to vary in relation to the reverberation time of the acoustical environment.[2] Phonation seems to be labored and fatiguing in auditoriums where reverberation time is less than two seconds, but becomes progressively easier as conditions change and the reverberation time is increased. Husson contends that longer reverberation time surrounds the singer with a higher sound level than that of short reverberation time, and therefore increases the quantity of feedback. In effect, the conflict between the tonal image and the sensations of external hearing is lessened because of increased air conducted feedback.

Since the singer has very little control over the various acoustical conditions demanded in performance, perceptions of feedback

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[1]Brown, p. 115.

[2]Raoul Husson, "How the Acoustics of a Hall Affect the Singer and Speaker," trans. by Pierre Delattre, The NATS Bulletin, XVIII (February, 1962), pp. 8-17.

will be governed by the particular reverberation time of the immediate environment. It seems unlikely that evironmental conditions can be controlled to the extent that an acceptable reverberation time can be maintained essentially constant for each performance situation.

Herbert-Caesari suggests one way of controlling the amount of feedback:

> To help concentrate inside oneself when singing, I advise pupils to put a small piece of cottonwool in each ear. This plugging of the ears is to block out the external sounds and enable one better to concentrate on the inner sensations. This is what the old Italian School used to teach and called it the inner life. With the ear unplugged, the pupil or singer dwells on the sounds outside him because he is mightily concerned about what the voice sounds like to others.[1]

Herbert-Caesari's suggestion to alleviate the conflict falls short of solution because bone conduction is still a major part of the sensations caused by external hearing.

If the conflict between image and external hearing could be removed or mitigated, more singers might learn to let go of external feedback and concentrate more on the tonal image. If dependence upon the external sensations could be lessened, a dependency on the tonal-mental image may occur, thereby resulting in a more acceptable vocal production. The aim of this study is to explore the possibility of strengthening the tonal-mental image by use of white noise masking.

The preceding paragraphs raise three points which seem to indicate a need for further investigation: (1) voice teachers theorize that tonal-mental imagery is prerequisite to acceptable vocal production, (2) there may be a natural conflict between the external hearing

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[1]Herbert-Caesari, p. 57.

sensations and the tonal-mental image of one's own voice, and, (3) white noise masking alters one's perception of the singing act by reducing the amount of feedback.

Purpose of the Study

The purpose of the study was to determine the differential effect of white noise masking of the external hearing sensations and the resultant manifestations on vocal quality of college applied voice students at the undergraduate and graduate level.

Hypotheses

It was hypothesized that:

1. The comparison of a singer's usual vocalization with a similar vocalization performed with white noise masking will result in perceived differences in vocal quality and production.[1]

2. The application of white noise masking during a vocal performance will result in perceived differences in vocal quality and production.[1]

3. A pedagogical process employing white noise masking would strengthen a singer's auditory tonal imagery and pharyngeal/laryngeal control to the extent that overall vocal quality and production would be enhanced.[1]

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[1]As determined by the criterion measure and experimental procedures employed in the study.

To facilitate the drawing of conclusions relating to the stated purpose of the study, the following null hypotheses were formulated:

$N\ H_1$: There will be no difference when comparing the student singers' usual vocalization to vocalization with the independent variable of white noise masking.

$N\ H_2$: There will be no difference in the student singers' vocal production when the independent variable of white noise is introduced during the singing of a standard piece of vocal literature.

$N\ H_3$: There will be no difference in the mean evaluation scores of student singers which were randomly assigned to each of four pedagogical treatment groups involved in the study.

Definition of Terms

Air conduction. The transmission of sound waves to the inner ear by way of the outer and middle ears. In normal hearing, almost all sounds are transmitted in this manner, except those of the hearer's own voice, which are transmitted partly by bone conduction.

Audiology. The study and practice of evaluation of individuals to determine if there is hearing loss and the planning and administering of therapy and/or prosthesis appropriate to such losses.[1]

Auditory deprivation. A condition resulting from the masking of auditory feedback by white noise.

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[1]Robert West, Merle Ansberry and Anna Carr, The Rehabilitation of Speech (3rd ed.; New York: Harper and Brothers, 1957), p. 587.

Bone conduction. The transmission of sound waves or vibrations to the inner ear by way of the bones of the skull.

Decibel (db). The Bel is a ratio between the intensities of two tones. One-tenth of a Bel (db) differs so slightly that, under medial conditions, the average hearer is able to detect a just-noticeable-difference (JND) in loudness.[1]

External hearing sensation. Perception by the brain of sound waves which stimulate the inner ear.

Feedback. The backflow of information concerning the output of a motor system. Auditory feedback refers to self-hearing; proprioceptive feedback to the self-perception of one's movements.[2]

Masking noise. Sound of any kind interfering with the audibility of another sound.

Perception. A single unified meaning obtained from sensory processes while a stimulus is present.[3]

Reverberation time. The time required by a perceived sound, immediately after ceasing, to fall to a millionth of its initial intensity.[4]

Sound level meter. Instrument used to measure the intensity output level (in db) of any sound source.

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[1]Lyman Spicer Judson and Andrew Thomas Weaver, Voice Science (New York: Appleton-Century-Crofts, 1965), pp. 295-6, 403.

[2]Charles Van Riper, p. 437.

[3]C. L. Barnhart and Jess Stein (eds.), The American College Dictionary (New York: Random House, 1958).

[4]Husson, p. 9.

Tonal-mental image. Conception of a previous auditory experience which can be recalled in the absence of the original sensory stimulation.

White noise. A sound whose spectrum contains, with uniform intensity, essentially all frequencies within the audio spectrum.

Limitations of the Study

The study was concerned with the immediate and extended (10-week) effect of white noise masking on the singing voice. It is generally acknowledged that speech and singing sounds are functionally related. Nevertheless, spoken sounds were not considered in the experiment.

The possibility of students with hearing disorders being included in the treatment groups and affecting the results of the investigation was not considered, in that they would have been randomly assigned to each of the groups studied.

Speech therapy tools and procedures, such as the "phonic ear" and delayed auditory feedback, were not used in this study.

Methodologies of voice teaching were not within the scope of this study. The writer is fully aware that some voice teachers place little emphasis on the importance of tonal-mental imagery in singing. Improvement of vocal production through the use of white noise masking would, however, give credence to the importance of imagery in the pitch-quality formation.

CHAPTER II

REVIEW OF RELATED LITERATURE

The literature pertinent to this study includes psychological studies of mental imagery and learning, studies in speech therapy and a survey of masking techniques.

Psychological Studies of Mental Imagery and Learning

Mental imagery was first tested in the 1880's by Sir Francis Galton. He found that some people had vivid visual imagery, while others reported none at all.[1] Galton later (1904) found it helpful to classify people into categories of "visile," "audile," and "motile" according to their dominant imagery. It is now known that there are great individual differences in mental imagery involving all of the senses, including smell and taste.[2] Beethoven, for example, relied upon a well-developed sense of tonal imagery while creating music after he had gone deaf. People with photographic memories have vivid senses of visual imagery.

A bitter controversy raged at the beginning of the century over the question of imageless thought--whether or not people could think without images. The controversy ended unresolved when psychologists turned their attention to other questions about the thinking process.

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[1] David Krech and others, Elements of Psychology (2nd ed.; New York: Alfred A. Knopf, 1969), p. 353.

[2] Peter McKellar, Imagination and Thinking (New York: Basic Books, Inc., 1957), pp. 19-20.

Mental imagery can best be studied by means of psychological experimentation. Most psychologists agree that the mental image must precede the vocal act itself.[1] But the entire sequence of image-motor response-feedback is highly complicated, much of it on the unconscious, automatic level. Only the effect of thought, not the process itself, can be observed.[2]

In a related area of research, it has been found that mental activity apparently produces electrical impulses that can be recorded. Jacobson asked several subjects to imagine a body movement, such as lifting an arm, and resulting electrical impulses were recorded from strategically placed electrodes.[3] He also found that mental activity can evoke slight speech movements in subjects.[4] Electrical impulses, however, show nothing of the quality or type of imagery involved.

Some of the most notable research in imagery has been done by Piaget. He hypothesized that mental imagery is not just a prolongation of perception, but involves an element of active imitation which has become internalized.[5] Studies by Gastaut using electroencephalograms

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[1]John Eisenson, The Improvement of Voice and Diction (New York: The Macmillan Company, 1958), p. 132.

[2]Jean Piaget, Barbel Inhelder and others, Mental Imagery in the Child (New York: Basic Books, Inc., 1971), p. xiv.

[3]Edmund Jacobson, "Electrophysiology of Mental Activities," American Journal of Psychology, (1932), 44:677-94.

[4]Edmund Jacobson, You Must Relax (New York: Whittlesey House, 1942), p. 166.

[5]Piaget, p. 5.

support this view. The mental thought of a motor skill causes the same brain wave pattern as the actual performance of the skill.[1]

Concerning images as related to motor skills, Piaget writes:

> And the situation is indeed quite different when the images become anticipatory under the influence of the operations. The image then constitutes an auxiliary that is not only useful to, but in many instances necessary for the functioning of the operations. After having structured and fashioned it in their own likeness, the operations in fact come to depend on the image.[2]

Piaget appears to substantiate Stanley's theory that vocalization is dependent upon an external stimulus which has become internalized as imagery.

The intricate mental-motor-feedback sequence of a learned skill such as singing consists of a number of perceptual and motor responses. Each response, when it becomes part of a skill, is modified and integrated into new patterns and sequences of performance. The perfection of skills is usually a slow process during which levels of integration become higher and higher and organization becomes increasingly sophisticated. In the growth of skill, unnecessary and wasteful movements are eliminated, and precision in the control of strength, speed, and direction of responses develops.[3]

Stanley writes in regard to the development of a singer:

> The more advanced the technic becomes, the more accurate must be the adjustments. When the voice is really "opened up", the

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[1] H. Gastaut and I. Bert, "EEG Chages During Cinematographic Presentation," EEG Clinical Neurophysiology, (1954), vi:433-44.

[2] Piaget, p. 378.

[3] Krech, pp. 333-48.

> precision of the attack must be very fine, and the "timing" of the tensions required must be performed with consummate skill.[1]

Husson, commenting on the development of a singer, contends:

> . . . a complex totality of regulations is established little by little which bear at the same time on the accommodation of the attack mechanism and upon the adaptation of the pharyngo-buccal cavity. In the exercise of theatrical singing, the subject is literally inundated with internal pharyngo-buccal sensitivities, powerfully felt and upon which is regulated at each instant a complex play of laryngo-pharyngo-buccal motor appropriations which constitute the <u>instantaneous conditioning of the emission</u>.[2]

Feedback, both proprioceptive and auditory, appears to be an integral part of the development and maintenance of the vocal sounds. It is the means by which the vocal mechanism monitors both consciously and unconsciously, the vocal output. The feedback feature provides a continuous error detection pathway by which the hearing mechanism monitors the quality of output.[3] Proprioceptive, or internal, feedback is formed before an overt response is produced by an individual. Auditory, or external, feedback occurs after the response is made.

During the formative stages of vocalization, the length of time required for the production of sound, the feedback return, and comparison and correction is relatively long. With practice, the process becomes virtually instantaneous.

How feedback works and how much an individual depends upon external and/or internal feedback has been at the theoretical stage for

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[1]Stanley, p. 326.

[2]Raoul Husson, "The Pharyngo-Buccal Cavity and its Phonatory Physiology," trans. by Evelyn Robe, <u>The NATS Bulletin</u>, XVI (February, 1960), p. 9.

[3]Patricia I. Myers and Donald D. Hammill, <u>Methods for Learning Disorders</u> (New York: John Wiley and Sons, Inc., 1969), pp. 32-7.

decades. Whether or not a person can control his external auditory feedback has been answered convincingly. Hebb indicates that one has the ability to control his sensory input by concentrating only on those sensory impulses which interest him.[1] This concentration involves the selective awareness of certain sensory messages with the simultaneous suppression of others. One's sense organs are activated by a great variety of sensory stimuli, but relatively few evoke conscious sensation at any given moment. It is common experience that there is a pronounced reduction of sensory awareness when our attention is focused on some particular matter. For example, a person engrossed in a book may not hear the news on television even though the television is within hearing distance. The aural stimulus is shut out in order to concentrate on the visual stimulus.

During experiments with unanesthetized cats, Hernández-Peón, et al., concluded:

> During the attentive state, it seems as though the brain integrates for consciousness only a limited amount of sensory information, specifically, those impulses concerned with the object of attention.[2]

Research by Gardner, et al., presents data interpreted as indicating that intense stimulation of one sense modality appears to inhibit the function of the other senses.[3] These studies suggest that

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[1]D. O. Hebb, The Organization of Behavior (New York: John Wiley and Sons, 1949), pp. 151-2.

[2]R. Hernández-Peón, H. Sherrer, and M. Jouvet, "Modification of Electric Activity in Cochlear Nucleus During Attention in Anesthetized Cats," Science, (1956), 123:331-2.

[3]W. J. Gardner, J. R. C. Licklider and A. Z. Weisz, "Suppression of Pain by Sound," Science, (1960), 132:32-3.

acoustic stimulation appears to suppress pain. Apparently, the pain-reducing effect of intense stimulation is not restricted to the auditory modality. Vibratory stimulation and a bright flask of light can inhibit pain response to a localized electrodermic shock.[1]

There is some evidence that internal feedback may be more important to the act of vocalization than external feedback. Studies by Welsh and Guttman found that many severely deafened persons demonstrate little loss of speech control and only minor changes in speech patterns.[2,3]

Goldiamond observed that people who continually speak without seeming to listen to themselves, are unaffected by delayed auditory feedback.[4] This would appear to indicate that the disruption of a person's external feedback only causes a breakdown in vocalization when one depends upon this avenue of feedback to the exclusion of proprioceptive feedback.

Ringle and Steer found that speech is more effectively disrupted by anesthetization of oral structures than by auditory masking.[5] The

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[1] Gardner, Licklider and Weisz, p. 33.

