LIPREADING PERFORMANCE AS A FUNCTION OF VISUAL ACUITY

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY
LARRY J. LOVERING
1969

This is to certify that the

thesis entitled

Lipreading Performance as a
Function of Visual Acuity

presented by

Larry J. Lovering

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Audiology
and Speech Sciences

Edward J. Hardick
Major professor

Date November 14, 1969

ABSTRACT

LIPREADING PERFORMANCE AS A FUNCTION OF VISUAL ACUITY

By

Larry J. Lovering

Few researchers have considered the significance of the eye in the lipreading process. The purpose of this study was to ascertain to what extent the lipreading scores obtained by subjects with normal vision would be affected if the subjects were made nearsighted.

To investigate the problem, it was decided to blur temporarily the vision of subjects with normal acuity. Various blurred conditions were created by means of optical lenses. Twenty sentences were presented for lipreading by motion picture films.

The subjects chosen for the study were five females between the ages of eighteen and twenty-two years. Each subject had normal hearing as determined by an audiometric screening test. Each subject also had normal visual acuity as determined by an optometric examination. Their vision was found to be within normal limits in the following dimensions: 1) accommodation, 2) color vision, 3) visual

field, 4) stereopsis, 5) phorias, 6) internal and external health of the eyes, and 7) monocular and binocular visual acuity.

At the time of the eye examination, an optometrist determined the proper lenses for each subject that would produce a blurred condition of the following levels at a distance of ten feet: 20/100, 20/80, 20/60, 20/40, and 20/20. At the time of the experiment, the proper lenses were placed into a glasses frame that was fitted on the subject. Five films with the same twenty sentences in random order served as the stimulus material and were individually shown to each experimental subject. To control for the learning effect, which presumably would occur as the result of seeing the stimulus material five times, control subjects were employed. They viewed the films in their normal acuity (no lens) condition. Their improvement in lipreading scores was obtained from one film presentation to the next one and was identified as the learning effect. These values were subtracted from the experimental group's scores; this yielded a conservative estimate of the effects of visual distortion on lipreading performance.

The results of the study indicated that lipreading performance is related to visual acuity with a trend in the direction of better lipreading scores as visual acuity was improved from 20/100 to 20/20. There was, at the .01 level of confidence, a statistically significant difference of

lipreading scores in the direction of better lipreading performance when visual acuity was improved from 20/100 to 20/40. Although there was some variation among individual lipreading scores as acuity was improved from 20/40 to 20/20, it was concluded that there was no statistically significant difference in lipreading performance between these two visual acuity levels. It was further concluded that there was no statistically significant difference in lipreading performance between a normal acuity condition (20/20, no lens) and two experimental conditions: 20/40 and 20/20 with optical lenses.

LIPREADING PERFORMANCE AS A FUNCTION OF VISUAL ACUITY

By

Larry J. Lovering

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Audiology and Speech Sciences

1969

ACKNOWLEDGEMENTS

Gratitude is extended to Dr. Philip E. Irion who examined the eyes of the subjects and who determined and provided the optical lenses that were needed to produce the visually blurred conditions that were employed in this study.

Appreciation is due Miss Barbara J. Lueck who served as the speaker in the motion picture film.

TABLE OF CONTENTS

TABLE OF CONTENTS--continued

TABLE OF CONTENTS--continued

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

For the most part, social interaction is accomplished through the transmission and reception of the spoken language. It is common knowledge that adequate hearing sensitivity and discrimination are prerequisite in the reception of speech. It is generally agreed that most people, hearing impaired or not, obtain some amount of information by consciously or unconsciously attending the face and lips of the speaker. As a hearing loss develops, a person may find himself attempting to obtain more information by closely watching the speaker. Upon the recommendation of medical or audiological specialists, hearing impaired persons are sometimes advised to obtain lipreading instructions.

The process by which the spoken language of one person is perceived by another one who cannot hear has sometimes been referred to as "visual hearing,"[1] "speechreading,"[2]

---

[1]Marie K. Mason, "A Cinematographic Technique for Testing Visual Speech Comprehension," Journal of Speech Disorders, Volume 8 (1943), pp. 271-78.

[2]Miriam D. Pauls, "Speechreading," in Hearing and Deafness, ed. by Hallowell Davis, and S. Richard Silverman (1st rev. ed.; New York: Holt, Rinehart and Winston, Inc., 1960), pp. 353-67.

and "lipreading."[3] Throughout this study, the term lipreading will be employed in place of the other two terms. O'Neill and Oyer operationally defined lipreading as ". . . visual thought comprehension."[4] In the present study, the definition proposed by Wood was employed. He stated that lipreading is ". . . the art of comprehending the speech of another through the visual interpretation of gestures, facial movements, and especially lip movements."[5]

Obviously, a blind person cannot read lips. In order to understand a speaker through lipreading, the stimulus must be seen. Therefore, it seems sensible to speculate that one of the necessary parameters in the encoding process of lipreading is the clarity with which input signals are received. The sharpness with which a speaker is viewed appears to be a sensible point of departure from which to begin a study addressed to lipreading performance.

---

[3]Kathryn A. Ordman and Mary P. Ralli, What People Say: The Nitchie School Basic Course in Lipreading (3rd ed., rev.; Washington, D.C.: The Volta Bureau, 1957), p. II.

[4]John J. O'Neill and Herbert J. Oyer, Visual Communication for the Hard of Hearing (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1961), p. 2.

[5]Kenneth S. Wood, "Terminology and Nomenclature," in Handbook of Speech Pathology, ed. by Lee E. Travis (New York: Appleton-Century-Crofts, Inc., 1957), p. 59.

Purpose of the Study

Most of the previous lipreading research, which will be discussed later, reflects a definite lack of concern about the lipreader's visual status. When it is remembered that in the lipreading process, the stimuli must be received prior to decoding, it appears that this facet might present itself as an area into which meaningful research could be accomplished. Feeling a need to determine how lipreading performance might be affected by altering vision, it was decided to select one of several visual conditions for study.

The purpose of this investigation was to ascertain to what extent the lipreading scores of subjects with normal visual acuity would be affected if they were made near-sighted at a distance of ten feet. A group of college students who had obtained measurable scores on a filmed lipreading task were optometrically evaluated. A sample of those who had normal vision was selected to view some lipreading films under different visual acuity conditions.

Hypothesis

It seemed reasonable to speculate that lipreading performance would be best under normal visual acuity conditions and that it would deteriorate as those conditions were changed. To test that assumption, the following null hypothesis was formulated: There is no significant difference among lipreading scores obtained at visual acuity levels of 20/100, 20/80, 20/60, 20/40 or 20/20.

Importance of the Study

Bruhn[6] mentioned that, in the lipreading process, the eyes must attend, perceive, and discriminate the speech articulators in action. O'Neill and Oyer contended that visual skill and lipreading ability offer frontier areas for research and stated that, "The eye should be brought back into the lipreading picture!"[7]

Few studies have been concerned with vision as it relates to lipreading performance. It seems important to learn if lipreading is affected as one of several visual parameters, specifically visual acuity, is varied. Therefore, it appears timely that a study should be conducted which is particularly addressed to lipreading performance as a function of visual acuity.

In terms of clinical importance, the results of this study might assist lipreading teachers to predict the lipreading performance of clients who have a certain level of visual acuity. Further, from the results of this study, suggestions or recommendations regarding the visual acuity status of a clinical population slated for lipreading classes might be submitted.

Much of the past research suggested that many of the areas studied were not strongly related to lipreading

---

[6]Martha Bruhn, The Mueller-Walle Method of Lip Reading for the Hard of Hearing (7th ed.; Boston: M. H. Leavis, 1949), p. 8.

[7]O'Neill and Oyer, Visual Communication, p. 69.

performance. Many of those studies were seemingly not concerned with the visual status of the subjects. The possibility exists that the results of some of the earlier inquiries might therefore be questioned. This study is important in that it may provide data with which the results of some of the previous investigations might be re-evaluated.

Definition of Terms

accommodation: ". . . the automatic focusing of the eye for seeing at different distances."[8]

astigmatism: ". . . a defect of curvature of the refractive surface of the eye in which rays of light from an observed object are not brought to a single focal point. This results in the formation of a distorted image."[9]

color vision: The ability to distinguish various colors.

myopia: (nearsightedness) In this study, the terms "myopia" and "nearsightedness" mean that near vision (less than ten feet) is clear and that far vision (ten feet or more) is blurred.

phoria: "Latent strabismus. A tendency for the visual axes to deviate from the direction in which there is binocular single vision."[10]

stereopsis: "The ability to fuse, with the appreciation of depth, similar images falling

---

[8]Roy O. Scholz, Sight: A Handbook for Laymen (Garden City, New York: Doubleday & Company, Inc., 1960), p. 163.

[9]Ibid.

[10]T. Keith Lyle and Kenneth C. Wybar, Lyle and Jackson's Practical Orthoptics in the Treatment of Squint (5th ed.; Great Britain: Charles C. Thomas Publisher, 1967), p. 615.

on points of the retinae which are slightly disparate laterally. The ability to appreciate the third dimension binocularly."[11]

viseme: "The term phoneme . . . suggests sound and the perception procession in an oral-visual system does not utilize sound. The phrase visual phoneme has been shortened to viseme, and will be used to refer to any individual and contrastive visually perceived unit."[12]

visual acuity: "The ability of the eye to discern and ascertain the shapes of objects in detail is called form perception. The keenness of this function is known as visual acuity."[13]

width of visual field: The arc through which an object is visible, approximately 190 degrees.[14]

Limitations

Although it is recognized that they also might play some role in lipreading performance, this study is not concerned with such visual parameters as the following: 1) accommodation, 2) astigmatism, 3) color vision, 4) phoria, 5) stereopsis, 6) width of visual field, or 7) the internal

---

[11] Ibid., p. 621.

[12] Cletus G. Fisher, "Confusions Among Visually Perceived Consonants," Journal of Speech and Hearing Research, Volume 11 (1968), p. 800.

[13] Joseph B. Gutstein, A Student's Guide to Optometry (2nd ed.; Chicago: Chicago College of Optometry, 1952), p. 28.

[14] Thomas F. Morrison, Fredrick D. Cornett, and J. Edward Tether, Human Physiology (New York: Henry Holt and Company, 1959), p. 126.

and external health of the eyes. Rather, this investigation is limited to the dimension of visual acuity.

With the other visual conditions remaining in their normal state, this inquiry is limited to the investigation of lipreading scores as the result of producing nearsightedness in a number of subjects who have normal vision. Consequently, the results of this study should be guarded in terms of projecting them to a population where any of the other visual dimensions are impaired.

This study is limited to producing myopia by means of prescribed optical lenses. An hypothesis, untested as yet, is posited that there will be a difference in lipreading scores of persons in whom the nearsighted condition is immediately created, as in this study, and the same visual condition which has existed over a period of time. Therefore, the results of this study should be guarded in terms of projecting them to a population in which a visual defect has been known to exist over a period of time.

This inquiry is limited to college students between eighteen and twenty-two years of age. That limits the results in terms of application to a non-college population and of a different age group.

The subjects were limited to females who had normal hearing sensitivity and normal vision. That might impose certain limitations if the results were projected to a male population in which a hearing and/or a vision impairment existed.

Organization of the Thesis

Chapter I included the following: 1) introduction, 2) purpose of the study, 3) null hypothesis, 4) importance of the investigation, 5) definition of terms, 6) limitations of the inquiry, and 7) organization of the thesis. Through a discussion, Chapter II contains a review of some of the research that has been accomplished in lipreading. A description of the equipment, development of the measuring instrument, subjects, and the procedures employed in conducting the study are included in Chapter III. A discussion of the results and the statistical analyses of the study are presented in Chapter IV. Chapter V contains the summary, conclusions, and recommendations for additional research.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

In this chapter, various studies are reviewed. Those cited are concerned with lipreading performance as a function of the following topics: 1) intelligence, 2) stimulus materials, 3) environment, 4) behavioral patterns, 5) speaker, 6) miscellaneous studies, 7) visual skills, 8) visual and mind training, 9) visual perception, and 10) visual acuity. Some lipreading tests are reviewed and the eye is briefly discussed at the end of the chapter.

Intelligence and Lipreading Performance

Pintner,[1] using the Pintner Nonlanguage Mental Test with a group of deaf pupils in a residential school, found a low correlation between lipreading performance and the nonlanguage test. Reid[2] administered a filmed lipreading

---

[1]Rudolf Pintner, "Speech and Speech-Reading Tests for the Deaf," Journal of Applied Psychology, Volume 13 (1929), pp. 220-25.

[2]Gladys Reid, "A Preliminary Investigation in the Testing of Lip-Reading Achievement," American Annals of the Deaf, Volume 91 (1946), pp. 403-13.

test to girls in schools for the deaf and found no significant relationship between intelligence and lipreading performance. Employing one of the Mason films, O'Neill[3] found a significant correlation between the Wechsler-Bellevue Adult Intelligence Scale and lipreading performance. Later, in a follow-up investigation, using a sample of university students with normal hearing, O'Neill and Davidson[4] found no significant correlation between lipreading performance and intelligence. Simmons,[5] employing hard-of-hearing individuals, found no meaningful correlation between lipreading ability and intelligence as measured by the Wechsler-Bellevue test. While studying 240 deaf school age students, Quigley and Frisina[6] found a low relationship between intelligence and lipreading performance on

---

[3]John J. O'Neill, "An Exploratory Investigation of Lipreading Ability Among Normal Hearing Students," Speech Monographs, Volume 18, No. 4 (1951), pp. 309-11.

[4]John J. O'Neill and JoAnn L. Davidson, "Relationship Between Lipreading Ability and Five Psychological Factors," Journal of Speech and Hearing Disorders, Volume 21, No. 4 (1956), pp. 478-81.

[5]Audrey A. Simmons, "Factors Related to Lipreading," Journal of Speech and Hearing Research, Volume 2, No. 4 (1959), pp. 340-52.

[6]Stephen P. Quigley and D. Robert Frisina, "Institutionalization and Psychoeducational Development of Deaf Children," C. E. C. Research Monograph, Series A, No. 3 (1961), pp. 1-49.

Form A of the Utley Test.[7] Smith,[8] while sampling a retarded population, discovered that lipreading performance varied with the level of intelligence; the individuals with higher intelligence were better lipreaders than were those with lower intelligence. With a filmed test of lipreading, the Heiders[9] found no significant relationship between lipreading performance and school achievement in a population at the Clarke School for the Deaf. With normal hearing children in the sixth, ninth, and twelfth grades, Cavender[10] found no meaningful relationship between lipreading and intelligence scores. With the exception of mentally retarded individuals, it appears that there is no clear demonstrated relationship between intelligence and lipreading performance.

---

[7]Jean Utley, "A Test of Lip Reading Ability," Journal of Speech Disorders, Volume 11 (1946), pp. 109-16.

[8]Richard C. Smith, "An Investigation of the Relationship Between the Lipreading Ability and Intelligence of the Mentally Retarded" (Unpublished Master's Thesis, Michigan State University, 1964).

[9]Fritz K. Heider and Grace M. Heider, "An Experimental Investigation of Lip Reading," Psychological Monographs, Volume 52 (1940), pp. 1-153.

[10]Betty J. Cavender, "The Construction and Investigation of a Test of Lip Reading Ability and a Study of Factors Assumed to Affect the Results" (Unpublished Master's Thesis, Indiana University, 1949).

Stimulus Materials and Lipreading Performance

Taaffe and Wong[11] determined that the length of the stimulus words, the number of syllables in a sentence, the number of words in a sentence, and the number of consonants and vowels affected lipreading performance. O'Neill,[12] in studying the visibility of phrases, vowels, words, and consonants, determined that vision accounted for 17.4 per cent in the identification of phrases, 29.5 per cent for vowels, 38.6 per cent for words, and 57.0 per cent for consonants. Morris,[13] while investigating lipreading stimulus materials, discovered that lipreading scores declined as the sentence became longer, that a word was more difficult to discriminate in a long sentence as compared to being placed in a short sentence, and that its position within a group of sentences did not especially influence the lipreadability of the message. While studying the visual components in the intelligibility of oral speech in a background of noise, Sumby and Pollack[14] learned that as the speech signal was

---

[11]Gordon Taaffe and Wilson Wong, "Studies of Variables in Lip Reading Stimulus Material," John Tracy Clinic Research Papers, III (December, 1957).

