LIPREADING PERFORMANCE AS AFFECTED BY CONTINUOUS AUDITORY DISTRACTIONS

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ABSTRACT

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By

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The major objectives of this investigation were (1) to ascertain the effects of different environments (quiet, babble, industrial noise, traffic noise, and music) on individuals being trained in the lipreading process and (2) to determine whether or not certain acoustical conditions (quiet, babble, industrial noise, traffic noise, and music) function as auditory distractors and, thereby, decrease the lipreading efficiency of trained lipreaders in a test situation.

The experimental procedure consisted of a training program and a test session. Forty normal hearing, normal seeing, college-age adults were randomly assigned to one of five training conditions, each condition representing a different auditory environment in which to learn to lipread. All groups contained eight subjects and were divided evenly between men and women. The five auditory environmental conditions (with sound pressure presentation levels in dB) included (1) quiet (ambient noise, 50 dB SPL), (2) babble (90 dB SPL), (3) industrial noise (90 dB SPL), (4) traffic noise (90 dB SPL), and (5) music (90 dB SPL). Each subject was shown, by way of television

monitor, one of six videotapes in which a male speaker was presenting a set of spondaic words. The task of the lipreader in the training session was to continue to watch the same videotape (given no more than eight times over a two day period) until correctly identifying 90 per cent or more of the vocabulary stimuli. Upon satisfying this training criterion, the subject was considered qualified to participate in the final phase of the experiment.

In the test procedure (given within forty-eight hours after training was completed) the same set of vocabulary words was presented five times, on each occasion in a different environmental situation, including a replication of the environment under which the subject had been trained.

Data from both the training and test procedures were analyzed statistically. The results of the data suggested the following conclusions:

1. Female subjects as a group lipread significantly better than male subjects in the test session.

2. Female participants needed significantly fewer training trials to qualify for the test session than did male participants.

3. The scores of male and female subjects trained in various sound environments varied as a function of the noise background employed in the test session. No definite pattern of subject response emerged relative to the noise backgrounds.

4. The results from the test session demonstrate that subjects trained in various sound backgrounds will achieve comparable scores, irrespective of the environment in which they were trained.

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CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

The act of communicating vocally, in which a talker and a listener are alternately involved, is a process which normally utilizes both the auditory and visual sense modalities of each participant. Under advantageous circumstances, i.e., in a quiet, relatively noise-free environment, expectations for a complete and adequate exchange of information are high. However, the intrusion of noise into the listening environment increases the likelihood that the conversation between individuals will be hampered.

The focus of most research on noise has been the potential threat of noise producing permanent hearing loss. The extent and type of auditory impairment induced by acoustic insult have been well documented (Kryter, 1970) and will not be discussed further. Instead, what should be understood is the influence of noise as a masker of speech intelligibility.

The majority of published reports evaluating noise as a masker of speech has found noise to be a demonstrably disruptive agent which produces confusion and misunderstanding between the speaker and receiver and induces errors. The masking of auditory functions by noise might cause the listener to use speechreading in order to maintain satisfactory communication.

O'Neill (1954) and others have sought to determine the relationship which vision and audition share in verbal discourse, particularly in environments with unfavorable signal-to-noise (S/N) ratios. When messages are auditorily hampered, either partially or completely, the necessity for implementing lipreading skills is often required if the desired information is to be exchanged.

Extensive investigations have previously demonstrated the effects of noise on man with other than auditory tasks, e.g., those of vigilance which rely heavily on the worker's vision (Broadbent, 1958). In addition to assessing the influence of audition on job performance, effects of noise on human attitudes, feelings (Cohen, 1969) and body physiology (Jansen, 1969) have also been ascertained.

When lipreading is resorted to under disadvantageous listening conditions, the effect of the environment on this process must be well understood. Berger (1972) has described vision as being subject to "more environmental restrictions than audition from a communications standpoint." The factors of lighting, distance and physical distractions (visual and auditory) are among those which must be considered. Of the parameters often identified as variables in the lipreading process (speaker-sender, lipreader-receiver, code or stimulus, and environment), the factor of environment is the least understood and researched (O'Neill and Oyer, 1961). In particular, the effects of auditory distractions on the lipreading process need to be clarified.

Purpose of the Study

The primary objective of this investigation is to establish whether or not various noise stimuli (babble, industrial noise, traffic noise, and music) function as auditory distractors and decrease lipreading efficiency. If lipreading performance is found to be affected, is one type of noise stimulus more disruptive than another?

Of equal interest to this study is to determine the effects that certain background noise stimuli (babble, industrial noise, traffic noise, and music) have on the training or teaching of the lipreading process. Do subjects trained to lipread in noise become more efficient lipreaders or learn to lipread faster than subjects trained in quiet?

Null Hypotheses

In order to answer statistically the aforementioned queries, the following null hypotheses were formulated:

1. For each subject trained to read lips in the five training environments (quiet, babble, industrial noise, traffic noise, and music), there are no differences when comparing their lipreading scores for the test measures of:

(a) quiet and babble
(b) quiet and industrial noise
(c) quiet and traffic noise
(d) quiet and music
(e) babble and industrial noise
(f) babble and traffic noise
(g) babble and music
(h) industrial noise and traffic noise
(i) industrial noise and music
(j) traffic noise and music

2. There are no differences in the lipreading performance of subjects with regard to the various environmental conditions under which they were trained to read lips.

3. There are no differences between the lipreading performance of male and female subjects trained under various environmental conditions to read lips with regard to the five auditory test conditions employed in this study.

Importance of the Study

The contribution of the environment to lipreading success or failure is still largely undetermined, especially when evaluating the effects that relevant or irrelevant auditory stimuli may have on the lipreading process. A study by Leonard (1962) found that continuous white noise, running speech and continuous background music impeded lipreading performance of subjects who were trained under conditions of relative quiet. Other investigations, employing different kinds of auditory distractors have disclosed conflicting findings. Therefore, additional research effort is necessary in order to establish more definitively the effects of auditory distractors on lipreading success. By ascertaining the influence of noise on lipreading performance, the need to make the environment as quiet as possible where people work and live may be illustrated.

This study also evaluates the impact that various controlled auditory conditions have on the training process of learning to read lips. To date, only the investigations of Ojima and Nakano (1961, 1962, 1963) have reported using noise while teaching the process of lipreading to experimental subjects. However, their findings regarding the effects of one auditory distractor (white noise) on lipreading performance are unclear. Consequently, additional research is indicated if the effects of auditory stimulation during lipreading acquisition are to be understood. By such efforts we may then determine how best to employ auditory stimulation so that it enhances the rate of lipreading acquisition, the skill of the lipreader, or both.

Terminology

For the purposes of this study, the terms used are defined operationally as follows:

Lipreading (speechreading).--A strictly visual, non-auditory process by which a subject correctly identifies spondaic word items spoken by a talker presented on videotape.

Spondaic words.--Words of two syllables spoken with approximately equal stress on both syllables, e.g., baseball, hotdog, etc.

Auditory distractors.--Various sound stimuli continuously presented without interruption. These auditory distractors were as follows: (1) babble--segments from a men's conversational group, a women's conversational group and a cocktail party with both men and women participating; (2) industrial noise--a recording of power plant generators in use; (3) traffic noise--a simulated traffic jam with car horns honking, ambulance sirens blaring and motorcycle engines running; and (4) music--Gershwin's Rhapsody in Blue.

Normal hearing.--The ability to pass a pure-tone screening test presented individually to both ears at 25 dB (ANSI, 1969) at octave intervals from 250 through 4000 Hz.

Normal vision.--Visual acuity of 20/20 in both eyes (with or without correction) as measured by a Bausch and Lomb, Modified orthorater.

Organization of the Dissertation

Chapter I contains a statement of introduction about the deleterious contribution of noise to the communication process and its possible effects on lipreading skills. The exact purpose of the study and its potential importance to the research literature are included. The major terms used in this study are defined and the null hypotheses are stated.

Chapter II reviews the scientific literature pertinent to this investigation. Previous studies which looked at, among others, the effects of environmental stimuli on lipreading ability, the physiological effects of noise on vision and the effects of noise as a distracting agent on various non-auditory tasks are summarized.

Chapter III describes, in detail, the subjects, the equipment, the materials and the experimental procedures employed in this study.

Chapter IV presents the data collected from this investigation and a discussion of the results.

Chapter V incorporates a summary of the problem investigated, the conclusions drawn as a result of this study and the recommendations for further research activity.

CHAPTER II

REVIEW OF THE LITERATURE

Importance of Visual Cues to Communication

Traditionally, vision and audition have been considered the distance or lead senses, particularly from the standpoint of message reception (Berger, 1972). Vision has served as the primary sense for the deaf or severely hard of hearing individual, whereas normal hearing persons have relied mainly on audition for effective communication.

Lipreading represents the process by which the visual modality functions to increase information flow. It is a useful tool for the hearing impaired person who is occasionally or consistently unable to differentiate clearly the sounds of language. Lipreading assists these individuals because it enables them to identify visually the shape and movement of a speaker's articulators, thereby filling in some of the information which otherwise might have remained unheard or undetected (O'Neill and Oyer, 1961).

This visual mode also serves a functional purpose for the normal-hearing. It augments the auditory channel when a noise environment precludes a satisfactory exchange of verbal information. Reliance on vision also helps the normal hearing listener who is communicating with a soft-spoken individual. The contribution of vision to speech perception and intelligibility has been investigated extensively, although the issue still remains somewhat in doubt.

O'Neill (1954), seeking to determine what role lipreading played in the communication process, found that the visual modality made its most significant mark as listening became less favorable. He enlisted thirty-two normal hearing subjects who were exposed to three talkers producing vowels, consonants, words and phrases. In half of the experimental conditions, the participants both heard and viewed the talker, each time listening in a different speech-to-noise ratio which became increasingly more difficult to understand. In the other situations, the S/N values remained the same, but the subjects only heard the speaker.

In two instances (for consonants and words) the scores for vision alone exceeded the results for audition alone. For vowels and phrases, the non-visual totals surpassed those of the visual, i.e., lipreading. However, in every case the combined approach of audition and vision was most efficient. In addition, O'Neill assessed the relative contribution of vision under S/N comparisons of -20 dB and +10 dB. The results, as stated above, showed that the visual mode added a more significant increment as the listening condition decreased. For example, the relative contribution of the visual process for words at a S/N ratio of -20 dB was 43 per cent but only 5 per cent at a S/N ratio of +10 dB.

Sumby and Pollack (1954) also investigated the contribution of vision to speech intelligibility in the presence of competing noise. A talker using live voice presented spondaic words, monosyllables and trisyllabic phrases to 109 listeners who wore earphones. These stimuli were presented unimodally (separately to the eyes and to the ears) and bimodally (where vision and audition are combined) under various S/N conditions, from 0 dB (the most favorable) to -30 dB (the poorest). In general, the authors found, as did O'Neill in 1954, that as the speech-to-noise ratio decreases, the advantage and benefit from vision in comprehending speech increases.

Another study attempting to quantify the contribution of vision to speech comprehension was carried out by Neely (1956). Thirty-five normal hearing listeners viewed a trained talker from various profiles and distances. The investigator determined that the visual modality, when combined with the auditory mode, increased the reception of speech by almost 20 per cent over hearing alone. Therefore, the importance of lipreading was upheld especially in the environment with high noise content.

Karlovich (1968) investigated the sensory interaction of the auditory and visual modalities. Eight normal hearing adults participated in an alternate binaural loudness balance (ABLB) task in which a 1000 Hz tone was balanced at sensation levels at 20 dB and 50 dB. In the first of three conditions, no visual stimulus was presented during the ABLB task. In the last two situations visual stimulation (a short duration stroboscopic light flash) was introduced. In the one case the visual stimulus was synchronized with the standard auditory stimulus during the ABLB task, whereas in the second instance, the visual stimulus was synchronized with the comparison auditory stimulus. The results showed that the visual stimulus facilitated the perception of loudness, especially at the higher sensation level. Consequently, this experiment demonstrated that there is interaction between the sensory modes of vision and audition.

Sanders and Goodrich (1971) also discovered the value of the speechreading process in procuring information where auditory reception is hampered because of failing listening conditions. Of interest to these authors was the role of vision and audition (both separately and collectively) in the reception of speech when auditory stimuli were selectively distorted. This research deviated from those studies cited previously in that the amount of available information to the auditory channel was controlled by filtering rather than the manipulation of the signal-to-noise ratio. The results demonstrated, in part, that when the listening situation is severely limited, as exemplified by a low-pass filter condition, the effect of combining the visual and auditory senses immeasurably augments comprehension, whereas each modality separately contributes substantially less.

Each of the above investigations demonstrates that vision and audition, when used in combination, provide more information to the receiver than when used separately. Also the value of vision appears to increase as the listening situation becomes more difficult. What apparently occurs is the reduction of information provided by the auditory signal. No longer is the listener able to predict accurately the content of the communication and thus increasingly relies on visual cues to supplement information.

In disagreement with the above findings are the results obtained by Gaeth (1967) who also evaluated the relative efficiency of the auditory and visual senses as individual and bimodal contributors to the process of communication. He found that either one of the single modalities was superior or equal to the combined audio-visual presentation.

Although some controversy may still exist as to the approximate contribution of these two primary communication channels, each is very important in its own way, depending on the particular environmental condition existing at that moment.

Some Effects of Environment on Lipreading

Vocal communication between individuals often occurs under physical circumstances over which neither the sender nor receiver has any appreciable control. Therefore, the success of the interchange of ideas is necessarily dependent upon the environmental factors which exist at that moment. In the preceding paragraphs the importance of lipreading to message reception was discussed. When, for whatever reasons, the desired acoustic signals are not received by the listener, research has demonstrated the value of using lipreading. It is, therefore, incumbent that the environmental factors which could facilitate or undermine the effectiveness of the process of lipreading be understood. These factors include lighting, the distance between speaker and lipreader, the transmission medium of the message, and visual and auditory distractions. The latter (auditory distractions) will be considered separately in the section Lipreading Studies in Noise (p. 20).