[2] Oliver Leo Welsh, "The Effects of Delayed Auditory Feedback on the Vocal Intensity and Speaking Rate of Adults With Hearing Loss" (unpublished doctoral dissertation, Boston University School of Education, 1965), p. 13.

[3] N. Guttman, "Experimental Studies of the Speech Control Mechanism" (unpublished doctoral dissertation, University of Illinois, 1954), pp. 49-50.

[4] Israel Goldiamond, "Stuttering and Fluency as Manipulatable Operant Response Classes," Research in Behavior Modification, eds. L. Krasner and L. P. Ullmann (New York: Holt, Rinehart and Winston, Inc., 1967), pp. 106-56.

[5] R. Ringel and M. D. Steer, "Some Effects of Tactile and Auditory Alterations on Speech Output," Journal of Speech and Hearing Research, (1963), 6:369-78.

authors interpret this as an indication that proprioception is the more important feedback signal in speech monitoring.

If proprioceptive feedback is more important than external, then persons exhibiting some kinds of vocal disorders may be overly attentive to auditory feedback. Since there is indication that concentration on one stimulus may cause other stimuli to remain essentially unperceived, it seems possible that attention on the external feedback may block proprioceptive feedback, causing a breakdown in the natural emission of sound.

If the external feedback of a singer could be lessened, it may not only be possible to alleviate the built-in conflict, but also redirect attention to the tonal image and proprioceptive feedback.

Speech Therapy--Research and Application

Some of the work of speech therapists may be applicable to the problems of singers. Many theories, for example, have been set forth regarding the causes of stuttering. One point of view, as held by many psychiatrists and some psychologists, is that stuttering is of a neurotic origin and character.[1] Stuttering behavior is viewed as the outward symptom of a basic inner conflict.

Other researchers feel that stuttering is learned behavior.[2] According to this theory, stuttering has its origin in the early

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[1]P. Glauber, "The Psychoanalysis of Stuttering," Stuttering: A Symposium, ed. J. Eisenson (New York: Harper and Row, 1958), p. 73.

[2]A. Murphy and R. Fitzsimons, Stuttering and Personality Dynamics (New York: The Ronald Press Co., 1960), pp. 41-114.

fumblings and hesitancies and interruptions which seem to be a natural phase of the speech learning process.

A third major theory which has been advocated strongly is that some stutterers have an organic basis for their affliction.[1,2] These researchers suggest a neurological dysfunction, perhaps a defective auditory processing system.

The problems of some stutterers have been alleviated by therapeutic applications which may suggest possible application to the problems of singers. As early as 1917, Bluemel proposed a theory which stated that some stutterer's difficulties were not due to organic deficiencies of the brain, but to a failure in the relationship between the process of imagery and the motor implementation of the imagery.[3] Many therapists, in conjunction with psychologists, have since substantiated Bluemel's original findings. Several speech problems appear to be related to a breakdown in the mental imagery process. A later study by Stromsta (1957) found that the faulty image of a stutterer may be caused by a disparity between the air conducted and bone conducted perception of his own speech.[4]

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[1]Charles Van Riper, The Nature of Stuttering (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971), pp. 335-82.

[2]J. Blake, Speech, Language and Learning Disorders (Springfield, Illinois: Charles C. Thomas, 1971), p. 134.

[3]R. West, "An Historical Review of the American Literature in Speech Pathology," Speech Pathology, eds. R. W. Rieber and R. S. Brubaker (Amsterdam: North-Holland Publishing Company, 1966), p. 34.

[4]C. P. Stromsta, "A Methodology Related to the Determination of the Phase Angle of Bone-Conducted Speech Sound Energy of Stutterers and Non-Stutterers," Speech Monographs, (1957), 24:147-8.

Reviewing a study by Shane (1955), Bloodstein reports that "the application of a loud masking noise to the stutterers ears tends to eliminate or markedly reduce his blockings. The inference has been drawn that stuttering is lessened in these cases by a reduction in the auditory feedback."[1] This finding was confirmed in a similar study by Maraist and Hutton (1957).[2]

Another method, the "phonic ear," is also used by speech therapists. It lessens the disparity between the image and feedback by amplifying the air conducted portion of the feedback. The phonic ear consists of a microphone, amplifier, and earphones. The subject speaks into the microphone and hears his amplified air conducted sound through the earphones. Both of these methods are aimed at reducing the conflict between the tonal image and the external hearing sensations.

Since speech and singing are the functions of the same vocal mechanism, it seems probable that some of the problems related to these motor skills have common origins. The conflict between the image and the auditory feedback might be lessened for singers by reducing auditory feedback by means of a technique similar to one of those employed in speech therapy.

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[1] O. Bloodstein and E. J. Brutten, "Stuttering Problems," Speech Pathology, eds. R. W. Rieber and R. S. Brubaker (Amsterdam: North-Holland Publishing Company, 1966), pp. 354-402.

[2] J. A. Maraist and G. Hutton, "Effects of Auditory Masking Upon the Speech of Stutterers, Journal of Speech and Hearing Disorders, (1957), 22:385-9.

Masking

The technique of masking was facilitated by the development of the audiometer. In 1914, the first electric generator was constructed by Stefanini. It produced an alternating current with an essentially complete range of frequencies. On the basis of Stefanini's principles, Lee W. Dean applied the electric generator to the first clinically useful audiometer in 1919.[1]

With the invention of the vacuum tube in 1921, pure tone generators came into commercial use. A pure tone generator delivers an audio signal adjustable to any frequency and intensity within the hearing range. This has been a very useful instrument in diagnosing hearing defects and in determining the hearing threshold throughout the audio spectrum. In addition, the need was recognized for a method of masking a good ear while a poorer ear was being tested. Consequently, in 1924, Jones and Knudson developed an audiometer which incorporated a masking noise source.[2]

The masking effect is a very common experience. Whenever two or more sounds containing the same frequencies reach the ear at the same time, one of the sounds, usually the more prominent, raises the hearing threshold for the other sounds. For example, in a noisy restaurant, it is difficult to hear normal conversation. The background noise masks, or raises the threshold for conversation.

The effect of masking is explained by the fact that one or more sounds reach the same delicate nerve fibres of the basilar membrane at

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[1]Aram Glorig (ed.), <u>Audiometry: Principles and Practices</u> (Baltimore: The Williams and Wilkins Company, 1965), pp. 7-8.

[2]Glorig, p. 9.

the same time. The fibres will vibrate to the more prominent stimulation and the rival sound is unheard.[1] In pure tone masking, a tone of the same frequency is introduced to mask the test tone.[2] When multi-frequency sounds are masked, the masking sound must contain all of the frequencies inherent in the sound to be masked.

White noise is a particularly good masker because it excites virtually all of the fibres on the basilar membrane. It can be generated by amplifying the background hiss produced by electronic vacuum tubes.[3]

White noise appears to be the best masker for eliminating auditory feedback in the singer. Wide spectrum masking is necessary because of the complex tonal structure of vocal sounds and the complexity of the hearing mechanism.

Masking techniques can be easily employed in the voice studio. The application of white noise to the singer through earphones effectively masks his hearing sensations. At the same time, an individual listening to the singer does not hear the white noise and therefore, is able to perceive changes, if any, in the singer's vocalization.

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[1] F. L. Dittrich, Biophysics of the Ear (Springfield, Illinois: Charles C. Thomas, 1963), p. 24.

[2] G. A. Studebaker, "Clinical Masking of Air and Bone Conducted Stimuli," Journal of Speech and Hearing Disorders, 29 (1964), pp. 23-35.

[3] Charles T. Tart, "An Inexpensive Masking Noise Generator," Psychophysiology, (1966), 2:170-2.

CHAPTER III

PROCEDURES

The Experimental Design

The purpose of the experiment was to determine the effect of white noise masking upon the vocalization of trained singers. The study was divided into two phases: immediate effects (Phase One), and cumulative effects (Phase Two).

Phase One of the study was concerned with the immediate effect of white noise masking on the singing voice. Separate applications of masking were used (Part I and Part II), and, in each case, a One-Group Pretest-Posttest Design was employed.[1] The design as applied to the present study is illustrated in Table 1.

Table 1. One-Group Pretest-Posttest Design, Phase One (Parts I and II)

		Procedure	
	Subjects	Step 1	Step 2
Part I	n = 24	Pretest	Posttest with white noise variable
Part II	n = 15	Pretest	Posttest with white noise variable

[1]Donald T. Campbell and Julian C. Stanley, "Experimental and Quasi-Experimental Designs for Research on Teaching," Handbook of Research on Teaching, ed. N. L. Gage (Chicago: Rand McNally and Company, 1967), pp. 177-82.

In Phase One, two aspects of the immediate effects of masking were examined. Procedures related to the investigation were as follows: (1) Subjects in Part I (n = 24) were recorded singing specific exercises twice, once with and once without the application of white noise. (2) Subjects in Part II (n = 15) began singing a familiar melody in their usual accustomed manner with the masking variable introduced at a random point. In order to minimize the shock effect of white noise and its accompanying auditory deprivation, a short trial period of familiarity with the masking phenomenon preceeded the actual taped trials for both Part I and Part II of the first phase of the experiment.

Phase Two of the study was concerned with the cumulative effect of white noise masking over an extended period (10-weeks). The Separate-Sample Pretest-Posttest Control Group Design was employed.[1] The design as applied to the present study is illustrated in Table 2.

In Phase Two, the available subject population (n = 20) was randomly divided into four groups of five subjects each. They were individually given two half-hour voice lessons each week for a period of ten weeks. The designated control group (CG) was treated with traditional studio practices. The remaining three groups contained the experimental variable in the following ways: (X_1) the subjects received instruction with masking but practiced without it; (X_2) the subjects received instruction without masking but practiced utilizing the masking variable; and (X_3) the subjects received instruction with masking and also practiced utilizing the masking variable. All subjects were recorded before commencement of teaching and again at the end of the ten-week period.

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[1] Campbell and Stanley, p. 225.

Table 2. Separate-Sample Pretest-Posttest Control Group Design, Phase Two

Treatment Group	Subjects	Procedure		
		Step 1	Step 2 (10 weeks)	Step 3
CG	n = 5	Pretest	Normal lessons Normal practice	Posttest
X_1	n = 5	Pretest	White noise lessons Normal practice	Posttest
X_2	n = 5	Pretest	Normal lessons White noise practice	Posttest
X_3	n = 5	Pretest	White noise lessons White noise practice	Posttest

The Experimental Subjects

The subjects for the first phase of the experiment, Part I, were voice students and teachers from Cameron College, Lawton, Oklahoma. They included 22 students officially enrolled in individual voice instruction at Cameron College, and two members of the voice faculty. All subjects were pursuing an undergraduate degree in music, with the exception of two faculty members who held the masters degree. Nine were male and 15 were female. The number of years of voice study ranged from 1 to 12 years with an arithmetic mean of 4.2 years. Ages ranged from 18 to 53 years with an arithmetic mean of 25.4 years.

For the introduction of white noise during vocalization, Phase One (Part II), 15 additional voice students from Cameron College were used. All subjects were enrolled in individual voice instruction at Cameron College. Three were male and 12 were female. The number of years of voice study ranged from 1 year to 9 years with an arithmetic mean of 3.4 years. Ages ranged from 18 to 40 with a mean age of 24.1 years.

The subjects for the second phase were the experimenter's voice students, all officially enrolled for two weekly half-hour lessons at Midwestern University, Wichita Falls, Texas. The 20 subjects comprised a full academic load of teaching for the spring, 1973, semester. Their ages ranged from 18 to 36 years with an arithmetic mean of 23.5 years. Thirteen were pursuing undergraduate degrees and seven, graduate degrees. Eight were male and 12 were female. Previous voice instruction ranged from one and one-half years to 10 years with an arithmetic mean of 4.9 years. Of the twenty, two subjects were new to the experimenter.

Selection of Exercises and Literature

For both phases of the experiment, vocal exercises and literature were carefully selected for preparation of the pretest-posttest evaluation tapes. In Phase One (Part I) and Phase Two, subjects were instructed to sing three vocal exercises and a portion of vocal literature. In Phase One (Part II), subjects were instructed to sing only the literature.

Throughout the exercises, the [ɑ] vowel, preceeded by the voiced consonant [m] was used for vocalization. The exercises were simple in nature, requiring no outside practice. Examples of the exercises are illustrated in Figure 1.

"The Star Spangled Banner" was selected for the literature test for three reasons: (1) it has a wide range of pitches and therefore explores all areas of the voice, (2) it was well known to all subjects, and, (3) there was little likelihood of practice between pretest and posttest.

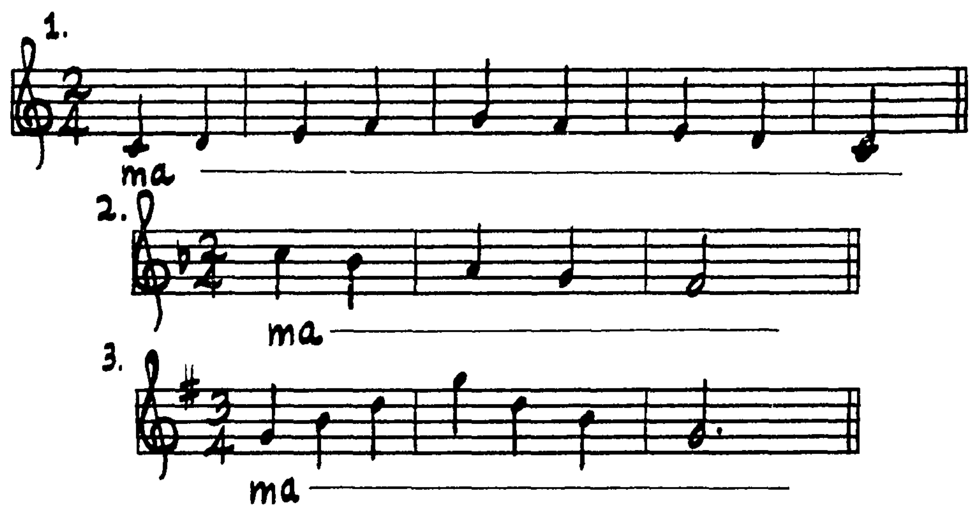

Figure 1. Vocal Exercises Used in the Experiment

For all tests, the vocal material was transposed to various keys so as to exploit the usable range of each subject. The subjects were instructed to sing with accustomed vocal production and at a comfortable volume. No further instructions were given.