[12]John J. O'Neill, "Contributions of the Visual Components of Oral Symbols to Speech Comprehension," Journal of Speech and Hearing Disorders, Volume 19 (1954), pp. 429-39.

[13]Dorothy M. Morris, "A Study of Some of the Factors Involved in Lipreading" (Unpublished Master's Thesis, Smith College, 1944).

[14]W. H. Sumby and Irwin Pollack, "Visual Contribution to Speech Intelligibility in Noise," Journal of the Acoustical Society of America, Volume 26 (1954), pp. 212-15.

decreased, there was an increased visual contribution to the intelligibility of speech. In a task of identifying the same stimulus words by vision and then by audition, Reams[15] did not obtain a significant relationship between identification and auditory discrimination. In studying the effects of visual clues on speech intelligibility, Neely[16] demonstrated that speech intelligibility was raised about 25 per cent when visual and auditory cues were combined. DeLand[17] pointed out that Alexander Graham Bell was credited with positing the hypothesis that some words look alike (homophenous) on the lips. Woodward,[18] and later Woodward and Barber,[19] studied the concept of homophenous units in lipreading. Those investigators felt that although the categories were contrastive, the members of any feature

---

[15]Mary H. Reams, "An Experimental Study Comparing the Visual Accompaniments of Word Identification and the Auditory Experience of Word Intelligibility" (Unpublished Master's Thesis, Ohio State University, 1950).

[16]Keith K. Neely, "Effect of Visual Factors on the Intelligibility of Speech," Journal of the Acoustical Society of America, Volume 28 (1956), pp. 1275-77.

[17]Fred DeLand, The Story of Lipreading: Its Genesis and Development (rev.; Washington: The Volta Bureau, 1968), p. 118.

[18]Mary F. Woodward, "Linguistic Methodology in Lip Reading Research," John Tracy Clinic Research Papers, IV (December, 1957).

[19]Mary F. Woodward and Carroll G. Barber, "Phoneme Perception in Lip Reading," Journal of Speech and Hearing Research, Volume 3 (1960), pp. 212-22.

looked alike; and differentiation between components of a given unit could only result from lexical, phonetic or grammatical redundancy. Fisher[20] studied the homophony of consonant sounds in English. His results tended to support the Woodward studies more than the classical listing of homophenous visemes from the traditional developers of lipreading methodology. For example, he suggested that there is no homophenous relationship among /n/, /t/, and /d/ in the initial or final positions. Greenberg and Bode[21] investigated consonants in terms of visual discrimination. They learned that consonant discrimination was higher when the whole face was viewed as opposed to seeing only the lips and that initial consonants were more easily identified than were final consonants. Franks[22] looked at some factors that might influence the identification of various visemes in lipreading. He reported that in the lipreading task, the identification of initial consonants is not influenced by the initial consonant and a known VC (vowel-consonant) stem. Visual identification of monosyllabic words by unskilled and skilled lipreaders was investigated

---

[20]Fisher, "Confusions Among Consonants," pp. 796-804.

[21]Herbert J. Greenberg and Daniel L. Bode, "Visual Discrimination of Consonants," Journal of Speech and Hearing Research, Volume 11 (1968), pp. 869-74.

[22]John R. Franks, "A Study of Factors that Influence the Identification of English Sounds in Lipreading" (Unpublished Doctoral Dissertation, Michigan State University, 1964).

by Brannon and Kodman.[23] Their results indicated no significance between the groups in their aptitude to identify isolated monosyllabic words visually. Haas and Oyer[24] studied visual recognition speed, familiarity, and redundancy pattern as related to lipreading performance. They found that duration speeds of 1/500 second for visual recognition provided significant correlations with lipreading performance and that the type of stimuli was a significant variable. It might be concluded that length, visibility and familiarity of the stimulus materials in addition to the redundancy and speed of recognition are important factors in the lipreading process.

Environment and Lipreading Performance

Some researchers have been concerned with the environment in which lipreading takes place. Mulligan[25] studied lipreading performance as the stimulus materials were presented through motion pictures. She discovered that the most favorable viewing distance between the screen and the

---

[23]John B. Brannon and Frank Kodman, "The Perceptual Process in Speech Reading," A. M. A. Archives of Otolaryngology, Volume 70 (1959), pp. 114-19.

[24]William H. Haas and Herbert J. Oyer, "Visual Recognition Speed, Familiarity, Redundancy Pattern, and Lipreading Performance," Unpublished Study, Department of Audiology and Speech Sciences, Michigan State University, 1969.

[25]Marigene Mulligan, "Variables in the Reception of Visual Speech from Motion Pictures" (Unpublished Master's Thesis, Ohio State University, 1954).

subjects was ten feet. In an investigation addressed to the effects of delayed auditory feedback upon lipreading performance, Miller, Rousey, and Goetzinger[26] found that lipreading performance improved after subjects were exposed about 0.19 seconds to a delayed sidetone. Thomas[27] studied the problem of light levels and lipreading performance. She learned that there was no significant decrease in lipreading performance until there was one-half foot candle of light on the speaker's face. Leonard[28] investigated the effects of auditory distractions during lipreading sessions. He reported that lipreading performance was highest in a quiet situation and lowest during the presence of speech in the background. Lowell[29] reported an inquiry in which the relationship between the reception of distorted speech and lipreading performance was studied. He discovered that the lipreaders who were classified as neither good nor bad were better listeners, whereas the best and the worst lipreaders appeared to be the poorest

---

[26]June Miller, Clyde L. Rousey, and C. P. Goetzinger, "An Exploratory Investigation of a Method of Improving Speechreading," American Annals of the Deaf, Volume 103, No. 1 (1958), pp. 473-78.

[27]Sharon L. Thomas, "Lipreading Performance as a Function of Light Levels" (Unpublished Master's Thesis, Michigan State University, 1962).

[28]Ralph Leonard, "The Effects of Continuous Auditory Distractions on Lipreading Performance" (Unpublished Master's Thesis, Michigan State University, 1962).

[29]Edgar L. Lowell, "Pilot Studies in Lip Reading," John Tracy Clinic Research Papers, VIII (February, 1958).

listeners. Subar[30] investigated the effects of the deprivation of visual stimuli on lipreading performance. With as much as 45 per cent of the visual stimuli removed from the viewer, she found no difference in lipreading performance. Keil[31] determined that various types of visual background distractions produced no significant effects on lipreading performance. It appears that lipreading is possible in minimal light and that lipreading performance is best in a quiet auditory background. It might also be concluded that visual background distractions do not affect lipreading and that lipreading can be accomplished with as much as 45 per cent of the stimulus removed.

Behavioral Patterns and Lipreading Performance

Some investigators have been curious about the various behavioral patterns of lipreaders. O'Neill,[32] using normal hearing college students, administered a number of tests which included the Rorschach Test, the Rotter Incomplete Sentence Test, the Knower-Dusenbury Test of Ability to Judge Emotions, and the Knower Speech Attitude Scale.

---

[30]Barbara E. Subar, "The Effects of Visual Deprivation on Lipreading Performance" (Unpublished Master's Thesis, Michigan State University, 1963).

[31]Janice M. Keil, "The Effects of Peripheral Visual Stimuli on Lipreading Performance" (Unpublished Doctoral Dissertation, Michigan State University, 1968).

[32]O'Neill, "Investigations of Lipreading Ability," pp. 309-11.

He attempted to correlate lipreading performance and the tests administered. There was no significant correlation between any of the areas and lipreading performance. In a similar study, O'Neill and Davidson[33] found no meaningful relationship between lipreading performance and the level of aspiration. While studying aptitudes, Wong and Taaffe[34] discovered a significant correlation between lipreading performance and associational fluency, spontaneous flexibility, and ideational fluency. Worthington[35] found no meaningful correlation between lipreading performance and various personality factors in a congenitally deaf high school population. Research suggests that there is no meaningful relationship between lipreading performance and the various behavioral patterns that were studied.

Speaker and Lipreading Performance

Several investigations have been addressed to lipreading ability as a function of the speaker. In terms of

---

[33]O'Neill and Davidson, "Lipreading Ability and Psychological Factors," pp. 478-81.

[34]Wilson Wong and Gordon Taaffe, "Relationships Between Selected Aptitude and Personality Tests and Lipreading Ability," John Tracy Clinic Research Papers, VII (February, 1958).

[35]Anna M. Worthington, "An Investigation of the Relationship Between the Lipreading Ability of Congenitally Deaf High School Students and Certain Personality Factors" (Unpublished Doctoral Dissertation, Ohio State University, 1956).

conveying information either by audition or vision, O'Neill[36] learned that the talker who transmitted more information visually was the easiest one understood through only the auditory channel. Stone[37] looked at lipreading performance as a function of lip mobility, facial exposure, and facial expression. He reported that normal lip movement, as opposed to a tight movement, and a plain face set, instead of a smiling one, resulted in higher lipreading performance. Byers and Lieberman[38] studied the rate of speech on lipreading performance. They accomplished that with a motion picture film with a projection speed which was set at four different rates. They discovered that slowing the production speed produced no significant difference in lipreading performance. Fulton[39] explored the visible differences between the unvoiced and voiced production of four words. He learned that unvoiced productions reflected the largest shifts and displayed tendencies toward exaggeration by the speakers.

---

[36]John J. O'Neill, "Contributions of the Visual Components of Oral Symbols to the Speech Comprehension of Listeners With Normal Hearing" (Unpublished Doctoral Dissertation, Ohio State University, 1951).

[37]Louis Stone, "Facial Cues of Context in Lip Reading," John Tracy Clinic Research Papers, V (December, 1957).

[38]Vincent W. Byers and Lewis Lieberman, "Lipreading Performance and the Rate of the Speaker," Journal of Speech and Hearing Research, Volume 2 (1959), pp. 271-76.

[39]Richard M. Fulton, "Comparative Assessment of Visible Differences Between Voiced and Unvoiced Words" (Unpublished Master's Thesis, Michigan State University, 1964).

Further, he reported that, while talking, females displayed a larger teeth area, a wider mouth, and a more prominent lip opening than did males. Facial movements during the utterance of homophenous words were investigated by Sahlstrom.[40] He reported that males exhibited more facial movement than did females for all consonant sounds and word positions. Joergenson[41] was concerned with the size of mouth openings when homophenous words were uttered. Results suggested differences in mouth openings during the production of homophenous words, but there was no statistical difference in mouth widths during which time the teeth were visible. Roback,[42] while studying homophenous words, discovered that they were not produced exactly the same even though they appeared highly similar. A study addressed to the effect of redundancy on the visual identification of frequently spoken words was conducted by Nielsen.[43] Her data suggested that there was no statistically significant improvement in visual recognition

---

[40]Lowell J. Sahlstrom, "Objective Measurement of Certain Facial Movements During Production of Certain Homophenous Words" (Unpublished Doctoral Dissertation, Michigan State University, 1967).

[41]Ann Joergenson, "The Measurement of Homophenous Words" (Unpublished Master's Thesis, Michigan State University, 1962).

[42]Ila M. Roback, "Homophenous Words" (Unpublished Master's Thesis, Michigan State University, 1961).

[43]Karen M. Nielsen, "The Effect of Redundancy on the Visual Recognition of Frequently Employed Spoken Words" (Unpublished Doctoral Dissertation, Michigan State University, 1966).

upon the repetition of the stimulus words. Aylesworth[44] conducted a study which was concerned with lipreading as a function of different speakers, as the result of presentations by the same speaker, and as a result of the sex of the speaker and lipreader. He found no difference among scores as a result of different speakers, presentations by the same speaker, or the speaker sex. However, female lipreaders were significantly more successful at the task than were male lipreaders. Black[45] investigated the ease with which words were lipread. He discovered that position of the accent in the word contributed to lipreading success. Research suggests several factors such as facial set, facial movement, etc., that influence lipreadability. The parameters reported appear to be important in the lipreading process.

Miscellaneous Studies of Lipreading Performance

Gault[46] investigated the identification of words by vision only and then by simultaneous vision and tactile

---

[44]Donald L. Aylesworth, "The Talker and the Lipreader as Variables in Face-to-Face Testing of Lipreading Ability" (Unpublished Master's Thesis, Michigan State University, 1964).

[45]John W. Black, "Accompaniments of Word Intelligibility," Journal of Speech and Hearing Disorders, Volume 17 (1952), pp. 409-18.

[46]Robert Gault, "On the Identification of Certain Vowel and Consonantal Elements in Words by Their Tactile Qualities and by Their Visual Qualities as Seen by the Lip-Reader," Journal of Abnormal Psychology, Volume 22 (1927-28), pp. 33-39.

stimulation. With the information being received in both channels, about twice as many words were recognized. In a similar study, Johnson[47] found that lipreading performance is higher when the subject simultaneously sees the visual message and feels it through cutaneous stimulation than when it is received only through lipreading. Blakeley[48] was curious to know if the ability to synthesize visual cues into language was correlated with abilities to understand incomplete patterns of speech delivered through auditory channels. He did not find any meaningful correlation between the two parameters. Upton,[49] an electronics engineer, described prototype eyeglasses as an aid to lipreading. An electronic analyzer extracts the voicing, fricative, and stop information from speech. The analyzer's output is fed to miniature lights that are mounted on the lenses of the spectacles. The speech stimulus causes the lights to flash in synchronism with the speech signal which produces light patterns that are seen. Research suggests that lipreading improves when the stimuli is simultaneously seen and felt. It was further concluded that there was no correlation

---

[47]Gerald F. Johnson, "The Effects of Cutaneous Stimulation by Speech on Lipreading Performance" (Unpublished Doctoral Dissertation, Michigan State University, 1963).

[48]Robert W. Blakeley, "Auditory Abilities Associated With Lip Reading" (Unpublished Master's Thesis, University of Oregon, 1953).

[49]Hubert W. Upton, "Wearable Eyeglass Speechreading Aid," American Annals of the Deaf, Volume 113 (1968), pp. 222-29.

between the ability to synthesize visual clues in language with the ability to understand incomplete speech through audition.

Visual Skills and Lipreading Performance

Visual skills held the fascination of various researchers. Kitson[50] appears to have been one of the pioneers who employed the tachistoscope to study lipreading performance. In his study, he found that persons who were better lipreaders obtained markedly better scores on tachistoscopically presented materials than did poorer lipreaders. Woolley[51] used the tachistoscope in teaching lipreading. Olson,[52] employing the tachistoscope, along with other instruments in a deaf population, learned that fingerspelling, manual signs, and lipreading were dependent on the rapidity of visual perception. O'Neill and Davidson,[53] using normal hearing individuals, compared lipreading performance and memory with tachistoscopically presented horizontally grouped digits. No significant correlation was found between

---

[50]H. D. Kitson, "Psychological Tests for Lipreading Ability," Volta Review, Volume 17 (1915), pp. 471-76.

[51]Florence T. Woolley, "How We Use the Tachistoscope," Hearing News, Volume 17 (1949), pp. 3-4.

[52]Jack Olson, "A Factor Analytic Study of the Relation Between the Speed of Visual Perception and the Language Abilities of Deaf Adolescents," Journal of Speech and Hearing Research, Volume 10, No. 2 (1967), pp. 354-59.

[53]O'Neill and Davidson, "Lipreading Ability and Psychological Factors," pp. 478-81.

lipreading performance and the memory for digits in that population. Simmons[54] conducted a similar study with digits tachistoscopically presented to hard-of-hearing subjects. Again, no meaningful correlation between the memory task and lipreading performance was obtained. Costello,[55] with hard-of-hearing and deaf individuals, presented digits in sequential order, i.e., one at a time, instead of groups of digits in line form, and found significant correlations between that task and lipreading performance. Further, she discovered significant correlations between the picture arrangement subtest of the WISC and lipreading performance with hard-of-hearing and deaf school age children. In that connection, Simmons[56] discovered a significant correlation between lipreading performance of filmed tests and the adult Wechsler picture arrangement in hard-of-hearing adults. On a test using digits, Pintner and Paterson[57] found that hearing and hard-of-hearing subjects had a better visual

---

[54]Simmons, "Factors Related to Lipreading," pp. 340-52.

