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Carl W. Asp

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SLEEP AND DREAM PATTERNS OF ORAL, MANUAL, AND AURAL/ORAL HEARING-IMPAIRED PEOPLE

A Thesis

Presented for the

Master of Arts

Degree

The University of Tennessee, Knoxville

Rex D. Banks

May 1989

DEDICATION

This thesis is dedicated to my parents, McLeod and Joyce Banks, for all of their love and support throughout my collegiate career. Thanks for always believing in me.

ACKNOWLEDGMENTS

I am forever thankful for the wonderful people who supported and guided me through this thesis. I would first like to thank Dr. Carl W. Asp (Chairman) for all of his hours of personal dedication and devotion to this project. Many thanks are extended to the members of my committee for their wisdom and patience during the course of this study: Dr. Allan Diefendorf, Dr. Dennis O'Connell, and Dr. Harold Peterson. I would also like to thank Dr. Patrick Carney (Departmental Head) for his interest and financial support of this project. Much appreciation is also given to Dr. Jack Ellison for his contribution in the psychological assessment of the subjects.

This study could not have been possible were it not for the dedicated technical staff at The Sleep Disorders Center of Fort Sanders Regional Medical Center. Thank you for your friendship and participation in this project. Members of the staff are: Peggy Dickerson (Director), Donna Plumlee, R.PSG.T., Marcie Tagliaferri, R.PSG.T., John Lay, PSG.T., and Mary Synder, PSG.T.

I wish to thank Mrs. Eva Saffer for always being there to listen and for her most sincere willingness to help throughout this project. Also, I would like to thank Mr. Mark Sandlin for being my voice and supporter at The Tennessee School for the Deaf.

Finally, I would like to extend an enormous amount of appreciation to the hearing-impaired young people, and their parents, who participated in the study. You have been an inspiration to all of us who had the opportunity to work with you. May God bless you all.

ABSTRACT

The sleep architecture of five hearing-impaired subjects was evaluated. The mode of communication for these subjects was one oral subject, one manual subject, and three aural/oral subjects. The mean age was twenty-one, with an age range of sixteen to thirty-four years. Twenty-one physiological measurements were obtained on each subject during a full night of sleep at The Sleep Disorders Center of Fort Sanders Regional Medical Center, Knoxville, Tennessee. Each measurement (e.g., EEG and EMG) was scored by two certified polysomnographic technologists. These measurements were used to evaluate the sleep architecture among the three modes of communication. Each subject had a psychological evaluation to determine levels of I.Q., depression, and anxiety. The subjects with the greatest hearing loss had more depression and anxiety than the subjects with less hearing loss. Three of the five subjects had high depression and anxiety scores. All three of the aural/oral subjects had alpha waves intruding into their deep sleep. This meant that they had traces of wakefulness interrupting their sleep. The Sleep Center only had a 3 percent occurrence of alpha intrusion in cases of normal hearing people. With some exceptions, the hearing-impaired subjects had less percent of time in REM (dream) sleep and either a longer or shorter latency to REM sleep than the

norms. The manual and two aural/oral subjects who were similar in age, were also similar in some sleep measures. The older subjects (twenty-one years for oral and thirty-four for aural/oral) were similar for some sleep measures. Age may have been a factor. It was not possible to determine the affect of first night effects on the data in this study. It may have contributed to the variability in the data from the norms. There were some differences in the results from the sleep studies in this study, and the results obtained for sleep studies on hearing-impaired people in other investigations that used successive nights of measure to minimize first night effects.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

> There lay the gods and slept, Morpheus and Eclympasteyre, who was heir to the god of sleep, who slept and did none other toil. This cave was dark everywhere about as the pit of hell. They had good leisure to snore in rivalry; who were the soundest of sleeper! Some hung chin on breast and slept standing upright, their heads hidden; and some lay abed and slept the long days through.
>
> This messenger came flying swiftly and cried, "Oh ho! Awake, and that anon!" It was in vain; none heard him. "Awake!" quoth he. "Who is it lies there?" And he blew his horn right in their ears and cried wondrous loud, "Awake!"
>
> This god of sleep opened one eye and asked, "Who calls there?"
>
> Chaucer, Book of the Duchess

Sleep, though as common as wakefulness, has long been a mystifying process. While practically everyone requires, experiences, and desires sleep, virtually no one fully understands it. Thus, sleep remains a common, but curious phenomenon (Foulkes 1966).

There are many different theories as to why people need sleep. Some stress that sleep is a period for restoration of physiological, neurological, and psychological states (Hartmann 1973). The primary basis behind this theory is that people feel tired before sleep and rested when they awaken.