Masking Levels

Masking levels were chosen with the following considerations in mind: (1) relatively complete masking can be achieved only when the masking sound exceeds the rival sound by about 15 db, (2) although the intensity of vocalization can vary greatly, it rarely exceeds 90 db, and, (3) some authorities suspect that sounds of 110 db or greater over extended periods of time can cause partial loss of hearing.

In order to achieve relatively complete masking conditions and at the same time be aware of possible injurious practices, 105 db was selected as a maximum level to be used in the experiment. The 105 db level was used only in the studio under the experimenter's supervision, and no period of exposure exceeded 10 minutes.

Since individual practice sessions were scheduled for 30 minutes, the secondary white noise source was calibrated and fixed at the level of 95 db. Although this level could not mask the highest level of phonation completely, it was felt that this level was justifiable in the interest of hearing safety.

Equipment

The following specified equipment was used in the series of experiments:

White noise generator. For these experiments, a white noise generator was constructed. A schematic by Tart provided the skeletal reference from which the unit was built.[1] It produced white noise over the audio spectrum ±db from 20 to 20,000 Hz for the amplitude of all spectral components. A rheostat control provided intensity increments adjustable to approximately 120 db. A reference dial allowed calibration of the output of white noise by means of a sound level meter. The generator was equipped with a mixing box which permitted either earphone or speaker application of the white noise. For this experiment, earphone masking was used.

Earphones, Pioneer (SE 30-A). Low-impedance earphones were connected to the white noise source and served as a feed to the subject's ears. The earpads inhibited air conducted sound while the earphone fed white noise which blocked bone conducted sound. The subject was essentially unable to hear his own vocalization.

Sound level meter, General Radio (Model 1552B). This instrument was used to calibrate the white noise generator output in db. It was also used to calibrate the tape recorder output designated as the secondary white noise source.

Tape recorder, Sony 260. This recorder served as the secondary white noise source. On it were employed pre-recorded tapes of white noise. This source was available for the subject's individual practice.

Cord with toggle switch. A cord with a toggle switch leading from the tape recorder to the earphones enabled the subjects to turn the

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[1]Charles T. Tart, "An Inexpensive Masking Noise Generator," Psychophysiology, (1966), 2:170-2.

white noise off easily without touching the recorder controls. A constant level of white noise was supplied in this manner.

Tape deck, Teac 4010SL stereo tape deck. This unit was used to record all of the pretest-posttest trials.

Tape decks, 2 Teac 6010SL stereo tape decks. These decks were used to edit unwanted sounds from the pretest and posttest tapes. Tedious editing and splicing was avoided by combining the separate pretest-posttest tapes onto a single master tape.

Microphones, 2 Sony ECM-19B electret condensers. These provided transmission of the subject's pretest-posttest trials into the Teac deck (4010SL).

Tapes, Ampex high output-low noise (1.5 ml.). All pretest-posttests were stored on these tapes. Final masters and all dubbings for evaluators were of the same specified quality.

Teaching and practice facilities. The white noise generator was installed in the experimenter's voice studio. The generator supplied the white noise variable to subjects in X_1 and X_3. White noise masking was used at least once a week during their regularly scheduled lessons. A cumulative record was kept of observable auditory effects from lesson to lesson.

A practice room was equipped with the secondary white noise source. The tape recorder supplied the white noise variable to subjects in groups X_2 and X_3. The subjects were assigned practice times and only they and the experimenter had keys to the room.

Reliability

There are problems of reliability inherent in experiments whose data depends upon subjective auditory discrimination. When two examples of vocalization are compared, the analysis depends upon subjective criticism by a judge. Lack of objective and definitive data that can be applied to the description of specific vocal qualities has resulted in an abundance of conflicting and overlapping terminology based largely upon subjective impression. Vocal quality terms have meaning only for the people who use them. Their use, therefore, is limited to very narrow discussion wherein the participants can reach some common agreement regarding the denotation, as well as connotation, of such terms.

Voice authorities often disagree as to what constitutes an acceptable singing sound. Confusion stems from the fact that an individual's concept of acceptable singing depends in large part on his listening experience. Each individual's criteria of judgment are based on subjective opinion. The resulting confusion makes any discussion of voice quality exceedingly cumbersome, and frequently, quite fruitless. Nevertheless, judgments must be made.

A degree of reliability was achieved in the following ways:

1. A series of pre-experimental trials was run to reduce the listening experience to those features most significantly affected by white noise.

2. Evaluation sheets were constructed according to the findings of the pre-experimental trials.[1]

[1]Appendix B

3. An orientation tape was made in order to familiarize the evaluators with the kinds of sounds and distinctions that they would need to make.

In the first pre-experimental trial, ten subjects were recorded singing paired exercises (one of the pair sung in the usual manner, and the other with white noise masking). Piano accompaniment was used for this experiment but was discontinued in subsequent testing. The accompaniment tended to draw attention from the vocalization and interfere with evaluation. Four evaluators, all professors of music, were asked to listen to the series of paired exercises and compare the second exercise to the first in terms of acceptable vocal production: better, same, or worse. The results were not heartening. The judges indicated that they were not sure what attributes of singing they were being asked to evaluate.

These preliminary investigations of the effects of white noise masking yielded the following observations: (1) a majority of the subjects exhibited a serious loss of the ability to sing in tune, (2) a substantial number of these subjects, nevertheless, actually appeared to improve in vocal quality and freedom, (3) some subjects were relatively unaffected by masking, and, (4) others fell between these extremes. As intonation appeared as a significant variable in the preliminary investigations, it was deemed necessary to include this vocal characteristic as a major consideration in the evaluation. Since intonation and quality appeared to be independent to some extent, it seemed useful to create a distinction between them. The judges unanimously agreed that this would be helpful in evaluating the tapes. This distinction was relevant only to the construction of evaluation sheets for the first phase of the experiment. The second phase evaluation was based on the subjects' degree of vocal improvement over a ten-week period and not on the immediate effect of the independent variable.

Theoretically, in a comparison of repeated exercises, it is possible that one exercise could suffer in intonation but be considered of better quality. Conversely, in comparison, one exercise could be considered in better tune but suffer in quality. The experimenter found that it was possible, though difficult, to simulate such paired exercises with his own voice. These simulations formed the basis of an orientation tape which was used to familiarize the evaluators with the kinds of sounds and distinctions they would be asked to discriminate between in the taped evaluations.

A second series of trials was conducted in order to determine the most practical and reliable evaluation procedure. Six subjects were subsequently recorded in a manner similar to that utilized in the first trial. The evaluators were asked to compare the second exercise to the first in terms of <u>acceptable vocal production</u>: better, same, or worse. However, <u>intonation</u> and <u>quality</u> were to be considered as separate criterion references in this determination.

Two different evaluation forms (A and B) were constructed.[1] The evaluators were asked to listen to the tapes twice and use a different evaluation form for each listening session. The order in which evaluation forms were used was evenly divided between the evaluators so as to equalize the effect of practice.

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[1]Appendix B

In order to determine the most reliable form for Phase One of the experiment, dub duplicates were randomly interspersed throughout the trials (A and B). This contrivance was made necessary by the fact that a judge's response to an actual evaluation could not be considered correct or incorrect, but merely an opinion. A dub consisted of a posttest being an exact rerecording of its pretest so that the only right response by a judge would be "same". If an acceptable degree of judge reliability could be established on the duplicates, then an estimate of reliability could be inferred on the actual evaluations. A judge's ability to compare paired exercises, whether he is detecting "sameness" or difference, infers the same type of discrimination capability. Therefore, judge performance on the dubs offered an estimate of reliability on the actual exercises.

The percentage of correct judge response on the Test A dubs was 92% and on Test B dubs was 94%. On the basis of percentage of correct responses, and on spoken and written comments by the evaluators, it was decided that Test B would be the most reliable test format for the first phase of the experiment.

On the basis of findings in the preliminary experiment, dub duplicates were interspersed through both phases as a means of providing an estimate of the reliability of judge performance. In addition, since there was no basis for right or wrong responses on the actual evaluation comparisons, an estimate of individual judge performance could be observed through modal judge agreement. That is, each judge was tested for reliability by comparing his response with the most common response. If the judges generally agreed with each other in their evaluation of the subject performances, an estimate of judge reliability could be made. Through judge response to the dubs and comparisons of modal agreement on the actual exercises, an *a priori* estimate of judge reliability could be obtained for each phase of the experiment.

Validity

The problem of validity in experimentation lies in the necessity of controlling extraneous variables; hence, an experiment must be designed so that results cannot be ascribed to variables other than those in which the experimenter is interested. In Phase One, problems of validity were not important because pretest and posttest were recorded within seconds of each other. Therefore, the following precautions pertain only to the second phase of the experiment.

Randomization of the placement of subjects in the four groups would normally assure that extraneous variables would be distributed purely by chance. But since the number of subjects in the experimental population was small ($n = 20$), it was deemed necessary to take further precautions in order to lessen the chance effects of extraneous variables.

One variable which might diminish the validity of the experiment was the difference in the amount of time spent practicing by the subjects. Although the factors which promote progress in vocal production and their interrelationships are not well understood, it is generally acknowledged that regular vocal activity, or lack of it, will have some noticeable effect upon vocal production. Insofar as was possible, the kinds and extent of vocal activity was controlled and equalized for all subjects.

Subjects were instructed to practice one-half hour each weekday on technical exercises prescribed by the experimenter. The types of exercises practiced were listed on the subjects' time sheet and consisted of exercises used in the experimenter's teaching technique.[1] The particular exercises for any given individual practice session were left to the discretion of the subject, but the experimenter suggested suitable exercises during formal lesson times. Careful records of practice time were kept.

The importance of regular, daily practice was emphasized. Particularly strenuous vocal activity was to be avoided. A record was kept of all vocal activity not required for the experiment, such as church choir activities and recital performances. On the basis of these records and the subject's time sheets, it was determined that the amount of vocal activity for the subjects did not differ significantly.

In order for the pretests and posttests to be valid, they needed to be indicative of the subjects' actual performing capabilities at the time of the tests. Yet, very few singers are consistent in vocal production on a day to day basis. A student who sings well one day may not sing well the next. If the number of available subjects is large, the inconsistencies would tend to equalize and average out over the groups if randomization procedures are carried out in group placement. Since the number of available subjects in Phase Two was limited (n = 20), a subject singing unusually well or considerably below par could produce results which would not average out and thus confound the experimental variable (white noise) with an extraneous variable (singing not indicative of the subject's capabilities). Therefore, the pretest and posttest performances of subjects were compared with the performance standards for each subject at the time of recording. One individual was considered

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[1] Appendix C

sub-standard for the pretest. He was recorded three days later and an acceptable pretest was taken. One individual was sub-standard for the posttest. He was recorded two days later, and was considered acceptable for the posttest.

A third validity factor was pertinent to the second phase of the experiment. Since the pretest and posttest were ten weeks apart, it was necessary to assure essentially constant conditions on recording techniques. For pretest and posttest, the subjects were recorded in the same room with the same recording equipment. The distance from the subject to the microphones and the recording levels were kept essentially constant. All tapes were recorded at seven and one-half ips to assure reasonable fidelity recording and playback. The subjects were recorded in no specific order in the pretest, but the same order was kept in the posttest so that they would sing at approximately the same time of day. These precautions were not necessary in the first phase of the experiment, since the pretest and posttest were within seconds of each other.

It seemed suitable to collect as much data as possible in order to check for unanticipated factors that might influence the experiment. A data sheet was filled out by each subject in the experiment. The sheet contained his name, age, and a record of previous voice instruction.

At the completion of the second phase of the experiment, each subject filled out a questionnaire designed to elicit candid feelings and personal reactions about the use of white noise as a teaching tool.[1] This questionnaire formed the basis of an attitude profile for each subject, which could be correlated with scores from the evaluation.

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[1]Appendix C

Preparation of Tapes

In order to prepare master tapes for the evaluation procedures, it was essential that each exercise be in pretest-posttest order. For the first phase of the experiment, this was accomplished during the actual recording of subject responses, since pretest and posttest were recorded within seconds of each other. However, for the second phase of the experiment, the pretest vocalizations were on one tape and the posttest vocalizations were on another--because of the 10-week interval between tapings. To make the master tape, it was necessary to employ the use of three tape recorders to avoid extensive splicing. Three Teac tape decks were used for this purpose. The pretest was mounted on one machine and the posttest on another. These were fed into a third machine to make the combined master tape. Final editing of the tapes was required to delete extraneous noise, to create time lapses, and to add dub duplicates.

To aid recall by the evaluators, consistent time lapses between pretest-posttest and between sets of exercises were desirable. For Phase One, Part II, no time lapse was created between the pretest and posttest because of the nature of the experimental design. For Phase One, Part I, and Phase Two, a silence of three seconds was determined on the basis of trials to be an optimum time lapse between pretest and posttest. Any longer break between vocalizations made recall more difficult because of fading auditory memory. For both phases, ten seconds between exercise comparisons was deemed sufficient for the evaluators to select their answers and write relevant comments. Dub duplicates were randomly interspersed throughout both phases as a means of estimating the reliability of the judges' evaluations.

In order to familiarize the evaluators with the kinds of distinction they needed to make, an orientation section was included on the Phase One tape. This consisted of possible variations of intonation and quality as they might appear in the evaluations. Rather obvious examples preceded examples illustrating finer gradations of difference.[1]

Evaluation Sheets

Explicit instructions accompanied the evaluation sheets.[1] The written instructions were also included as dialogue on the tapes so as to afford a clear understanding of how each section of the experiment was to be evaluated. The evaluation sheets were divided into four sections: Orientation, Evaluation 1, Evaluation 2, and Evaluation 3.