[55]Mary R. Costello, "A Study of Speech Reading as a Developing Language," Speech Monographs, Volume 25 (1958), pp. 137-38.

[56]Simmons, "Factors Related to Lipreading," pp. 340-52.

[57]Rudolf Pintner and Donald G. Paterson, "A Comparison of Deaf and Hearing Children in Visual Memory for Digits," Journal of Experimental Psychology, Volume 2 (1917), pp. 76-88.

memory than did deaf persons. Blair[58] found that deaf subjects had a better memory for visual movements than did hearing subjects. It can be concluded that visual skills are important in the lipreading process.

Visual and Mind Training and Lipreading Performance

At the same time realizing the importance of other parameters in lipreading performance, some researchers have focused their attention mainly on visual and/or mind training as important to lipreading. Stobschinski[59] suggested four types of speech thinking. They were the 1) script-motor, 2) speech-motor, 3) acoustic, and 4) visual-speech types. He concluded that for the acquisition of lipreading, the visual-speech type was of paramount importance. The Nitchies[60,61] were strong advocates of the synthetic approach in which the eye and mind were trained to grasp the whole message quickly from only a part of the visually

---

[58]Francis X. Blair, "A Study of the Visual Memory of Deaf and Hearing Children," American Annals of the Deaf, Volume 102 (1957), pp. 254-63.

[59]Robert Stobschinski, "Lip Reading: Its Psychological Aspects and Its Adaptation of the Individual Needs of the Hard of Hearing," American Annals of the Deaf, Volume 73 (1928), pp. 234-42.

[60]Edward B. Nitchie, Lip-Reading (New York: Fredrick A. Stokes Company, 1919), pp. 1-324.

[61]Elizabeth H. Nitchie, "The Synthetic Method and Why I Believe In It." Volta Review, Volume 21, No. 12 (December, 1919), pp. 764-71.

discriminated stimuli. Bell[62] pointed out that adequate eyesight alone cannot completely solve the problems associated with lipreading. She emphasized that the mind must be trained to grasp the whole meaning of speech from only a fraction of what is seen. Torrey[63] stressed the importance of a synthetic mind and of mind training as an important adjunct to the acquisition of lipreading ability. Kitchen[64] investigated the relationship between lipreading performance and visual synthetic ability. He found that visual synthesis was positively related to the lipreading of words and stories. Howell[65] stressed the importance of a synthetic mind in the lipreading process and pointed out how it was unnecessary to see every lip movement. Kenfield[66] suggested that no special sense was required for lipreading. Rather, she stressed the significance of undeveloped ability and the importance of training the eyes and mind as a requisite for successful lipreading experience.

---

[62]Mabel H. Bell, "Helping the Deaf Read the Lips of Their Hearing Contemporaries," Volta Review, Volume 42, No. 10 (1940), pp. 607-10.

[63]Gertrude Torrey, "Lip Reading for the Adult Deaf," Volta Review, Volume 16, No. 8 (1914), pp. 535-39.

[64]Dale W. Kitchen, "The Relationship of Visual Synthesis to Lipreading Performance" (Unpublished Doctoral Dissertation, Michigan State University, 1968).

[65]Louise Howell, "Lipreading for the Hard of Hearing Adult," Volta Review, Volume 19, No. 1 (1917), pp. 15-16.

[66]Coralie Kenfield, "Some Mental Problems of Lipreading," Volta Review, Volume 21, No. 1 (1919), pp. 38-39.

Keith[67] corroborated Kenfield's point but stressed the importance of repetitive drills as a necessary facet in lipreading performance. From an analytical, rather than a synthetic point of view, Brainerd[68] studied the relationship between a person's lipreading skill and the tendency to perceive his visual environment analytically. She concluded that performance on a filmed lipreading test is positively related to performance on an embedded figures test. With reference to visual training, per se, Forrest[69] emphasized its importance when he pointed out that over 80 per cent of the stimuli received by the human organism is visual. Further, he stated that

> . . . it must be remembered that a sense receptor brings only coded data to the organism. How this [sic] data is [sic] matched with the information the organism already has accumulated through movement determines how much the organism will get from the world around him.[70]

Visual Perception

There are many articles and studies which have dealt with the perception of visual stimuli. A number of studies

---

[67]John Keith, "Everyone Has What it Takes," Volta Review, Volume 45, No. 9 (1943), pp. 576-78.

[68]Susan C. Brainerd, "An Investigation of the Relation Between Performance on a Filmed Lipreading Test and Analysis of the Visual Environment" (Unpublished Master's Thesis, Michigan State University, 1969).

[69]Elliot B. Forrest, "Approaching Vision Training," Academic Therapy Quarterly, Volume 3, No. 3 (1968), pp. 155-61.

[70]Ibid., p. 160.

were reviewed that employed the tachistoscope in search of information about visual perception, word probability, and duration of thresholds.[71-81] Psychologists have studied

---

[71]Katherine E. Baker and Herman Feldman, "Threshold-Luminance for Recognition in Relation to Frequency of Prior Exposure," American Journal of Psychology, Volume 69 (1956), pp. 278-80.

[72]Patricia K. Ellison and James J. Jenkins, "The Durational Threshold of Visual Recognition as a Function of Word Frequency," American Journal of Psychology, Volume 67 (1954), pp. 700-03.

[73]G. L. Freeman, "An Experimental Study of the Perception of Objects," Journal of Experimental Psychology, Volume 12 (1929), pp. 341-58.

[74]James J. Gibson, "The Reproduction of Visually Perceived Forms," Journal of Experimental Psychology, Volume 12, No. 1 (1929), pp. 1-39.

[75]Davis H. Howes and Richard L. Solomon, "Visual Duration Threshold as a Function of Word-Probability," Journal of Experimental Psychology, Volume 41 (1951), pp. 401-10.

[76]Mortimer Mishkin and Donald G. Forgays, "Word Recognition as a Function of Retinal Locus," Journal of Experimental Psychology, Volume 43 (1952), pp. 43-48.

[77]Craig Mooney, "Closure as Affected by Viewing Time and Multiple Visual Fixations," Canadian Journal of Psychology, Volume 11 (1957), pp. 21-28.

[78]Jan Pierce, "Some Sources of Artifact in Studies of the Tachistoscopic Perception of Words," Journal of Experimental Psychology, Volume 66, No. 4 (1963), pp. 363-70.

[79]Frank Smith, "An Experimental Investigation of Perception," British Journal of Psychology, Volume 6 (June 1913-February 1914), pp. 321-62.

[80]Richard L. Solomon and Leo Postman, "Frequency of Usage as a Determinant of Recognition Thresholds for Words," Journal of Experimental Psychology, Volume 43 (January-June, 1952), pp. 195-201.

[81]Endel Tulving and Cecille Gold, "Stimulus Information and Contextual Information as Determinants of Tachistoscopic Recognition of Words," Journal of Experimental Psychology, Volume 66, No. 4 (1963), pp. 319-27.

visual shape perception, visual recognition, short term visual memory, perception of visual texture, development of visual and tactile-kinesthetic perception, the geometrical probability in visual perception and many more related topics.[82,83] Although there appeared to be many studies addressed to visual perception, per se, none were found that were specifically concerned with visual perception as it relates to lipreading performance.

Visual Acuity and Lipreading Performance

While examining a deaf population, Braly[84] and Stockwell[85] found that there was a higher incidence of visual impairment in that group than in a normal hearing population. Sloan and Rosenthal[86] suggested that from 20 per cent to 30 per cent of the normal hearing school population has visual

---

[82]Weiant Wathen-Dunn, ed., Models for the Perception of Speech and Visual Form (Cambridge: The M. I. T. Press, 1967), pp. 1-470.

[83]C. H. Graham, "Visual Perception," in Handbook of Experimental Psychology, ed. by S. S. Stevens (New York: John Wiley & Sons, Inc., 1951), pp. 868-920.

[84]Kenneth W. Braly, "A Study of Defective Vision Among Deaf Children," American Annals of the Deaf, Volume 83 (1938), pp. 192-93.

[85]Eunice Stockwell, "Visual Defects in the Deaf Child," A. M. A. Archives of Ophthalmology, Volume 48 (1952), pp. 428-32.

[86]Albert E. Sloan and Perry Rosenthal, "School Vision Testing," A. M. A. Archives of Ophthalmology, Volume 64 (1960), pp. 763-70.

impairment. Suchman[87] pointed out that it was reasonable to assume that a deaf population would present visual impairment. In elaborating on that point, she stated that

> . . . since the cochlea and retina are formed at the same developmental stage from the same embryonic layer, it is not surprising that both frequently show impairment.[88]

In testing the vision of 103 deaf children ranging in age from 4 to 12 years, Suchman found that 58 per cent of them were visually impaired. The teachers of these visually impaired deaf children reported that they were significantly less able to lipread than were the deaf children with normal vision.[89] Burg[90] was concerned with dynamic visual acuity which is the ability to discriminate an object that is in motion. He found a high degree of correlation between dynamic and static acuity performance. Further, he reported that for a moving target, visual acuity is poorer than for a stationary one. In addition, it was reported that with advancing age there is a decline in visual acuity and the decline is markedly more pronounced with a moving target

---

[87]Rosslyn G. Suchman, "Visual Impairment Among Deaf Children--Frequency and Educational Consequences," Volta Review, Volume 70, No. 1 (1968), pp. 31-37.

[88]Ibid., p. 31.

[89]Ibid., p. 37.

[90]Albert Burg, "Visual Acuity as Measured by Dynamic and Static Tests: A Comparative Evaluation," Journal of Applied Psychology, Volume 50, No. 6 (1966), pp. 460-66.

than with a stationary one. Finally, Burg[91] concluded that men, on the average, have slightly better visual acuity than do women. In another study where he employed some 17,300 subjects ranging in age from 16 to 92 years, Burg[92] discovered that women demonstrated a larger visual field than did men. Goetzinger,[93] using a face-to-face presentation of the Utley sentence Form A, studied monocular versus binocular vision in lipreading performance. His subjects were 36 females. Twenty-seven were between 18 and 22 years, and the other nine were between 25 and 37 years. Eye dominance was determined. The subjects, in groups of six each, were assigned as binocular, dominant eye monocular, or nondominant eye monocular viewers. The subjects sat in chairs that were arranged in a slight arch at a distance of eight feet from the speaker who presented each sentence twice. An opaque shield covered one eye in the monocular situation. The subjects were instructed to write their responses after the second presentation. Scoring was accomplished by counting the correct words. When the lipreading sessions were completed, the subjects had their vision tested on an Ortho-Rater, a product of the Bausch & Lomb Optical Corporation.

---

[91] Ibid., p. 464.

[92] Ibid., Volume 52 (1968), pp. 10-15.

[93] Cornelius P. Goetzinger, "A Study of Monocular Versus Binocular Vision in Lipreading," in Report of the Proceedings of the 41st Meeting of the Convention of American Instructors of the Deaf, Congressional Document No. 106, 88th Congress, June 22-28, 1963.

Tests of vertical and lateral phoria, depth perception, and visual acuity for both eyes were obtained. The specific results of those vision tests were not reported by the author. In reference to the binocular condition, 5 of the 12 subjects had some ocular imbalance even while wearing glasses. The average score was 67 for the impaired binocular group and 63 for the unimpaired group. Goetzinger concluded the following: 1) depth perception did not appear to be a significant variable for successful lipreading performance, 2) superiority of binocular over monocular vision in lipreading performance was not demonstrated, 3) visual acuity did not appear to be an important factor in lipreading ability in the monocular condition, 4) minor deviations in acuity or phorias did not negatively affect lipreading performance, and 5) as a group, older subjects were significantly poorer lipreaders than were younger subjects.

From a review of the literature, it appears that the investigation by Hardick, Oyer, and Irion[94] was the first one of its kind to consider visual acuity as a prime factor in lipreading performance. Specifically, that was the first published research that employed the joint efforts of workers in the fields of audiology and optometry. The basic question posed was whether normal hearing subjects

---

[94]Edward J. Hardick, Herbert J. Oyer, and Philip E. Irion, "Lipreading Performance as Related to Measurement of Vision" (Accepted for Publication in the Journal of Speech and Hearing Research, 1969).

who were both good and poor lipreaders could be optometrically differentiated. From a total of fifty-three college students, eight who obtained the highest, and eight who obtained the lowest lipreading scores on the Utley Test,[95] were optometrically evaluated. With the exception of visual acuity, the subjects were within normal limits in all visual parameters. It was discovered that the subjects with better visual acuity obtained higher lipreading scores than did those with poorer acuity. Hardick, Oyer, and Irion stated that

> The results of this study indicate that there is a relationship between lipreading performance and visual acuity and that people with relatively minor acuity problems will obtain significantly lower scores on a lipreading test than those with normal acuity.[96]

Those researchers recommended that candidates for lipreading classes should have their vision evaluated and corrected, if necessary, prior to lipreading instruction. Lastly, they suggested that additional research should be accomplished to determine how large an acuity change is necessary to affect lipreading performance.

Lipreading Tests

Various parameters, as they relate to lipreading performance, have been presented. At this point it seems

---

[95]Utley, "A Test of Lipreading Ability," pp. 109-16.

[96]Hardick, Oyer, and Irion, "Lipreading Related to Vision."

appropriate to discuss briefly some of the attempts to measure lipreading performance.

A number of lipreading tests have been reported in the literature.[97-103] Of those which were filmed, the tests by Utley,[104] Mason,[105] and Morkovin,[106] may be the best known.

The Utley test, titled "How Well Can You Read Lips?" is divided into three parts. Part I consists of Forms A and B, each of which contains 31 sentences and short phrases. Part II is divided into Form A and B and contains 36 isolated words in each form. Part III contains 6 stories or

---

[97]Edmund S. Conklin, "A Method for the Determination of Relative Skill in Lip-Reading," Volta Review, Volume 19 (1917), pp. 216-19.

[98]Kitson, "Psychological Lipreading Ability," pp. 471-76.

[99]Marie K. Mason, Visual Hearing (Unpublished Manual, Ohio State University Press, 1951).

[100]Heider and Heider, "An Experimental Investigation of Lipreading," pp. 1-153.

[101]Reid, "Testing of Lipreading Achievement," pp. 403-13.

[102]Utley, "A Test of Lipreading Ability," pp. 109-16.

[103]Boris V. Morkovin, Life Situation Motion Pictures: A Contextual Approach for Speech Reading (Berkeley: University of California Press, 1944).

[104]Utley, "A Test of Lipreading Ability," pp. 109-16.

[105]Mason, Visual Hearing.

[106]Morkovin, Life Situation Motion Pictures.

short conversations. The test was administered to 761 deaf individuals who ranged in age from 8 to 21 years. Utley[107] found that the coefficient of correlation between Forms A and B of the sentence test was .866 with a combined reliability of .928. A correlation of .663 was found between Forms A and B of the word list. Only one form of the Story Test was evaluated. Therefore, the reliability of that test was proposed on the basis of correlation with scores made on the other parts of the test. A correlation of .614 was reported between the Word Test and the Story Test.

Mason developed a filmed lipreading test for children[108] and another for adults.[109] Only the lipreading test for adults is presented here. The Mason Film 30 consists of twenty sentences spoken by a male. There are a total of 330 words with a mean sentence length of 16.5 words.

A series of ten life situation films were developed by Morkovin and Moore[110] for the purpose of lipreading training. Film Number 101 features four speakers: 1) a father, 2) a mother, 3) a 17 year old daughter, and 4) an 11 year old son. The scene is that of the family during dinner. The manual includes questions which pertain to

---

[107]Utley, "A Test of Lipreading Ability," pp. 109-16.

[108]Mason, "Cinematographic Testing Speech Comprehension," pp. 271-78.

[109]Mason, Visual Hearing.

[110]Morkovin, Life Situation Motion Pictures.

evaluating the subject's comprehension of situational clues, the conversation used in the scene, and an over-all understanding of the scene.