Conversely, Pavlov (1927) supports the Protective Theory. It states that people do not sleep because they are exhausted, but to avoid becoming exhausted; sleep protects the cortical system from exhaustion.

The Energy Conservation Hypothesis (Berger 1975) concludes that sleep functions to conserve or save energy which will be needed to meet the demands of wakefulness.

Still another theory, the Ethological Theory (Meddis 1975) holds that sleep is a function of survival. Each species sleeps in accordance to their ecological niche. Animals adapt a system of sleep patterns which accommodate the survival of their species.

Finally, Moruzzi (1966) states that sleep is an instinct, much like migration or nest building. Moruzzi supports the idea that sleep is simply an expression of behavior.

For the most part, man has discovered the physiological mechanisms which are responsible for the onset and maintenance of sleep. However, in spite of all the theories as to why man must sleep, there is still no definite answer (Foulkes 1966).

Statement of the Problem

Hearing-impaired people experience psychological problems similar to those of normal hearing people. While the incidence of schizophrenia is not significantly different between the two groups, hearing-impaired people have certain psychological problems which are thought to be related specifically to their hearing loss (Grinker 1969).

Erdman, Crowley, and Gillespie (1984) found that one-third of a hundred interviewed hearing-impaired individuals reported feelings of embarrassment, stress, anxiety, and incompetence in the work environment. Isolation, boredom, and disinterest were commonly displayed emotions for social situations. In the home, feelings of anger and irritation were often present.

According to Altschuler et al. (1969) most institution-alized deaf people suffered from aggressive and impulsive behavioral disorders. Their aggression seemed to be related to a communicational barrier, which isolated them from the majority of the population.

If a person cannot communicate with others, he may experience a great deal of anxiety and frustration. This could lead to feelings of aggression, which may be reflected in irregular dream patterns and sleep cycles. Evans (1983) stated that individuals with high levels of anxiety and frustration may require more dream sleep in order to solve or work out their problems.

People use dreams to work out their fears, unfulfilled desires, unrecognized anxieties, and hopes (Foulkes 1966). If hearing-impaired people do not experience normal dream patterns or sleep cycles, they may be deprived of the refreshing and healthy process of dreaming. Dream deprivation can result in a deterioration in personality functioning, and can contribute to serious psychological problems (Altman 1969).

External disturbances in one's personal life can contribute to insufficient amounts of sleep (Cohen 1979). Perhaps the emotional implications of hearing impairment could bring about sleep deprivation. Conversely, Hartmann (1973) argues that people with emotional disturbances tend to be lengthy sleepers. The question of long-sleepers versus short-sleepers with relation to mental health is disputable. Nevertheless, whether one receives excessive sleep or insufficient sleep, neither is thought to be healthy.

The study of sleep in the hearing-impaired populations has been all but neglected. Even though the depth of sleep can be a function of auditory perception, the published literature revealed only three investigations concerning the sleep patterns or sleep architecture of hearing-impaired people.

Robinson and Dawson (1975) examined the EEG and REM patterns of four congenitally deaf males between the ages of twenty and twenty-three years. These subjects used manual communication as their primary means of communicating. Each subject's sleep was evaluated on five consecutive nights and compared to fifteen age matched control subjects with no hearing impairments. Robinson and Dawson reported that there was no difference between deaf and normal hearing subjects in minutes of total sleep or REM time. However, they reported that deaf subjects had fewer early morning awakenings, spent less time in delta sleep and NREM sleep than normal hearing subjects. These investigators did not account for the aural/oral population, but did indicate that some of the subjects used both sign and voice.

Stojanovic and Guberina (1975) wanted to investigate the changes that may occur in the central nervous system during sleep when the input of sensory information had been decreased. More specifically, they looked at the sleep and dream patterns of deaf children, who because of their deafness, had a decreased perception of acoustic signals. Development of speech is hindered by impairment of acoustic signals. Speech is part of the maturation and growth of children which is necessary for normal social adjustment. These investigators wanted to compare those hearing-impaired children who did not utilize residual hearing to those who did. Their hypothesis was that children who utilized residual hearing and developed oral communication skills would have dream and sleep cycles similar to normally hearing children. Children who did not utilize residual hearing and did not develop oral communication skills would be delayed in their general social maturation. This delay in maturation, which was due to not utilizing residual hearing or stimulating acoustic perception, may have an effect on the central nervous system which may be reflected or manifested in their sleep and dream patterns.