Evaluation 1 pertained to Phase One, Part I, of the experiment. It was designed to study the immediate effects of white noise masking through comparison of vocalizations, one with the variable, and one without. Intonation and quality were considered as separate entities.

Evaluation 2 pertained to Phase One, Part II, of the experiment. It was designed to study the effects of the introduction of the white noise variable at a random point in the performance of a selected melody. The evaluators were asked to indicate by measure number any noticeable change in vocal production. Again, intonation and quality were considered separate entities.

Evaluation 3 pertained to Phase Two of the experiment. It was designed to test the effectiveness of white noise masking as a teaching tool. After hearing sets of exercises, the evaluators were asked to

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[1] Appendix D

compare the second exercise to the first in terms of acceptable vocal production: great progress, considerable progress, some progress, same (no apparent difference), and worse.

In each of the evaluations, the judges were encouraged to write comments concerning perceivable differences other than intonation and quality. A compilation of these comments indicated whether or not the effects of other factors appeared significant. In Evaluations 1 and 3, after hearing and evaluating each subject's performance, the evaluators were asked to rate each subject in terms of vocal competence: beginning, intermediate, or advanced.

Selection of Evaluators

Judges were selected as representative of three types of musicians. The categories selected were voice teachers, professional musicians (non-voice), and lay musicians. A number of individuals considered acceptable in each category were contacted by letter, inquiring about their willingness to participate as an evaluator.[1] Upon acceptance, they were sent tapes and evaluation sheets with instructions on how to proceed.[1] In order to eliminate bias in connection with evaluation of the tapes, the evaluators were told that they were participating in a study of white noise masking, but they were not told of the actual nature of the experiment. Each category consisted of three judges, for a total of nine. All judges evaluated all subjects.

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[1]Appendix D

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

This chapter presents collected data, statistical procedures, analyses, and findings. A preliminary analysis section precedes the investigation of each of the hypotheses and their related questions.

Phase One

The first phase of the study was concerned with the immediate effects of the introduction of the white noise masking variable and considered as follows:

Part I: Subjects were recorded singing specific exercises twice, once with and once without the application of white noise.

Part II: Subjects began singing a familiar melody in their usual accustomed manner with the masking variable introduced at a random point.

Parts I and II were subjected to analysis separately, due to procedural differences in the treatment of the data.

Preliminary Analysis of Data Relating to Immediate Effects of the White Noise Variable, Part I

The preliminary analysis of Phase One, Part I, consisted of: (1) determining the correlation between the two variables, intonation and quality, (2) estimating the reliability of the judges' performance, and, (3) estimating the reliability of the vocal competence rating scale.

The pre-experimental trials described in Chapter III disclosed the need to examine the relationship between intonation and quality as dependent variables in assessing the effect of white noise masking on vocal performance. Data yielded from the main study on the criterion variables obtained a correlation coefficient of +.37--utilizing the Pearson product-moment formula. A subsequent test of significance employing a conversion procedure confirmed the lack of dependent relationship ($t = 1.59$ with 16 d.f.) requiring the criterion variables to be considered separately in subsequent analyses.

As stated in Chapter III, precautions were taken in the preparation of the evaluation tapes so that a measure of judge reliability could be obtained. The inclusion of dub duplicates made possible the computation of percentage of correct responses for each judge and judge type. Since the dubs provided a random cross section of judge response, the reliability of the judges on the dubs was assumed as indicative of an estimate of reliability of the actual evaluation comparisons. Another estimate of individual judge performance was obtained by determining the percentages of modal judge agreement on the actual evaluation comparisons.

The percent of correct responses on intonation for each judge and judge type is shown in Table 3. The lowest percentage of correct response attained by a judge was 63.6%. The probability that a judge, with an option of three choices, would score at least 63.6% correct responses by random guessing is $P < .05$.[1] Since each judge scored at least 63.6% correct

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[1]Binomial probability distribution

responses on the dubs, the reliability of each judge was considered acceptable. Concurrently, each judge type exceeded the established acceptable percentage of correct responses, so the judge types' performances were considered reliable for the intonation variable.

The percent of correct responses on quality for each judge and judge type is shown in Table 4. The lowest percentage attained by a judge was 54.5%. The probability that a judge would score 54.5% correct responses by random guessing is $P > .05$.[1] Since judge O's percentage of judge agreement could have been achieved on the basis of chance, his responses were rejected from further analysis on the quality portion of Phase One, Part I. All other judges exceeded acceptable levels of correct responses. Furthermore, each judge type exceeded the established acceptable percentage of correct responses (63.6%). Therefore, the judge types' performances were considered reliable for the quality variable.

The overall reliability of judge performance on Phase One, Part I, was assumed by averaging the judge types on both variables, intonation and quality. The mean correct response for Phase One, Part I (85.8%) was above the acceptable level (63.6%); therefore, the overall judge performance was considered reliable.

Since there was no basis for right or wrong responses on the actual evaluation questions, an estimate of individual judge performance could be observed through modal judge agreement. That is, each judge's response was compared to the other judges on the actual evaluation answers. Modal judge agreement was computed separately for intonation and quality (Tables 5 and 6).

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[1]Binomial probability distribution

Table 3. Percentage of Correct Response on Dubs for Judges and Judge Types in Phase One, Part I (Intonation)

	Type I[1] Judges	Type II[2] Judges	Type III[3] Judges
	A 100.0%	M 100.0%	X 63.6%
	B 81.8%	N 90.9%	Y 90.9%
	C 72.7%	O 63.6%	Z 90.9%
Type means	84.8%	84.8%	81.8%

Table 4. Percentage of Correct Response on Dubs for Judges and Judge Types in Phase One, Part I (Quality)

	Type I Judges	Type II Judges	Type III Judges
	A 90.9%	M 100.0%	X 63.6%
	B 100.0%	N 100.0%	Y 100.0%
	C 90.9%	O 54.5%	Z 90.9%
Type means	93.9%	84.8%	84.8%

[1] Professional voice teachers

[2] Professional non-voice musicians

[3] Lay musicians

Table 5. Percentage of Modal Judge Agreement on Actual Evaluation for Phase One, Part I (Intonation)

	Type I Judges	Type II Judges	Type III Judges
	A 88.2%	M 92.9%	X 10.6%
	B 92.9%	N 87.1%	Y 83.5%
	C 85.9%	O 88.2%	Z 88.2%
Type means	89.0%	89.4%	60.8%

Table 6. Percentage of Modal Judge Agreement on Actual Evaluation for Phase One, Part I (Quality)

	Type I Judges	Type II Judges	Type III Judges
	A 81.2%	M 76.7%	X 68.2%
	B 68.2%	N 67.1%	Y 82.3%
	C 60.0%	O 56.7%	Z 69.4%
Type means	69.8%	66.8%	73.3%

As shown in Table 5, judge X's modal judge agreement was significantly lower than the other judges. From X's comments on the evaluation sheet, it was evident that he did not understand the procedure involving intonation. His acceptable performance on all other portions of the evaluation supports this contention. Judge X's evaluations were thus eliminated from the analysis of the intonation section of Phase One, Part I.

Originally, vocal competence was to be considered as a controllable variable. Rating scales were included in Phase One, Part I, and Phase Two, so that a level of competence for each subject could be obtained. However, since the rating was dependent on the subjective opinion of each judge, there was no way of determining a "correct" response. Modal judge agreement provided the only method of determining the level of competence. Since modal judge agreement alone was not deemed sufficient in establishing reliability, the competence level of subjects was dropped from further analytical consideration.

In summary, with the exception of the two instances noted, the judges, judge types, and their overall performance was considered reliable. The independence of intonation and quality hinted at in the pre-experimental trials was confirmed, and justified the distinction made between these vocal characteristics. The judges' performance on the vocal competence rating was considered unreliable and was dropped from further consideration.

The Analysis of Data Relating to the Immediate Effects of the White Noise Variable, Part I

The first null hypothesis of the study states: There will be no difference when comparing the student singers' usual vocalization to vocalization with the independent variable of white noise masking.

The analysis of Phase One, Part I, consisted of testing the first hypothesis, and exploring three related questions. The vocal characteristics, intonation and quality, were analyzed separately, due to the lack of dependent relationship indicated in the preliminary analysis. To test the hypothesis, the data were analyzed by a chi-square test.

As noted in Tables 7 and 8, the variable effects for intonation and quality obtained chi-square values of 581.10 and 258.76, respectively, indicating a significant difference in the intonation and quality of singers when comparing unmasked with white noise masking performance levels. The null hypothesis was thus rejected.

In addition to exploring the effect of the white noise variable, the possibility that other variables could affect the subjects' performance was considered:

1. Is there any significant difference between the four selections[1] used?
2. Is there any significant difference between the three judge types in their rating of the subjects' vocalization?
3. What, if any, is the interaction effect between selections and judge types?

To study the questions, the data were analyzed separately for intonation and quality by a two-factor analysis of variance,

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[1]Includes three exercises and a portion of literature

Table 7. Chi-Square Test Comparing Frequency of Student Response to Expected Response (Intonation)

Preference Category	f_o	f_t	$(f_o - f_t)$	$(f_o - f_t)^2$	$\frac{(f_o - f_t)^2}{f_t}$
Better	6	144	-138	19044	132.25
Same	47	144	- 97	9409	65.34
Worse	379	144	235	55225	383.51
					χ^2 = 581.10

Table 8. Chi-Square Test Comparing Frequency of Student Response to Expected Response (Quality)

Preference Category	f_o	f_t	$(f_o - f_t)$	$(f_o - f_t)^2$	$\frac{(f_o - f_t)^2}{f_t}$
Better	18	144	-126	15876	110.25
Same	125	144	- 19	361	2.51
Worse	289	144	145	21025	146.00
					χ^2 = 258.76

as described by Li.[1] A summary of the data is shown in Tables 9 and 10.

Main effects. For the selections effect, the obtained F-ratios were .045 and 1.30 for intonation and quality, respectively. The obtained ratios indicate that there was no significant difference between the three types of exercises and literature for either criterion variable. Concerning question two, the obtained F-ratio (F = 3.83) for intonation exceeded the critical value of F at the .025 level. For quality, the obtained F-ratio (F = 7.64) exceeded chance occurrence at the .005 level. The analysis indicates that there was a significant difference in the judge types' responses to the listening examples for both intonation and quality.

Interaction effect. The interaction of "selection x judge types" disclosed F-ratios of .488 and 1.04 for the criterion variables. The analysis indicates that this interaction was not significant at any level of acceptability for either intonation and quality.

Findings. The analysis of variance used to investigate the three questions yielded no significant difference for selections. The obtained F-ratios (F = 3.83 for intonation, and F = 7.64 for quality) for the judge types effect, however, shows the presence of a measurable difference in the response patterns exhibited by the judge types. Concerning the third question, the analysis indicates that the "selection x judge types" interaction was not significant.

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[1]Jerome C. R. Li, Statistical Inference I (Ann Arbor: Edwards Brothers, Inc., 1964), pp. 355-66.

Table 9. Analysis of Variance of Selections and Judge Types (Intonation)

Source of Variation	Sum of Squares	d.f.	Mean Squares	F-Ratio
Replications	9.1343	17		
Selections[1]	.0509	3	.01697	.045
Judge Types	2.28843	2	1.44215	3.83 *
Selections x Judge Types	1.1018	6	.18363	.488
Error	76.7223	204	.37609	

[1]Includes exercises and a portion of literature
*Significant at the .025 level

Table 10. Analysis of Variance of Selections and Judge Types (Quality)

Source of Variation	Sum of Squares	d.f.	Mean Squares	F-Ratio
Replications	20.412	17		
Selections[1]	2.495	3	.83167	1.30
Judge Types	9.7866	2	4.89330	7.64*
Selections x Judge Types	3.9911	6	.66518	1.04
Error	130.7223	204	.64080	

[1]Includes exercises and a portion of literature
*Significant at the .005 level

Due to the significance of the obtained F-ratios for judge types as indicated in the analysis of variance for both intonation and quality, Duncan's new multiple-range test was applied to the mean type ratings to determine which specific judge types differed significantly from the others.[1] For intonation, Type I judges differed significantly from Types II and III in response to perceived differences in unmasked-masked comparisons. Types II and III, however, did not differ significantly from one another. A comparison of mean type ratings for quality show that each of the three judge types differed significantly from one another. These data are presented in summary form in Tables 11 and 12.

Preliminary Analysis of Data Relating to Immediate Effects of the White Noise Variable, Part II

The preliminary analysis of Phase One, Part II, consisted of estimating the reliability of the judges' performance. Incomplete judge response, in addition to an already small number of collected samples, made a correlation study between intonation and quality, meaningless, so a determination of the relationship between the two variables was not undertaken.

As in Part I, the percentage of correct response for judge types was computed from the dub duplicates. However, individual judge percentages were not computed on this evaluation because of the small number of dubs (n = 2). Acceptable reliability of the individual judges, however, was inferred from their acceptable performance on

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[1]James L. Bruning and B. L. Kintz, Computational Handbook of Statistics (Glenview, Illinois: Scott, Foresman and Company, 1968), pp. 115-7.

Table 11. Duncan's New Multiple-Range Test Applied to Judge Types (Intonation)

Means Compared	Difference	SSR	Conclusion
II-I	1.1	.420	Significant*
II-III	.27	.398	Not significant
III-I	.84	.398	Significant*

*Significant at the .05 level

Table 12. Duncan's New Multiple-Range Test Applied to Judge Types (Quality)

Means Compared	Difference	SSR	Conclusion
II-III	2.05	.555	Significant*
II-I	1.34	.526	Significant*
I-III	.71	.526	Significant*

*Significant at the .05 level

Phase One, Part I, since the same kinds of listening discrimination were involved.