O'Neill and Stephens[111] studied the relationship among the Utley, Mason, and Morkovin tests. They found that the correlations ranged from .49 to .56 and were considered significant at or beyond the .05 level of confidence. They stated that "These results indicate that there is a better than chance relationship between scores on tests based on the Mason film and the Utley and Morkovin films."[112]

The Utley test was evaluated by several researchers. Heider[113] concluded that the test is too long for children. DiCarlo and Kataja[114] felt that the test was too long for adults. They pointed out that since the test does not discriminate among groups of lipreaders who have and who have not received lipreading instruction, the understanding of speech by only lip movements is insufficient in discriminating between the groups. Further, DiCarlo and Kataja pointed out that the Utley test is so difficult that

---

[111]John J. O'Neill and Mary C. Stephens, "Relationships Among Three Filmed Lip-Reading Tests," Journal of Speech and Hearing Research, Volume 2, No. 1 (1959), pp. 61-65.

[112]Ibid., p. 63.

[113]Grace M. Heider, "The Utley Lip Reading Test," Volta Review, Volume 49 (1947), pp. 457-58, 488-90.

[114]Louis M. DiCarlo and Raymond Kataja, "An Analysis of the Utley Lipreading Test," Journal of Speech and Hearing Disorders, Volume 16 (1951), pp. 226-40.

even the best lipreaders are discouraged. The criticisms by DiCarlo and Kataja have not yet been refuted.

The Peripheral Visual Mechanism

Perhaps a brief discussion of vision might be useful at this time. It is common knowledge that the eye is one of the most complex and remarkable organs in the human body. At a velocity of over 186,000 miles per second, light waves are converted, by the eyes, into nerve impulses that are transmitted via the optic nerves to the brain where the stimulus is interpreted. A person with normal vision can perceive objects that are near or far; he has vision in artificial light, as well as in bright or dim light; and he has black and white vision in addition to color vision.[115] Gregory stated that

> Only about ten per cent of the light reaching the eye gets to the receptors, the rest being lost by absorption and scattering within the eye before the retina is reached. In spite of this loss, it would be possible under ideal conditions to see a single candle placed seventeen miles away.[116]

The eyeball has a diameter of approximately one inch. It houses several hundred million functioning parts so connected and arranged to perform many different functions. The eye is so constructed that it can suffer shocks without disturbing the many delicate parts. It is so well suspended

---

[115]Morrison, Cornett, and Tether, Human Physiology, p. 115.

[116]R. L. Gregory, Eye and Brain (New York: McGraw-Hill Book Company, 1966), p. 19.

and controlled that it can be fixed on an object while the head is in motion, and its aim can be shifted with speed and amazing accuracy from one object to another.[117]

Since visual acuity is the controlled variable in the present study, a brief discussion of it follows. There appear to be several technical definitions of visual acuity.[118] In this study, visual acuity is defined as the keenness with which the eye can discern the shapes of objects in detail. Visual acuity can be determined by a number of tests. The Snellen Letter Acuity Test might be one of the most familiar ones.[119] The results of the Snellen Test are presented in a fraction where:

$$\text{Visual acuity} = \frac{\text{distance at which test is made}}{\text{distance at which smallest letter subtends an angle of 5 minutes}}$$[120]

Although the test is usually accomplished at a distance of 20 feet, it can be administered at other distances. If the letters on the chart can be read at a distance of 20 feet, visual acuity is reported as 20/20 which is considered to be within normal limits. If an individual can see at 20 feet

---

[117]James R. Gregg and Gordon G. Heath, The Eye: And Sight (Boston: D. C. Heath and Company, 1964), pp. 1-2.

[118]Irvin M. Borish, Clinical Refraction (Chicago: The Professional Press, Inc., 1954), pp. 138-39.

[119]Gregg and Heath, The Eye: And Sight, pp. 108-10.

[120]Ibid., p. 109.

what an average person can see at 100 feet, visual acuity is recorded as 20/100.[121]

In this study, acuity levels of 20/100, 20/80, 20/60, 20/40, and 20/20 were produced by optical lenses in individuals with normal acuity. Table 1 shows the various acuity conditions as compared to their percentage of acuity efficiency.[122] The data in Table 1 are presented only to offer the reader an estimate of the Snellen Test results as a function of visual acuity efficiency. No interpretation was made from the data regarding this study.

TABLE 1

ACUITY EFFICIENCY RATINGS IN PERCENTAGE

Snellen Fraction	Rating Percentage
20/100	48.9
20/80	58.5
20/60	69.9
20/40	83.6
20/20	100.0

Summary

This review of the literature suggests that previous research studies have been addressed to lipreading performance

[121]Morrison, Cornett, and Tether, Human Physiology, p. 134.

[122]Borish, Clinical Refraction, p. 159.

as a function of such parameters as visual skill, intelligence, behavioral patterns, and others. However, there appears to be a considerable variation among the results of the different studies. Several reasons for this variation among the reported results might be proposed. When it is remembered that most of the previous investigators were either not concerned about the visual status of the subjects, or did not bother to report if visual testing were accomplished, the question of how impaired vision might have affected the results could be raised. Hardick, Oyer, and Irion hold definite feelings on this matter and comment that ". . . much previous research in lipreading may be of questionable validity since scores on lipreading tests may have been contaminated by differences in visual acuity."[123]

Various tests of lipreading were discussed. It was understood that the Utley test is difficult even for good lipreaders. Also, there is a better than chance relationship among the Utley, Mason, and Morkovin films. The eye and visual acuity were briefly discussed.

---

[123]Hardick, Oyer, and Irion, "Lipreading Related to Vision."

CHAPTER III

EQUIPMENT, DEVELOPMENT OF MEASURING INSTRUMENT, SUBJECTS, AND PROCEDURES

Introduction

The ambition of this study was to ascertain to what extent the lipreading performance of people with normal vision would change if they were made nearsighted. It was decided to blur temporarily the vision of subjects by means of optical lenses. While in the blurred conditions, they were presented some sentences to lipread.

The purpose of this chapter is to discuss how the problem was investigated. The chapter is divided into several parts. In Part I the equipment is listed. Part II consists of the development of the measuring instrument. Part III contains a discussion of the subjects, and in Part IV the procedures are discussed.

Part I: Equipment

The following is a list of the equipment employed in the study:

1. movie camera: Super 8mm (Honeywell Elmo, model Dual Filmatic)

2. filter: No. 85 (Honeywell Elmo)
3. flood lamps:
   (2) 375 watt in light exposure bar (Holiday model 2200)
   (1) 625 watt (Sylvania Gun II, model SG-55)
   (1) 650 watt (General Electric Mardi Gras, model MG)
4. tripod: (Quickset Hobby Deluxe Elevator, model 330)
5. film splicer: (Craig Master Splicer, model s-6)
6. exposure meter: (New Spectra Combi-500)
7. pure tone audiometer: (Maico, model 2B)
8. movie projector: (Bell & Howell Autoload Design 458-A)
9. viewing screen: (Radiant Wall Master)
10. stopwatch: (Meylan type, 204 BD)
11. modified ortho-rater: (Bausch & Lomb Optical Company)
12. trial frame: (American Optical Company)
13. trial lenses: (American Optical Company)

Part II: Development of Measuring Instrument

It seemed reasonable that the stimulus material should be familiar enough to the subjects so that they would, were it not for their blurred vision, be able to lipread

most of the sentences. The Utley,[1] Mason,[2] and Morkovin[3] films were considered as possible stimulus material. In terms of meeting the needs for this study, however, the above three films pose several disadvantages. Because of its difficulty, the Utley test would possibly be insensitive to the changes effected through visual distortion. The other tests would probably produce about the same results as the Utley test. None of these films are specifically designed for a college population from which the subjects were drawn. The films were made a number of years ago which tends to date the way the speakers wore their hair and make-up. Besides, none of the films have been validated as tests of lipreading. Since this study did not require the use of a standardized test but rather a relatively simple lipreading task was desired, it was decided to develop a measuring instrument specifically for use in this investigation.

Both the familiarity of the stimulus material and the population to be tested were considered in the construction of the experimental sentences. Seventy-five interrogative sentences, which it was believed would be familiar to a group of college students, were devised. Because they had been successfully employed with a college population, the

---

[1]Utley, "A Test of Lipreading Ability," pp. 109-16.

[2]Mason, Visual Hearing.

[3]Morkovin, Life Situation Motion Pictures.

32 sentences by Katt[4] were added to the list of 75 interrogative sentences. Appendix A contains a list of the 107 sentences that appeared in the pre-test film which will be discussed later.

Since the purpose of this study was to see how different visual acuity conditions would affect lipreading scores, it seemed reasonable that the stimulus material should be limited to a certain group of sentences. For example, it was reasoned that if different sentences were presented at different acuity levels, it would be difficult to determine whether the changes in lipreading scores were the result of a particular blurred visual condition or the subject's ability or inability to lipread the sentences. Therefore, it was decided to present the same group of sentences at the different acuity levels. The use of a film is a reasonable way to present the same stimulus material several times.

Choice of Films

The use of motion picture films has been reported by a number of investigators who studied lipreading and has generally been found to be acceptable.[5-8] The cost of

---

[4]Terry L. Katt, "Construction and Evaluation of an Eight Millimeter Filmed Lipreading Test" (Unpublished Master's Thesis, Michigan State University, 1967).

[5]Utley, "A Test of Lipreading Ability," pp. 109-16.

[6]Mason, Visual Hearing.

[7]Morkovin, Life Situation Motion Pictures.

producing a 16mm film is considerable. Since Katt[9] and Franks[10] had both successfully used 8mm film in lipreading studies, the possibility of employing it in this study was entertained. Recent advances in film manufacture have produced a modification of 8mm film which is called Super 8 millimeter. This new type of film has a 50 per cent larger image area as compared with the regular 8mm film.[11] Super 8mm film is, therefore, nearer in size to 16mm than is 8mm film. The stimulus material was recorded on Super 8mm Outdoor & Indoor Type A color film. A professional photographer was employed who furnished the photographic equipment and filmed, edited, and spliced the various films.

Preparation of Pre-test Film

A college graduate with normal hearing and speech was selected to present the stimulus material because she was photogenic with no apparent facial aberrations that would

---

[8]Gordon Taaffe, "A Film Test of Lipreading," John Tracy Clinic Research Papers, II (November, 1957).

[9]Katt, "Construction of an Eight Millimeter Filmed Test."

[10]Franks, "Factors that Influence Identification of Sounds in Lipreading."

[11]"Super-8mm. Type of 8mm. film with a 50 per cent larger image area as compared with traditional 8mm. film. The Super-8mm. film also has an increased frame height and perforation pitch, so that there are only about 72 frames per foot (instead of 80). The perforation size is smaller. The film can only be used with appropriately designed cameras and projectors." The Focal Encyclopedia of Photography, Volume 2 (New York: Focal Press, 1965), p. 1485.

distract the lipreader. The speaker spoke aloud the 107 sentences as a silent motion picture was taken. The speaker sat on a bench in front of a white backdrop. The height of her eyes from the floor was 42 inches. She was located in front of the camera at a distance of 10 feet. Four flood lights were turned on which produced 125 footcandles of light intensity at her face.

The speaker sat with a pack of numbered cue cards in her lap. On one side of each card a large black number was printed. On the other side of the card, the sentence to be spoken appeared in typed form. In the filming process prior to each sentence presentation, the speaker held a single numbered cue card in front of her face. Such action provided the indexing necessary to identify the sentence, while at the same time, it gave her an opportunity to read the sentence which she was to present. Further, the numbered cue cards helped in the editing process when the master film (containing twenty sentences) was constructed.

It was felt that the speaker should begin each sentence from a closed mouth position. After having removed the numbered cue card from in front of her face, the speaker briefly paused before beginning each sentence. The hesitation provided her an opportunity to begin each sentence from a closed mouth position. The sentences were carefully monitored. If the speaker moved or appeared unnatural, the sentence was repeated as many times as necessary to obtain

what was believed to be a natural presentation that was free from any noticeable distractions.

When the pre-test film containing the 107 sentences had been processed, it was cut and a twelve-inch blank leader tape was spliced between each sentence. The purpose of the leader tape was to provide a place to stop the projector while the subjects recorded their responses.

Presentation of Pre-test Film

The pre-test film was shown to forty-six female and twenty-one male college students. The film was presented three different times in a classroom in which about twenty to twenty-five students were seated. Figure 1 shows how the equipment was arranged in the classroom and how the students and the investigator were seated. The students wrote

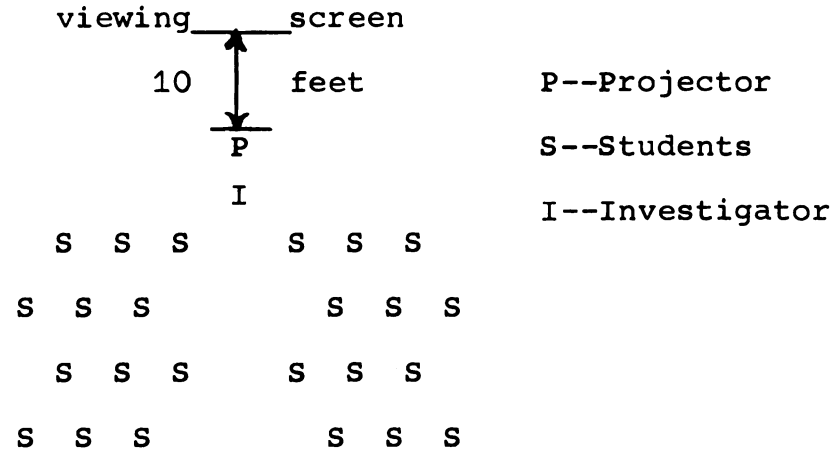

Figure 1. Arrangement of equipment, students and investigator in classroom.

their responses on answer sheets that had blank spaces numbered from 1 to 107. The method of scoring is discussed later in Part IV under Procedures. The range of scores was from 88 to 0 per cent correct.

Preparation of Master Film

From the pool of 107 sentences, 20 were selected because they were lipread most often by the 67 students who saw the film. The range of scores was from 88 to 52 per cent correct. The sentence "Do you smoke?" was lipread correctly by 88 per cent of the students, whereas 52 per cent of them correctly lipread the sentence "Do you have a scholarship?" Table 2 shows the sentences that were used in the master film and the percentage of correct responses that were obtained on each sentence by 67 students.

Once the sentences were chosen, they were easily identified by the numbered cue card. Next, they were cut from the pre-test film and spliced together with a twelve-inch blank leader tape between each sentence. That resulted in twenty filmed sentences which comprised the master film that was duplicated five times by professional processors. The duplicated films were cut between each of the twenty sentences and the numbered cue card frames were removed. The twenty sentences in each of the five films were scrambled according to a table of random numbers and spliced back together with a twelve-inch blank leader tape between each

TABLE 2

MASTER FILM SENTENCES AND THE PERCENTAGE OF CORRECT RESPONSES FOR EACH SENTENCE BY SIXTY-SEVEN STUDENTS

Sentence	Per Cent Correct
1. Do you smoke?	88
2. How many sisters do you have?	86
3. How old are you?	82
4. What is your name?	82
5. Do you have a phone?	79
6. What time is it?	77
7. How many brothers do you have?	77
8. Where have you been?	76
9. Have you ever been fishing?	73
10. Do you watch TV?	68
11. Do you have a roommate?	65
12. Do you wear glasses?	62
13. Oh Boy!	62
14. How long have you gone to college?	56
15. Where do you live?	56
16. What time do you get up in the morning?	55
17. The weather is bad.	55
18. Do you have a driver's license?	55
19. Did you go home for Christmas?	53
20. Do you have a scholarship?	52

sentence. The number of frames for each sentence were counted. By counting and cutting, the same number of frames appeared for each sentence in each of the five films. The finished film product resulted in five separate films labelled Films A, B, C, D, and E. Each film contained the twenty sentences in ramdom order.

Presentation of Test Films A, B, C, D, and E

The five test films were shown to five experimental and thirteen control subjects. Each subject viewed the films

individually. The subjects and films are discussed in more detail later in Part IV under Procedures.

Part III: Subjects

Previous research has demonstrated that females, as a group, are better lipreaders than are males.[12-14] Since the effects of visual blurring on lipreading performance were to be indexed by a change in lipreading scores, it seemed reasonable that subjects should be selected from a population of better lipreaders. Since females were known to be better lipreaders and since they had obtained higher lipreading scores on the pre-test film than had males, females were selected as subjects for this study.