Stojanovic and Guberina compared the sleep and REM patterns of three groups. The groups consisted of fifteen children between the ages of fourteen and sixteen. The three groups were: five normal hearing children, five aural/oral children, and five manual children. The results from their investigation concluded that the manual deaf children had a significantly shorter REM duration of sleep and a shorter latency to REM sleep as compared to the other two groups. The aural/oral subjects were similar to the normally hearing children in relation to REM and sleep patterns.

Max (1935) examined the sleep patterns of thirty-three manual adult deaf people. He wanted to investigate whether or not there would be any effort or carry-over of sign language into sleep which may be manifested during REM sleep by an increased amount of EMG activity at the arm. His hypothesis was that normally hearing people talk in their sleep, because their oral structures are their base for communication. Possibly manual communicators might have an increased amount of EMG activity at their arms and fingers during dream sleep since their primary mode of communication lies there.

Max reported that 69 percent of the manual communicators exhibited an increased amount of muscle or EMG activity during the REM stage of sleep. This suggested the effort to use sign language during the dreaming stage. He measured EMG activity of 3.5-3.6 microvolts during REM at the flexores digitorum. There was minimal EMG activity present in the normal hearing control subjects (less than 1 microvolt). These findings suggested a possible physiological difference, with regards to muscle movement, between normally hearing people and manual communicators during REM sleep.

Summary of Sleep Variables Among Hearing-Impaired People

In terms of psychological development, Erdman, Crowley, and Gillespie (1984) reported that some hearing-impaired people had feelings of embarrassment, boredom, anxiety, and incompetence due to their hearing loss. These feelings may cause aggression or frustration. Evans (1983) reported that individuals with high levels of anxiety and frustration may require more dream sleep in order to solve or work out their problems. On the other hand, hearing-impaired people may not get enough sleep. Cohen (1979) reported that disturbances in a person's life could result in insufficient amounts of sleep. If a hearing-impaired person experiences excessive grief because of their hearing loss, they may not be getting enough sleep.

Robinson and Dawson (1975) reported that hearing-impaired people who communicated through sign language spent more time awake during the night, had less early morning awakenings, spent less time in NREM sleep, and less time in delta sleep than normally hearing people.

Stojanovic and Guberina reported that manual deaf children had a delayed latency to REM sleep, and had a decreased percentage of REM sleep as compared to aural/oral deaf children and normally hearing children.

Max (1935) reported that manual deaf adults had increased amounts of EMG activity at the arm and finger during REM sleep. This suggested the effort to use sign language during REM sleep. This increase in EMG activity was not seen in normally hearing adults.

Based on all of the above findings, the purpose of the current study was to compare the sleep and dream patterns (sleep architecture) of five individuals; one manual communicator, one oral communicator, and three aural/oral communicators.

Experimental Question

Does sleep architecture differ in hearing-impaired individuals with different types of communication modes (oral, manual or aural/oral)?

The parameters, 1-19, described the sleep architecture. Some of the parameters were used in the studies that were reviewed, while other parameters represent advancements in sleep technology. Parameters 20-22 are routinely required measurements in accredited polysomnographic labs, and served as safety measures.

Sleep Architecture

1. total sleep time
2. total REM sleep time
3. total NREM sleep time
4. sleep efficiency
5. amount of early morning awakenings
6. wake before sleep
7. wake during sleep
8. wake after sleep
9. percent of time spent in stage wake

10. total number of awakenings
11. percent of time spent in stage 1
12. percent of time spent in stage 2
13. percent of time spent in stages 3 and 4
14. percent of time spent in stage REM
15. latency to stage 1
16. latency to stage 2
17. latency to persistent sleep
18. latency to REM
19. EMG activity at the arm and anterior tibialis

Safety Measures

20. EKG activity during sleep
21. blood oxygen levels during sleep
22. breathing efforts during sleep

Definition of Terms

The following terms were used in this study:

alpha wave--EEG wave with a frequency of 8-13 cycles per second (cps) and characteristic of relaxed wakefulness with the eyes closed (Guilliminault 1982).

delta wave--EEG wave with a frequency of .5 to 2 cps and is characteristic of stages 3 and 4 of sleep (Guilliminault 1982).

early morning awakening--An awakening that occurs between the hours of 3:00 a.m. and 6:00 a.m.

electrocardiogram (EKG)--Record of the muscle activity of the heart (Guilliminault 1982).

electroencephalogram (EEG)--Record of the electrical activity of the brain (Guilliminault 1982).

electromyogram (EMG)--Record of the electrical activity of muscles (Guilliminault 1982).

electro-oculogram (EOG)--Record of the muscle activity of the eyes (Guilliminault 1982).

frequency--The number of complete cycles of a rhythm in one second (Guilliminault 1982).