Mean judge type correct responses were respectively, 66.7%, 75%, and 100%, all above the acceptable percentage level (63.6%), as established in Phase One, Part I. The overall reliability of judge performance on Phase One, Part II (80.6%) was estimated by averaging the percentage of correct responses for all judge types. Judge performance was considered reliable with 80.6% mean correct response on the dubs. One judge's responses were not included because a significant number of responses were left unanswered.

The Analysis of Data Relating to Immediate Effects of the White Noise Variable, Part II

The second null hypothesis of the study states: There will be no difference in the student singers' vocal production when the independent variable of white noise is introduced during the singing of a standard piece of vocal literature.

The analysis of Phase One, Part II, was concerned with testing the second hypothesis. To test the hypothesis, the data were analyzed by a chi-square test. The obtained chi-square, $\chi^2 = 240.98$, for the independent variable effect was significant. The statistical evidence, provided in Table 13, supports the second hypothesis of the study. The obtained chi-square indicates that the judges were able to detect the point of variable introduction in terms of perceivable differences in the subjects' vocalization.

Table 13. A Chi-Square Test to Determine the Judge's Ability to Detect the Point of Variable Introduction

Judge's Response	f_o	f_t	$(f_o - f_t)$	$(f_o - f_t)^2$	$\frac{(f_o - f_t)^2}{f_t}$
Correct	56	9.7	+46.3	2143.7	221.00
Incorrect	61	107.3	-46.3	2143.7	19.98
					χ^2 = 240.98

Phase Two

The second phase of the study was concerned with the cumulative effect of the white noise masking variable over a 10-week period. Subjects were randomly assigned to four groups, consisting of three experimental groups and one control group.

Preliminary Analysis of Data Relating to Cumulative Effects of the White Noise Variable

The preliminary analysis of Phase Two consisted of estimating the reliability of the vocal competence rating scale, and, estimating the reliability of the judges' performance. As previously stated in the preliminary analysis section for Phase One, Part I, the vocal competence rating was viewed as unreliable and thus was not analyzed.

The percentage of correct response for each judge and judge type was computed from the dubs, and the reliability of the judges' performance was estimated. The data is shown in Table 14.

The probability that a judge, with an option of five choices, would score at least 54.5% correct responses by random guessing is $P < .05$. Since each judge scored at least 54.5% correct responses on the dubs, the reliability of each judge was considered acceptable. Since judge type means and the overall mean percentage of correct response (75.8%) exceeded the acceptable level ($P < .05$), the judge types and the total judge performance on Phase Two were considered sufficiently reliable.

Modal observer agreement for the individual judges in Phase Two, as shown in Table 15, revealed no significant patterns of deviant judge response so all judges were included in all further analyses.

The Analysis of Data Relating to Cumulative Effects of the White Noise Variable

The third null hypothesis of the study states: There will be no difference in the mean evaluation scores of student singers who were randomly assigned to each of four pedagogical treatment groups involved in the study. Pertinent questions are listed as follows:

1. Is there any significant difference between the four selections used?
2. Is there any significant difference between the three judge types in their rating of the subjects' vocalization?
3. What, if any, are the interaction effects of the three tested variables--treatments, selections, and judge types?
4. Is there any significant difference between the standard deviations of each group?
5. Is there any significant difference in the subjects' mean score values due to age or sex factors?

Table 14. Percentage of Correct Response on Dubs for Judges and Judge Types on Phase Two

	Type I Judges	Type II Judges	Type III Judges
	A 81.8%	M 90.9%	X 72.7%
	B 54.5%	N 63.6%	Y 90.9%
	C 72.7%	O 81.8%	Z 72.7%
Type means	69.7%	78.8%	78.8%

Table 15. Percentage of Modal Observer Agreement on Actual Evaluation for Judges and Judge Types in Phase Two

	Type I Judges	Type II Judges	Type III Judges
	A 62.3%	M 71.0%	X 56.5%
	B 62.3%	N 66.7%	Y 62.3%
	C 66.7%	O 73.9%	Z 60.9%
Type means	63.8%	70.5%	59.9%

6. Is there any significant difference in mean scores due to the subjects' attitude toward the experiment?

To test the hypothesis and the first three questions, the data were analyzed by a 4 x 4 x 3 factorial analysis of variance adapted from Li.[1] The statistical summary relevant to the third hypothesis is shown in Table 16.

Main effects. As shown in Table 16, the obtained F-ratios (F = 3.03) for the treatment effect exceeded the critical value of F at the .05 level. The null hypothesis was thus rejected. Mean evaluation scores and standard deviations for each treatment group are shown in Table 17.

The differences in mean evaluation scores between selections produced an F-ratio of 5.42, a ratio beyond the critical value of F at the .005 level. The analysis of judge types, however, was not significant (F = 1.33).

Interaction effect. The interaction of "selection x judge types" disclosed an F-ratio of 3.22. Since the obtained F-ratio exceeds the critical value at the .01 level, the significance of the interaction can be accepted. None of the other interactions approached statistical significance.

Findings. The statistical evidence listed in Table 16 supports the third hypothesis of the study. Mean score differences between treatment groups (F = 3.03) were significant at the .05 level, indicating that there were measurable differences in the degree of progress of the

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[1]Jerome C. R. Li, Statistical Inference II (Ann Arbor: Edwards Brothers, Inc., 1964), pp. 502-20.

Table 16. A 4 x 4 x 3 Factorial Analysis of Variance of Mean Evaluation Scores on Phase Two

Source of Variation	Sum of Squares	d.f.	Mean Squares	F-Ratio
Subjects	41.1916	4		
Treatments	44.833	3	14.944	3.03*
Selections°	80.183	3	26.728	5.42***
Judge Types	13.125	2	6.5625	1.33
Treatments x Selections	16.650	9	1.8500	.038
Treatments x Judge Types	29.658	6	4.9430	1.00
Selections x Judge Types	95.142	6	15.857	3.22**
Treatments x Judge Types x Selections	32.825	18	1.8236	.370
Error	946.800	192	4.93125	

°Includes exercises and a portion of literature

*Significant at the .05 level

**Significant at the .01 level

***Significant at the .005 level

four pedagogical treatment groups. A comparison of the mean evaluation scores listed in Table 17 reveals that subjects receiving the white noise variable during lessons achieved significantly higher average scores than control group subjects or subjects who practiced with the variable.

Concerning the first three questions related to the third hypothesis, the obtained F-ratio (F = 5.42) for selections effect indicates that mean evaluation scores differed significantly for the type of exercise employed. The F-ratio used to probe the second question found no significant difference for judge types. The obtained F-ratio (F = 3.22) for the "selections x judge types" effect, however, shows the presence of a significant interaction between these variables. No other interactions tested were significant at any acceptable level of probability.

Table 17. Mean Evaluation Scores and Standard Deviations for Phase Two

Treatment Group	Mean	Standard Deviation
CG	73.8	2.8
X_1	70.4	13.9
X_2	81.4	23.8
X_3	82.8	17.3

Duncan's new multiple-range test was applied to the mean evaluation scores of each of the significant variables (treatments, selections, and "selections x judge types") to determine which specific means differed significantly from the others. A summary of the results is provided in Tables 18, 19, and 20.

As shown in Table 18, the mean scores for each of the treatment effects differed significantly from one another, with the exception of treatment groups X_1 and X_3. A comparison of the mean scores for selections listed in Table 19 reveals that each type of exercise differed significantly from one another. Duncan's test applied to the interaction effect, as shown in Table 20, indicates that judge types differed significantly from one another in response to specific vocal selections.

Table 18. Duncan's New Multiple-Range Test of Mean Treatment Scores

Treatment Means Compared	Difference	SSR	Conclusion
$X_3 - X_2$	12.4	3.00	Significant*
X_3 - CG	9.0	2.90	Significant*
$X_3 - X_1$	1.4	2.75	Not significant
$X_1 - X_2$	11.0	2.90	Significant*
X_1 - CG	7.6	2.75	Significant*
CG - X_2	3.4	2.75	Significant*

*Significant at the .05 level

Table 19. Duncan's New Multiple-Range Test of Mean Selection Scores

Selection Means Compared	Difference	SSR	Conclusion
3 - 1	18.4	3.00	Significant*
3 - 2	12.4	2.90	Significant*
3 - 4	5.6	2.75	Significant*
4 - 1	12.8	2.90	Significant*
4 - 2	6.8	2.75	Significant*
2 - 1	6.0	2.75	Significant*

*Significant at the .05 level

Table 20. Duncan's New Multiple-Range Test of Mean Judge Type x Selection Scores

Interaction Means Compared	Difference	SSR	Conclusion
JT_{II} x S - JT_{I} x S	11.25	2.90	Significant*
JT_{III} x S - JT_{I} x S	3.75	2.75	Significant*
JT_{II} x S - JT_{III} x S	7.5	2.75	Significant*

*Significant at the .05 level

To probe question four, a test was run to compare the sample variances of each group (Appendix E) with each of the other three treatment groups. F values for X_1/X_2 ($F = 2.94$), X_3/X_2 ($F = 1.55$) and X_1/X_3 ($F = 1.89$) were not significant. However, F values for X_2/CG ($F = 25.10$), X_1/CG ($F = 73.80$) and X_3/CG ($F = 38.99$) exceeded the critical value of F beyond the .02 level. These obtained values indicate that there is a significant difference in group standard deviations when comparing the control group with each of the experimental treatment groups. A comparison of treatment group standard deviations is shown in Table 17.

Concerning question five, a t-test was employed to probe differences in the subjects' scores due to sex or age differences. The t-score for age differences was .507. The value of t for sex differences was 1.37. In each case, the differential effect of mean evaluation scores for these variables was not significant.

A questionnaire completed by each subject using white noise was designed to elicit feelings and attitudes pertaining to the use of masking in their lessons and practice (Appendix C). On the basis of response to the questionnaire, the subjects were divided into the following categories: (1) enthusiastic, (2) tolerant. The t-score ($t = .414$) indicated that subject attitudes did not measurably affect mean score values.

CHAPTER V

SUMMARY AND CONCLUSIONS

Purpose of the Study

The purpose of the study was to determine the differential effect of white noise masking of the sensations caused by the stimulus of external hearing and the resultant manifestations on vocal quality of college applied voice students at the undergraduate and graduate levels.

Experimental Procedures

Three experimental conditions were employed--two were designed to observe the immediate effects, if any, of white noise masking on the singing voice, and one was designed to observe the effect of masking on the singing voice when used as a pedagogical tool over an extended period of time.

The first phase of the experiment was conducted at Cameron College, Lawton, Oklahoma, during the spring term, 1973, and was designed to study the immediate effects of masking. The experimental design employed in both parts of Phase One followed the one group pretest-posttest design described by Campbell and Stanley.[1] Phase One, Part I, utilized twenty-four subjects (22 voice students, and two voice teachers).

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[1]Donald T. Campbell and Julian C. Stanley, "Experimental and Quasi-Experimental Designs for Research on Teaching," Handbook of Research on Teaching, ed. N. L. Gage (Chicago: Rand McNally and Company, 1967), pp. 177-82.

These subjects sang specific exercises and literature, once with and once without the application of white noise masking. Phase One, Part II involved 15 additional subjects, all voice students. These subjects sang "The Star Spangled Banner" in their accustomed manner with the masking variable introduced at a random point. All pretest-posttest trials in Phase One were tape recorded.

Phase Two of the experiment was conducted at Midwestern University, Wichita Falls, Texas, in conjunction with the experimenter's applied voice teaching responsibilities. The experimental design employed in the extended Midwestern University study followed the separate sample pretest-posttest control group design as suggested by Campbell and Stanley.[1] The student subjects involved in the study, $n = 20$, were randomly assigned to four groups, $n = 5$, three experimental groups and one control group. Phase Two was conducted during an uninterrupted ten-week period during the academic spring term, 1973. Subjects were tape recorded prior to the ten-week teaching and practice sessions and recorded again at the end of the term.

Conditions for all experiments were controlled as carefully as possible to assure a reasonable degree of reliability and validity. Data sheets were collected from each subject involved in the experiment, including his name, sex, age, and a record of previous voice instruction. The data were analyzed to determine if there was any correlation between the subjects' responses and these variables.

In Phase Two, the experimenter kept a cumulative record for each subject of perceived auditory changes in vocalization throughout the

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[1]Campbell and Stanley, p. 225.

ten-week period. All subjects kept a record of exercises used and literature covered during individual practice. In addition, subjects in the white noise groups completed questionnaires designed to elicit attitudes toward the use of white noise and the experiment in general.

A series of short preliminary experiments was conducted to determine the best way to construct the evaluation sheets, and an orientation tape was made in order to familiarize the judges with the kinds of sounds and distinctions they needed to make.

Three groups of judges, voice teachers (n = 3), professional non-voice musicians (n = 3), and lay musicians (n = 3), were secured to evaluate the recorded experimental data.

Findings

Preliminary analysis for each of the three evaluations revealed that, with minor exceptions, judges, judge types, and overall judge performance on each evaluation were reliable. The independence of intonation and quality hinted at in the preliminary experiment was confirmed and justified the distinction made between these vocal characteristics. The judges' performance in the vocal competence rating was considered unreliable and was dropped from further analytical consideration

The first null hypothesis of the study, which stated that there would be no difference when comparing the student singers' usual vocalization to vocalization with the white noise variable, was tested by a chi-square test. The vocal characteristics, intonation and quality, were analyzed separately, due to the independence indicated by a t-test.

The analysis resulted in rejection of the first null hypothesis, as the obtained chi-square indicated a significant deterioration of both intonation and quality when white noise masking vocalization was compared to unmasked vocalization.

A two-factor analysis of variance showed that neither vocal intonation nor quality was noticeably affected by the type of exercise used. There was, however, a significant difference between the three judge types' ratings of the subjects' vocalization on both intonation and quality. A comparison of mean judge type ratings on intonation revealed that professional voice musicians' evaluations differed significantly from professional non-voice and lay musicians, but that the evaluations of professional non-voice and lay musicians did not vary in excess of chance. On quality, each of the three judge types differed significantly from one another. For reference, these data are shown in Tables 11 and 12 on page 53. The interaction of "exercises x judge types" was not significant.