Experimental Subjects

Five students from the group of sixty-seven who saw the pre-test film were chosen as the experimental subjects. Certain criteria were met by the experimental group. Anyone who wore glasses or contact lenses was not considered eligible for the study. Each potential experimental subject had his vision tested by means of a Modified Ortho-Rater. The following visual parameters were tested: 1) vertical

---

[12]Taaffe, "A Film Test of Lipreading."

[13]Taaffe and Wong, "Variables in Lip Reading Material."

[14]Aylesworth, "The Talker and Lipreader as Variables in Testing of Lipreading."

and lateral phoria at near and far distance, 2) monocular and binocular visual acuity at near and far distance, and 3) color and depth perception.

Potential subjects who did not wear glasses or contact lenses and whose vision was within normal limits as measured by the Modified Ortho-Rater were given a hearing screening test. Anyone who had a unilateral or bilateral average hearing loss of 10 dB or more (re: audiometric zero, ISO, 1964) by air conduction for the frequencies of 500, 1000, and 2000 Hz was eliminated from the study. Anyone who had obtained a lipreading score below 60 per cent on the 20 sentences contained in the pre-test film of 107 sentences was not considered eligible for the study.

Having met the above requirements, the subjects received a complete optometrical examination. Each of them was found to be optometrically within normal limits in the following dimensions: 1) accommodation, 2) color vision, 3) visual field, 4) stereopsis, 5) phoria, 6) internal and external health of the eyes, and 7) in monocular and binocular visual acuity. Five females, between eighteen and twenty-two years, who met all of the requirements, served as the experimental subjects for the study.

Control Subjects

It was felt that a certain amount of learning would occur as the result of presenting the stimulus material a

number of times to the experimental subjects. It was believed that a closer estimate of the experimental subjects' lipreading scores obtained while in the various blurred conditions would be reflected if the learning effect were subtracted from the scores that the experimental subjects obtained. To ascertain the learning effect, thirteen females, between eighteen and twenty-two years, who had passed the aforementioned hearing screening and vision tests, were selected as the control subjects for the study.

Part IV: Procedures

Each of the experimental and control subjects individually viewed the films. Figure 2 shows how the equipment, subject, and investigator were located in the test room. The subject was seated beside the projector which

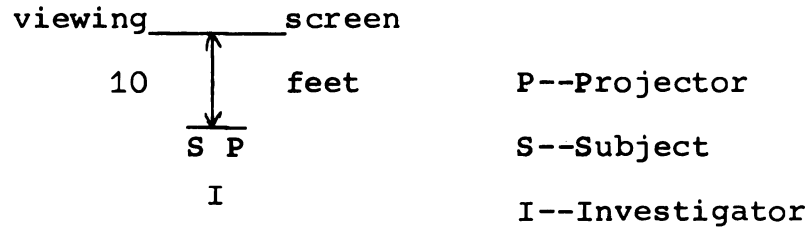

Figure 2. Arrangement of equipment, subject and investigator in test room.

was located at a distance of ten feet in front of the viewing screen. The investigator stood behind the subject and the projector.

The projected image on the screen was life size. That was accomplished in the following manner. The projector was threaded with the master film which contained the speaker holding the numbered cue cards. The projector was run forward until a frame containing a numbered cue card appeared. The projector was stopped on that particular frame. While an assistant held the original numbered cue card against the screen in a supra-position with the projected image, the zoom lens on the projector was adjusted until the projected image of the numbered cue card was superimposed on the actual numbered cue card.

The height of the speaker's eyes was forty-two inches above the floor. Prior to testing, each subject was given a written instruction sheet and was asked to follow along as the investigator read aloud the instructions. With one exception, the instructions for the experimental and control subjects were the same. The instructions (Appendix B) for the experimental subjects pointed out that vision would be temporarily blurred, whereas the instructions for the control subjects (Appendix C) did not contain that information. A period of one minute was allowed after the light was shut off for the subject to get accustomed to the darkened room. Sufficient light was provided for the subject to write her answers on response forms that contained blank spaces numbered from one to twenty. The projector was started and stopped after each sentence. The projector remained stopped

on a part of the blank leader tape for a period of twenty seconds to allow the subject time to write her answers. The films were presented to each subject in the following order each time: Film E first, Film D second, Film C third, Film B fourth, and Film A fifth.

Experimental Subjects

At the time of the eye examination, the optometrist determined the particular optical lens for each eye of each person that would produce the following binocular visual acuity conditions at a distance of ten feet: 20/100, 20/80, 20/60, 20/40, and 20/20. The appropriate lenses for blurring the eyes and the glasses frame into which the lenses fit were loaned to the investigator. After the experimental subject had read and heard her instructions, the glasses frame which contained the appropriate blurring lenses was placed on her and adjusted by the investigator. A period of about three minutes, approximately the time it takes to rewind and thread the projector, was allowed for the subject to look through the lenses prior to showing the film. Each experimental subject viewed the following films through the appropriate optical lenses: Film E at 20/100, Film D at 20/80, Film C at 20/60, Film B at 20/40, and Film A at 20/20.

Control Subjects

Each of the control subjects viewed the films in the same order as did the experimental subjects. The control

subjects saw the films in their normal visual acuity condition.

Scoring

Each of the twenty sentences carried a value of 5 per cent. Scoring was accomplished by adding the percentage of each correct sentence for each subject. Contractions were counted correct. However, no credit was given for partial answers. If a sentence were not correct, word for word, it was marked wrong.

Learning Effect

As previously mentioned, it was believed that learning would occur as the result of exposing the experimental subjects to the same stimulus material a number of times. The purpose of the control group was to obtain a measure of learning which would later be subtracted from the scores of the experimental subjects. Although that procedure was followed, it tended to over-correct the scores of the experimental subjects. For example, each time that the control subjects viewed the films, they did so with their normal visual acuity, which might have allowed them to learn more than did the experimental subjects who viewed each film through the blurring lenses. Therefore, subtracting the control subjects' learning effect from the experimental subjects' scores, resulted in a conservative estimate of the

effect of visual distortion on lipreading performance.

Summary

Basically, the question was asked, "To what extent will lipreading performance be affected as the result of producing a blurred visual condition by means of optical lenses?" To study the problem, a lipreading task was filmed and shown to some subjects who viewed the material through lenses that produced visual acuity levels that ranged from 20/100 to 20/20.

In this chapter, the equipment, development of the measuring instrument, subjects, and procedures that were used in the study were presented. The results of the study are discussed next in Chapter IV.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

This chapter is divided into several parts. The following topics are discussed: 1) preliminary test results, 2) reliability of the measuring instrument, 3) control group data, 4) experimental group data, and 5) final test results.

In this study, lipreading performance was determined by means of the percentage of sentences that were correctly lipread. Percentage scores were employed in calculating the measures of central tendency and dispersion.

The terms "correction" and "visual correction" are frequently employed in this chapter. In the present study, the two terms are synonymous with either glasses or contact lenses.

Preliminary Test Results

A total of sixty-seven male and female college students viewed the pre-test film that contained 107 sentences. The list of these sentences together with the percentage of correct responses for each one is found in Appendix A.

Some of the students were wearing glasses or contact lenses when they saw the film, whereas others viewed it

with no correction. The visual acuity of the students was unknown. However, by having them circle the words "yes" or "no" on the answer sheets, it was determined who were and who were not wearing correction.

Twenty sentences from the pool of 107 were selected for the master film. Table 3 shows the measures of central tendency and dispersion that were computed from the responses made by the sixty-seven students who saw the twenty sentences that were part of the 107 that appeared in the pretest film. In Table 3, it is seen that females obtained higher means and medians than did males. It can be observed that, regardless of sex, students who wore no visual

TABLE 3

MEAN, MEDIAN, STANDARD DEVIATION, AND QUARTILE RANGE SCORES OF SIXTY-SEVEN STUDENTS COMPUTED ON THE TWENTY SENTENCES CHOSEN FOR EXPERIMENTAL USE

Subjects		Mean	SD	Median	Q
females	(N=46)	76.57	17.87	75.00	9.22
without glasses	(N=17)	82.64	14.56	89.67	13.58
with glasses	(N=29)	70.51	21.18	75.08	13.75
males	(N=21)	50.41	25.16	54.75	16.06
without glasses	(N= 9)	58.33	23.92	60.00	19.06
with glasses	(N=12)	42.50	26.41	45.00	24.50

correction were better lipreaders than were those who wore glasses. It also appears that females, even while wearing visual correction, were better lipreaders than males who were not wearing correction. In terms of dispersion, it is seen that the standard deviation and quartile range are smaller for females than for males. Further, the students who were not wearing correction obtained smaller measures of dispersion than did those students who were wearing correction.

Discussion

It is unknown why females obtained higher lipreading scores than did males. However, the findings are consistent with research as previously mentioned and point out that females were more successful at the lipreading task than were males. It also appears that females, regardless of visual impairment, were better lipreaders than were males. The dispersion data suggest that females and students without correction displayed less variation in their responses to the lipreading task than did males and those students who wore visual correction.

Reliability

An estimate of the reliability of the measuring instrument was obtained by the test-retest technique. One of the five films was shown to twelve college students.

A week later, another randomization of the same film was shown to the same group of students. The data, analyzed by means of the Spearman Rank Correlation Coefficient,[1] yielded a rho of .80.

Control Group Data

Thirteen females between eighteen and twenty-two years of age with normal vision served as the control subjects. They viewed the five films in their normal acuity (20/20, no lens) condition. Nonparametric statistics are conventionally employed when the number of subjects is small. Since the median, rather than the mean, is the best measure of central tendency in a small sample, it was used in reporting the results of the control subjects. Because it is generally used in connection with the median, the quartile range (Q) was employed as the measure of dispersion.[2]

Learning Effect

Before the lipreading scores of the experimental subjects are presented, it is appropriate to discuss the learning effect. As previously mentioned, because they were

---

[1]Sidney Siegel, Nonparametric Statistics: For the Behavioral Sciences (New York: McGraw-Hill Book Company, Inc., 1956), pp. 202-13.

[2]Allen L. Edwards, Statistical Methods: For the Behavioral Sciences (New York: Rinehart & Company, Inc., 1954), pp. 47-48.

viewing the same twenty sentences five times, it was felt that the experimental subjects' scores would be influenced by learning. To account for that, control subjects were employed. The learning effect was computed by obtaining the difference score between the control subjects' median scores for each of the film presentations. For example, the median score obtained for film presentation one was subtracted from the median score obtained for film presentation two, two was subtracted from three, etc. This procedure was followed through film presentation five. The resulting values were termed the learning effect.

Since it was presumed that there would be a carry-over of learning from one film presentation to the next one, the learning effect scores that were obtained for the film presentations were added together. This calculation produced an estimate of the cumulative learning effect for each of the relevant film presentations.

Table 4 shows a difference of 5.13 per cent in the control subjects' median scores between the first and second film presentation, 5.04 per cent between the second and third presentation, a negative 0.17 per cent between the third and fourth presentation, and 0.25 per cent between the fourth and fifth presentation. Since it was presumed that learning carried over from one film presentation to the next one, the cumulative learning percentages were summed as shown in Table 4.

TABLE 4

SUMMARY OF LEARNING EFFECT OBSERVED IN FIVE PRESENTATIONS OF THE LIPREADING STIMULI

	Order of Presentation				
	1	2	3	4	5
Control Group's Median Scores	84.75%	89.80%	94.92%	94.75%	95.00%
Amount of Learning	0.0	5.13%	5.04%	*-0.17%	0.25%
Cumulative Amount of Learning	0.0	5.13%	10.17%	10.17%	10.42%

* Computed as 0 per cent learning effect.

Figure 3 shows the control and experimental subjects' median lipreading scores without learning present. It can be observed that if no learning had occurred, the control subjects' median scores would have been displayed in a flat line at the 84.75 per cent level of lipreading performance. On the other hand, the median lipreading scores of the experimental group do not appear as a flat straight line but, rather, reflect a rising curve configuration. It can be observed that the experimental group obtained lower lipreading scores for all film presentations than did the control subjects.

Figure 4 shows the control and experimental subjects' median lipreading scores with learning present. It can be observed that the experimental group obtained poorer lipreading scores at all presentations than did the control group.

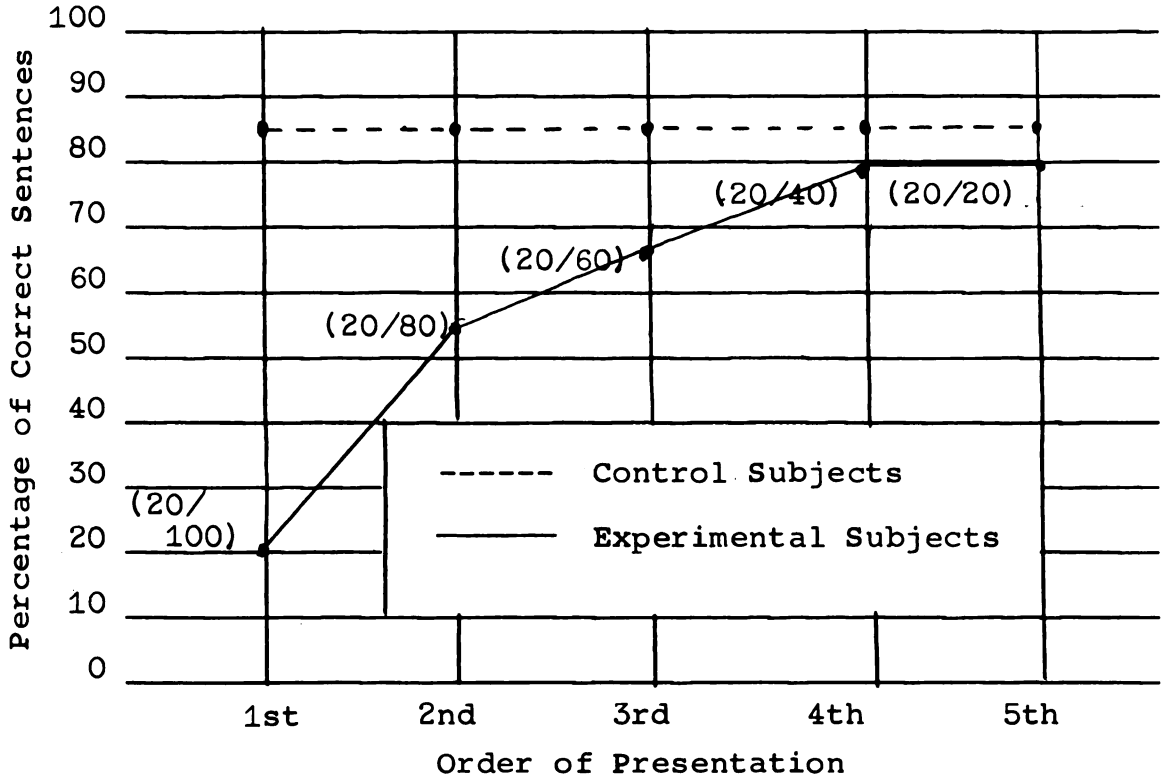

Figure 3. Control and experimental subjects' median lipreading scores corrected for learning.