Lighting

Few studies have investigated the effects of lighting on lipreading ability. Thomas (1962) trained twenty adults to lipread thirty test sentences under illumination which remained constant throughout the practice lessons. Afterwards, these same stimuli were presented again under six different intensities of light as measured in foot candles (lumina) in order to evaluate the effect of decreasing light levels on lipreading performance. The results showed that diminishing light intensities did not significantly change lipreading scores. Even under the most adverse conditions of luminescence (0.5 lumen) satisfactory lipreading was possible.

Jackson in 1967 (Berger, 1972) found that relatively inexperienced lipreaders scored better when the light source was strategically placed below and in front of the talker rather than above the speaker in the conventional manner of classroom lighting. With the more experienced lipreaders, light placement made little difference.

Distance Between Speaker and Lipreader

Numerous studies have attempted to establish the optimum distance from which lipreading can be taught and practiced. Cavender in 1949 (O'Neill and Oyer, 1961) had subjects speechread from distances up to eighteen feet. No significant test differences were found. Similarly, Mulligan in 1954 (O'Neill and Oyer, 1961) uncovered no statistically important distinctions between scores by speechreaders viewing a filmed talker at distances of 5, 10, 15 and 20 feet, although the best results occurred at ten feet.

Neely (1956) placed subjects at intervals of 3, 6 and 9 feet from the speaker. No significant differences could be noted at those three distances.

Berger (1972) concluded that speechreading performance should not be affected by distances up to twenty-four feet provided the observer's vision is within normal limits. However, for practical purposes, speechreading is best carried out from five to ten feet away, a distance representative of most conversational speech situations.

Transmission Medium

An important variable in lipreading is the medium through which the information passes from the speaker to the receiver. The transmission link can be person to person (live), films, or television (closed circuit or videotape). Each of these channels has been used experimentally for purposes of training or testing speechreading ability. Berger (1972) concludes that the major fault of live speechreading presentations is the inability of the speaker to duplicate exactly the original speech stimuli time and time again (a factor of reliability). Filmed tests, not without limitations, are criticized for being a two-dimensional process, whereas speechreading in a live situation is three-dimensional (Berger, 1972).

Oyer (1961) found that lipreading could be taught successfully through the medium of closed-circuit television. A group of thirty-two normal hearing college students was given ten weeks of training. In a post-training filmed test situation they made fewer mistakes than in the initial test session.

Cancel (1970) also employed television in his speechreading investigation. This researcher, however, used the process of videotape to present the test stimuli (bisyllables and sentences). This study was developed to test the lipreading skills of Spanish-speaking individuals who were either hearing impaired or deaf.

Visual Distractions

Miller (1965) examined the effects of an assortment of selected visual distractions on lipreading performance. Fourteen subjects lipread a female speaker under four conditions: (1) without distraction (the control condition), (2) a flashing light, (3) a spinning disc, and (4) nonpurposeful hand movements (made by the speaker as the test materials were presented). The only significant and influential visual distractor was the nonpurposeful movement of the hands.

Keil (1968) investigated the consequences of background stimuli on lipreading performance. The peripheral visual stimuli used in this study included (1) a neutral, gray background, (2) this same backdrop with a female projected on each side of the talker, (3) a still picture of a building with trees and an automobile, and (4) a moving scene of people at a busy street corner. No significant differences in lipreading performance were noted for either normal hearing or hearing impaired lipreaders.

The Effects of Noise on Man

For several years a number of investigations have attempted to determine whether or not noise affects man's (1) ability to perform tasks efficiently, (2) physiological reactions, and (3) personal feelings and attitudes.

Noise Effects on Task Performance

The published reports which have characterized the influence of audition on task performance have arrived at a number of widely disparate conclusions, partly because the parameters of interest were as equally divergent. The discrepant results may be attributable, among others, to one or both of the following reasons: (1) the nature or demands of the work performed and (2) the type of auditory stimulus employed, its intensity, duration and/or mode of presentation.

The Nature of Task Performance

Cohen (1969) concluded that the majority of those studies evaluating non-auditory sensory and perceptual experience (and citing noise as a disruptive influence) involve performance tasks of vigilance in which the subject is required to monitor visually a number of clocks or dials for the purpose of detecting slight changes in movement or intensity of light.

Broadbent (1954) established that the task efficiency of a group of ten subjects became impaired in the presence of a 100 dB SPL noise but not in a noise level of 70 dB SPL. The vigilance operation was to monitor a display panel of several steam-pressure gauges which were difficult to read.

These results contrast with those of a similar experiment reported in the same study where a different group of twenty subjects, completing an easier type of vigilance assignment, manifested no discernible effects from the noise.

Jerison (1959) conducted an investigation with a group of male subjects whose monitoring task was to observe an arrangement of three clocks for a duration of two hours in conditions of "quiet" (83 dB SPL of environmental noise) and noise (114 dB SPL). The results demonstrated that the noise had no appreciable effect on work performance for the first hour and a half. However, during the remaining thirty minutes performance efficiency deteriorated under the noise condition, although no comparable change occurred during the last half-hour interval in the quieter condition. The investigator concluded that noise, if intense enough, will lessen task capability provided duration time of exposure is sufficient and the task requires substantial shifts in task attention, e.g., monitoring several clocks.

This same investigator in an earlier study (Jerison, 1957) had found no differences in efficiency for a simple vigilance task (watching one stepping clock) carried out by twenty subjects under similar conditions of exposure (noise, 112.5 dB SPL; quiet, 79 dB SPL of ambient noise) and duration (one and three-quarter hours).

Cohen (1969) also concluded that tasks conducted in noise which "demand less than the total skillfulness of the individual" can be successfully completed by drawing upon reserve capacity. This stands in contrast to any task (most likely vigilance) which requires constant surveillance and involvement. Here performance has been found on occasion to falter when noise is introduced.

Auditory Stimuli: Types, Intensity, Duration and Mode of Presentation

A portion of the conflicting data has been attributed to the influence of the various acoustical stimuli employed in the different investigations or to any number of parameters or combinations of variables such as sound pressure level, duration of exposure and mode of presentation of the auditory stimuli.

Cohen (1969) referred to studies by Woodhead in 1959 and by Forwalt in 1965 in which they found, independently, that the probable sources behind poorer performances were random, intermittent noises rather than the steady-state, continuous type of noise.

Broadbent (1957) found that a 100 dB SPL high frequency machinery noise (filtered to contain frequency bands above 2000 Hz) contributed to twice as many errors in performance than did a low frequency sound (filtered to contain frequency bands below 2000 Hz) of similar sound pressure. However, at levels of 80 dB and 90 dB SPL no such effects appeared. Nevertheless, Broadbent recommended eliminating or reducing the high frequency components in noise for improved performance.

Jerison's (1959) study showed that high noise levels (114 dB SPL) over a period of time produced increased error frequency in comparison to low intensity noise (83 dB SPL) for work tasks which can be described as demanding and repetitive.

Kryter (1970) reiterated, from results he reported in 1950, that noise as such is not responsible for performance decrements in non-auditory work situations. Any changes, he felt, are ephemeral, relatively insignificant, or tied to worker attitudes or feelings of motivation which are subject to fluctuation.

Physiological Assessments

Lipreading is a procedure which exclusively relies upon the visual modality, and it represents the sole means by which the test stimuli in this current research effort can be identified. Therefore, it is incumbent to understand the potential role of noise on the integrity of the visual process.

In 1941 Stevens (Cohen, 1969) found that intense acoustic levels had the effect of slowing down the rate of eye movement and, concomitantly, producing a focusing problem for the identification of near and distant objects. Stevens surmised that the noise precipitated a restraining effect on the ciliary muscles which regulate the lens covering the pupil. Cohen cautioned, however, that such changes in visual capacity as a result of stimulation from noise are minimal except at the very highest exposure levels.

Two studies reviewed by Kryter (1970) reached different conclusions regarding the effects of noise on sight. Loeb, in 1954, found vision unaffected by 115 dB SPL of broadband noise, whereas the subjects in a 1954 Rubenstein investigation reacted unpropitiously to intensity levels as low as 75 dB SPL. In Kryter's opinion, the major portion of research has shown noise to have fairly negligible effects on vision.

According to Jansen (1969) any acoustic stimulus, irrespective of its meaning to the listener, might potentially influence the individual's physiological integrity. The critical determinants are the intensity and frequency of the stimulus. His experiments have demonstrated that alterations take place in pupil function and in the eyes' peripheral circulatory system. When young adult subjects were exposed daily for thirty to sixty minute sessions in 90 dB SPL of white noise over three years, they evinced measurable pupil dilitation. Jansen demonstrated that there is a direct relationship between the intensity and bandwidth of a stimulus and pupil size. He found that as either intensity or bandwidth was increased, so did the magnitude of the visual organ increase when subjected to white noise at exposure levels of 70 dB SPL or greater. However, noise delivered at 95 dB SPL or less had no apparent pathological side effects on vision. A previous investigation by Jansen in 1959 had confirmed the occurrences of such side effects when intensities exceeded the 95 dB SPL level.

Personal Feelings and Attitudes

The presence of noise or other acoustic agents, when in close proximity to human subjects, can significantly influence feelings and attitudes, especially toward job satisfaction and work productivity. These feelings have been found to evoke both negative and positive responses.

Cohen (1969), in particular, has evaluated the effects of annoyance on human emotion and response when caused by divergent auditory stimuli. Annoyance, he contends, can be due to a qualitative or quantitative characteristic of the stimulus or the result of the type of message which the stimulus conveys. He cited the Goodfriend and Cardinell study of 1963 in which hospital patients reported being upset having overheard the conversations of hospital employees who were discussing other patients' conditions and operations. This led to unpleasant feelings which were precipitated by sounds whose content was disruptive and irritating though not physically intense.

Stein (1963) discovered that music positively influenced the therapy of disturbed patients. For example, those individuals who were emotionally upset responded favorably to melodic, rhythmic music, whereas those who exhibited depression were stimulated by bouncy, fast-paced music.

Kryter (1970) described instances where music has been used in industry to elicit changes in worker morale in an effort to increase production, especially among employees performing monotonous tasks. Wyatt and Langdon in 1935 (Kryter, 1970) found no consistent relationship between the use of music and increased work output. Kryter's general conclusions were that if beneficial effects do occur, they will be small and transitory at best in regard to worker motivation and production.

Another type of acoustic stimulus which has been found to be disturbing is roadway traffic. Wilson in 1963 (Cohen, 1969) discovered that such noise, when heard at home, was felt to be an intrusion to rest and privacy.

Lipreading Studies in Noise

Of special interest to this investigation are those studies which have evaluated the lipreading performance of subjects who were being exposed to various combinations of acoustic stimuli and intensity levels or who were being trained to lipread under different kinds and conditions of noise.

Leonard (1962) employed twelve normal adult subjects who were initially trained under conditions of quiet (55 dB SPL of ambient noise) to lipread a talker repeating fifty monosyllabic and bisyllabic words. The talker was filmed in advance with the test vocabulary inaudible to the listeners. Each subject was required to achieve an 86 per cent correct response criterion of the test words before he could participate in the experimental test session.

The experimental session was similar to the training program in that the vocabulary and test format were the same. However, this time two conditions were different: (1) a total of four different films was used, each one representing a randomly scrambled ordering of the test items and (2) lipreading ability was measured under the following background conditions: (a) in quiet (55 dB SPL of environmental noise) and in 80 dB SPL of (b) white noise, (c) running speech, and (d) music.

The results in general showed that certain continuously present acoustic stimuli can reduce lipreading performance substantially. Each stimulus (white noise, running speech, and music) lowered lipreading performance in a statistically significant manner, although the background music did so to a lesser degree than the others.

Pettit (1963) evaluated the lipreading proficiency of thirty-three subjects who watched silent motion-picture films in the presence of different auditory maskers. The participants were evenly divided into three groups depending upon their lipreading skills. One-third were considered to be trained lipreaders, another third were familiar with the process of lipreading, whereas the remaining eleven subjects were classified as untrained, i.e., having little skill or knowledge of lipreading methods.

A total of four lipreading films was made. Each included the same 104 test items (monosyllables). These words had been previously rank-ordered as to ease of lipreadability and divided into four equally difficult subtests of twenty-six words. Each silent film also used four different talkers vocalizing twenty-six items apiece. Therefore, in all four films, all four speakers delivered a different subtest of words, whose order of presentation also changed from film to film.

Each film was viewed by all participants under the following listening conditions: (1) quiet, (2) babble, (3) traffic noise, and (4) white noise. Quiet represented 55 dB SPL of ambient room noise. The other three stimuli were presented under earphones at 90 dB SPL. All motion pictures contained forty practice items presented in a setting of quiet which preceded the test words.

The results demonstrated that speechreaders performed differentially under divergent acoustical environments. Scores were better in quiet than in white noise when these two conditions were contrasted, whereas the totals for the stimulus of traffic noise were superior when compared individually to both white noise and babble. In each case these differences were statistically significant. Interestingly enough, the comparisons of quiet versus traffic noise and quiet versus babble manifested no statistical differences. The scores of trained speechreaders were found to be significantly different from the results of their untrained counterparts, whereas no such distinctions statistically could be made for the comparisons trained versus familiar and familiar versus untrained lipreaders.

The most recent study to investigate the effects of noise on lipreading skills (Berger and Lewis, 1972) employed twelve normal hearing subjects who had received speechreading training. Each participant lipread various monosyllabic word pairs spoken by a talker isolated in a room and viewed only through a large, double window. The test was conducted under three contrasting listening environments: (1) quiet (55 dB SPL of ambient noise), (2) continuous white noise (90 dB SPL), and (3) intermittent (one-half second on, one-half second off) white noise (90 dB SPL). The authors hypothesized that an intermittent noise stimulus would precipitate more distraction than a continuous stimulus.

The best scores were made in quiet, the worst in the intermittent white noise. However, the separations in scores among the three conditions were not significant.