The second null hypothesis of the study, which stated that there would be no difference in the student singers' vocal production when the variable is introduced during the singing of a piece of literature, was analyzed by a chi-square test. The obtained chi-squares for the independent variable was significant, resulting in rejection of the null hypothesis. The data indicated that the judges were able to detect the point of variable introduction in terms of changes in the subjects' vocalization.

The third null hypothesis of the study, which stated that pretest-posttest mean evaluation scores of four pedagogical treatment groups would be equal, was tested by a factorial analysis and resulted in rejection of the null hypothesis. Differences in the mean evaluation scores of the four treatment groups proved significant, revealing that subjects receiving the white noise variable during lessons achieved significantly higher average scores than control group subjects or subjects who practiced with the variable. Mean scores for the four selections also differed significantly. There was, however, no significant difference between the three judge types in their evaluation of subject performance.

A significant interaction was found between "selection x judge types". None of the other interactions involving treatments, selections, or judge types approached statistical significance.

Duncan's new multiple-range test was applied to further analyze the F-ratios that proved significant in the factorial analysis. A comparison of mean evaluation scores for each significant F-ratio was undertaken to determine which of the specific means differed significantly from others. Concerning the four treatment groups, mean scores differed significantly from one another, with the exception of the group receiving voice instruction with masking but practicing without it (X_1), and the group receiving voice instruction with masking and also practicing with the masking variable (X_3). A comparison of mean scores for these groups indicated no significant difference. Mean score comparisons of the song and vocal exercises revealed significant differences between each of the four types. For the interaction of "selection x judge types", a comparison of mean scores indicated that judge types differed significantly from one another in their evaluation of specific selections. These data are summarized in Tables 18, 19, and 20 on pages 61 and 62.

Progress score variances for each treatment group revealed significant F values when the control group was compared with each experimental group. The obtained ratios indicated that there was significantly greater variance within each treatment group than within the control group. These data are provided for comparative reference in Table 18, page 61.

Sex, age, or length of study were not found to be significant variables. Student attitude was not found to be a factor in mean score differences.

Conclusions

Considering the subjective nature of the evaluation process, there was a question as to whether or not judge performance reliability could be established. An acceptable estimate of reliability was obtained on the basis of judge response to contrived dub comparisons and judge modal agreement.

The judges were asked to make comments relative to perceived vocal differences other than the characteristics selected for the experiments. Only three of the judges offered comments in a consistent manner, of whom two were voice teachers and the other a professional musician. As expected, no pattern of relationship was disclosed, underscoring the lack of means of observing and measuring the perception of vocal characteristics.

The vocal competence rating was dropped from consideration as a controllable variable because of lack of agreement among the judges as to the performance level of the students. The number of factors to be considered in a vocal performance are so numerous, so interrelated and variable, and so strongly subject to individual interpretation, that obtaining acceptable agreement would be difficult, if not impossible.

The findings supported the three major hypotheses of the investigation. The specific conclusions to be drawn are stated and discussed in this section of the present chapter.

Concerning Phase One, Part I, most subjects exhibited pitch and qualitative differences as compared to their usual performance when their sensations created by external hearing were masked. In most cases, there was a perceived reduction in pitch accuracy and a deterioration of vocal quality due to the masking stimulus. For some subjects, the reduced pitch accuracy was accompanied by either an improvement in quality, or no apparent change in quality. The intonation and quality of a few appeared to be unaffected by masking. The effects appeared not to be any more noticeable on any particular type of vocalization: low range, middle range, high range, or the specified music literature.

In the first phase of the experiment, the judge types exhibited measurable differences in their evaluation of unmasked-masked vocalization. Since the evaluation required a qualitative judgment as to whether a perceived difference was better or worse, it seems likely that differences in vocal listening experiences could account for mean score differences between judge types.

Concerning Phase One, Part II, the judges were able to consistently identify the point of introduction of masking by perceiving changes in the intonation and quality. For most subjects, there was an immediate deterioration of both intonation and quality. Two subjects exhibited little or no apparent loss of intonation and an improvement in quality. Two subjects showed no readily apparent perceivable differences in either intonation or quality.

According to the findings of the first phase of the experiment, it appears that the immediate perceived effects of masking vary considerably, but that generally, there is a deterioration of vocal quality and a reduction in pitch accuracy.

Concerning Phase Two, subjects who received white noise masking as a pedagogical tool <u>during lessons</u> exhibited significant mean gains in vocal progress over subjects who received the traditional voice instruction. Subjects who experienced white noise masking <u>only during individual lessons</u>, however, showed significant <u>lack</u> of progress when compared to each of the other groups. A comparison of treatment means is shown in Table 17, page 60. In view of the evidence, it can be concluded that masking applied during lessons under supervision may be beneficial to vocal progress, whereas unsupervised individual practice with the variable may actually hinder vocal progress. It appears that a teacher can supervise the use of masking in a constructive manner. Teacher guidance apparently acts as a means of feedback which is unavailable during individual practice.

Inasmuch as the exercises explored the top, middle, and bottom vocal range of each subject, vocalization including the top range showed higher mean progress scores. However, the conclusion that masking is more beneficial to the singing of high pitches may not be warranted. In order for this to be a valid conclusion, tests would have to be conducted to assure that each judge's perception capabilities in the various ranges of the sound spectrum were essentially equal. Such testing was not within the purview of this study.

Even though no difference was found between judge types in their evaluation of subject performance, the interaction of "selection x judge types" indicates that the judge types differed measurably in their evaluation of subject progress when specific exercises are compared. It seems likely that differences in the judge types' listening experiences could account for differences in mean scores on the exercises; e.g., voice teachers may evaluate high and/or low pitches quite differently from non-voice musicians or lay musicians.

Vocal progress, or lack of it, was not related to any of the selected types of vocalization: low range, middle range, high range, or literature. The subjects' age sex, or length of vocal study apparently had no bearing on the degree of progress. No correlation was found between the attitude of the subject and his vocal progress. This would seem to indicate that the enthusiastic subject was no more predisposed to progress than the merely tolerant, or overtly skeptical subject.

Further analysis indicated that subjects in groups using masking as a teaching tool varied widely in degree of progress as compared to subjects in the control group. Observation of the data shows that the six highest and the six lowest scores are found in the experimental groups (Appendix E). This observation seems to bear out findings from the first phase of the experiment. Perceived masking effects vary widely from subject to subject in both immediate and extended applications. These findings are in accord with research in the masking of speech vocalization. Alpert has indicated that subjects may have a tendency to respond to different aspects of the perceptual field.[1] It is possible

[1]Murray Alpert, "Feedback Effects of Hearing on Voice Level" (unpublished doctoral dissertation, New York University, 1966), p. 6.

that attention to various aspects of the image-motor-feedback system of vocalization may cause marked changes in the perceivable auditory effect of individuals. Masking the feedback system may cause a varied number of responses depending upon the individual's degree of dependency upon his auditory feedback sensations.

Even though mean progress scores for subjects who received masking during supervised lessons demonstrated gains over subjects who did not receive masking in this manner, the variability of response indicates that some subjects do not respond favorably to teaching techniques involving masking. From the findings of this experiment, it is not possible to draw conclusions as to what type of student could benefit from masking used as a pedagogical tool. In view of the evidence, however, it can be concluded that masking could be an important teaching tool for <u>some</u> students.

Although not relevant to the experimental aims of the study, an interesting observation appeared concerning the dispersion of incorrect responses to the dub duplicates. A correct response by a judge to the dubs would be "same". However, in cases where an incorrect response was made by the judge, the incorrect response of "better" (43 responses) heavily outweighed the response of "worse" (9 responses). A normal distribution curve would have proximated an equal response for "better" and "worse" under pure chance conditions. Perhaps a combination of expectation and perceptual illusion was at work. Since the judges expected to discern differences, they may have imagined them. In a situation of doubt, it might be expected that a judge would evaluate "better" instead of "worse".

Summary. The immediate auditory effects of white noise masking on trained singers can be perceived and reliably measured. Intonation and quality appear to be somewhat independently affected. Although the effects were variable, there was a general tendency toward a deterioration of vocal quality and a reduction in pitch accuracy.

Subjects who received white noise as a pedagogical tool in individual lessons made, on the average, more vocal progress than subjects who did not receive the masking in this manner. The effects, however, were highly variable as some subjects appeared to be helped by masking while others appeared to be hindered in their progress. No conclusion can be drawn as to what type of student could benefit from masking used as a pedagogical tool.

Observations

Since the judges were limited in the number of variables they could evaluate at one time, it seemed suitable to include in this portion of the study, observations made by the judges, subjects, and the experimenter.

Masking seemed to cause most subjects to intensify vocal production. This observation is in accord with related research in speech vocalization.[1] However, in a few examples, there appeared to be no noticeable change in level, and one subject actually appeared to decrease in intensity.

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[1]Paul Herbert Gluck, "Changes in Noncontent Aspects of Speech as a Function of High Intensity White Noise" (unpublished doctoral dissertation, University of Maryland, 1967), p. 54.

Masking apparently caused most subjects to flat ascending passages and to sharp descending passages. This observation was evident on both exercises and literature. Sustained pitches tended to slide sharp. There were exceptions to the above tendencies. Some subjects sharped ascending passages and flatted descending passages, while others flatted on sustained pitches.

In regard to vowel sounds, there was a tendency to modify [ɑ] toward [ɔ] while under the masking stimulus; a few modified toward [a].

The effects of masking appeared to be more exaggerated when the variable was introduced during singing of literature as compared to the singing of exercises. Furthermore, two subjects markedly increased the tempo when the variable was introduced. These subjects demonstrated a dramatic gain in intensity and a severe reduction in pitch accuracy and deterioration of quality.

The following suggestions are offered as to the possibility of the exaggerated effect of introducing masking to a student during the singing of literature:

1. The shock of introducing masking <u>during</u> singing may be more disruptive than introducing it <u>before</u> the act is begun.

2. The singing of literature offers a more complicated activity in that there is a relatively constant change of vowels, consonants, and direction of pitch as compared to controlled exercises.

3. Perhaps, for some subjects, the act of singing literature has a different impact psychologically upon the vocal mechanism as compared to singing exercises.

Subject response to the white noise stimulus on the whole was favorable, and, with one exception, no discomfort was indicated by the subjects when the masking noise was applied. This observation is in agreement with findings of studies of white noise masking of speech.[1,2] One subject who practiced with masking for one-half hour a day complained of disorientation and a ringing in the ears immediately following its use, but this condition disappeared after one week. Since there is evidence that white noise masking diminishes the perception of other sense modalities, it is possible that any feelings of discomfort or disorientation might be so diminished for this reason.

Some subjects seemed to be able to sing higher and/or lower, and appeared to sing more easily during masking. It may be inferred, on the basis of Mahl's observations, that some singers may be able to extend their ranges and sing more easily during masking because they are less inhibited.[3] It seems possible that inhibited singers may perform more acceptably when they can no longer control the vocal mechanism by their external hearing sensations.

It appeared that the more advanced singers were less affected by masking. This observation agrees with Ekstrom's conclusion that experienced singers may rely heavily upon proprioceptive sensations for the control of intensity, whereas inexperienced singers seem to rely more heavily upon auditory sensations.[4] Advanced singers may be relatively

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[1]G. F. Mahl, "Sensory Factors in the Control of Expressive Behavior: An Experimental Study of the Function of Auditory Self-Stimulation and Visual Feedback in the Dynamics of Vocal and Gestural Behavior in the Interview Situation," Acta Psychologica, (1961), 19:497-8.

[2]Alpert, pp. 16-8.

[3]Mahl, p. 498.

[4]E. Ross Ekstrom, "Control of Singing Intensity as Related to Singer Experience," The NATS Bulletin, XVII (December, 1960), pp. 8-12.

unaffected by masking because they do not depend upon external feedback as much as less advanced singers do.

The experimenter's observations during the use of white noise in lessons supports the variability in response encountered in analysis of the evaluations. For the same subject, the perceived effects of masking were variable from lesson to lesson and even from minute to minute. The multitude of responses and perceived effects might be explained by the assumption that individuals apparently have the ability to respond to various aspects of the perceptual field at any given moment.[1]

How an individual alters his perceptual field is not understood. It may be assumed that most of the sensations of external hearing feedback are removed by masking. How the proprioceptive feedback is affected is not known, but studies indicate that perhaps all of the sense modalities are diminished.[2] Guttman found that after both external and internal feedback were cut off, individuals could still produce speech.[3] This would suggest that neither of the known avenues of feedback are essential for vocalization. That vocalization can still take place indicates that there may be feedback avenues which do not depend upon the sensory mechanisms. It is even possible that once neural images are strong enough, feedback is no longer necessary. Osgood has constructed a theoretical model of the language sequence which does not take into

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[1]Alpert, p. 73.

[2]W. J. Gardner, J. R. C. Licklider and A. Z. Weisz, "Suppression of Pain by Sound," Science, (1960), 132:32-3.

[3]N. Guttman, "Experimental Studies of the Speech Control Mechanism" (unpublished doctoral dissertation, University of Illinois, 1954), pp. 49-50.

account any kind of feedback. His schema is a two stage stimulus-response process and is regarded seriously by many psychologists.[1] This would seem to suggest that singers with well-developed tonal imagery may not depend upon feedback for vocalization. A study by Welsh indicates that the feedback mechanism may be more easily interfered with at the neural level.[2] Until the mental processes are better understood, judgment must be reserved.

Implications

1. Singing vocalization appears to be affected by white noise masking in much the same manner as speech vocalization. This implies the functional similarities of the vocal acts and underscores the possible use of speech therapy remedies on the singing voice.

2. The effects themselves indicate that perhaps much of the speech mechanism is on the neural level and defies available means of observation and measurement.