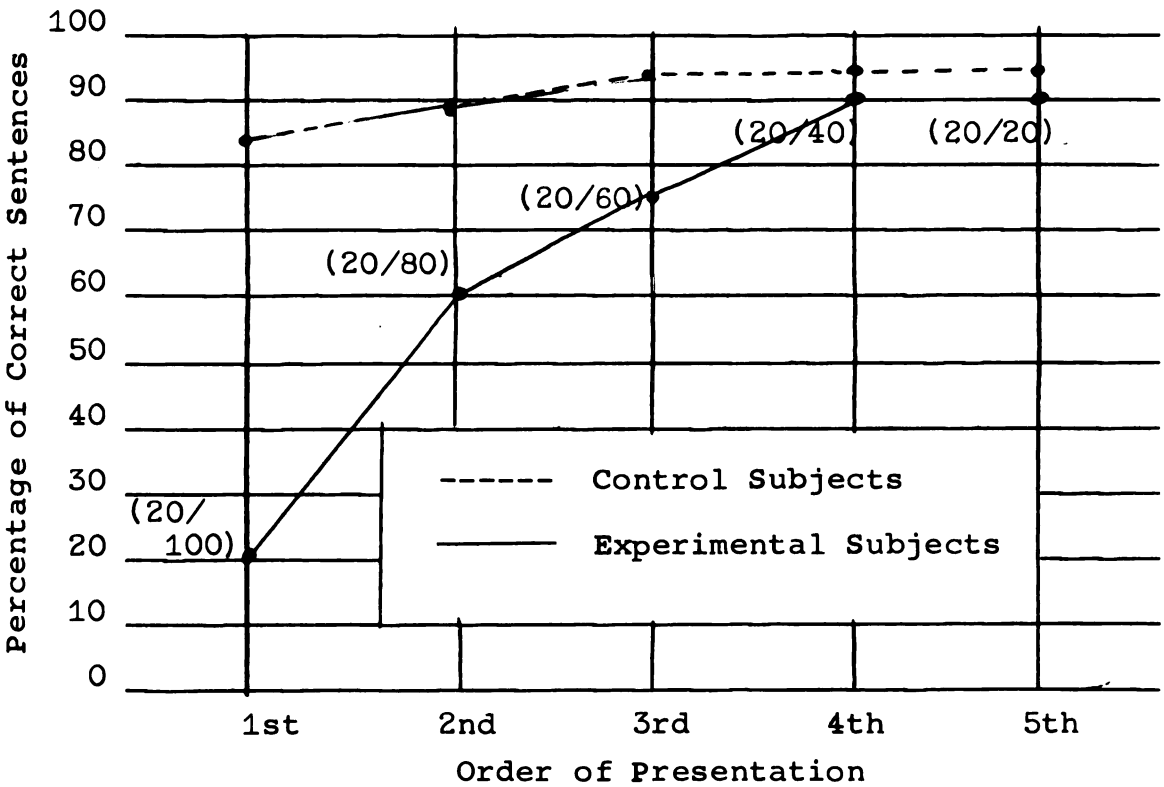

Figure 4. Control and experimental subjects' median lipreading scores not corrected for learning.

Discussion

It was observed that there was a 5.13 per cent learning effect as the result of seeing the films twice and an additional learning factor of 5.04 per cent as the result of viewing the films a third time. It was also noted that the control group's median score dropped 0.17 per cent between the third and fourth presentations. It was difficult to presume that the subjects actually "unlearned" 0.17 per cent of the stimulus material between the third and fourth presentations. Therefore, it was concluded that no learning took place between the third and fourth presentations. A learning factor of 0.25 per cent occurred between the fourth and fifth presentations. The total cumulative learning effect was 10.42 per cent. The possibility exists that since the control subjects viewed all of the films in their normal acuity (no lens) condition, they learned more than did the experimental subjects who saw each film through optical lenses. If this were true, subtracting the control group's learning effect from the experimental subjects' scores would probably result in scores that were overcorrected for learning. However, since there appeared to be no better way to account for learning and since it was believed to exist, the method followed was to subtract the median learning value obtained by the control group from the median scores obtained by the experimental group. The purpose of this discussion was to point out that when the learning factor was accounted for in the experimental group,

a conservative estimate of the effects of visual distortion on lipreading performance was reflected.

Experimental Group Data

Five females, between eighteen and twenty-two years of age with normal vision, acted as the experimental group. They viewed the five films through optical lenses that produced different visually blurred conditions. The median was used as the measure of central tendency and the quartile range was employed as the measure of dispersion.

Effects of Visual Distortion

The data in Table 5 show what the lipreading scores of the experimental subjects were at the various acuity levels.

TABLE 5

MEDIAN LIPREADING SCORES OF EXPERIMENTAL SUBJECTS FOR EACH VISUAL ACUITY CONDITION

Experimental Subjects (N=5)	Order of Presentation (1) 20/100	(2) 20/80	(3) 20/60	(4) 20/40	(5) 20/20
Uncorrected Score	20.00%	60.00%	75.00%	90.00%	90.00%
Corrected Score	20.00%	54.87%	64.83%	79.83%	79.58%

It can be observed that the experimental subjects' median corrected scores (minus learning) were 20.00, 54.87, 64.83,

79.83, and 79.58 per cent for the visual acuity levels of 20/100, 20/80, 20/60, 20/40, and 20/20 respectively.

Figure 5 shows the experimental group's median lipreading curve with learning present and the curve which is corrected for learning. A separation between the curves of 5.13 per cent occurred at the 20/80 acuity level whereas the curves are separated 10.42 per cent at the 20/20 level of acuity.

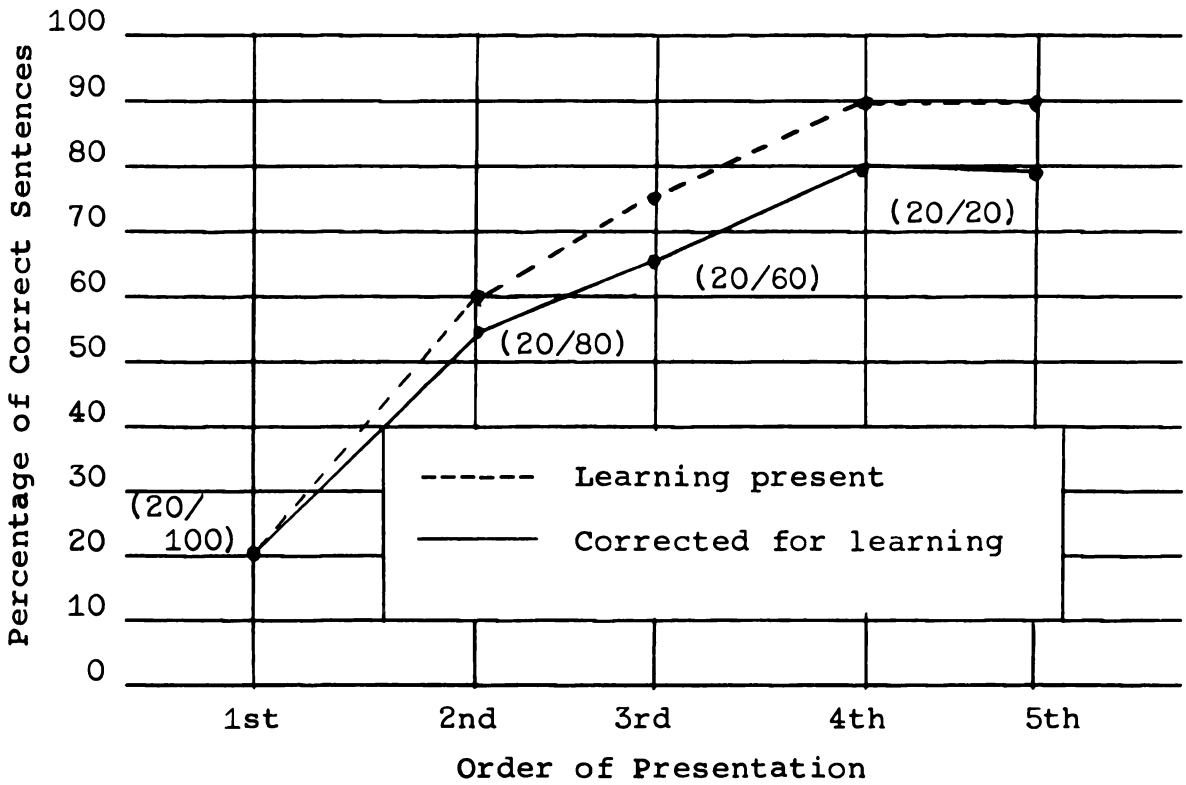

Figure 5. Experimental subjects' median lipreading scores corrected and not corrected for learning.

From the data in Table 6, it can be observed that subjects 1, 2, and 3 were better lipreaders than were subjects 4 and 5. That is, they obtained higher lipreading scores in

TABLE 6

THE SCORES (CORRECTED FOR LEARNING) THAT EACH OF THE EXPERIMENTAL SUBJECTS OBTAINED AT THE VARIOUS VISUAL ACUITY LEVELS

	Visual Distortion				
Subjects	20/100	20/80	20/60	20/40	20/20
1	45.00%	69.87%	74.83%	84.83%	89.58%
2	20.00%	59.87%	79.83%	84.83%	84.58%
3	40.00%	54.87%	59.83%	69.83%	79.58%
4	15.00%	19.87%	64.83%	79.83%	74.58%
5	5.00%	24.87%	29.83%	74.83%	69.58%

most visual conditions than did subjects 4 and 5. All of the subjects showed an improvement in lipreading scores when acuity was changed from 20/100 to 20/80, from 20/80 to 20/60, and from 20/60 to 20/40. Some rather unexpected responses were obtained when acuity was changed from 20/40 to 20/20. Two of the three better lipreaders obtained higher lipreading scores. Subject 1 gained 4.75 per cent in lipreading performance and subject 3 gained 9.75 per cent. The lipreading performance of one of the three better lipreaders (subject 2) was lowered 0.25 per cent when acuity was changed from 20/40 to 20/20. The two poorer lipreaders (subjects 4 and 5) each obtained a lower lipreading score of 5.25 per cent when acuity was improved from 20/40 to 20/20.

The individual scores obtained by the experimental subjects are plotted in Figure 6. It can be observed that

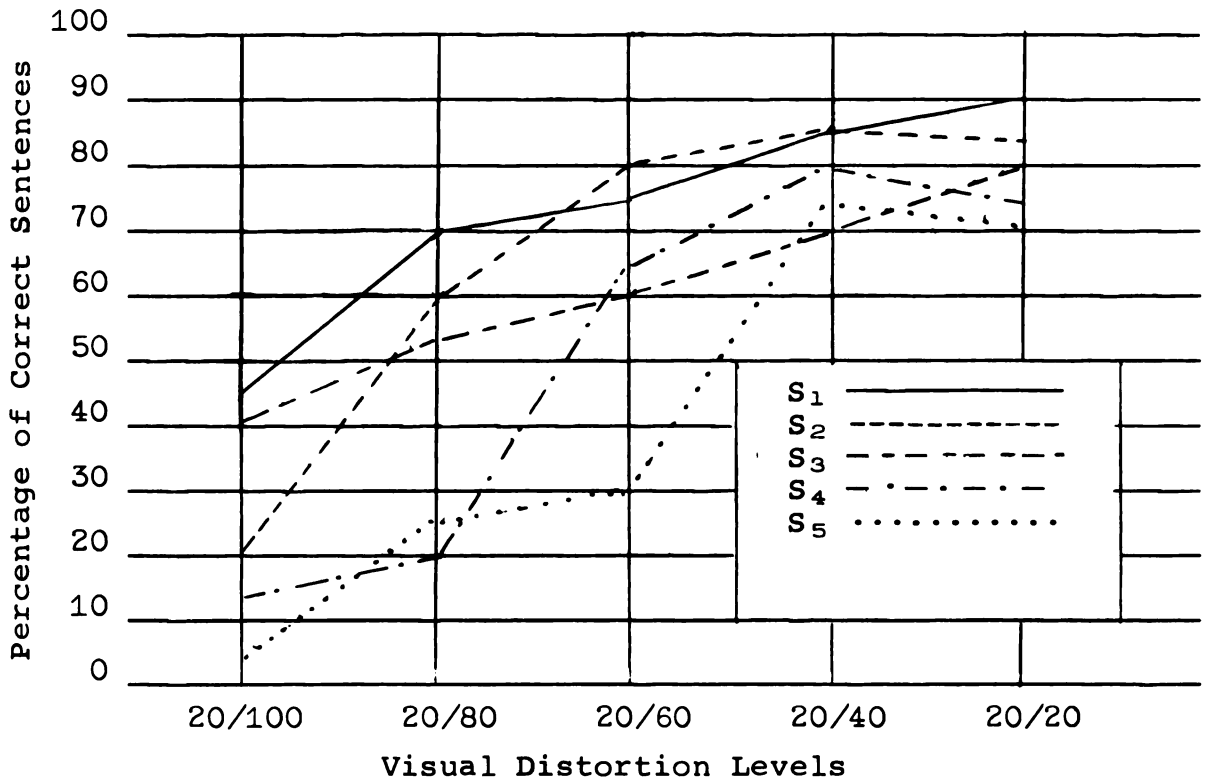

Figure 6. Experimental subjects' lipreading scores (corrected for learning) obtained at five acuity levels.

the lipreading performance of subject 1 (the best lipreader) was least affected, whereas the lipreading performance of subject 5 (the poorest lipreader) was affected the most by visual acuity distortion.

In Table 7 the experimental subjects' measures of central tendency and dispersion are shown. The greatest amount of variability in lipreading performance occurred at the acuity level of 20/80 whereas the smallest variance was noted at 20/40. It can be observed that there was over two times as much variance in lipreading scores at the acuity level of 20/100 than there was at the level of 20/20.

TABLE 7

EXPERIMENTAL SUBJECTS' MEDIAN SCORE AND QUARTILE RANGE OBTAINED AT FIVE LEVELS OF VISUAL DISTORTION

	Visual Distortion				
	20/100	20/80	20/60	20/40	20/20
Median Score	*20.00%	54.87%	64.83%	79.83%	79.58%
Quartile Range	12.50%	17.75%	7.75%	5.07%	5.25%

*All scores are corrected for learning.

It can be seen that lower lipreading scores occurred at the acuity levels of 20/100, 20/80, and 20/60 where the measures of dispersion were larger as compared to higher lipreading performance at acuity levels of 20/40 and 20/20 where the variability scores were smaller.

Discussion

As a group, the data suggest a trend in the direction of better lipreading performance as visual acuity was improved from 20/100 to 20/40. For two of the three better lipreaders improving acuity from 20/40 to 20/20 resulted in higher lipreading performance. One of the three better lipreader's score was lowered 0.25 per cent when acuity was changed from 20/40 to 20/20. Changing the acuity level from 20/40 to 20/20 lowered the lipreading scores of the two poorer lipreaders 5.25 per cent. The lipreading performance

of the individual experimental subjects imply that visual distortion had the most deleterious effects on the performance of the poorer lipreaders. These data might have some clinical importance. Specifically, it might be reasonable to speculate that persons believed to be poor lipreaders should be certain that their visual acuity is as nearly normal as is possible before lipreading practice is undertaken.

The dispersion data suggest that lipreading scores were more variable at the 20/100 acuity level than they were at the 20/20 level. A similar trend in dispersion scores was found in the study by Hardick, Oyer, and Irion.[3] With the exception of the word test section of the Utley test, they found that smaller dispersion scores were obtained by the normal vision group (better lipreaders) than by the visually impaired subjects (poorer lipreaders) who obtained higher standard deviation scores.

Results of Statistical Analyses

At this time it is appropriate to present and discuss the final results of the study. The analyses of the data were accomplished with median lipreading scores that were corrected for learning. The lipreading scores that were obtained by any particular subject were not compared with scores obtained by any of the other experimental subjects.

---

[3]Hardick, Oyer, and Irion, "Lipreading Related to Vision."

Instead, each individual subject's scores were compared with her own scores that were obtained at the various visual acuity levels. The most powerful tool available to accomplish these analyses was the Wilcoxon Matched-Pairs Signed-Ranks Test.[4] For the null hypothesis to be rejected at the .01 level of confidence, it was necessary that T, the statistic on which the test is based, be zero.

In Table 8 it can be observed that the T was zero at all visual acuity levels from 20/100 to 20/40. It can be observed that when lipreading scores obtained at 20/40 were compared with those obtained at 20/20, the T was seven. Since there was no statistical difference in lipreading performance between the acuity levels of 20/40 and 20/20, the question arose whether there would be a difference between lipreading scores obtained at the above acuity levels with lenses and the subjects' normal acuity (20/20) without lenses. As was previously mentioned, the experimental subjects were selected from among the sixty-seven students who had been the pre-test film. Since the twenty sentences were among those previously seen by the experimental group in the pre-test film, data were available regarding how they had previously performed in their normal acuity (no lens) condition. Therefore, it was decided to perform another Wilcoxon Test to determine whether a difference in lipreading scores existed between the lens and the no lens conditions.

---

[4]Siegel, Nonparametric Statistics, pp. 75-83.