The results are conflicting as to the effect of noise on lipreading performance, in general. The first study (Leonard, 1962) found all stimuli significantly and negatively affecting lipreading scores. The Pettit (1963) investigation found some significant score differences but not others, whereas the most recent research (Berger and Lewis, 1972) found small differences between quiet and noise, but these differences were not statistically significant. The types of stimuli have varied, the mode of presentation has varied (sound field versus earphones), but the intensity level of stimulation has remained comparable among these studies.

Ojima and Nakano have published three studies in which noise was introduced while their subjects were learning to lipread. In the first of these reports (1961) ten normal hearing students learned and practiced to lipread words, vowels and syllables under conditions of a white noise masker. Although the authors concluded that practice positively aided lipreading scores, the effect of the masking on performance was not stipulated. The format of the second investigation (1962) was similar to the first. The results showed that the frequency of errors made throughout the investigation remained constant. Masking did not significantly contribute to an increased error rate. Also the identification of low vowels was immeasurably better than that for high vowels. The latest of their studies (1963), which also involved the lipreading training of ten normal hearing subjects under white noise, found that lipreading performance under noise improved with practice although the increases varied from slight to considerable. These variations were attributed to the type of stimulus lipread and individual subject differences.

Summary

The scientific literature has clearly indicated the role which vision plays in the communication process, particularly in the presence of adverse auditory environmental conditions where the verbal message is received unintelligibly. The successful application of lipreading skills, however, is subject to a number of variables, many of which could be directly influenced by the physical surroundings which exist at that moment. Of these, the parameter which potentially appears to have the most significant effect on lipreading performance is noise. The disrupting consequence of noise on some non-auditory tasks has been demonstrated. In addition, noise has been found to alter human feelings, attitudes and physiology.

Although a handful of investigations has looked directly at the effects of noise on lipreading performance, disparate conclusions have been drawn. In addition, those few studies which have looked at the influence of auditory stimuli in the acquisition or training of lipreading proficiency have not completely exhausted this aspect of aural rehabilitative research. Therefore, the necessity for further exploration in this area is justified and indicated.

CHAPTER III

EXPERIMENTAL DESIGN

Subjects

Forty normal hearing, normal seeing adults, all of whom were college educated and affiliated with the Audiology and Speech Sciences Department of Michigan State University as either students, staff or spouses of a student, served as subjects in the present investigation. The age range of these forty persons (twenty men and twenty women) was twenty to forty-two years with a mean age of 25.75 years, with a standard deviation of 3.73 years.

To satisfy the criterion for normal hearing, each participant passed a pure-tone audiometric screening test in each ear given at a level of 25 dB (re ANSI, 1969) at the octave frequencies from 250 through 4000 Hz via Telephonics TDH-49/10Z earphones mounted in MX-41/AR cushions. The examination was completed in an Industrial Acoustics Company (IAC), model 1600 series (ACT), sound insulated suite using a calibrated Grason-Stadler diagnostic audiometer, model 1701.

In addition, each individual had to satisfy the visual screening criterion of 20/20 in both eyes (with or without correction) as measured with a Bausch and Lomb, Modified orthorater.

In both cases, these screening measures were performed and evaluated by the investigator and carried out in the Rehabilitative Audiology Research Laboratory of the Audiology and Speech Sciences Department prior to the subject's involvement in any of the formal experimental procedures.

Materials

Below is a list of the materials employed in this investigation along with a descriptive note about each of them:

The test vocabulary consisted of fifty spondaic stimulus items, i.e., two syllable words such as "baseball" and "hotdog," which were taken from the Central Institute for the Deaf's Auditory Test W-1 and Harvard's Psychoacoustic Laboratory Auditory Test Number Nine (Lists I and II). The test vocabulary was placed into six random orders (see Appendix A) according to accepted statistical procedures for use with all subjects in the training and test procedures of this study.

Videotapes using these six random orderings of the vocabulary were made. A Cohu, model 20/20, black and white television camera videotaped the full face contour of a native male talker (the investigator) as he uttered each one of the fifty vocabulary items. The camera captured the talker's face so that it would appear life size when played back on a twenty-one inch television screen. Each tape was electronically edited so that every spondaic item was exactly the same in all versions. For each group of eight subjects one of these six tapes (by random selection) served as the training tape, whereas the five other tapes were utilized in the test session.

The construction of each tape was as follows. Each stimulus item was preceded by ten to eleven seconds of blank videotape and approximately 1-1/2 to 2-1/2 seconds of tape showing the talker ready to present the item from the closed lips position. After the vocabulary word was uttered, the talker remained on camera for a period of from three to five seconds before more blank videotape appeared. The time separation between vocabulary items varied between sixteen and eighteen seconds. (See Appendix B for exact time sequences of all six videotapes.) The total running time of each tape was approximately fifteen minutes.

Four background <u>sound tapes</u> were recorded for use with the training and test procedures. These auditory sounds included (1) babble, (2) industrial noise, (3) traffic noise, and (4) music. Each was recorded on Scotch 201 magnetic tape at a speed of seven and one-half inches per second for approximately sixteen minutes and played back on an Ampex tape recorder, model AG600.

Various <u>incidental materials</u> were used and samples of them can be found in Appendix C. They included:

(1) two hundred scoring sheets for use by the forty subjects to record their answers to the stimuli presented under the five test conditions,

(2) approximately 200 scoring sheets which were used during the training sessions by the forty subjects for their written responses,

(3) forty vocabulary lists of the fifty spondaic words (listed in alphabetical order) for purposes of familiarization by the subjects,

(4) forty instruction sheets describing the training procedures,

(5) eight number two lead pencils for writing responses.

Training and Test Environment and Equipment

Test Environment

An eighteen by nineteen foot, windowless sound-treated classroom located in the Audiology and Speech Sciences Building served as the training and test environment. A schematic diagram of this room (Figure 1) pinpoints the placement of the equipment.

Equipment

A Sony Videocorder Production Deck (model 3600), which accommodates one-half inch black and white videotape, played the final dubbed versions of the vocabulary in both the training and test procedures. It was located at the rear of the classroom illustrated below and was linked to a television monitor situated at the front of the classroom.

In addition to the Videocorder Production Deck, a Sony Videocorder Edit Deck (model 3650) and two Sony black and white television monitors (models CVM-920U and PVJ-510) were used together to dub magnetically the vocabulary into the six desired tapes.

A Motorola twenty-one inch black and white television set served as the monitor of the videotaped vocabulary. It was physically situated about twelve inches above the eye level of the subjects in the experimental room.

Eight chair-desks were arranged in two rows of four seats each. The seats nearest the television monitor were six feet away, whereas the chair-desks in the second row were placed three feet further back. All seats were situated so that all subjects had an unobstructed view of the television set.

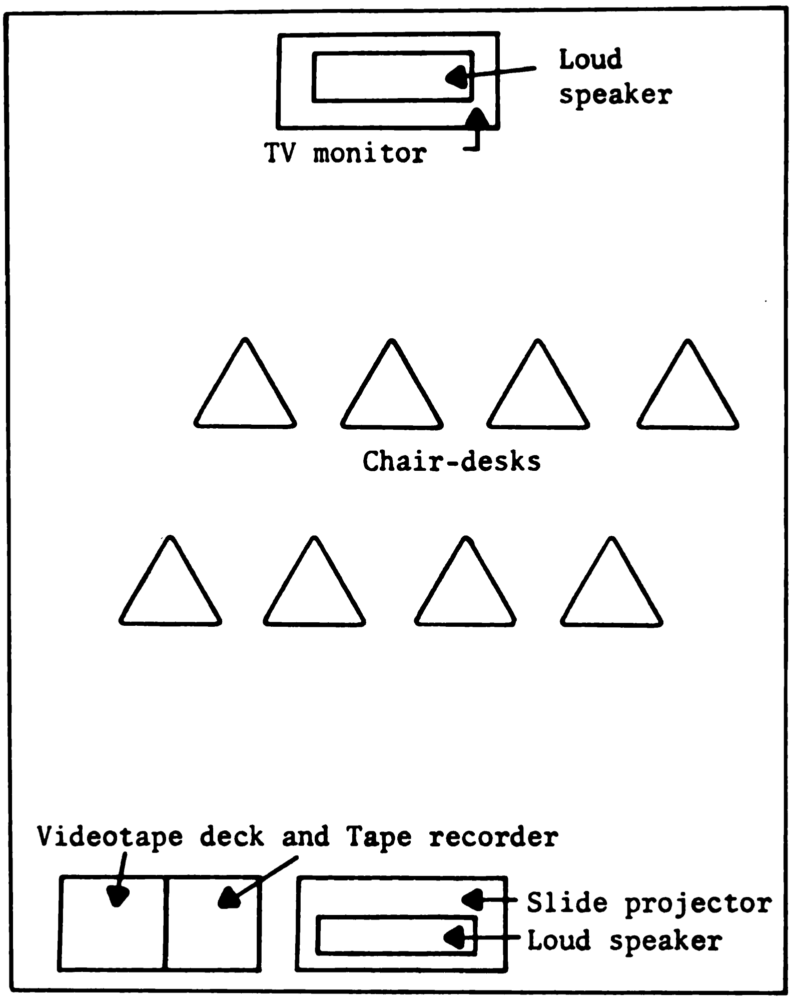

Figure 1. Physical Arrangement of the Equipment and Chair-desks in the Test (Training) Environment.

An Ampex, model AG600, tape recorder fed the pre-recorded sound tapes into two Ampex, model AA620, loud speakers. This recorder was juxtaposed with the Videocorder Production Deck at the rear of the classroom.

The auditory background sounds were reproduced by the two Ampex loud speakers which were placed at a zero degree azimuth to the front and rear of the experimental subjects. Each loud speaker was equi-distant from the nearest row to ensure that all subjects were exposed to equivalent levels of sound pressure. To monitor the desired output of sound pressure from both loud speakers, a Bruel and Kjaer sound pressure level meter (model 2203) was employed.

A Sawyers (model 570AF) two by two slide projector, situated above the rear loud speaker and operated by the investigator, projected the appropriately numbered sequence of the spondaic stimulus above the television monitor in order to preclude any subject from writing an answer out of sequence during either the training or test trials. Each appropriate item number was flashed from the moment one stimulus item had been presented until the next stimulus word was to be offered but not during the presentation of any vocabulary item.

Procedures

Each subject participated in two different experimental procedures. The first was a training procedure, the second, a test procedure. Each training and test format is described below. Prior to their inclusion in the study, all subjects had met the auditory and visual requirements.

Training Procedure

The forty experimental participants were assigned on a random basis to one of five groups. The male and female subjects were assigned separately so that there would be four members of each sex per group. Each aggregate of eight subjects was differentiated only by the type of background environment under which the vocabulary of fifty spondaic words was to be lipread.

Group I lipread in quiet. The ambient noise level of the training environment was approximately 50 dB SPL as determined by the C scale of a sound pressure level meter. The remaining four groups were trained in a sound field of 90 dB SPL (monitored by sound pressure level meter). The types of sound employed in the remaining four groups were as follows: (a) Group II, babble; (b) Group III, industrial noise; (c) Group IV, traffic noise; and (d) Group V, music.

The objective of the training procedure was to familiarize the subjects with the experimental vocabulary so that each participant could learn to lipread this vocabulary and attain at least a correct response criterion of 90 per cent (i.e., at least forty-five correct out of fifty).

Two days prior to the training session each subject was given a copy of the instructions to be followed during the training period and an alphabetized list of the vocabulary. The instructions, which were read by the investigator prior to the training procedure, were as follows:

> This is a test of your ability to lipread fifty inaudible words such as "outside" and "cowboy" as they are presented by me on the television monitor in front of you under a background condition of either quiet or auditory stimulation. On the

answer sheet in front of you, decide what word you saw on the screen and write it in the appropriately numbered space provided. Prior to the presentation of each stimulus, its sequence number will appear above the monitor. Each vocabulary word is preceded by several seconds of blank videotape and approximately two seconds of videotape showing the talker ready to present a stimulus item from the closed lips position. After the vocabulary item is uttered, the talker remains on camera for a brief moment before more blank tape appears. After each spondaic item is presented, write down your answer quickly and then look up and prepare to respond to the next stimulus item. About three seconds before each word is presented a pure tone will sound alerting you to the presentation of the next stimulus item. At any time you may refer to your alphabetized vocabulary list. Guessing is encouraged, but if you cannot guess, be sure to draw a line through that particular response blank. Some items may be very easy to identify, others more difficult. In any event, watch the monitor closely when vocabulary items are being presented. All words are just given once. Do you have any questions about what I have asked you to do?

If the training situation called for one of the four auditory background tapes to be played, it was started about one minute before the videotape was run to minimize any possible mistakes because of a surprise reaction to the introduction of the sound. The presentation level of 90 dB SPL for each auditory sound was pre-set on the equipment.

All papers from the training session were collected after the last of the fifty word stimuli was given (considered one trial) and each was graded while the subjects took a rest break. Those who scored 90 per cent or higher were considered to be trained lipreaders for the purpose of this study and dismissed, since they had met the pre-established criterion for participating in the test procedure. For those not meeting this criterion, the same conditions under which they were initially exposed resumed. Each subject was told only his per cent correct score. The above procedure was carried out until the 90 per cent correct response criterion was met. If a subject needed more than four such trials, he was brought back the next day to avoid the possibility of excessive fatigue. Each subject, however, was not given more than eight trial runs to satisfy the training criterion. If unsuccessful, the subject was replaced. Once each subject had met the training requirements, he or she was ready for the test procedure.

Test Procedure

The test procedure was similar to that of training except for a few changes. The lipreading ability of each subject was now evaluated under all five conditions used in the training procedure, including the condition under which that particular individual had been trained (quiet, babble, industrial noise, traffic noise, and music). The experimental vocabulary remained the same, but for each of the five test situations a different videotaped ordering of the spondaic stimuli was presented in an effort to preclude vocabulary order effects. All other conditions remained the same. In the test session a rest period of approximately ten minutes was given after the second and fourth trials. The papers were not corrected during this test phase.