3. Masking can be easily employed in the voice studio, and it does not appear to have any detrimental effect on singers.

4. The effect of masking is immediately perceivable and appears to be cumulative over an extended period.

5. Masking may be a useful tool for teachers of singing. The effects of masking, however, are too variable to be applied

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[1] Patricia I. Myers and Donald D. Hammill, Methods for Learning Disorders (New York: John Wiley and Sons, Inc., 1969), p. 30.

[2] Oliver Leo Welsh, "The Effects of Delayed Auditory Feedback on the Vocal Intensity and Speaking Rate of Adults With Hearing Loss" (unpublished doctoral dissertation, Boston University School of Education, 1965), p. 68.

indiscriminately as a panacea for singers. Until it can be determined which students can be aided by masking, further experimentation appears warranted.

Recommendations for Additional Research

1. A replication of the present experiment to further evaluate the tendency of singers to progress more easily under supervised masking training than under unmasked training, and to reassess the lack of progress exhibited by the self-supervised treatment group.

2. A study to determine if the effect of masking could be reduced to meaningful acoustic data using the techniques of fundamental frequency and spectral analysis.

3. A study of the physiological effect of masking using slow-motion photography.

4. A study to determine the applicability of thermography as a means of observing muscle activity during vocalization.

5. A study to determine the effect of masking on advanced singers.

6. A study to determine the effect of delayed auditory feedback on a singer's performance.

7. A study utilizing the "phonic ear" as a method of lessening the conflict between the tonal-mental image and the sensations created by external hearing.

8. A study to determine whether individuals are predisposed toward certain kinds of imagery.

9. A study to determine if certain disciplines tend to be oriented toward specific types of imagery.

10. A study to assess the possibility of predicting the success of individuals in disciplines which appear to require highly developed, specific kinds of imagery.

11. A study to determine if the immediate variable effect of masking can be categorized into specific perceived tendencies.

12. A study to determine if personality characteristics of individuals are related to specific perceived effects of masking.

13. A study to determine if field-dependent and field-independent individuals respond differently to masking.

14. A study of neurological activity during vocalization to determine the effect of self-hearing on the other sense modalities.

15. A study designed to analyze the effect of auditory fatigue on the singer's vocal performance.

16. A study designed to analyze the effect of auditory fatigue on a judge's perceptive evaluation abilities.

17. A study relative to differences, if any, in an individual's perception capabilities in the various ranges of the sound spectrum.

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APPENDIX A

Letter from Dr. John P. Zubeck

THE UNIVERSITY OF MANITOBA

DEPARTMENT OF PSYCHOLOGY

WINNIPEG, CANADA

July 20, 1970

Mr. Donald E. Maxwell,
3502 Kinyon,
LAWTON, Oklahoma - 73501.

Dear Mr. Maxwell:

I was pleased to hear that you are proposing to do some research on the effects of auditory deprivation, a topic that has been almost totally ignored in the past. With regard to your methodological question, I feel that piping a white noise into earphones is probably the best approach for reducing the ability of the subject to hear himself when he is singing. I can't think of a better method. Furthermore, I do not think it is essential that you achieve 100 percent success in masking the singing. In all of the human deprivation studies that have been done, one only obtains a partial rather than a~~n~~ ~~absolute~~ total reduction in the level of sensory stimulation. Even when total darkness is used, only a partial reduction in visual stimulation occurs because of the presence of some spontaneous "firing" in the visual system. The same situation applies in the auditory system. In the absence of sound, some auditory nerve fibers will discharge spontaneously. I would suggest, therefore, that you proceed with your proposed method taking into account the fact that total reduction is impossible unless, of course, surgical deafferentation is employed.

I wish you every success with your dissertation. I am certain that you will come up with some interesting results.

Sincerely,

John P. Zubek

JPZ:dmc

John P. Zubek,
Research Professor

APPENDIX B

Preliminary Evaluation Forms

Name______________________________

MINI-EXPERIMENT EVALUATION 1

The tape consists of a series of six paired exercises for each subject. After hearing each set of exercises, you will be asked to compare the second exercise to the first in terms of acceptable vocal production: (A) improvement, (B) no difference, (C) deterioration.

Subject #1
(1) A B C
(2) A B C
(3) A B C
(4) A B C
(5) A B C
(6) A B C

Subject #2
(1) A B C
(2) A B C
(3) A B C
(4) A B C
(5) A B C
(6) A B C

Subject #3
(1) A B C
(2) A B C
(3) A B C
(4) A B C
(5) A B C
(6) A B C

Subject #4
(1) A B C
(2) A B C
(3) A B C
(4) A B C
(5) A B C
(6) A B C

Subject #5
(1) A B C
(2) A B C
(3) A B C
(4) A B C
(5) A B C
(6) A B C

MINI-EXPERIMENT 2

(Form A)

The tape consists of a series of paired exercises. After hearing each set of exercises, you will be asked to compare the second to the first in terms of acceptable vocal production: better, worse, same.

You are asked to consider intonation and quality as the basis for your decisions. Please consider intonation and quality as separate entities. It is conceivable that intonation may have deteriorated while quality may have improved or remained the same.

Subject #1

1. Intonation
   Better ( )
   Worse ( )
   Same ( )

   Quality
   Better ( )
   Worse ( )
   Same ( )

2. Intonation
   Better ( )
   Worse ( )
   Same ( )

   Quality
   Better ( )
   Worse ( )
   Same ( )

3. Intonation
   Better ( )
   Worse ( )
   Same ( )

   Quality
   Better ( )
   Worse ( )
   Same ( )

4. Intonation
   Better ( )
   Worse ( )
   Same ( )

   Quality
   Better ( )
   Worse ( )
   Same ( )

5. Intonation
   Better ( )
   Worse ( )
   Same ( )

   Quality
   Better ( )
   Worse ( )
   Same ( )

6. Intonation
   Better ( )
   Worse ( )
   Same ( )

   Quality
   Better ( )
   Worse ( )
   Same ( )

MINI-EXPERIMENT EVALUATION 2

(Form B)

The tape consists of a series of paired exercises. After hearing each set of exercises, you will be asked to evaluate them in the following manner:

Circle A if the first example is better in terms of acceptable vocal production;
Circle B if the second example is better;
Circle C if there is no apparent difference.

After making your selection for each pair of examples, please check the appropriate reasons for your choice.

Subject #1				Intonation	Quality	Other (write in)
(1)	A	B	S	( )	( )	________
(2)	A	B	S	( )	( )	________
(3)	A	B	S	( )	( )	________
(4)	A	B	S	( )	( )	________
(5)	A	B	S	( )	( )	________
(6)	A	B	S	( )	( )	________

Please evaluate this subject in terms of vocal competency.

Beginning ( )   Intermediate ( )   Advanced ( )

APPENDIX C

Student Data Sheets

CAMERON COLLEGE* STUDENT DATA SHEET

Name____

Age_______________

Voice Category_________________________ ________

Number of years of voice study________________________

Kind of instruction: Class ( ) Private ( )

Number of years of piano study________________________

*Renamed Cameron University, Spring, 1974

MIDWESTERN UNIVERSITY STUDENT DATA SHEET

Name ____

Address ____

____

Phone ____________________ Age ____________

Voice Category ___________________________________

Number of years of voice study ____________ Kind of instruction _______

____

Number of years of piano study ____________

Degree(s) held:

Degree now enrolled in ____________________.

List vocal experiences outside of your applied voice requirements and number of hours of involvement per week (include college choirs, church choirs, and any other possible involvements such as opera productions):

PRACTICE REPORT FORM

Name ____

DATE	TIME	EXERCISES AND/OR LITERATURE

EXERCISE PROCEDURES:

1. Five tone descending pattern - Progress up by half steps
2. 1-5-4-3-2-1 pattern - " " " " "
3. Five tone ascending pattern - " " " " "
4. Descending arpeggio pattern - " " " " "
5. Ascending arpeggio pattern - " " " " "
6. 1 thru 9 Asc. and Desc. pattern - " " " " "
7. Asc. arpeggio to 12th, Descend on 7th pattern arpeggio
8. Separation work in low register
9. Separation work in high register

Name ______________________________

Midwestern University

WHITE NOISE QUESTIONNAIRE

Please answer freely and fully <u>all</u> questions.

1. What were your first thoughts concerning the use of white noise in your practice and/or lessons?

2. What was your impression of your first contact with white noise?

3. What was your feeling about white noise after the initial impression wore off (about two weeks into the experiment)?

4. What were your feelings toward the end of the ten-week period?

5. What were your feelings after termination of the experiment?

6. Did you feel that white noise had improved your voice production (your personal opinion)?

7. Would you like to continue using white noise in the development of your voice?

8. Do you have any other comments pertaining to the experiment?

APPENDIX D

Form Letters to Judges and Evaluation Sheets

MIDWESTERN UNIVERSITY

3400 Taft

Wichita Falls, Texas
76308

March 19, 1973

Dear ______________:

I am asking a few highly qualified voice teachers to aid me in an experiment which is being conducted at Midwestern University, Wichita Falls, Texas. I am writing to you because of your known dedication to the profession of voice teaching and to voice research.

Dr. Bruce Govich, Head of the Voice Faculty and Dr. Ralph Verrastro, Co-ordinator of Graduate Studies at the University of Oklahoma, Norman, Oklahoma, are overseeing the study. The experiment is of a groundbreaking nature and could prove to be of importance to voice teachers. It is a study of the effects of white noise masking on the vocal production of voice students. Should you choose to help in this endeavor, you will be asked to evaluate paired recorded vocal exercises and literature. Your task will be to judge whether the vocal sound of the second exercise is an improvement or a deterioration of the first. The listening and evaluation will require a significant amount of your time (about 2 1/2 hours) but may be done at your convenience.

If it seems that you would be interested in this kind of study, please let me know. Upon acceptance, a reel to reel tape and explicit instructions will be forwarded to you. It should be evaluated and returned as soon as possible.

I hope you will be interested in helping with the experiment.

Sincerely,

Donald E. Maxwell

Donald E. Maxwell
Assistant Professor of Voice

P.S. A small honorarium will be offered for services rendered. Upon completion of the study, a copy of the results and conclusions of the experiment will be mailed to you, if you so desire.

MIDWESTERN UNIVERSITY

3400 Taft

Wichita Falls, Texas
76308

May 6, 1973

Dear ______________:

Thank you for accepting the responsibility as an evaluator in an experiment in vocal research. Enclosed you will find evaluation sheets, a vocal score of "The Star Spangled Banner," and postage for returning these materials. Three recording tapes will arrive under separate cover.

The evaluation consists of four parts: Orientation (8 minutes), Evaluation 1 (66 minutes), Evaluation 2 (18 1/2 minutes), and Evaluation 3 (57 minutes). These comprise a total listening time of approximately 2 1/2 hours. You are asked to listen to the tapes in the specified order.

The tapes have been recorded at 7 1/2 ips in stereo on the first side of the tape only. You may play them either monaural or stereo but use a recorder with high quality reproduction.

You should plan to do the evaluation when you are rested and there is little likelihood of interruption. Read the directions carefully that preceed each evaluation. You may play the tapes as many times as you wish or repeat individual exercises before reaching your decisions. Consider each answer carefully.

If you do not agree with the given answers to the orientation, indicate which of the answers you would have chosen. Disagreement will in no way invalidate your evaluations. Just to be sure that you are consistent in your answers. Please return the evaluation sheets and the tapes when you are finished. Upon their return, an honorarium will be forwarded to you.

Sincerely,

Donald E. Maxwell

Donald E. Maxwell
Assistant Professor of Voice

Enclosures

ORIENTATION

A few sample exercises have been prepared in order to familiarize you with the kinds of sounds and vocal characteristics pertinent to this study. You will hear a series of paired exercises. After hearing each set of exercises, you will be asked to compare the <u>second</u> to the <u>first</u> in terms of acceptable vocal production: better, same (no apparent difference), worse.

You are asked to consider intonation and quality as the basis for your decisions. Please consider intonation and quality as separate entities. It is conceivable that intonation may have deteriorated while quality may have remained the same or improved.

	Intonation	Quality
Example #1	Better ( )	Better ( )
	Same ( )	Same ( )
	Worse ( )	Worse ( )
Example #2	Better ( )	Better ( )
	Same ( )	Same ( )
	Worse ( )	Worse ( )
Example #3	Better ( )	Better ( )
	Same ( )	Same ( )
	Worse ( )	Worse ( )
Example #4	Better ( )	Better ( )
	Same ( )	Same ( )
	Worse ( )	Worse ( )
Example #5	Better ( )	Better ( )
	Same ( )	Same ( )
	Worse ( )	Worse ( )
Example #6	Better ( )	Better ( )
	Same ( )	Same ( )
	Worse ( )	Worse ( )
Example #7	Better ( )	Better ( )
	Same ( )	Same ( )
	Worse ( )	Worse ( )
Example #8	Better ( )	Better ( )
	Same ( )	Same ( )
	Worse ( )	Worse ( )

INSTRUCTIONS FOR EVALUATION #1

Evaluation #1 consists of a series of paired exercises similar to those contained in the orientation. You are asked to compare the second to the first in terms of acceptable vocal production: better, same (no apparent difference), worse. After you have made your selection under "intonation" and "quality," feel free to comment on other differences you observed.

After hearing the four pairs of exercises for each subject, you will be asked to give your evaluation of the subject's proficiency of vocal production: beginning, intermediate, advanced.