TABLE 8

STATISTICAL ANALYSES OF THE EXPERIMENTAL DATA BY MEANS OF THE WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST

		20/80	20/60	20/40	20/20
20/100	N	5	5	5	5
	T*	0	0	0	0
20/80	N		5	5	5
	T*		0	0	0
20/60	N			5	5
	T*			0	0
20/40	N				5
	T*				7

*Wilcoxon T which serves as the test statistic. A T=0 required for significance at the .01 level of confidence.

The null hypothesis was posited that there would be no difference in lipreading scores obtained at the 20/40 and 20/20 acuity levels with lenses as compared with scores obtained at the normal acuity (20/20) level with no lenses. Again, for significance at the .01 level of confidence, the T required was zero.

The results of the statistical analyses are shown in Table 9 where it is seen that a T of four and three were obtained. The null hypothesis of no difference in lipreading scores when visual acuity was 20/40 and 20/20 with lenses as compared with scores obtained in the normal acuity (20/20, no lens) condition was not rejected.

TABLE 9

STATISTICAL ANALYSES BY MEANS OF THE WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST OF DATA OBTAINED BY FIVE SUBJECTS WHO VIEWED THE STIMULUS MATERIAL WITH AND WITHOUT LENSES

		With Lenses	
		20/40	20/20
Without Lenses			
20/20	N	5	5
	T*	4	3

*Wilcoxon T which serves as the test statistic. A T=0 required for significance at the .01 level of confidence.

Discussion

The results of the statistical analyses indicate that the null hypothesis of no difference in lipreading scores as acuity was progressively changed from 20/100 to 20/40 can be rejected at the .01 confidence level. This finding suggests that lipreading performance was significantly enhanced as visual acuity was progressively changed from 20/100 to 20/40. The null hypothesis of no difference in lipreading scores when acuity was changed from 20/40 to 20/20 cannot be rejected. It was therefore concluded that there was no difference in lipreading performance when visual acuity was 20/40 or 20/20.

As was previously noted, two of the three better lipreaders obtained a higher lipreading score when visual acuity was changed from 20/40 to 20/20, whereas a third subject's

score was lowered 0.25 per cent. Interestingly enough, the scores of the other two lipreaders, who were the poorest in the group, showed a decline of 5.25 per cent in lipreading performance as acuity was improved from 20/40 to 20/20. The possibility exists that the peak in lipreading performance had been reached at the 20/40 acuity level for some of the subjects, whereas others continued to show improvement in performance up to the 20/20 acuity level. It is further interesting to note that the two subjects who continued to show improvement in lipreading performance as acuity was changed from 20/40 to 20/20 were from among the better lipreaders.

Based on the statistical findings, it was impossible to reject the null hypothesis of no difference in lipreading scores obtained at the 20/40 and 20/20 acuity levels with lenses as compared with scores obtained at the normal acuity (20/20) level with no lenses. The results suggest that there was no deleterious affect on lipreading performance when optical lenses (20/40 and 20/20) were placed before normal eyes not accustomed to seeing through them. These findings may therefore imply that optical lenses which produce a loss of visual acuity no greater than 20/40 could be used in future research studies that are addressed to lipreading performance and visual conditions.

At first glance, the results of this study, which indicate no difference in lipreading performance between visual acuity levels of 20/40 and 20/20, appear to be in

conflict with the data reported by Hardick, Oyer, and Irion[5] who pointed out that people with minor acuity problems will be poorer lipreaders than those who have normal vision. Because of the differences in stimulus materials used in the two studies, it is doubtful that the results can be compared. Irrespective of the reason advanced as to why the results of the two studies probably should not be compared, it seems strange that they produced results that were different.

The results of no difference in lipreading performance when visual acuity was 20/40 or 20/20 are puzzling and are unresolved at this time. Although it may be true that better lipreaders take a greater advantage of vision than do poorer ones, such a presumption was not proposed. A more conservative approach was taken. It is possible that since the scores of the poorer lipreaders were low to begin with, the change, if there were any, might not be reflected because of the already low lipreading performance. The reasons for these findings, however, are not clear. It is unknown why changing the acuity level from 20/40 to 20/20 improved the lipreading scores for some subjects but did not for others. This unresolved question may well serve as a point of departure for additional research to determine whether a difference in lipreading performance does exist between the acuity levels of 20/40 and 20/20.

---

[5]Hardick, Oyer, and Irion, "Lipreading Related to Vision."

Summary

The purpose of this chapter was to discuss the results of the present investigation. It was learned that in a group of sixty-seven students who saw a silent movie of 107 sentences, females were better lipreaders than were males and that persons not wearing visual correction obtained higher lipreading scores than did those who were wearing glasses or contact lenses.

The lipreading performance of five experimental subjects was studied as visual acuity was changed from 20/100 to 20/20. Although there was some variation in the results obtained among the subjects, higher lipreading performance was achieved as visual acuity was improved from 20/100 to 20/40. Although there was a trend in the direction of improved lipreading performance, there was no statistically significant difference in lipreading scores when visual acuity was changed from 20/40 to 20/20. Statistical analyses of the data at acuity levels of 20/40 and 20/20 with lenses as compared with the normal acuity condition (no lens) suggested that there was no detrimental affect on lipreading performance when optical lenses were placed before normal eyes that were not accustomed to them.

It is realized that the results of this study are based on a small sample of young healthy college females with normal vision. Therefore, the findings are limited; and it is felt that they should be especially guarded in

terms of application to individual cases. However, it is also believed that a conservative estimate of the affects of visual acuity distortion on lipreading performance was reported. The possibility exists that acuity deprivation had a greater adverse affect on lipreading performance than appeared in the data. This study has demonstrated that improving visual acuity in normal eyes to at least the level of 20/40 resulted in higher lipreading performance on a given task. It is unknown at this time whether improving visual acuity in impaired eyes would also result in higher lipreading performance. However, if this were true, the results of this investigation, within the limitations of visual acuity, might be generalized to a population different from the study sample.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The importance of eye training, along with other types of training, has been cited in the literature as an important adjunct to successful lipreading. However, a survey of the literature shows a paucity of studies that have been concerned with visual conditions and lipreading performance. A need was felt to study lipreading performance as it must relate to one of several parameters operative in the peripheral visual mechanism, specifically visual acuity.

The purpose of the present study was to ascertain to what extent the lipreading scores of individuals with normal vision would change if they were made nearsighted. To investigate the problem, it was decided to blur temporarily the vision of subjects with normal acuity. Various blurred conditions were created by means of optical lenses. Twenty sentences were presented for lipreading by motion picture films. Since a relatively easy lipreading task was desired, a measuring instrument was especially developed for use in the present investigation. Seventy-five

sentences, with which it was believed a college population would be familiar, were added to thirty-two sentences that had been previously employed with a college group. These 107 sentences were spoken by a female while a silent Super 8mm color motion picture film was taken. The 107 sentences comprised the pre-test film that was shown to sixty-seven college students. Some of the students were wearing visual correction when they saw the film, whereas others were not. It was observed that females and persons not wearing visual correction achieved higher lipreading performance than did males and individuals who were wearing glasses or contact lenses. It was also observed that females who were wearing glasses obtained higher lipreading scores than did males who were not wearing correction. Twenty of the 107 sentences were chosen because of their ease in lipreading. These twenty sentences were spliced together to form the master film that was duplicated five times. As a result, the stimulus material consisted of the same twenty sentences that appeared in random order in five separate films. The experimental subjects chosen for the study were five females between the ages of eighteen and twenty-two years. Each subject had normal hearing as determined by an audiometric screening test. Each subject also had normal visual acuity as determined by an optometric examination. Their vision was found to be within normal limits in the following dimensions: 1) accommodation, 2) color vision, 3) visual field,

4) stereopsis, 5) phorias, 6) internal and external health of the eyes, and 7) monocular and binocular visual acuity. At the time of the eye examination, the optometrist determined the proper lenses for the subjects that would produce a blurred condition of the following levels at a distance of ten feet: 20/100, 20/80, 20/60, 20/40, and 20/20. At the time of the experimental testing, the appropriate lenses that would produce the desired blurred condition were placed into a glasses frame that was fitted on the subject. One at a time, the subjects saw the films. Since it was presumed that a certain amount of learning would occur as the result of seeing the same sentences five times, control subjects were employed. They viewed the five films in their normal acuity condition. The median improvement in their scores from one film presentation to the next one was identified as the learning effect. Their learning effect scores were subtracted from the experimental group's scores. The remaining scores were believed to represent a conservative estimate of the effects of visual distortion on lipreading performance.

It was found that lipreading performance was significantly changed when visual acuity was varied from 1) 20/100 to the following levels: 20/80, 20/60, 20/40, and 20/20; 2) 20/80 to the following levels: 20/60, 20/40, and 20/20; and 3) 20/60 to the following levels: 20/40 and 20/20. There was no significant change in lipreading performance

as acuity was changed from 20/40 to 20/20. Further, it was learned that there was no significant change in the lipreading scores that were obtained while viewing the stimulus material through optical lenses that produced the acuity levels of 20/40 and 20/20 and the scores that were obtained in the normal acuity condition (no lens). Since it was observed that visual acuity deprivation produced the most deleterious effect on the lipreading performance of the poorer lipreaders, it was felt that persons believed to be poor lipreaders should be certain that their vision is as nearly normal as possible before undertaking lipreading practice.

Conclusions

Within the limitations of this study, and from the results obtained by the statistical analyses of the data, the following conclusions appear justified:

1. Lipreading performance was significantly improved when visual acuity was changed from 20/100 to the following levels: 20/80, 20/60, 20/40, and 20/20.

2. Lipreading performance was significantly improved when visual acuity was changed from 20/80 to the following levels: 20/60, 20/40, and 20/20.

3. Lipreading performance was significantly improved when visual acuity was changed from 20/60 to the following levels: 20/40 and 20/20.

4. Lipreading performance was not significantly improved when visual acuity was changed from the level of 20/40 to the level of 20/20.

5. Clinicians should be made aware that higher lipreading performance can be expected as visual acuity is improved from the 20/100 level to at least the 20/40 level.

6. Individuals for whom lipreading training has been recommended should be encouraged to have their vision tested, and corrected if necessary, before practice is begun.

Recommendations For Further Research

Although there was no statistically significant difference in lipreading performance between the visual acuity levels of 20/40 and 20/20, there was a trend in the direction of higher scores as acuity was improved. It is felt that lipreading performance at the visual acuity levels of 20/40 and 20/20 need further study to detect the subtle differences if, in fact, they do exist. Additional research addressed to lipreading performance at and between the levels of 20/40 and 20/20 is also encouraged.

Further studies should include the following: 1) the lipreading performance of a group of people with a visual loss of the same magnitude as the optical lenses in this study provided, should be compared with the results of this study; 2) lipreading performance should be studied in a normal group where all but one of the following visual conditions

such as visual field, stereopsis, vertical and lateral phoria, astigmatism and color vision was held constant while one of the above conditions was varied; 3) lipreading performance should be investigated in a group of individuals with normal vision where several of the above visual parameters are simultaneously varied with each other; and 4) the lipreading performance of persons who wear different types of optical lenses, such as bifocals and trifocals, should also receive the researcher's attention.

SELECTED BIBLIOGRAPHY

SELECTED BIBLIOGRAPHY

Books

Borish, Irvin M. Clinical Refraction. Chicago: The Professional Press, Inc., 1954.

Bruhn, Martha. The Mueller-Walle Method of Lip Reading for the Hard of Hearing. 7th ed. Boston: M. H. Leavis, 1949.

Deland, Fred. The Story of Lipreading: Its Genesis and Development. rev. Washington: The Volta Bureau, 1968.

Dunn, Weiant W., ed. Models for the Perception of Speech and Visual Form. Cambridge: The M. I. T. Press, 1967.

Edwards, Allen L. Statistical Methods: For the Behavioral Sciences. New York: Rinehart & Company, Inc., 1954.

Graham, C. H. "Visual Perception," Handbook of Experimental Psychology. Edited by S. S. Stevens. New York: John Wiley & Sons, Inc., 1951.

Gregg, James R., and Heath, Gordon G. The Eye: And Sight. Boston: D. C. Heath and Company, 1964.

Gregory, R. L. Eye and Brain. New York: McGraw-Hill Book Company, 1966.

Gutstein, Joseph B. A Student's Guide to Optometry. 2nd ed. Chicago: Chicago College of Optometry, 1952.

Lyle, T. K., and Wybar, Kenneth C. Lyle and Jackson's Practical Orthoptics in the Treatment of Squint. 5th ed. Great Britain: Charles C. Thomas Publisher, 1967.

Morkovin, Boris V. Life Situation Motion Pictures: A Contextual Approach for Speech Reading. Berkeley: University of California Press, 1944.

Morrison, Thomas F.; Cornett, Fredrick D.; and Tether, J. E. Human Physiology. New York: Holt and Company, 1959.

Nitchie, Edward B. Lip-Reading. New York: Fredrick A. Stokes Company, 1919.

O'Neill, John J., and Oyer, Herbert J. Visual Communication for the Hard of Hearing. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1961.

Ordman, Kathryn A., and Ralli, Mary P. What People Say: The Nitchie School Basic Course in Lipreading. 3rd rev. ed. Washington: The Volta Bureau, 1957.

Pauls, Miriam D. "Speechreading," Hearing and Deafness. Edited by Hallowell Davis, and S. Richard Silverman. 1st rev. ed. New York: Holt, Rinehart and Winston, Inc., 1960.

Scholz, Roy O. Sight: A Handbook for Laymen. Garden City, New York: Doubleday & Company, Inc., 1960.

Siegel, Sidney. Nonparametric Statistics: For the Behavioral Sciences. New York: McGraw-Hill Book Company, Inc., 1956.

Wood, Kenneth S. "Terminology and Nomenclature," Handbook of Speech Pathology. Edited by Lee E. Travis. New York: Appleton-Century-Crofts, Inc., 1957.

Reports

Goetzinger, Cornelius P. "A Study of Monocular Versus Binocular Vision in Lipreading," in Report of the Proceedings of the 41st Meeting of the Convention of American Instructors of the Deaf, Congressional Document No. 106, 88th Congress, June 22-28, 1963.

Lowell, Edgar L. "Pilot Studies in Lip Reading," John Tracy Clinic Research Papers, VIII (February, 1958).

Stone, Louis. "Facial Cues of Context in Lip Reading," John Tracy Clinic Research Papers, V (December, 1957).

Taaffe, Gordon. "A Film Test of Lipreading," John Tracy Clinic Research Papers, II (November, 1957).

Taaffe, Gordon, and Wong, Wilson. "Studies of Variables in Lip Reading Stimulus Material," John Tracy Clinic Research Papers, III (December, 1957).

Wong, Wilson, and Taaffe, Gordon. "Relationships Between Selected Aptitude and Personality Tests and Lipreading Ability," John Tracy Clinic Research Papers, VII (February, 1958).

Woodward, Mary F. "Linguistic Methodology in Lip Reading Research," John Tracy Clinic Research Papers, IV (December, 1957).

Periodicals

Baker, Katherine E., and Feldman, Herman. "Threshold-Luminance for Recognition in Relation to Frequency of Prior Exposure," American Journal of Psychology, 69 (1956), 278-80.

Bell, Mabel H. "Helping the Deaf Read the Lips of Their Hearing Contemporaries," Volta Review, 42 (1940), 607-10.

Black, John W. "Accompaniments of Word Intelligibility," Journal of Speech and Hearing Disorders, 17 (1952), 409-18.

Blair, Francis X. "A Study of the Visual Memory of Deaf and Hearing Children," American Annals of the Deaf, 102 (1957), 254-63.

Braly, Kenneth W. "A Study of Defective Vision Among Deaf Children," American Annals of the Deaf, 83 (1938), 192-93.

Brannon, John B., and Kodman, Frank. "The Perceptual Process in Speech Reading," A. M. A. Archives of Otolaryngology, 70 (1959), 114-19.

Burg, Albert. "Lateral Visual Field as Related to Age and Sex," Journal of Applied Psychology, 52 (1968), 10-15.

_____. "Visual Acuity as Measured by Dynamic and Static Tests: A Comparative Evaluation," Journal of Applied Psychology, 50 (1966), 460-66.

Byers, Vincent W., and Lieberman, Lewis. "Lipreading Performance and the Rate of the Speaker," Journal of Speech and Hearing Research, 2 (1959), 271-76.