For each group of eight subjects, the sequence in which the background sounds was presented was also different to preclude order effects, as it had been for vocabulary lists. See Appendix D for the order of test and vocabulary sequence presentations.

The training and test procedures were both completed within two to three days so that the subjects would not lose their trained efficiency for lipreading the vocabulary.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

This chapter is divided into two main sections: results and discussion. The results include the statistical analyses to which the data were subjected along with a descriptive and, where appropriate, a graphic explanation of what these analyses revealed. Finally, a discussion of the results as they relate to other relevant research is provided.

Of the original forty subjects (twenty men, twenty women) who attempted to satisfy the training criterion (90 per cent correct identification of the spondaic word stimuli), thirty-four (fifteen men, nineteen women) qualified in eight trials or less. Six subjects were replaced. Three of the five non-qualifying males had been trained to lipread in music, one in quiet and the other in industrial noise. The one female who dropped out came from the group trained in traffic noise. Their six replacements subsequently fulfilled the established training criterion and participated in the study.

Results

Two analyses were employed in this investigation. The first was a two-way, fixed-effects analysis of variance (5 x 2) which was calculated to establish the relationship of training condition (quiet, babble, industrial noise, traffic noise, and music) and sex (male, female) to the number of trials needed by a subject to qualify for the test phase of the experiment.

The second procedure was a three-way, fixed-effects analysis of variance (5 x 2 x 5) with repeated observations on one of the factors (test measures). The lipreading scores obtained from the five test measures (quiet, babble, industrial noise, traffic noise, and music) were analyzed as a function of the treatments of training condition (quiet, babble, industrial noise, traffic noise, and music) and sex (male, female).

Trials as a Function of Training Condition and Sex

Table 1 represents a two-way, fixed-effects (training by sex) analysis of variance on the number of trials needed by subjects to

TABLE 1

SUMMARY OF THE TWO-WAY, FIXED-EFFECTS (TRAINING BY SEX) ANALYSIS OF VARIANCE FOR THE NUMBER OF TRAINING TRIALS NEEDED TO QUALIFY FOR THE TEST SESSION

Source of Variation	Degrees of Freedom	Mean Square	F Value	Probability of Statistic
A (Training)	4	4.41	1.04	0.4030
B (Sex)	1	13.22	3.11	0.0880
AB (Training x Sex)	4	1.66	0.39	0.8141
Error (Within)	30	4.24		

qualify for the test phase of the study. The results indicate that there is no significant main effect for training (factor A) and no significant training by sex interaction (factor AB). However, the sex main effect (factor B) was statistically significant at the .088 level.

The mean data for these trials were tabulated by training condition and sex and appear in Table 2. The row mean for women (across all training conditions) was 3.35 trials versus a row mean for men of 4.50 trials, indicating that female subjects required fewer trials to qualify than did their male counterparts. The analysis of variance found this difference between these two means to be significant. Figure 2 graphically traces these mean scores for trials as a function of sex across all training conditions.

TABLE 2

MEAN NUMBER OF TRIALS, TABULATED BY SEX AND TRAINING CONDITION, NEEDED TO QUALIFY FOR THE TEST SESSION

Sex	Training Condition					
	Quiet	Babble	Industrial Noise	Traffic Noise	Music	Row Mean
Male	4.00	5.50	4.50	3.25	5.25	4.50
Female	2.75	4.75	3.25	3.25	2.75	3.35
Column Mean	3.38	5.13	3.88	3.25	4.00	3.93

Table 3 contains the basic information on the number of trials needed by each subject to qualify. These data are grouped by sex and training condition. Note that one member of each sex (subject number twenty-one, female, trained in industrial noise; subject number

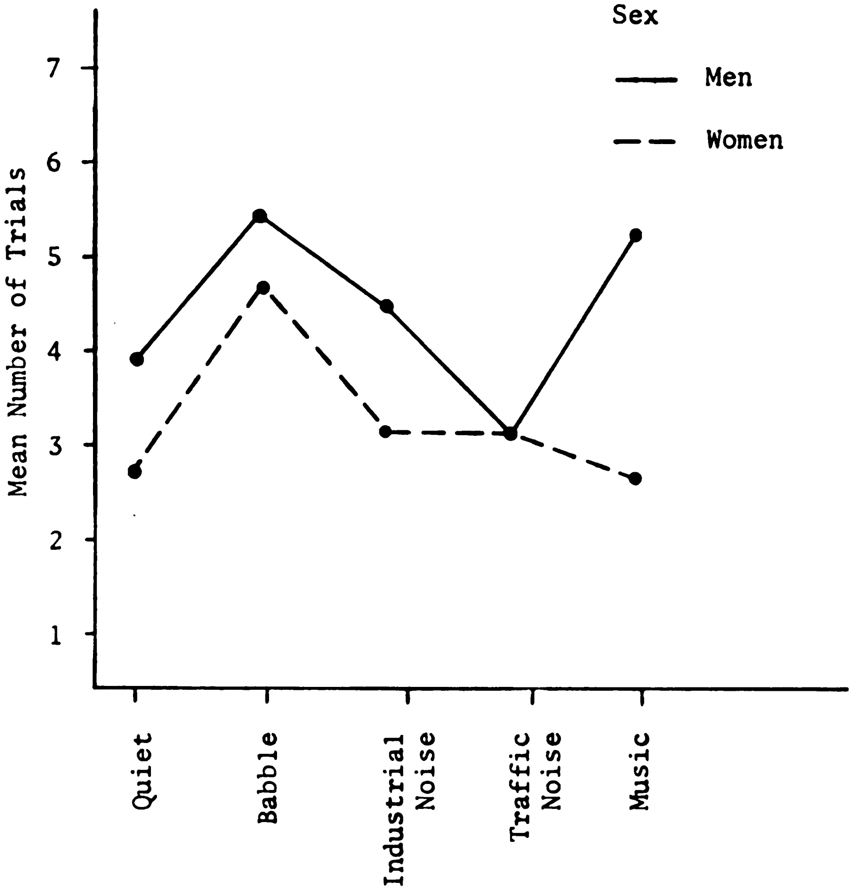

Figure 2. Mean Number of Trials Across Training Conditions as a Function of Sex.

TABLE 3

NUMBER OF TRAINING TRIALS NEEDED BY EACH SUBJECT TO QUALIFY FOR THE TEST SESSION

Subject Number	Sex	Training Condition	Trials Needed	Subject Number	Sex	Training Condition	Trials Needed
1	M	Quiet	2	5	F	Quiet	2
2	M	Quiet	3	6	F	Quiet	4
3	M	Quiet	6	7	F	Quiet	2
4	M	Quiet	5	8	F	Quiet	3
9	M	Babble	2	13	F	Babble	3
10	M	Babble	5	14	F	Babble	8
11	M	Babble	8	15	F	Babble	4
12	M	Babble	7	16	F	Babble	4
17	M	Industrial Noise	5	21	F	Industrial Noise	1
18	M	Industrial Noise	3	22	F	Industrial Noise	2
19	M	Industrial Noise	2	23	F	Industrial Noise	3
20	M	Industrial Noise	8	24	F	Industrial Noise	7
25	M	Traffic Noise	2	29	F	Traffic Noise	2
26	M	Traffic Noise	1	30	F	Traffic Noise	3
27	M	Traffic Noise	7	31	F	Traffic Noise	6
28	M	Traffic Noise	3	32	F	Traffic Noise	2
33	M	Music	5	37	F	Music	2
34	M	Music	4	38	F	Music	2
35	M	Music	6	39	F	Music	4
36	M	Music	6	40	F	Music	3

twenty-six, male trained in traffic noise) qualified in just one trial, whereas all other individuals needed two or more (up to the limit of eight) trials to satisfy the entry requirements for the test phase.

Lipreading Scores as a Function of Training and Sex: Sources of Variation Between Subjects

Table 4 represents a three-way, fixed-effects analysis of variance (training by sex by measure) with repeated observations on the the last factor. The data contained in this table are discussed separately as a function of the treatment main effects for between subjects (factor A: training; factor B: sex) and their interaction (factor AB: training by sex) and as a function of the treatment main effect for within subjects (factor C: measure) and its appropriate interactions.

Factor A, the treatment effect for training, was not found significant. In addition, its interaction with sex (factor AB) was nonsignificant. However, the treatment main effect for sex (factor B) was significant at the .0747 level.

Table 5 summarizes the mean lipreading scores (in per cent) as a function of training condition, sex and test measure. Also provided are the combined cell, column, row, and grand means. Note that the total means for sex (men, 88.60 per cent; women, 92.58 per cent) resulted in a difference which favored the female subjects. This separation between means, as indicated above, was statistically significant at the .0747 level.

Table 6 contains the raw score data (in per cent) and is grouped by training condition and sex as a function of the five test

TABLE 4

SUMMARY OF THE THREE-WAY, FIXED-EFFECTS ANALYSIS OF VARIANCE WITH REPEATED OBSERVATIONS ON THE TEST MEASURES

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F Value	Probability of Statistic
Between Subjects	10156.78	39			
A (Training)	641.68	4	160.42	0.69	0.6033
B (Sex)	792.02	1	792.02	3.41	0.0747
AB (Training x Sex)	1766.88	4	441.72	1.90	0.1363
Error (Between)	6956.20	30	231.87		
Within Subjects	3041.60	160			
C (Measure)	252.68	4	63.17	5.31	0.0006
AC (Training x Measure)	807.52	16	50.47	4.25	0.0000
BC (Sex x Measure)	119.48	4	29.87	2.51	0.0454
ABC (Train. x Sex x Meas.)	435.12	16	27.20	2.28	0.0061
Error (Within)	1426.80	120	11.89		

TABLE 5

MEAN SCORES IN PER CENT AS A FUNCTION OF TRAINING CONDITION, SEX AND TEST MEASURE

Training Condition	Sex	Test Measure: Quiet	Babble	Industrial Noise	Traffic Noise	Music	Row Means Training Condition
Quiet	Male	83.50	87.00	91.00	92.50	94.00	89.60
	Female	93.00	81.50	90.00	93.00	89.50	89.40
	Combined Mean	88.25	84.25	90.50	92.75	91.75	89.50
Babble	Male	89.50	87.50	82.00	87.00	91.00	87.40
	Female	95.00	86.00	91.00	93.50	94.50	92.00
	Combined Mean	92.25	86.75	86.50	90.25	92.75	89.70
Industrial Noise	Male	89.50	93.00	92.00	91.00	96.00	92.30
	Female	90.50	92.00	87.50	89.50	91.00	90.10
	Combined Mean	90.00	92.50	89.75	90.25	93.50	91.20
Traffic Noise	Male	92.00	92.50	92.00	88.50	97.00	92.40
	Female	96.50	94.50	95.00	91.50	98.50	95.20
	Combined Mean	94.25	93.50	93.50	90.00	97.75	93.80
Music	Male	81.50	79.50	84.50	83.50	77.50	81.30
	Female	95.00	97.00	98.00	94.50	96.50	96.20
	Combined Mean	88.25	88.25	91.25	89.00	87.00	88.75
	Male	87.20	87.90	88.30	88.50	91.10	88.60
	Female	94.00	90.20	92.30	92.40	94.00	92.58
	Column Means Test Measure	90.60	89.05	90.30	90.45	92.55	90.59 Grand Mean

TABLE 6

SUBJECT LIPREADING SCORES IN PER CENT ACROSS ALL TEST MEASURES, GROUPED BY TRAINING CONDITION AND SEX[a]

			Test Measure				
Subject Number	Sex	Training Condition	Quiet	Babble	Industrial Noise	Traffic Noise	Music
1	M	Quiet	86	98	100	100	100
2	M	Quiet	88	88	94	96	100
3	M	Quiet	88	88	92	94	94
4	M	Quiet	72	74	78	80	82
5	F	Quiet	94	84	94	94	92
6	F	Quiet	86	70	86	86	80
7	F	Quiet	92	78	84	96	86
8	F	Quiet	100	94	96	96	100
9	M	Babble	94	94	88	88	92
10	M	Babble	84	88	78	84	88
11	M	Babble	82	84	72	80	92
12	M	Babble	98	84	90	96	92
13	F	Babble	96	90	92	96	96
14	F	Babble	94	86	94	94	98
15	F	Babble	94	82	90	94	96
16	F	Babble	96	86	88	90	88
17	M	Industrial Noise	90	94	96	100	100
18	M	Industrial Noise	94	88	94	86	94
19	M	Industrial Noise	94	100	98	96	100
20	M	Industrial Noise	80	90	80	82	90
21	F	Industrial Noise	100	100	96	98	100
22	F	Industrial Noise	96	100	100	100	100
23	F	Industrial Noise	94	96	84	88	94
24	F	Industrial Noise	72	72	70	72	70

[a]Raw scores.

TABLE 6 (Continued)[a]

Subject Number	Sex	Training Condition	Test Measure: Quiet	Babble	Industrial Noise	Traffic Noise	Music
25	M	Traffic Noise	88	94	94	92	96
26	M	Traffic Noise	100	100	100	100	100
27	M	Traffic Noise	84	84	88	84	94
28	M	Traffic Noise	96	92	86	78	98
29	F	Traffic Noise	100	100	98	98	100
30	F	Traffic Noise	100	90	98	88	98
31	F	Traffic Noise	94	94	92	86	96
32	F	Traffic Noise	92	94	92	94	100
33	M	Music	86	86	90	88	82
34	M	Music	94	80	92	82	78
35	M	Music	82	80	82	90	78
36	M	Music	64	72	74	74	72
37	F	Music	88	90	92	88	90
38	F	Music	98	100	100	100	100
39	F	Music	94	98	100	92	96
40	F	Music	100	100	100	98	100

[a]Raw scores.

measures. The lipreading scores extended from a low of 64 per cent to a high of 100 per cent (the best possible result and one achieved by several subjects).