Page ____, Evaluation 1

Subject ____

	Intonation	Quality	Comments
1.	Better ( )	Better ( )	
	Same ( )	Same ( )	
	Worse ( )	Worse ( )	
2.	Better ( )	Better ( )	
	Same ( )	Same ( )	
	Worse ( )	Worse ( )	
3.	Better ( )	Better ( )	
	Same ( )	Same ( )	
	Worse ( )	Worse ( )	
Lit.	Better ( )	Better ( )	
	Same ( )	Same ( )	
	Worse ( )	Worse ( )	

Please evaluate this subject in terms of vocal competence.
Beginning ( ) Intermediate ( ) Advanced ( )

Subject ____

	Intonation	Quality	Comments
1.	Better ( )	Better ( )	
	Same ( )	Same ( )	
	Worse ( )	Worse ( )	
2.	Better ( )	Better ( )	
	Same ( )	Same ( )	
	Worse ( )	Worse ( )	
3.	Better ( )	Better ( )	
	Same ( )	Same ( )	
	Worse ( )	Worse ( )	
Lit.	Better ( )	Better ( )	
	Same ( )	Same ( )	
	Worse ( )	Worse ( )	

Please evaluate this subject in terms of vocal competence.
Beginning ( ) Intermediate ( ) Advanced ( )

INSTRUCTIONS FOR EVALUATION #2

In Evaluation #2, each subject will sing an abbreviated version of "The Star Spangled Banner." With the aid of the score, you are asked to indicate by measure number where there is a noticeable change in the vocal production. If there is no apparent change, you will be asked to check "same" under both intonation and quality.

Page ____, Evaluation 2

Subject A, Measure #__________

Intonation		Quality		Comments:
Better	( )	Better	( )	
Same	( )	Same	( )	
Worse	( )	Worse	( )	

Subject B, Measure #__________

Intonation		Quality		Comments:
Better	( )	Better	( )	
Same	( )	Same	( )	
Worse	( )	Worse	( )	

Subject C, Measure #__________

Intonation		Quality		Comments:
Better	( )	Better	( )	
Same	( )	Same	( )	
Worse	( )	Worse	( )	

Subject D, Measure #__________

Intonation		Quality		Comments:
Better	( )	Better	( )	
Same	( )	Same	( )	
Worse	( )	Worse	( )	

Subject E, Measure #__________

Intonation		Quality		Comments:
Better	( )	Better	( )	
Same	( )	Same	( )	
Worse	( )	Worse	( )	

Subject F, Measure #__________

Intonation		Quality		Comments:
Better	( )	Better	( )	
Same	( )	Same	( )	
Worse	( )	Worse	( )	

Subject G, Measure #__________

Intonation		Quality		Comments:
Better	( )	Better	( )	
Same	( )	Same	( )	
Worse	( )	Worse	( )	

INSTRUCTIONS FOR EVALUATION #3

Evaluation #3 consists of a series of paired exercises. After hearing each set of exercises, you will be asked to compare the second to the first in terms of acceptable vocal production: great progress, considerable progress, some progress, same (no apparent difference), worse.

After hearing the four pairs of exercises for each subject, you will be asked to give your evaluation of the subject's proficiency of vocal production: beginning, intermediate, advanced.

Page ____, Evaluation 3

Subject __________ Comments

1. great progress ( )
   considerable progress ( )
   some progress ( )
   same ( )
   worse ( )

2. great progress ( )
   considerable progress ( )
   some progress ( )
   same ( )
   worse ( )

3. great progress ( )
   considerable progress ( )
   some progress ( )
   same ( )
   worse ( )

Lit. great progress ( )
   considerable progress ( )
   some progress ( )
   same ( )
   worse ( )

Please evaluate this subject in terms of vocal competence.
Beginning ( ) Intermediate ( ) Advanced ( )

APPENDIX E

Raw Data from Evaluations 1, 2, and 3

Raw Data for Evaluation 1

Subject*	Variable	Judge Types to Exercise 1			Judge Types to Exercise 2			Judge Types to Exercise 3			Judge Types to Exercise 4		
		I	II	III	I	II	III	I	II	III	I	II	III
A	Intonation	2	2	2	D**	D	D	2	2	3	2	2	3
A	Quality	4	3	3	D	D	D	4	4	3	3	2	3
B	Intonation	3	2	2	2	2	2	D	D	D	2	2	2
B	Quality	3	4	3	3	2	4	D	D	D	2	2	2
C	Intonation	2	2	2	2	4	3	2	2	2	D	D	D
C	Quality	2	2	2	5	4	4	2	3	3	D	D	D
D	Intonation	2	2	2	D	D	D	2	2	2	2	2	2
D	Quality	2	2	2	D	D	D	3	4	2	2	2	3
E	Intonation	D	D	D	3	2	2	2	3	2	2	2	2
E	Quality	D	D	D	2	2	2	2	3	3	2	2	3
F	Intonation	2	2	2	2	2	2	2	2	3	D	D	D
F	Quality	3	4	3	3	4	3	3	3	2	D	D	D
G	Intonation	2	2	2	2	2	2	D	D	D	2	2	2
G	Quality	2	2	2	2	2	2	D	D	D	2	4	3
H	Intonation	2	2	2	3	2	2	D	D	D	2	3	2
H	Quality	2	3	2	2	2	2	D	D	D	2	3	2

*The twenty-four subjects were reduced to eighteen replications when the dubs were removed for statistical analyses.

**Denotes dub

Subject	Variable	Judge Types to Exercise 1			Judge Types to Exercise 2			Judge Types to Exercise 3			Judge Types to Exercise 4		
		I	II	III	I	II	III	I	II	III	I	II	III
I	Intonation	2	2	2	2	2	2	2	6	2	D	D	D
I	Quality	2	3	2	2	2	2	4	2	3	D	D	D
J	Intonation	D	D	D	2	2	3	2	2	2	2	3	2
J	Quality	D	D	D	3	2	2	2	3	2	2	3	2
K	Intonation	D	D	D	2	2	2	2	2	2	2	3	3
K	Quality	D	D	D	3	3	4	4	6	3	2	4	3
L	Intonation	D	D	D	2	2	2	2	2	3	2	2	3
L	Quality	D	D	D	2	4	3	2	2	2	3	3	2
M	Intonation	2	3	2	D	D	D	2	2	2	2	2	2
M	Quality	3	4	3	D	D	D	3	3	3	3	3	2
N	Intonation	2	2	2	2	2	2	D	D	D	2	2	5
N	Quality	2	2	2	2	2	2	D	D	D	3	2	2
O	Intonation	D	D	D	2	2	2	3	2	2	2	2	2
O	Quality	D	D	D	3	4	3	4	3	3	3	4	3
P	Intonation	2	2	2	2	2	2	D	D	D	2	2	2
P	Quality	2	2	2	3	3	2	D	D	D	2	4	2
Q	Intonation	2	2	2	D	D	D	2	3	2	2	3	2
Q	Quality	2	2	2	D	D	D	2	3	2	2	5	2
R	Intonation	2	2	2	D	D	D	2	4	2	2	3	2
R	Quality	3	3	2	D	D	D	3	3	2	3	4	2

Subject	Variable	Judge Types to Exercise 1			Judge Types to Exercise 2			Judge Types to Exercise 3			Judge Types to Exercise 4		
		I	II	III	I	II	III	I	II	III	I	II	III
S	Intonation	3	3	4	3	4	3	2	2	2	D	D	D
S	Quality	3	3	3	3	2	2	4	2	2	D	D	D
T	Intonation	3	3	3	2	2	2	2	2	2	D	D	D
T	Quality	3	2	2	2	4	2	2	5	2	D	D	D
U	Intonation	D	D	D	2	5	4	2	2	2	2	2	3
U	Quality	D	D	D	3	4	4	4	2	3	3	5	4
V	Intonation	2	4	3	2	2	3	D	D	D	2	2	3
V	Quality	4	4	2	4	3	3	D	D	D	3	2	2
W	Intonation	2	4	3	D	D	D	2	2	3	3	2	2
W	Quality	2	2	2	D	D	D	3	3	3	3	5	3
X	Intonation	2	2	2	2	2	2	2	3	2	D	D	D
X	Quality	2	4	3	3	4	3	2	3	2	D	D	D

Raw Data for Evaluation 2

Subject	Total Possible	Correct Responses by Judge Types		
		Type I	Type II	Type III
A	3	1	0	1
B	3	3	1	2
C	3	2	0	2
D	3	3	2	3
E	3	2	0	2
F	3	2	3	2
G	3	2	3	3
H	3	1	0	0
I	3	3	3	2
J	3	1	1	1
K	3	1	3	3
L	3	1	1	3
M	3	3	2	2
Totals	39	25	19	26

Raw Data for Group CG (Evaluation 3)

Exercise	Judge Types	Student A	B	C	D	E
1	Voice teachers	3	7	5	6	8
2		6	3	5	6	8
3		6*	9	8	9	7
4		5	3	7	4	3
1	Professional non-voice musicians	3	8	3	4	6
2		6	3	7	8	8
3		6*	10	9	5	6
4		6	5	9	9	8
1	Lay musicians	7	8	3	6	7
2		8	4	7	8	5
3		6*	7	6	5	5
4		10	3	6	5	6
Totals		72	70	75	75	77

* Dub score weighted and averaged

Group Total = 369

Group Mean = 73.8

Sample Variance = 7.7

Raw Data for Group X_1 (Evaluation 3)

		Student				
Exercise	Judge Types	A	B	C	D	E
1	Voice teachers	5	3*	6*	5	6*
2		6*	5	3	4	9
3		6	3	7	10	9
4		5	3	3	4	7
1	Professional non-	3	3*	6*	5	6*
2	voice musicians	6*	7	5	5	7
3		3	3	13	9	10
4		9	6	8	5	11
1	Lay musicians	4	3*	6*	4	6*
2		6*	5	6	4	6
3		6	5	5	5	10
4		8	10	4	4	6
Totals		67	56	72	64	93

* Dub score weighted and averaged

Group Total = 352

Group Mean = 70.4

Sample Variance = 193.3

Raw Data for Group X_2 (Evaluation 3)

		Student				
Exercise	Judge Types	A	B	C	D	E
1	Voice teachers	9	7	6	3	6
2		8	9	3	6*	6*
3		9*	8	3	8	9
4		7	9	4	8	7
1	Professional non-	5	7	3	7	3
2	voice musicians	9	7	3	6*	6*
3		9*	12	3	10	8
4		5	12	6	10	8
1	Lay musicians	9	6	5	7	5
2		10	10	3	6*	6*
3		9*	9	3	7	7
4		10	11	4	3	3
Totals		99	107	46	81	74

* Dub score weighted and averaged

Graoup Total = 407

Group Mean = 81.4

Sample Variance = 568.3

Raw Data for Group X_3 (Evaluation 3)

		Student				
Exercise	Judge Types	A	B	C	D	E
1	Voice teachers	4	9	5	6*	8
2		6*	7	7	4	10
3		7	4	9*	8	11
4		4	5	8	3	7
1	Professional non-voice musicians	4	6	6	6*	8
2		6*	5	6	5	7
3		4	4	9*	8	10
4		10	7	12	9	9
1	Lay musicians	5	4	10	6*	9
2		6*	6	7	7	6
3		6	4	9*	8	8
4		7	4	11	8	10
Totals		69	65	99	78	103

* Dub score weighted and averaged

Group Total = 414

Group Mean = 82.8

Sample Variance = 300.2

APPENDIX F

Tape Recordings of Evaluations

Tape recordings of all pretest-posttests are on file in the Music Library, The University of Oklahoma, Norman, Oklahoma, 73069.

APPENDIX G

JUDGES' NAMES AND ADDRESSES

Professional Voice Musicians

Mr. Hermanus Baer
4043 Fairway Drive
Wilmette, Illinois 60091

Dr. J. Loren Jones
Department of Music
Michigan State University
East Lansing, Michigan 48823

Dr. Ethel Smith
130 Jackson Boulevard
Terre Haute, Indiana 47803

Professional Non-Voice Musicians

Mr. Philip Baker
Highland Park United Methodist Church
3300 Mockingbird Lane
Dallas, Texas 75205

Mr. James Duncan
Department of Music, Head
Southern Colorado State University
Pueblo, Colorado 81005

Dr. Thomas Shaw
Department of Music
Florida Southern College
Lakeland, Florida 33803

Lay Musicians

Mr. Dwayne Brittain
Vice President
Security National Bank
Duncan, Oklahoma 73533

Mr. Michael Crosslin
Purcell High School
Purcell, Oklahoma 73080

Dr. J. W. Ousley
Department of Religion, Director
Baylor University
Waco, Texas 76703

VITA

Donald Edward Maxwell was born in Greenwich, Connecticut, June 10, 1941, to Charles and Evelyn Maxwell. After graduation from Greenwich High School in 1958, he enrolled at Colgate University, Hamilton, New York. In June, 1963, he was awarded a Bachelor of Arts degree with a major in zoology. That fall, he began studies at Friends University, Wichita, Kansas, leading toward the Bachelor of Music with an emphasis in applied voice. In 1968, the Master of Music degree was conferred at the University of Oklahoma. That year he began studies leading toward the Doctor of Music Education.

He became seriously interested in a music career after singing with the Central City opera chorus, Central City, Colorado, in the summer of 1963. During his residence at Friends University, he became active as an opera performer, recitalist, and church soloist. His singing continued at the University of Oklahoma with frequent appearances in opera, oratorio, and as a recitalist. He has been the recipient of several audition awards. He was a NATS Regional finalist on three occasions, second place winner in the Midwestern Regional Metropolitan Opera Auditions, and a first place winner in the Bloch Audition, Oklahoma City, Oklahoma.

In 1966, he began teaching as a graduate assistant in voice at the University of Oklahoma. In 1969, he joined the faculty at Cameron College, Lawton, Oklahoma, as an instructor in voice. He left Cameron in 1971 and currently is an Associate Professor of Music at Midwestern

University, Wichita Falls, Texas. In addition to teaching voice, he has taught courses in vocal pedagogy and music history, and has directed opera productions.

He was greatly influenced in his musical development by Gerald Mack, high school choral director, Greenwich, Connecticut, and by Elisabeth Parham, a former member of the voice faculty at the University of Oklahoma. He is a member of Phi Mu Delta, Music Educators National Conference, Wichita Falls Music Teachers Association, Texas Music Teachers Association, Music Teachers National Association, and the National Association of Teachers of Singing.

In August of 1966, he was married to Nancy Lynne Breneman, Benton, Kansas. They have two daughters, Jennifer and Melissa.