Conklin, Edmund S. "A Method for the Determination of Relative Skill in Lip-Reading," Volta Review, 19 (1917), 216-19.

Costello, Mary R. "A Study of Speech Reading as a Developing Language," Speech Monographs, 25 (1958), 137-38.

DiCarlo, Louis M., and Kataja, Raymond. "An Analysis of the Utley Lipreading Test," Journal of Speech and Hearing Disorders, 16 (1951), 226-40.

Ellison, Patricia K., and Jenkins, James J. "The Durational Threshold of Visual Recognition as a Function of Word Frequency," American Journal of Psychology, 67 (1954), 700-03.

Fisher, Cletus G. "Confusions Among Visually Perceived Consonants," Journal of Speech and Hearing Research, 11 (1968), 796-804.

Forrest, Elliot B. "Approaching Vision Training," Academic Therapy Quarterly, 3 (1968), 155-61.

Freeman, G. L. "An Experimental Study of the Perception of Objects," Journal of Experimental Psychology, 12 (1929), 341-58.

Gibson, James J. "The Reproduction of Visually Perceived Forms," Journal of Experimental Psychology, 12 (1929), 1-39.

Greenberg, Herbert J., and Bode, Daniel L. "Visual Discrimination of Consonants," Journal of Speech and Hearing Research, 11 (1968), 869-74.

Gault, Robert. "On the Identification of Certain Vowel and Consonantal Elements in Words by Their Tactile Qualities and by Their Visual Qualities as Seen by the Lip-Reader," Journal of Abnormal Psychology, 22 (1927-28), 33-39.

Hardick, Edward J.; Oyer, Herbert J.; and Irion, Philip E. "Lipreading Performance as Related to Measurements of Vision," Accepted for Publication in Journal of Speech and Hearing Research (1969).

Heider, Fritz K., and Heider, Grace M. "An Experimental Investigation of Lip Reading," Psychological Monographs, 52 (1940), 1-153.

Heider, Grace M. "The Utley Lip Reading Test," Volta Review, 49 (1947), 457-58, 488-90.

Howell, Louise. "Lipreading for the Hard of Hearing Adult," Volta Review, 19 (1917), 15-16.

Howes, Davis H., and Solomon, Richard L. "Visual Duration Threshold as a Function of Word-Probability," Journal of Experimental Psychology, 41 (1951), 401-10.

Keith, John. "Everyone Has What it Takes," Volta Review, 45 (1943), 576-78.

Kenfield, Coralie. "Some Mental Problems of Lipreading," Volta Review, 21 (1919), 38-39.

Kitson, H. D. "Psychological Tests for Lipreading Ability," Volta Review, 17 (1915), 471-76.

Mason, Marie K. "A Cinematographic Technique for Testing Visual Speech Comprehension," Journal of Speech Disorders, 8 (1943), 271-78.

Miller, June; Rousey, Clyde L.; and Goetzinger, C. P. "An Exploratory Investigation of a Method of Improving Speechreading," American Annals of the Deaf, 103 (1958), 473-78.

Mishkin, Mortimer, and Forgays, Donald G. "Word Recognition as a Function of Retinal Locus," Journal of Experimental Psychology, 43 (1952), 43-48.

Mooney, Craig. "Closure as Affected by Viewing Time and Multiple Visual Fixations," Canadian Journal of Psychology, 11 (1957), 21-28.

Neely, Keith K. "Effect of Visual Factors on the Intelligibility of Speech," Journal of the Acoustical Society of America, 28 (1956), 1275-77.

Nitchie, Elizabeth H. "The Synthetic Method and Why I Believe in It," Volta Review, 21 (1919), 764-71.

Olson, Jack. "A Factor Analytic Study of the Relation Between the Speed of Visual Perception and the Language Abilities of Deaf Adolescents," Journal of Speech and Hearing Research, 10 (1967), 354-59.

O'Neill, John J. "An Exploratory Investigation of Lipreading Ability Among Normal Hearing Students," Speech Monographs, 18 (1951), 309-11.

_____. "Contributions of the Visual Components of Oral Symbols to Speech Comprehension," Journal of Speech and Hearing Disorders, 19 (1954), 429-39.

O'Neill, John J., and Davidson, JoAnn L. "Relationship Between Lipreading Ability and Five Psychological Factors," Journal of Speech and Hearing Disorders, 21 (1956), 478-81.

_____, and Stephens, Mary C. "Relationships Among Three Filmed Lip-Reading Tests," Journal of Speech and Hearing Research, 2 (1959), 61-65.

Pierce, Jan. "Some Sources of Artifact in Studies of the Tachistoscopic Perception of Words," Journal of Experimental Psychology, 66 (1963), 363-70.

Pintner, Rudolf. "Speech and Speech-Reading Tests for the Deaf," Journal of Applied Psychology, 13 (1929), 220-25.

_____, and Paterson, Donald G. "A Comparison of Deaf and Hearing Children in Visual Memory for Digits," Journal of Experimental Psychology, 2 (1917), 76-88.

Quigley, Stephen P., and Frisina, D. Robert. "Institutionalization and Psychoeducational Development of Deaf Children," C. E. C. Research Monograph, Series A (1961), 1-49.

Reid, Gladys. "A Preliminary Investigation in the Testing of Lip-Reading Achievement," American Annals of the Deaf, 91 (1946), 403-13.

Simmons, Audrey A. "Factors Related to Lipreading," Journal of Speech and Hearing Research, 2 (1959), 340-52.

Sloan, Albert E., and Rosenthal, Perry. "School Vision Testing," A. M. A. Archives of Ophthalmology, 64 (1960), 763-70.

Smith, Frank. "An Experimental Investigation of Perception," British Journal of Psychology, 6 (1913-1914), 321-62.

Solomon, Richard L., and Postman, Leo. "Frequency of Usage as a Determinant of Recognition Thresholds for Words," Journal of Experimental Psychology, 43 (1952), 195-201.

Stobschinski, Robert. "Lip Reading: Its Psychological Aspects and Its Adaptation of the Individual Needs of the Hard of Hearing," American Annals of the Deaf, 73 (1928), 234-42.

Stockwell, Eunice. "Visual Defects in the Deaf Child," A. M. A. Archives of Ophthalmology, 48 (1952), 428-32.

Suchman, Rosslyn G. "Visual Impairment Among Deaf Children--Frequency and Educational Consequences," Volta Review, 70 (1968), 31-37.

Sumby, W. H., and Pollack, Irwin. "Visual Contribution to Speech Intelligibility in Noise," Journal of the Acoustical Society of America, 26 (1954), 212-15.

Torrey, Gertrude. "Lip Reading for the Adult Deaf," Volta Review, 16 (1914), 535-39.

Tulving, Endel, and Gold, Cecille. "Stimulus Information and Contextual Information as Determinants of Tachistoscopic Recognition of Words," Journal of Experimental Psychology, 66 (1963), 319-27.

Upton, Hubert W. "Wearable Eyeglass Speechreading Aid," American Annals of the Deaf, 113 (1968), 222-29.

Utley, Jean. "A Test of Lip Reading Ability," Journal of Speech Disorders, 11 (1946), 109-16.

Woodward, Mary F., and Barber, Carroll G. "Phoneme Perception in Lip Reading," Journal of Speech and Hearing Research, 3 (1960), 212-22.

Woolley, Florence T. "How We Use the Tachistoscope," Hearing News, 17 (1949), 3-4.

Unpublished Materials

Aylesworth, Donald L. "The Talker and the Lipreader as Variables in Face-to-Face Testing of Lipreading Ability," Unpublished Master's Thesis, Michigan State University, 1964.

Blakeley, Robert W. "Auditory Abilities Associated With Lip Reading," Unpublished Master's Thesis, University of Oregon, 1953.

Brainerd, Susan C. "An Investigation of the Relation Between Performance on a Filmed Lipreading Test and Analysis of the Visual Environment," Unpublished Master's Thesis, Michigan State University, 1969.

Cavender, Betty J. "The Construction and Investigation of a Test of Lip Reading Ability and a Study of Factors Assumed to Affect the Results," Unpublished Master's Thesis, Indiana University, 1949.

Franks, John R. "A Study of Factors that Influence the Identification of English Sounds in Lipreading," Unpublished Doctoral Dissertation, Michigan State University, 1964.

Fulton, Richard M. "Comparative Assessment of Visible Differences Between Voiced and Unvoiced Words," Unpublished Master's Thesis, Michigan State University, 1964.

Haas, William H., and Oyer, Herbert J. "Visual Recognition Speed, Familiarity, Redundancy Pattern, and Lipreading Performance," Unpublished study, Michigan State University, 1969.

Joergenson, Ann. "The Measurement of Homophenous Words," Unpublished Master's Thesis, Michigan State University, 1962.

Johnson, Gerald F. "The Effects of Cutaneous Stimulation by Speech on Lipreading Performance," Unpublished Doctoral Dissertation, Michigan State University, 1963.

Katt, Terry L. "Constructipn and Evaluation of an Eight Millimeter Filmed Lipreading Test," Unpublished Master's Thesis, Michigan State University, 1967.

Keil, Janice M. "The Effects of Peripheral Visual Stimuli on Lipreading Performance," Unpublished Doctoral Dissertation, Michigan State University, 1968.

Kitchen, Dale W. "The Relationship of Visual Synthesis to Lipreading Performance," Unpublished Doctoral Dissertation, Michigan State University, 1968.

Leonard, Ralph. "The Effects of Continuous Auditory Distractions on Lipreading Performance," Unpublished Master's Thesis, Michigan State University, 1962.

Mason, Marie K. Visual Hearing, Unpublished Manual, Ohio State University Press, 1951.

Morris, Dorothy M. "A Study of Some of the Factors Involved in Lipreading," Unpublished Master's Thesis, Smith College, 1944.

Mulligan, Marigene. "Variables in the Reception of Visual Speech from Motion Pictures," Unpublished Master's Thesis, Ohio State University, 1954.

Nielsen, Karen M. "The Effect of Redundancy on the Visual Recognition of Frequently Employed Spoken Words," Unpublished Doctoral Dissertation, Michigan State University, 1966.

O'Neill, John J. "Contributions of the Visual Components of Oral Symbols to the Speech Comprehension of Listeners With Normal Hearing," Unpublished Doctoral Dissertation, Ohio State University, 1951.

Reams, Mary H. "An Experimental Study Comparing the Visual Accompaniments of Word Identification and the Auditory Experience of Word Intelligibility," Unpublished Master's Thesis, Ohio State University, 1950.

Roback, Ila M. "Homophenous Words," Unpublished Master's Thesis, Michigan State University, 1961.

Sahlstrom, Lowell J. "Objective Measurement of Certain Facial Movements During Production of Certain Homophenous Words," Unpublished Doctoral Dissertation, Michigan State University, 1967.

Smith, Richard C. "An Investigation of the Relationship Between the Lipreading Ability and Intelligence of the Mentally Retarded," Unpublished Master's Thesis, Michigan State University, 1964.

Subar, Barbara E. "The Effects of Visual Deprivation on Lipreading Performance," Unpublished Master's Thesis, Michigan State University, 1963.

Thomas, Sharon L. "Lipreading Performance as a Function of Light Levels," Unpublished Master's Thesis, Michigan State University, 1962.

Worthington, Anna M. "An Investigation of the Relationship Between the Lipreading Ability of Congenitally Deaf High School Students and Certain Personality Factors," Unpublished Doctoral Dissertation, Ohio State University, 1956.

Encyclopedia

The Focal Encyclopedia of Photography. New York: Focal Press, 1965.

APPENDICES

APPENDIX A

THE PERCENTAGE OF CORRECT REPONSES BY SIXTY-SEVEN STUDENTS WHO SAW THE PRE-TEST FILM WHICH CONTAINED THE FOLLOWING 107 SENTENCES

Sentence	Per Cent Correct
1. What is your name?	82
2. Where have you been?	76
3. Where do you live?	56
4. Do you have a phone?	79
5. What street do you live on?	44
6. Where were you born?	49
7. How old are you?	82
8. Do you have a brother or a sister?	14
9. Are your parents living?	26
10. How many brothers do you have?	77
11. Where did you go to high school?	10
12. Did you go home for Christmas?	53
13. How many sisters do you have?	86
14. What is your social security number?	10
15. When is your birthday?	26
16. What is your student number?	05
17. Do you have a car?	29
18. Do you like to dance?	13
19. Do you like to water ski?	25
20. Do you wear glasses?	62
21. What is your favorite sport?	50
22. Do you like football?	37
23. Have you ever played basketball?	49
24. Have you ever been fishing?	73
25. Do you like to write term papers?	10
26. Where did you get the new coat?	0
27. What color is your car?	01
28. Where did you go for spring break?	20
29. Do you like to go to movies?	40
30. Do you have a typewriter?	44
31. Where did you get the flowers?	22
32. What is your major?	44
33. Who is your advisor?	17

Sentence	Per Cent Correct
34. How long have you gone to college?	56
35. What department are you in?	07
36. What did you do last weekend?	10
37. Where were you last Thursday?	17
38. Do you ever cut classes?	07
39. When do you expect to graduate?	17
40. What is your favorite hobby?	37
41. Where will you go after graduation?	22
42. Do you live on campus?	40
43. Do you like to fly?.	41
44. Do you ride the campus bus?	22
45. When is your first class?	23
46. What time do you get up in the morning?	55
47. Were you here fall term?	11
48. Where do you eat lunch?	11
49. Do you think prices are high?	02
50. Do you have a scholarship?	52
51. What kind of music do you like?	19
52. Do you ever buy used books?	02
53. How many credits are you carrying this term?	16
54. Did you vote in the last election?	02
55. Are you wearing a new dress?	0
56. Where do you shop for clothes?	07
57. Do you smoke?	88
58. Do you like the weather?	41
59. Do you have a pencil?	19
60. Where is your ticket?	0
61. Who are you going with?	32
62. Do you watch TV?	68
63. Do you have a driver's license?	55
64. What is your favorite TV program?	47
65. Do you like ice cream?	44
66. Do you have a roommate?	65
67. What was your highest grade last term?	01
68. Do you live off campus?	50
69. Do you drive your car on campus?	02
70. Do you go home on weekends?	34
71. How much do you pay for rent?	13
72. Do you pay out-of-state tuition?	14
73. Do you live in a dorm?	35
74. How much money do you spend on books?	16
75. Do you have a class at three o'clock?	14
76. She wrote with a pencil.	0
77. She wears short skirts.	01
78. Each of you were wrong.	0
79. The weather is bad.	55
80. The dogs barked.	0
81. The cat caught the mouse.	23
82. The team played well.	02

Sentence	Per Cent Correct
83. Don't run away.	29
84. Good morning, how are you?	37
85. I don't know.	29
86. My horse died.	08
87. This house is for sale.	38
88. The speaker is nervous.	0
89. What's your reply?	04
90. Come with me.	16
91. The boys were noisy.	10
92. I cannot find him.	13
93. She looks lovely.	11
94. My salary is low.	14
95. How fast will the car go?	10
96. Mary had a little lamb.	20
97. I shall tell.	01
98. I like pumpkin pie.	08
99. The child was crying.	07
100. Birds fly south for the winter.	02
101. I am boastful.	01
102. He swam a mile.	0
103. His answers were foolish.	0
104. Mop the floor.	16
105. Have I met you before?	40
106. Oh Boy!.	62
107. What time is it?	77

APPENDIX B

INSTRUCTIONS TO EXPERIMENTAL SUBJECTS

You are going to see, but not hear, some movies of a person saying some sentences. Your task is to watch the movie, and then write, on the answer sheets which are provided, what you think the person said.

In addition, your vision will be temporarily blurred by means of optical lenses that were especially prescribed for you by the optometrist who examined your eyes. The investigator will position and adjust the glasses frame for you.

At the end of each movie, the answer sheet will be collected and a different blurring lens will be put into the glasses frame. This process will be repeated five times.

Do you have any questions?

APPENDIX C

INSTRUCTIONS TO CONTROL SUBJECTS

You are going to see, but not hear, some movies of a person saying some sentences. Your task is to watch the movie, and then write, on the answer sheets which are provided, what you think the person said.

At the end of each movie, the answer sheet will be collected. This process will be repeated five times.

Do you have any questions?