Lipreading Scores as a Function of Test Measure: Sources of Variation Within Subjects

As shown in Table 4, there was a significant three-way interaction (factor ABC: training by sex by measure) at the .0061 level. In view of this study's stated null hypotheses, it was of prime interest to ascertain the sources contributing to the significance of such an interaction. Therefore, the statistic of simple main effects was employed to calculate the significance of every test measure at each level of sex and training condition. However, selecting this test statistic to identify the sources contributing to the significance of this three-way interaction precluded any further statistical analyses of the sources of variation within subjects.

The analysis of variance for these simple effects appears in Table 7. Each notation, e.g., measures at A1B1, refers to one of the ten simple effects which is a part of this complex interaction and which denotes the simple effect for all of the five test measures at a particular level of training and sex.

Alpha significance for each simple effect was set at the .02 level, making the overall level of significance in Table 7 (within subjects) consistent with a .05 overall alpha level in Table 4 (within subjects). Consequently, the significance level for the combined factors of C (measure), AC (training by measure), BC (sex by measure), and ABC (training by sex by measure) which are contained in Table 4

TABLE 7

ANALYSIS OF VARIANCE FOR SIMPLE EFFECTS OF THE TRAINING BY SEX BY MEASURE INTERACTION

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F Value	Probability of Statistic
Within Subjects	3041.6	160			
Measures at A1B1[a]	294.8	4	73.70	6.1975	0.0001[b]
A1B2	354.8	4	88.70	7.46	0.0000[b]
A2B1	186.8	4	46.70	3.9275	0.0049[b]
A2B2	218.0	4	54.50	4.5825	0.0018[b]
A3B1	95.2	4	23.80	2.0025	0.0985
A3B2	46.8	4	11.70	0.985	0.4185
A4B1	146.8	4	36.70	3.0875	0.0185[b]
A4B2	107.2	4	26.80	2.255	0.0671
A5B1	131.2	4	32.80	2.7575	0.0309
A5B2	33.2	4	8.30	0.6975	0.5951
Error (Within)	1426.8	120	11.89		

[a]A1 - Training condition, Quiet
A2 - Training condition, Babble
A3 - Training condition, Industrial Noise
A4 - Training condition, Traffic Noise
A5 - Training condition, Music

B1 - Sex, Male
B2 - Sex, Female

[b]Significant at the .02 level.

and designated at an overall alpha level of .05 is equivalent to the overall significance level represented by the collection of ten simple main effects (A1B1, A1B2, etc.) listed in Table 7 and valued at a .02 alpha level.

The data contained in Table 7 manifested significant results for five (A1B1, A1B2, A2B1, A2B2, and A4B1) of the ten simple effects. Based on these results of significance, two post hoc test procedures (Tukey, Scheffé) were selected to determine further the source of these significant effects.

The Tukey test provided the capability to make ten pairwise mean comparisons between the five test measures of each significant simple effect using a .02 alpha level, whereas the Scheffé statistic was chosen to contrast the differences between the test measure mean for quiet of each simple effect and the combined (equally weighted) test measure means of the four noise conditions (babble, industrial noise, traffic noise, and music), also using a .02 level of significance.

In Table 8, all possible pairwise contrast conditions and their 98% confidence intervals are presented as a function of all test measures by level (training condition, sex). Each significant contrast, as revealed by the Tukey analysis, is identified and discussed below.

At level A1B1 (males trained in quiet), the significant test measure mean contrasts were (a) quiet versus traffic noise and (b) quiet versus music. In both comparisons, the mean (see Table 5) for quiet was significantly less than the means for traffic noise

TABLE 8

CONFIDENCE INTERVALS AROUND DIFFERENCES BETWEEN TEST MEASURE MEANS USING TUKEY

Source of Variation	Contrast Conditions	98% Confidence Interval
Measures at A1B1[a]	Quiet vs. Babble	(-11.1188, + 4.1188)
	Quiet vs. Industrial Noise	(-15.1188, + 0.1188)
	Quiet vs. Traffic Noise	(-16.6188, - 1.3812)[b]
	Quiet vs. Music	(-18.1188, - 2.8812)[b]
	Babble vs. Industrial Noise	(-11.6188, + 3.6188)
	Babble vs. Traffic Noise	(-13.1188, + 2.1188)
	Babble vs. Music	(-14.6188, + 0.6188)
	Industrial Noise vs. Traffic Noise	(- 9.1188, + 6.1188)
	Industrial Noise vs. Music	(-10.6188, + 4.6188)
	Traffic Noise vs. Music	(- 9.1188, + 6.1188)
Measures at A1B2	Quiet vs. Babble	(+ 3.8812, +19.1188)[b]
	Quiet vs. Industrial Noise	(- 4.6188, +10.6188)
	Quiet vs. Traffic Noise	(- 7.6188, + 7.6188)
	Quiet vs. Music	(- 4.1188, +11.1188)
	Babble vs. Industrial Noise	(-16.1188, - 0.8812)[b]
	Babble vs. Traffic Noise	(-19.1188, - 3.8812)[b]
	Babble vs. Music	(-15.6188, - 0.3812)[b]
	Industrial Noise vs. Traffic Noise	(-10.6188, + 4.6188)
	Industrial Noise vs. Music	(- 7.1188, + 8.1188)
	Traffic Noise vs. Music	(- 4.1188, +11.1188)
Measures at A2B1	Quiet vs. Babble	(- 5.6188, + 9.6188)
	Quiet vs. Industrial Noise	(- 0.1188, +15.1188)
	Quiet vs. Traffic Noise	(- 5.1188, +10.1188)
	Quiet vs. Music	(- 9.1188, + 6.1188)
	Babble vs. Industrial Noise	(- 2.1188, +13.1188)
	Babble vs. Traffic Noise	(- 7.1188, + 8.1188)
	Babble vs. Music	(-11.1188, + 4.1188)
	Industrial Noise vs. Traffic Noise	(-12.6188, + 2.6188)
	Industrial Noise vs. Music	(-16.6188, - 1.3812)[b]
	Traffic Noise vs. Music	(-11.6188, + 3.6188)

[a]A1 - Training condition, Quiet
A2 - Training condition, Babble

B1 - Sex, Male
B2 - Sex, Female

[b]Significant at the .02 level

TABLE 8 (Continued)

Source of Variation	Contrast Conditions	98% Confidence Interval
Measures at A2B2[a]	Quiet vs. Babble	(+ 1.3812, +16.6188)[b]
	Quiet vs. Industrial Noise	(- 3.6188, +11.6188)
	Quiet vs. Traffic Noise	(- 6.1188, + 9.1188)
	Quiet vs. Music	(- 7.1188, + 8.1188)
	Babble vs. Industrial Noise	(-12.6188, + 2.6188)
	Babble vs. Traffic Noise	(-15.1188, + 0.1188)
	Babble vs. Music	(-16.1188, - 0.8812)[b]
	Industrial Noise vs. Traffic Noise	(-10.1188, + 5.1188)
	Industrial Noise vs. Music	(-11.1188, + 4.1188)
	Traffic Noise vs. Music	(- 8.6188, + 6.6188)
Measures at A4B1	Quiet vs. Babble	(- 8.1188, + 7.1188)
	Quiet vs. Industrial Noise	(- 7.6188, + 7.6188)
	Quiet vs. Traffic Noise	(- 4.1188, +11.1188)
	Quiet vs. Music	(-12.6188, + 2.6188)
	Babble vs. Industrial Noise	(- 7.1188, + 8.1188)
	Babble vs. Traffic Noise	(- 3.6188, +11.6188)
	Babble vs. Music	(-12.1188, + 3.1188)
	Industrial Noise vs. Traffic Noise	(- 4.1188, +11.1188)
	Industrial Noise vs. Music	(-12.6188, + 2.6188)
	Traffic Noise vs. Music	(-16.1188, - 0.8812)[b]

[a]A2 - Training condition, Babble
A4 - Training condition, Traffic Noise

B2 - Sex, Female
B1 - Sex, Male

[b]Significant at the .02 level

(83.5 per cent vs. 92.5 per cent) and music (83.5 per cent vs. 94.0 per cent), respectively.

For women trained in quiet (A1B2), the contrasts which differed significantly were (a) quiet versus babble (93.0 per cent vs. 81.5 per cent), (b) babble versus industrial noise (81.5 per cent vs. 90.0 per cent), (c) babble versus traffic noise (81.5 per cent vs. 93.0 per cent), and (d) babble versus music (81.5 per cent vs. 89.5 per cent). In every instance, the mean for babble was significantly lower than the means for each of the other test measures contrasted with it.

The only significant contrast mean for men trained in babble (A2B1) was that of industrial noise versus music, where the mean of music (91.0 per cent) was significantly higher than the mean of industrial noise (82.0 per cent). For their women counterparts (A2B2), the data revealed significant differences for (a) quiet vs. babble (95.0 per cent vs. 86.0 per cent) and (b) babble versus music (86.0 per cent vs. 94.5 per cent). In both instances the mean for babble was significantly poorer for these particular contrast pairs.

Finally, level A4B1 (men trained in traffic noise) produced a mean contrast (traffic noise versus music) which was a source of significant difference. The mean for music (97.0 per cent) was significantly superior to the mean for traffic noise (88.5 per cent).

The Scheffé procedure investigated the complex contrast of the test measure mean for quiet versus the combined means (equally weighted) of the other test measures (babble, industrial noise, traffic noise, and music) at all five levels of training condition and sex where significance for a simple main effect had been identified (see Table 7).

In Table 9 the results of these complex comparisons are presented. For male subjects trained in quiet (A1B1), a significant contrast between these test measure means (quiet versus all noise stimuli combined) emerged. The mean for quiet (83.5 per cent) proved to be significantly lower than the average of the combined noise stimuli means (91.1 per cent). However, for the other simple effects (A1B2, A2B1, A2B2, and A4B1), no such significant contrasts were present.

Discussion

In this section, the results as described above are compared and contrasted to the relevant findings of previous investigations. In addition, the decisions whether or not to accept or reject the stated null hypotheses are given. For purposes of clarity, a discussion of each treatment main effect is separately presented.

The Effects of Training Conditions on Lipreading Scores

The data show that there is no statistically significant difference between any one of the five auditory backgrounds used in this research to train subjects to lipread. Therefore, as the figures indicate in Table 4, the null hypothesis that there are no differences in the lipreading performance of subjects with regard to the various environmental conditions under which they were trained to read lips cannot be rejected.

To date, no known investigations have specifically examined the effects of noise on subjects being trained to lipread, although Ojima and Nakano of Japan (1961, 1962, 1963), in a series of

TABLE 9

CONFIDENCE INTERVALS AROUND DIFFERENCES IN THE TEST MEASURE MEANS OF QUIET VERSUS THE COMBINED NOISE STIMULI USING SCHEFFÉ

Source of Variation	Complex Contrasts	98% Confidence Interval
Measures at A1B1[a]	Quiet vs. Combined Noise Stimuli	(- 5.7375, - 0.3625)[b]
A1B2	Quiet vs. Combined Noise Stimuli	(- 8.8747, +44.8747)
A2B1	Quiet vs. Combined Noise Stimuli	(-16.3747, +37.3747)
A2B2	Quiet vs. Combined Noise Stimuli	(-11.8747, +41.8747)
A4B1	Quiet vs. Combined Noise Stimuli	(-28.8747, +24.8747)

[a]A1 - Training condition, Quiet
A2 - Training condition, Babble
A4 - Training condition, Traffic Noise

B1 - Sex, Male
B2 - Sex, Female

[b]Significant at the .02 level

experiments, exposed individuals to white noise as they practiced learning to lipread bisyllabic words. Unfortunately, only a brief summary of the authors' findings has been published in this country, and it neither elaborates on the specific design used nor comments on the intent of the overall experimental process.

Even though no differences between any of the five training conditions were revealed, it must be reported that three out of the six subjects replaced were trained under the condition "music," whereas the remaining three non-qualifying subjects came from three other, different conditions. Therefore, the training category of music was not an easy one in which to qualify. One reason might be that the music was more meaningful and its sequencing more predictable, in general, than in the other conditions of quiet, babble, industrial noise and traffic noise.

Future investigations will likely evaluate other auditory conditions in which lipreading could be taught and tested. Such background noises might include those which are unpredictably intermittent or highly intelligible, e.g., selected comedy material.

In the meantime, rehabilitation programs can begin to incorporate the findings gleaned from this current research which show that lipreading can be taught successfully in background noises other than quiet.

The Effects of Sex on Lipreading Scores

The treatment of sex was found to be significant as a function of training condition and test measure (Table 4). Across all training conditions, women achieved higher scores than men under every test measure. Across each test measure for subjects trained in music, women consistently outscored men. It should be noted that all three subjects who failed to qualify in this training category (music) were men. In addition, the comments made by the female participants to the investigator about the music were complimentary, whereas the male subjects said they would have preferred a different selection. In the case of the training category of music, the better scores attained by women subjects might have been due to their interest in and their familiarity with the music used as the background sound.

In previous studies evaluating the effects of auditory conditions on lipreading performance (Leonard, 1962; Pettit, 1963; and Berger and Lewis, 1972) sex differences were not specifically investigated. However, the research of Aylesworth (1964) and Keil (1968) represent two studies which, in general, have shown female lipreaders superior to male lipreaders. These data from the current study stand out as additional evidence of this difference.

When these results are applied to a rehabilitative situation, the lipreading scores of men and women should tend to be different with any variance usually favoring the women. The reason for this difference is, as yet, unexplained. Hopefully, future investigations will discover the source of this variance.

The Effects of Test Measures on Lipreading Scores

The significance of test measures on lipreading scores was evaluated by using the simple main effects test statistic to investigate the significant three-way interaction which existed among the training, sex and test measure treatments (see Table 7).

The results of two post hoc analyses (the Tukey and Scheffé test statistics) are contrasted below, along with the conclusions drawn by previous investigators. In the research of Leonard (1962) and Pettit (1963), their subjects were only trained in quiet and not at all in noise. The subjects of Berger and Lewis (1972) had been given a course in lipreading but had no specific training with the test stimuli. Therefore, any comparisons between these studies and this research are necessarily limited. As mentioned previously, none of these investigators looked at the results of men and women separately. Instead, sex data were combined and they are reported in that way below.

In discussion which follows, the results from the ten pairwise contrast means of each level (by training condition and sex) of every measure found to be significant are examined in light of similar comparisons made earlier by these other studies. The ten pairwise contrast means for those subjects (both men and women) trained to lipread in quiet are presented first.

Subjects Trained in Quiet

Quiet Versus Babble

In this current experiment male subjects manifested comparable results for the test measures of quiet and babble. Pettit's (1963) research supports similar findings. However, the scores of this study's female subjects for these two contrasts demonstrated a significant difference in which the better scores were achieved in quiet. Leonard's (1962) study also arrived at this latter conclusion (his test measure was running speech).

Quiet Versus Industrial Noise

Both Leonard (1962) and Pettit (1963) found significant differences between the test measures of quiet and white noise, with the better scores achieved in quiet. Berger and Lewis (1972) reported no differences when quiet was compared with either continuous or intermittent white noise. This present study also manifested no differences, irrespective of sex.

Quiet Versus Traffic Noise

A significant contrast between these two measures (quiet and traffic noise) occurred in the case of the males. Once again quiet scores were worse than the traffic noise scores. No such differences were noted either for the female subjects of this study or for those individuals in the Pettit (1963) experiment.

Quiet Versus Music

Significant differences between the measures of quiet and music existed in both this study and Leonard's (1962). Male subjects achieved better results while lipreading in music, whereas the participants in Leonard's experiment scored higher in quiet. Female subjects in this research scored comparably in both conditions. Note that cell size in Leonard's experiment was twelve versus a cell size of four in this study. An increased number per cell in the current research might have resulted in comparable findings.

Babble Versus Industrial Noise

Female mean scores were significantly different for these test measures (babble, industrial noise) with the best results achieved in industrial noise. Male subject response was comparable, a similar finding from the Leonard (1962) investigation.

Babble Versus Traffic Noise

The traffic noise results achieved by this study's female population were significantly higher than the scores in babble, a finding supported by the Pettit (1963) research. In contrast, male subjects of the present study manifested no differences for these two measures.

Babble Versus Music

In the current investigation, women subjects scored significantly better in music than in babble, whereas the men demonstrated no dissimilarity between these two measures. Leonard's (1962) data also found no such differences.

Industrial Noise Versus Traffic Noise

The Pettit (1963) research showed that her subject's means from traffic noise were significantly higher than those of white noise. However, the men and women (considered separately) of this investigation manifested equivalent mean scores.

Industrial Noise Versus Music

In similar fashion, non-significant findings were evident for both sexes in this current experiment, whereas Leonard's (1962) results were significant, favoring the white noise stimulus score.

Traffic Noise Versus Music

Both male and female subject groups in this experiment manifested comparable scores for this pair of test measures (traffic noise, music). No such comparisons were made in any of the other research studies cited above.

In light of the data (Table 8) gathered in this study, the following null hypotheses can be rejected:

1. For male subjects trained to read lips in a quiet environment, there are no differences when comparing their lipreading scores for the test measures of:

(a) quiet vs. traffic noise
(b) quiet vs. music

2. For female subjects trained to read lips in a quiet environment, there are no differences when comparing their lipreading scores for the test measures of:

(a) quiet vs. babble
(b) babble vs. industrial noise
(c) babble vs. traffic noise
(d) babble vs. music

However, the following null hypotheses cannot be rejected:

1. For male subjects trained to read lips in a quiet environment, there are no differences when comparing their lipreading scores for the test measures of:

(a) quiet vs. babble
(b) quiet vs. industrial noise
(c) babble vs. industrial noise
(d) babble vs. traffic noise
(e) babble vs. music
(f) industrial noise vs. traffic noise
(g) industrial noise vs. music
(h) traffic noise vs. music

2. For female subjects trained to read lips in a quiet environment, there are no differences when comparing their lipreading scores for the test measures of:

(a) quiet vs. industrial noise
(b) quiet vs. traffic noise
(c) quiet vs. music

(d) industrial noise vs. traffic noise
(e) industrial noise vs. music
(f) traffic noise vs. music

The results of the Scheffé complex comparison suggest the following. The fact that males trained in quiet scored significantly poorer in the test measure quiet when this score was compared to an equally weighted sum of all four test measures of noise stimuli contrasts unfavorably, in general, with the results noted by Leonard (1962) who reached opposite conclusions. However, the limitation of cell size (four) in the current study might have been a contributing factor.

The non-significant finding for women trained in identical conditions (quiet) for this same complex contrast (quiet versus the combined noise stimuli) tends to support the evidence gathered by Berger and Lewis (1972) and, in part, by Pettit (1963).

Subjects Trained in Babble

None of the three studies cited immediately above trained their subjects to lipread in noise. Therefore, no further pairwise mean comparisons of test measures from other studies are possible.

Because this present investigation found significant differences for some pairs of test measure means by both male and female subjects trained in babble (Table 8), the following null hypotheses can be rejected:

1. For male subjects trained to read lips in babble, there are no differences when comparing their lipreading scores for the test measures of:

(a) industrial noise vs. music

2. For female subjects trained to read lips in babble, there are no differences when comparing their lipreading scores for the test measures of:

(a) quiet vs. babble
(b) babble vs. music

On the other hand, the following null hypotheses cannot be rejected:

1. For male subjects trained to read lips in babble, there are no differences when comparing their lipreading scores for the test measures of:

(a) quiet vs. babble
(b) quiet vs. industrial noise
(c) quiet vs. traffic noise
(d) quiet vs. music
(e) babble vs. industrial noise
(f) babble vs. traffic noise
(g) babble vs. music
(h) industrial noise vs. traffic noise
(i) traffic noise vs. music

2. For female subjects trained to read lips in babble, there are no differences when comparing their lipreading scores for the test measures of:

(a) quiet vs. industrial noise
(b) quiet vs. traffic noise
(c) quiet vs. music
(d) babble vs. industrial noise
(e) babble vs. traffic noise
(f) industrial noise vs. traffic noise
(g) industrial noise vs. music
(h) traffic noise vs. music

Subjects Trained in Industrial Noise

No significant differences between test measures for either men or women subjects were found. Therefore, the null hypothesis cannot be rejected which states that for subjects trained to read lips in industrial noise, there are no differences when comparing their lipreading scores for all five test measures.

Subjects Trained in Traffic Noise

Test measure mean differences between traffic noise and music were found significant for male subjects (Table 8). Consequently, the following null hypothesis can be rejected:

1. For male subjects trained to read lips in traffic noise, there are no differences when comparing their lipreading scores for the test measures of:

(a) traffic noise vs. music

However, the following null hypotheses cannot be rejected:

1. For male subjects trained to read lips in traffic noise, there are no differences when comparing their lipreading scores for the test measures of:

(a) quiet vs. babble
(b) quiet vs. industrial noise
(c) quiet vs. traffic noise
(d) quiet vs. music
(e) babble vs. industrial noise
(f) babble vs. traffic noise
(g) babble vs. music
(h) industrial noise vs. traffic noise
(i) industrial noise vs. music

2. For female subjects trained to read lips in traffic noise, there are no differences when comparing their lipreading scores for all five test measures.

Subjects Trained in Music

The male and female participants of this study manifested no significant differences between test measure means. As a result, the null hypothesis cannot be rejected which states that for subjects trained to read lips in music, there are no differences when comparing their lipreading scores for all five test measures.

In order to place into proper perspective some of the information presented above, a few final comments are warranted. Of particular interest is the inability of some women subjects to cope with the test measure background of babble. For two categories of training (quiet and babble) the test measure means of women subjects in babble, when compared at their respective training levels to the means of the other test measures, were found to be either significantly lower or lower, but not at a level of .02 significance. Many women, after completing the experiment, commented that they caught themselves sometimes listening to the babble which occasionally contained a recognizable word or short phrase. Although sound represents a sensory stimulus difficult to tune out, most women were able to ignore successfully the other background sounds except for babble. Of these other test measures only music could be judged as meaningful and, therefore, possibly more disruptive.

Men trained in quiet, on the other hand, achieved their poorest scores in quiet. When compared one at a time to the four other test measure means, the mean for quiet was significantly worse in two cases and non-significant but poorer in the remaining two comparisons. The possibility that men more frequently work and play in noise might account for the better scores in those particular test categories.

In the future, when training subjects to lipread or when testing their performance in this process, it is advisable to remember the responses given by the men and women of this study under the various test conditions.

The data, in general, reflect higher scores for the test measures than were anticipated. One reason might be attributed to the high motivation manifested by the group as a whole. Most participants appeared interested in attaining the highest scores possible.

Consequently, they attempted to ignore the various environmental test noises by concentrating on the test stimuli. Secondly, the task of identifying spondaic words could have been viewed as a monotonous undertaking, had it not been for the periodic change in background noise from measure to measure. This change, coupled with the brief duration (fifteen minutes) of each videotape did not make this task monotonous to the point of reducing test scores. In fact, this investigator noticed that many subjects continually looked for subtle differences in the test stimuli which could make them easier to identify.

The Relationship of Trials Needed to Qualify for the Test Session to Training Condition and Sex

The results from this current research revealed that female subjects required significantly fewer trials to qualify for the test session than did male subjects. Although the Leonard (1962) investigation did not test for the relationship between number of trials needed to meet the training criterion and sex of subject, the experimenter did report that his twelve subjects needed from three to ten trials to lipread at the 86 per cent correct level. This compares favorably to the present study where subjects took from one to eight trials (maximum number allowed) to qualify.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The major objectives of this investigation were (1) to ascertain the effects of environment (quiet, babble, industrial noise, traffic noise, and music) on individuals being trained in the lipreading process and (2) to determine whether or not various acoustical conditions (quiet, babble, industrial noise, traffic noise, and music) function as auditory distractors and, thereby, decrease the lipreading efficiency of trained lipreaders in a test situation.

The experimental procedure consisted of a training program and a test session. Forty normal hearing, normal seeing, college-age adults were randomly assigned to one of five groups. All groups contained eight subjects and were divided evenly between men and women. Each subject was placed in one of five different background noise situations and shown, by way of television monitor, one of six videotapes in which a male speaker was presenting a set of spondaic words. The five auditory environmental conditions (with sound pressure presentation levels in dB) included (1) quiet (ambient noise, 50 dB SPL), (2) babble (90 dB SPL), (3) industrial noise (90 dB SPL), (4) traffic noise (90 dB SPL), and (5) music (90 dB SPL). The task of the lipreader in the training session was to continue to watch the same videotape (given no more than eight times over a two day period) until correctly identifying 90 per cent or more of the vocabulary stimuli. Upon satisfying this training criterion, the subject was considered qualified to participate in the final phase of the experiment.

In the test procedure (given within forty-eight hours after training was completed) the same set of vocabulary words was presented five times, on each occasion in a different environmental situation, including a replication of the environment under which the subject had been trained. For each group of subjects, vocabulary word order and test presentation sequence were randomized to preclude order effects.

Data from both the training and test procedures were analyzed statistically. A two-way, fixed-effects analysis of variance was employed to determine the relationship of the number of trials a subject needed to qualify for the test procedure to training condition and sex. The results indicated that men required significantly more trials than women to qualify.

A three-way, fixed-effects analysis of variance with repeated observations was applied to the mean data as a function of training condition, sex and test measure. No significant differences between training categories were noted. However, female subjects achieved significantly higher scores than male subjects. In addition, certain pairs of test measures were found to be significantly different from one another, but these differences were not consistently maintained across training condition and sex.

Conclusions

The results of the data suggest the following conclusions:

(1) Female subjects as a group lipread significantly better than male subjects in the test session.

(2) Female participants needed significantly fewer training trials to qualify for the test session than did male participants.

(3) The scores of male and female subjects trained in various sound environments varied as a function of the noise background employed in the test session. No definite pattern of subject response emerged relative to the noise backgrounds.

(4) The results from the test session demonstrate that subjects trained in various sound backgrounds will achieve comparable scores, irrespective of the environment in which they were trained.

Recommendations

The following are suggestions for continued research exploration:

(1) Future studies, investigating lipreading performance as affected by continuous auditory distractions, should reduce the number of treatment measures tested from five to perhaps three, thereby lessening the opportunity for practice or learning effects among subjects in the test session. A concomitant suggestion would be to enlarge cell size well beyond four subjects. Both of the above changes would increase the power of the test statistic. In addition, the inclusion of treatment measures which are highly intelligible to the test subjects (e.g., selected comedy material) or which are

unpredictable and intermittent in their modes of presentation might prove to be excellent auditory distractors.

(2) Other investigations might alter the nature of the test stimulus to be lipread or the experimental task to be performed by subjects in order to preclude the occurrence of maximum (100%) scores. If, in fact, there are real differences between the treatments of training condition and test measure, they would have a better opportunity of being discovered. A change in test stimuli might include monosyllabic words or selected sentence materials, whereas an alteration in task performance might be (a) training subjects with one set of vocabulary stimuli but testing them with another though comparable set, or (b) training and testing subjects using a different speaker each time.

(3) There should be a further analysis of the effects of babble as a distractor in the successful completion of the lipreading task.

(4) There should be a thorough, penetrating analysis of the differences between men and women as related to a set of criteria that would lead to an understanding of why females seem to be better lipreaders than males.

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APPENDICES

APPENDIX A

VIDEOTAPE WORD ORDERS NUMBERS ONE THROUGH SIX

WORD ORDER FOR VIDEOTAPE #1

1. hotdog
2. mushroom
3. backbone
4. woodwork
5. doormat
6. grandson
7. headlight
8. daybreak
9. pancake
10. iceberg
11. baseball
12. platform
13. lifeboat
14. armchair
15. firefly
16. outside
17. northwest
18. oatmeal
19. railroad
20. inkwell
21. cupcake
22. beehive
23. shipwreck
24. padlock
25. blackboard
26. eardrum
27. coughdrop
28. duckpond
29. birthday
30. toothbrush
31. pinball
32. cowboy
33. mousetrap
34. greyhound
35. farewell
36. stairway
37. therefore
38. playground
39. horseshoe
40. hothouse
41. schoolboy
42. workshop
43. hardware
44. whitewash
45. footstool
46. airplane
47. sunset
48. sidewalk
49. drawbridge
50. vampire

WORD ORDER FOR VIDEOTAPE #2

1. drawbridge
2. blackboard
3. oatmeal
4. therefore
5. greyhound
6. headlight
7. backbone
8. cupcake
9. lifeboat
10. schoolboy
11. airplane
12. northwest
13. padlock
14. vampire
15. platform
16. sidewalk
17. workshop
18. firefly
19. footstool
20. inkwell
21. pinball
22. shipwreck
23. toothbrush
24. doormat
25. sunset
26. birthday
27. mousetrap
28. whitewash
29. armchair
30. grandson
31. eardrum
32. baseball
33. playground
34. coughdrop
35. cowboy
36. stairway
37. mushroom
38. beehive
39. farewell
40. duckpond
41. railroad
42. horseshoe
43. hardware
44. woodwork
45. hothouse
46. iceberg
47. pancake
48. hotdog
49. daybreak
50. outside

WORD ORDER FOR VIDEOTAPE #3

1. northwest
2. drawbridge
3. hardware
4. coughdrop
5. greyhound
6. workshop
7. sunset
8. baseball
9. platform
10. farewell
11. mushroom
12. headlight
13. iceberg
14. shipwreck
15. schoolboy
16. playground
17. oatmeal
18. backbone
19. armchair
20. eardrum
21. cowboy
22. pancake
23. firefly
24. duckpond
25. railroad
26. hothouse
27. outside
28. padlock
29. toothbrush
30. inkwell
31. stairway
32. hotdog
33. daybreak
34. mousetrap
35. footstool
36. cupcake
37. woodwork
38. whitewash
39. pinball
40. grandson
41. lifeboat
42. vampire
43. blackboard
44. beehive
45. therefore
46. airplane
47. doormat
48. birthday
49. sidewalk
50. horseshoe

WORD ORDER FOR VIDEOTAPE #4

1. sidewalk
2. padlock
3. woodwork
4. eardrum
5. greyhound
6. sunset
7. therefore
8. farewell
9. outside
10. shipwreck
11. beehive
12. stairway
13. grandson
14. pinball
15. baseball
16. playground
17. workshop
18. vampire
19. whitewash
20. cowboy
21. platform
22. mushroom
23. schoolboy
24. mousetrap
25. hotdog
26. toothbrush
27. doormat
28. armchair
29. headlight
30. hardware
31. birthday
32. coughdrop
33. oatmeal
34. hothouse
35. iceberg
36. drawbridge
37. railroad
38. duckpond
39. daybreak
40. firefly
41. northwest
42. lifeboat
43. footstool
44. horseshoe
45. airplane
46. inkwell
47. blackboard
48. backbone
49. cupcake
50. pancake

WORD ORDER FOR VIDEOTAPE #5

1. hothouse
2. farewell
3. mushroom
4. footstool
5. airplane
6. shipwreck
7. vampire
8. hardware
9. mousetrap
10. birthday
11. doormat
12. daybreak
13. duckpond
14. cupcake
15. platform
16. horseshoe
17. oatmeal
18. beehive
19. grandson
20. sidewalk
21. schoolboy
22. whitewash
23. headlight
24. pinball
25. cowboy
26. sunset
27. workshop
28. baseball
29. firefly
30. railroad
31. greyhound
32. hotdog
33. therefore
34. toothbrush
35. woodwork
36. coughdrop
37. eardrum
38. backbone
39. outside
40. stairway
41. playground
42. drawbridge
43. iceberg
44. northwest
45. armchair
46. padlock
47. pancake
48. blackboard
49. lifeboat
50. inkwell

WORD ORDER FOR VIDEOTAPE #6

1. coughdrop
2. pancake
3. mousetrap
4. playground
5. firefly
6. platform
7. baseball
8. beehive
9. hotdog
10. eardrum
11. doormat
12. blackboard
13. pinball
14. inkwell
15. therefore
16. cowboy
17. oatmeal
18. lifeboat
19. northwest
20. grandson
21. mushroom
22. duckpond
23. iceberg
24. railroad
25. backbone
26. birthday
27. farewell
28. outside
29. toothbrush
30. armchair
31. shipwreck
32. stairway
33. headlight
34. cupcake
35. greyhound
36. horseshoe
37. woodwork
38. padlock
39. daybreak
40. workshop
41. sidewalk
42. airplane
43. sunset
44. drawbridge
45. hothouse
46. whitewash
47. vampire
48. hardware
49. schoolboy
50. footstool

Individual Stimulus Item Time Sequences for Videotape #1 (in seconds
(a=set; b=word; c=post-word set; d=response interval)

1)	a- 1.8	b- 1.0	c- 3.0	d- 10.0
2)	a- 4.2	b- 1.0	c- 3.6	d- 10.6
3)	a- 1.8	b- 1.0	c- 3.6	d- 10.0
4)	a- 2.4	b- 1.0	c- 3.6	d- 10.0
5)	a- 3.0	b- 1.0	c- 3.6	d- 10.6
6)	a- 3.6	b- 1.0	c- 4.2	d- 10.6
7)	a- 1.2	b- 1.0	c- 4.2	d- 10.0
8)	a- 2.4	b- 1.0	c- 4.2	d- 10.6
9)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
10)	a- 2.4	b- 1.0	c- 4.7	d- 10.6
11)	a- 1.8	b- 1.0	c- 4.2	d- 10.6
12)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
13)	a- 2.4	b- 1.0	c- 4.7	d- 10.6
14)	a- 1.8	b- 1.0	c- 4.2	d- 10.6
15)	a- 1.8	b- 1.0	c- 4.2	d- 10.6
16)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
17)	a- 1.8	b- 1.0	c- 3.6	d- 10.6
18)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
19)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
20)	a- 1.2	b- 1.0	c- 4.7	d- 9.4
21)	a- 2.4	b- 1.0	c- 4.7	d- 10.6
22)	a- 1.8	b- 1.0	c- 4.2	d- 10.6
23)	a- 1.8	b- 1.0	c- 3.6	d- 10.6
24)	a- 2.4	b- 1.0	c- 4.2	d- 10.0
25)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
26)	a- 1.8	b- 1.0	c- 3.6	d- 10.6
27)	a- 2.4	b- 1.0	c- 4.2	d- 10.6
28)	a- 1.8	b- 1.0	c- 4.2	d- 10.0
29)	a- 2.4	b- 1.0	c- 4.2	d- 13.6
30)	a- 2.4	b- 1.0	c- 4.7	d- 10.6
31)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
32)	a- 1.2	b- 1.0	c- 4.2	d- 10.6
33)	a- 2.4	b- 1.0	c- 4.2	d- 10.6
34)	a- 2.4	b- 1.0	c- 4.2	d- 10.6
35)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
36)	a- 1.8	b- 1.0	c- 3.6	d- 10.6
37)	a- 2.4	b- 1.0	c- 4.7	d- 10.6
38)	a- 1.8	b- 1.0	c- 4.2	d- 10.6
39)	a- 1.8	b- 1.0	c- 4.2	d- 10.6
40)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
41)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
42)	a- 1.8	b- 1.0	c- 3.6	d- 10.6
43)	a- 1.8	b- 1.0	c- 5.3	d- 10.6
44)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
45)	a- 1.8	b- 1.0	c- 4.2	d- 10.6
46)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
47)	a- 1.8	b- 1.0	c- 4.2	d- 10.6
48)	a- 1.8	b- 1.0	c- 4.7	d- 10.6
49)	2- 1.8	b- 1.0	c- 4.2	d- 10.6
50)	a- 2.4	b- 1.0	c- 5.3	

APPENDIX B

INDIVIDUAL STIMULUS ITEM TIME SEQUENCES FOR VIDEOTAPES NUMBERS ONE THROUGH SIX

Individual Stimulus Item Time Sequences for Videotape #2 (in seconds)
(a=set; b=word; c=post-word set; d=response interval)

Item	a-	b-	c-	d-
1)	1.8	1.0	3.6	10.6
2)	1.8	1.0	4.7	10.6
3)	1.8	1.0	3.6	10.6
4)	1.8	1.0	3.6	10.6
5)	1.8	1.0	3.6	10.6
6)	1.8	1.0	4.7	10.6
7)	1.8	1.0	4.2	10.6
8)	2.4	1.0	3.6	10.6
9)	1.8	1.0	3.6	10.6
10)	1.8	1.0	4.2	10.6
11)	1.8	1.0	4.2	10.6
12)	1.2	1.0	4.7	10.6
13)	1.8	1.0	3.6	10.6
14)	1.8	1.0	3.6	10.6
15)	2.4	1.0	3.6	10.6
16)	2.4	1.0	3.6	10.6
17)	2.4	1.0	3.6	10.6
18)	2.4	1.0	3.6	10.6
19)	1.8	1.0	4.7	10.6
20)	1.8	1.0	4.2	10.6
21)	1.8	1.0	3.6	10.6
22)	1.8	1.0	3.6	10.6
23)	2.4	1.0	3.6	10.6
24)	2.4	1.0	3.6	10.6
25)	1.8	1.0	4.2	10.6
26)	1.8	1.0	4.2	10.6
27)	2.4	1.0	3.6	10.6
28)	2.4	1.0	4.2	10.6
29)	3.0	1.0	3.6	10.6
30)	3.0	1.0	3.6	10.6
31)	1.8	1.0	4.2	10.6
32)	2.4	1.0	3.6	10.6
33)	2.4	1.0	4.2	10.6
34)	3.0	1.0	3.0	10.6
35)	1.8	1.0	3.6	10.6
36)	2.4	1.0	3.6	10.6
37)	1.8	1.0	4.2	10.6
38)	2.4	1.0	3.6	10.6
39)	2.4	1.0	3.6	10.6
40)	2.4	1.0	3.6	10.6
41)	2.4	1.0	3.6	10.6
42)	1.8	1.0	3.6	10.6
43)	1.8	1.0	4.2	10.6
44)	2.4	1.0	3.6	10.6
45)	1.8	1.0	3.6	10.6
46)	3.0	1.0	3.6	10.6
47)	1.8	1.0	4.7	10.6
48)	2.4	1.0	3.6	10.6
49)	2.4	1.0	3.6	10.6
50)	2.4	1.0	3.6	

Individual Stimulus Item Time Sequences for Videotape #3 (in seconds)
(a= set; b=word; c=post-word set; d=response interval)

1) a- 1.8	11) a- 1.8	21) a- 1.8	31) a- 1.8	41) a- 2.4
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 4.7	c- 4.2	c- 3.6	c- 4.7	c- 4.7
d- 10.6	d- 10.6	d- 10.6	d- 10.6	d- 10.6
2) a- 1.8	12) a- 1.2	22) a- 1.8	32) a- 1.8	42) a- 1.8
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 4.2	c- 4.2	c- 4.2	c- 4.2	c- 4.2
d- 10.6	d- 10.6	d- 10.6	d- 10.6	d- 10.6
3) a- 1.8	13) a- 2.4	23) a- 1.8	33) a- 2.4	43) a- 1.8
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 4.2	c- 4.2	c- 3.6	c- 4.2	c- 4.2
d- 10.6	d- 10.6	d- 10.6	d- 10.6	d- 10.6
4) a- 1.8	14) a- 1.8	24) a- 1.8	34) a- 2.4	44) a- 1.8
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 4.7	c- 4.2	c- 3.6	c- 4.2	c- 4.2
d- 10.6	d- 10.6	d- 10.6	d- 10.6	d- 10.6
5) 2- 1.8	15) a- 2.4	25) a- 2.4	35) a- 1.8	45) a- 2.4
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 5.3	c- 4.7	c- 4.2	c- 4.2	c- 4.7
d- 10.6	d- 10.6	d- 10.6	d- 10.6	d- 10.6
6) a- 1.8	16) a- 1.8	26) a- 1.8	36) a- 2.4	46) a- 2.4
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 4.2	c- 4.2	c- 4.2	c- 4.7	c- 4.2
d- 10.6	d- 10.6	d- 10.6	d- 10.6	d- 10.6
7) a- 1.2	17) a- 1.8	27) a- 1.8	37) a- 1.8	47) a- 1.8
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 4.2	c- 4.2	c- 4.2	c- 4.7	c- 4.2
d- 10.6	d- 10.6	d- 10.6	d- 10.6	d- 10.6
8) a- 2.4	18) a- 1.8	28) a- 1.8	38) a- 1.8	48) a- 1.8
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 3.6	c- 4.7	c- 4.2	c- 4.7	c- 4.2
d- 10.6	d- 10.6	d- 10.6	d- 10.6	d- 10.6
9) a- 1.8	19) a- 2.4	29) a- 2.4	39) a- 1.8	49) a- 1.8
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 4.2	c- 5.3	c- 4.2	c- 4.2	c- 4.2
d- 10.6	d- 10.6	d- 10.6	d- 10.6	d- 10.6
10) a- 1.8	20) a- 1.8	30) a- 1.8	40) a- 2.4	50) a- 1.8
b- 1.0	b- 1.0	b- 1.0	b- 1.0	b- 1.0
c- 4.7	c- 3.6	c- 4.2	c- 3.6	c- 4.2
d- 10.6	d- 10.6	d- 10.6	d- 10.6	

Individual Stimulus Item Time Sequences for Videotape #4 (in seconds)
(a=set; b=word; c=post-word set; d=response interval)

1)	a- 2.4	11)	a- 1.8	21)	a- 2.4	31)	a- 2.4	41)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 4.2		c- 4.2		c- 3.6		c- 4.2		c- 4.2
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		d- 10.6
2)	a- 1.8	12)	a- 1.8	22)	a- 1.8	32)	a- 1.8	42)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 3.6		c- 4.7		c- 4.2		c- 4.2		c- 3.6
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		d- 10.6
3)	a- 2.4	13)	a- 2.4	23)	a- 1.8	33)	a- 1.8	43)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 3.6		c- 4.7		c- 3.6		c- 4.2		c- 3.6
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		d- 10.6
4)	a- 1.8	14)	a- 2.4	24)	a- 2.4	34)	a- 1.8	44)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 4.2		c- 4.2		c- 3.6		c- 4.2		c- 4.2
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		d- 10.6
5)	a- 2.4	15)	a- 2.4	25)	a- 1.8	35)	a- 2.4	45)	a- 2.4
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 4.2		c- 4.2		c- 4.2		c- 3.6		c- 3.6
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		d- 10.6
6)	a- 1.8	16)	a- 1.8	26)	a- 2.4	36)	a- 1.8	46)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 4.7		c- 4.2		c- 3.6		c- 3.6		c- 4.7
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		d- 10.6
7)	a- 2.4	17)	a- 2.4	27)	a- 1.8	37)	a- 1.8	47)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 4.2		c- 3.6		c- 4.2		c- 3.6		c- 4.2
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		d- 10.6
8)	a- 1.8	18)	a- 1.8	28)	a- 2.4	38)	a- 1.8	48)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 4.7		c- 4.2		c- 3.6		c- 3.6		c- 4.2
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		d- 10.6
9)	a- 1.8	19)	a- 1.8	29)	a- 1.8	39)	a- 1.8	49)	a- 2.4
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 4.7		c- 4.2		c- 4.2		c- 3.6		c- 3.6
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		d- 10.6
10)	a- 1.8	20)	a- 1.8	30)	a- 2.4	40)	a- 2.4	50)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 4.2		c- 4.2		c- 4.2		c- 3.6		c- 4.2
	d- 10.6		d- 10.6		d- 10.6		d- 10.6		

Individual Stimulus Item Time Sequences for Videotape #5 (in seconds)
(a=set; b=word; c=post-word set; d=response interval)

1) a- 1.8 b- 1.0 c- 4.2 d- 10.6
2) a- 1.8 b- 1.0 c- 4.7 d- 10.6
3) a- 1.8 b- 1.0 c- 5.9 d- 10.6
4) a- 1.8 b- 1.0 c- 4.2 d- 10.6
5) a- 2.4 b- 1.0 c- 3.6 d- 10.6
6) a- 2.4 b- 1.0 c- 4.7 d- 10.6
7) a- 1.8 b- 1.0 c- 4.2 d- 10.6
8) a- 1.8 b- 1.0 c- 4.7 d- 10.6
9) a- 2.4 b- 1.0 c- 3.6 d- 10.6
10) a- 2.4 b- 1.0 c- 4.2 d- 10.6
11) a- 1.8 b- 1.0 c- 4.7 d- 10.6
12) a- 1.8 b- 1.0 c- 3.6 d- 10.6
13) a- 1.8 b- 1.0 c- 4.2 d- 10.6
14) a- 2.4 b- 1.0 c- 3.6 d- 10.6
15) 2- 1.8 b- 1.0 c- 3.6 d- 10.6
16) a- 1.8 b- 1.0 c- 4.2 d- 10.6
17) a- 1.8 b- 1.0 c- 4.2 d- 10.6
18) a- 1.8 b- 1.0 c- 4.2 d- 10.6
19) a- 1.8 b- 1.0 c- 4.2 d- 10.6
20) a- 2.4 b- 1.0 c- 3.6 d- 10.6
21) a- 1.8 b- 1.0 c- 4.2 d- 10.6
22) a- 1.8 b- 1.0 c- 3.6 d- 10.6
23) a- 1.8 b- 1.0 c- 4.7 d- 10.6
24) a- 2.4 b- 1.0 c- 4.2 d- 10.6
25) a- 1.8 b- 1.0 c- 4.2 d- 10.6
26) a- 1.8 b- 1.0 c- 4.2 d- 10.6
27) a- 1.8 b- 1.0 c- 4.2 d- 10.6
28) a- 2.4 b- 1.0 c- 3.6 d- 10.6
29) a- 2.4 b- 1.0 c- 4.2 d- 10.6
30) a- 2.4 b- 1.0 c- 3.6 d- 10.6
31) a- 2.4 b- 1.0 c- 4.2 d- 10.6
32) a- 1.8 b- 1.0 c- 4.7 d- 10.6
33) a- 2.4 b- 1.0 c- 4.2 d- 10.6
34) a- 2.4 b- 1.0 c- 3.6 d- 10.6
35) a- 1.8 b- 1.0 c- 4.2 d- 10.6
36) a- 1.8 b- 1.0 c- 4.2 d- 10.6
37) a- 1.8 b- 1.0 c- 4.7 d- 10.6
38) a- 1.8 b- 1.0 c- 4.2 d- 10.6
39) a- 1.8 b- 1.0 c- 4.2 d- 10.6
40) a- 1.8 b- 1.0 c- 3.6 d- 10.6
41) a- 1.8 b- 1.0 c- 4.2 d- 10.6
42) a- 1.8 b- 1.0 c- 4.2 d- 10.6
43) a- 2.4 b- 1.0 c- 3.6 d- 10.6
44) a- 1.8 b- 1.0 c- 4.2 d- 10.6
45) a- 2.4 b- 1.0 c- 3.6 d- 10.6
46) a- 1.8 b- 1.0 c- 4.2 d- 10.6
47) a- 1.8 b- 1.0 c- 4.2 d- 10.6
48) a- 1.8 b- 1.0 c- 4.2 d- 10.6
49) a- 2.4 b- 1.0 c- 3.6 d- 10.6
50) a- 1.8 b- 1.0 c- 4.2

Individual Stimulus Item Time Sequences for Videotape #6 (in seconds)
(a=set; b=word; c=post-word set; d=response interval)

1)	a- 3.0	11)	a- 2.4	21)	a- 1.2	31)	a- 1.8	41)	a- 1.2
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 4.7		c- 3.0		c- 1.8		c- 3.0		c- 1.8
	d- 9.4		d- 10.0		d- 7.6		d- 9.4		d- 10.0
2)	a- 1.2	12)	a- 1.8	22)	a- 4.7	32)	a- 1.8	42)	a- 1.2
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 1.8		c- 1.8		c- 1.8		c- 3.0		c- 3.0
	d- 10.0		d- 10.6		d- 10.6		d- 10.0		d- 10.6
3)	a- 2.4	13)	a- 1.2	23)	a- 3.0	33)	a- 1.2	43)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 3.0		c- 2.4		c- 1.8		c- 3.0		c- 3.0
	d- 7.6		d- 7.6		d- 10.0		d- 10.0		d- 10.0
4)	a- 4.7	14)	a- 4.2	24)	a- 1.8	34)	a- 1.8	44)	a- 1.2
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 1.8		c- 1.8		c- 2.4		c- 3.0		c- 3.0
	d- 7.6		d- 10.6		d- 10.6		d- 10.0		d- 10.6
5)	a- 3.6	15)	a- 1.8	25)	a- 1.2	35)	a- 1.8	45)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 2.4		c- 1.8		c- 2.4		c- 2.4		c- 3.0
	d- 10.6		d- 10.0		d- 10.0		d- 10.0		d- 10.0
6)	a- 2.4	16)	a- 1.8	26)	a- 1.2	36)	a- 1.2	46)	a- 1.2
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 3.0		c- 1.8		c- 1.8		c- 2.4		c- 3.0
	d- 10.0		d- 10.6		d- 10.0		d- 5.9		d- 10.6
7)	a- 4.2	17)	a- 2.4	27)	a- 1.2	37)	a- 1.8	47)	a- 1.8
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 1.8		c- 1.8		c- 2.4		c- 3.0		c- 3.0
	c- 10.0		d- 10.0		d- 10.0		d- 10.0		d- 10.6
8)	a- 1.2	18)	a- 1.2	28)	a- 1.8	38)	a- 1.2	48)	a- 1.2
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 2.4		c- 2.4		c- 1.8		c- 3.0		c- 3.0
	d- 9.4		d- 12.4		d- 10.0		d- 10.0		d- 10.6
9)	a- 1.2	19)	a- 1.8	29)	a- 1.8	39)	a- 1.8	49)	a- 1.2
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 2.4		c- 1.8		c- 1.8		c- 3.0		c- 3.0
	d- 10.0		d- 9.4		d- 10.0		d- 10.6		d- 10.6
10)	a- 1.2	20)	a- 1.2	30)	a- 1.8	40)	a- 1.8	50)	a- 1.2
	b- 1.0		b- 1.0		b- 1.0		b- 1.0		b- 1.0
	c- 1.8		c- 1.8		c- 2.4		c- 3.0		c- 3.0
	d- 10.0		d- 10.0		d- 10.0		d- 10.6		

APPENDIX C

FORMS: ALPHABETIZED EXPERIMENT VOCABULARY, EXPERIMENT INSTRUCTIONS, TRAINING ANSWER SHEET AND TEST ANSWER SHEET

EXPERIMENT VOCABULARY

The following list of spondaic words will be employed in this investigation in which you have agreed to participate. It is important that you become very familiar with this vocabulary list as you will be asked to lipread each of these word stimuli in both a training and a test session:

1. airplane
2. armchair
3. backbone
4. baseball
5. beehive
6. birthday
7. blackboard
8. coughdrop
9. cowboy
10. cupcake
11. daybreak
12. doormat
13. drawbridge
14. duckpond
15. eardrum
16. farewell
17. firefly
18. footstool
19. grandson
20. greyhound
21. hardware
22. headlight
23. horseshoe
24. hotdog
25. hothouse
26. iceberg
27. inkwell
28. lifeboat
29. mousetrap
30. mushroom
31. northwest
32. oatmeal
33. outside
34. padlock
35. pancake
36. pinball
37. platform
38. playground
39. railroad
40. schoolboy
41. shipwreck
42. sidewalk
43. stairway
44. sunset
45. therefore
46. toothbrush
47. vampire
48. whitewash
49. woodwork
50. workshop

EXPERIMENT INSTRUCTIONS

Below are the instructions which are to be followed during the training and test portions of the study in which you have agreed to participate. It is important that you become familiar with this experimental procedure in order to achieve the best possible performance.

> "This is a test of your ability to lipread fifty inaudible words such as 'outside' and 'cowboy' as they are presented by me on the television monitor in front of you under a background condition of either quiet or auditory stimulation. On the answer sheet in front of you, decide what word you saw on the screen and write it in the appropriately numbered space provided. Prior to the presentation of each stimulus, its test sequence number will appear above the monitor. Each test word is preceded by several seconds of blank videotape and approximately two seconds of videotape showing the talker ready to present a stimulus item from the closed lips position. After the vocabulary item is uttered, the talker remains on camera for a brief moment before more blank tape appears. After each spondaic item is presented, write down your answer quickly and then look up and prepare to respond to the next stimulus item. About three seconds before each word is presented a pure tone will sound alerting you to the presentation of the next stimulus item. At any time you may refer to your alphabetized vocabulary list. Guessing is encouraged, but if you cannot guess, be sure to draw a line through that particular response blank. Some items may be very easy to identify, others more difficult. In any event, watch the monitor closely when vocabulary items are being presented. All words are just given once. Do you have any questions about what I have asked you to do?"

TRAINING ANSWER SHEET SUBJECT NO._____ NAME_______________

CONDITION____ DATE_______________

1. ________________	18. ________________	35. ________________
2. ________________	19. ________________	36. ________________
3. ________________	20. ________________	37. ________________
4. ________________	21. ________________	38. ________________
5. ________________	22. ________________	39. ________________
6. ________________	23. ________________	40. ________________
7. ________________	24. ________________	41. ________________
8. ________________	25. ________________	42. ________________
9. ________________	26. ________________	43. ________________
10. ________________	27. ________________	44. ________________
11. ________________	28. ________________	45. ________________
12. ________________	29. ________________	46. ________________
13. ________________	30. ________________	47. ________________
14. ________________	31. ________________	48. ________________
15. ________________	32. ________________	49. ________________
16. ________________	33. ________________	50. ________________
17. ________________	34. ________________	

TEST ANSWER SHEET SUBJECT NO.______ NAME______________

CONDITION____ DATE______________

1.______________	18.______________	35.______________
2.______________	19.______________	36.______________
3.______________	20.______________	37.______________
4.______________	21.______________	38.______________
5.______________	22.______________	39.______________
6.______________	23.______________	40.______________
7.______________	24.______________	41.______________
8.______________	25.______________	42.______________
9.______________	26.______________	43.______________
10.______________	27.______________	44.______________
11.______________	28.______________	45.______________
12.______________	29.______________	46.______________
13.______________	30.______________	47.______________
14.______________	31.______________	48.______________
15.______________	32.______________	49.______________
16.______________	33.______________	50.______________
17.______________	34.______________	

APPENDIX D

PRESENTATION ORDER OF THE BACKGROUND NOISE CONDITIONS AND VIDEOTAPE VOCABULARY SEQUENCES USED FOR EACH GROUP OF SUBJECTS EMPLOYED IN THE TRAINING AND TEST SESSIONS

PRESENTATION ORDER OF THE BACKGROUND NOISE CONDITIONS AND VIDEOTAPE VOCABULARY SEQUENCE USED FOR EACH GROUP OF SUBJECTS EMPLOYED IN THE TRAINING AND TEST SESSIONS

Training Session	Test Session				
	(Background noise conditions and videotape vocabulary sequences)				
Quiet (1)	Babble (2)	Quiet (6)	Music (5)	Traffic (3)	Industrial (4)
Babble (6)	Babble (3)	Music (1)	Traffic (2)	Quiet (5)	Industrial (4)
Industrial (1)	Traffic (5)	Music (4)	Quiet (1)	Industrial (3)	Babble (2)
Traffic (1)	Traffic (6)	Music (5)	Babble (3)	Quiet (2)	Industrial (4)
Music (2)	Industrial (3)	Traffic (4)	Quiet (1)	Music (6)	Babble (5)