K-complex--EEG wave forms having a well delineated negative sharp wave immediately followed by a positive component; duration exceeds 0.5 seconds; waves of 12-14 cps (sleep spindles) may or may not constitute part of the complex; generally maximal over vertex regions; occurring during sleep either spontaneous or in response to sudden (usually auditory) stimuli; characteristic of stage 2 of sleep (Guilliminault 1982).

low voltage EEG--EEG in which no activity larger than 20 microvolts can be recorded between any two points on the scalp (Guilliminault 1982).

nocturnal myoclonus--Leg twitches recorded from the right and left anterior tibialis muscle which repeat every 20 to 40 seconds.

nonrapid eye movement (NREM)--Stages 1, 2, 3, and 4 of sleep, which are characterized by an absence of rapid eye movements (Guilliminault 1982).

persistent sleep--This is achieved when a person has ten consecutive minutes of stage 1 sleep without awakening.

rapid eye movement (REM)--A relatively low voltage, mixed frequency EEG, in conjunction with episodic REMs and low amplitude EMG (Rechtshaffen and Kales 1977); the dreaming state of sleep (Hauri 1982).

sleep efficiency--This is determined by dividing the total sleep time by the time spent in bed.

stages of sleep--There are four distinct stages of sleep which occur during an evening of sleep. There is little or no eye movement during these stages. They are labeled stages "1," "2," "3," and "4" (Hauri 1982).

stage W (wakefulness)--The EEG contains alpha activity and/or low voltage mixed frequency activity (Rechtschaffen and Kales 1977).

sleep spindles--A waxing and waning waveform with a frequency of 12-14 cps, most prominent in stage 2 sleep (Guilliminault 1982).

theta waves--EEG waves with a duration of 3-7 cps and are characteristic of stage 1 of sleep (Hauri 1982).

vertex sharp waves--May appear at the end of stage 1 and may be as high as 200 microvolts (Rechtschaffen and Kales 1977).

wake after sleep--This occurs when an individual awakens during the night and remains awake.

wake before sleep--The amount of time the subject remains awake before falling asleep.

wake during sleep--This is determined by subtracting the wake before sleep and wake after sleep from the total amount of wakefulness.

CHAPTER II

REVIEW OF LITERATURE FOR SLEEP ANALYSIS

What is sleep? A seemingly easy question on the surface, but one which requires much consideration and definition. Hartmann (1973) defines sleep as a recurrent, easily reversible condition characterized by relative quiescence and by a greatly increased threshold for response to external stimulation. Hartmann stresses that while EEG studies are an important aspect of sleep, sleep is a behavioral state, not an EEG tracing.

Sleep is a normal and necessary process for human beings, yet fifty million Americans seek medical attention for sleep difficulties each year (IOM Report 1979). This high incidence of sleep associated problems has prompted considerable research over the past fifty years. While sleep was once thought to be a simple process, its intricacy has recently come to light.

In the late 1930s, Loomis and Harvey described specific EEG patterns occurring during human sleep. Unfortunately, their research came to a halt with the outbreak of the Second World War. Along with specific EEG patterns, Aserinsky and Kleitman (1953) were the first to describe rapid eye movements (REM) during sleep. The relation between REM and dreaming was explained by Dement and Kleitman (1957). These early investigators paved the way for modern researchers.

It is generally agreed upon that two stages of sleep exist: REM (rapid eye movement) and NREM (nonrapid eye movement) (Hauri 1982). There are several differences between these two states of sleep. The most prominent difference being the presence or absence of the rapid eye movements. REM sleep is also known as the dream state. When individuals are aroused during REM sleep, they often report dreams (Foulkes 1966). Usually, the only type of bodily movements present during NREM sleep are whole body movements (Hartmann 1973). There are also several areas of physiological changes during REM sleep: penile erections; irregularities in respiration, body temperature, heart rate, and blood pressure; and changes in blood levels of free fatty acids. EMG activity during REM sleep is almost nonexistent (Hall 1977).

There are four stages of sleep within the NREM state. Before an individual enters stage 1 of NREM, he/she is in a drowzy stage of alpha activity, or waking EEG patterns (see Figure 1). As the individual falls asleep, the alpha waves begin to disappear and reappear until they are gradually gone (Koella 1967).

With the disappearance of alpha activity, the subject moves into stage 1 of NREM sleep. Stage 1 is the lightest

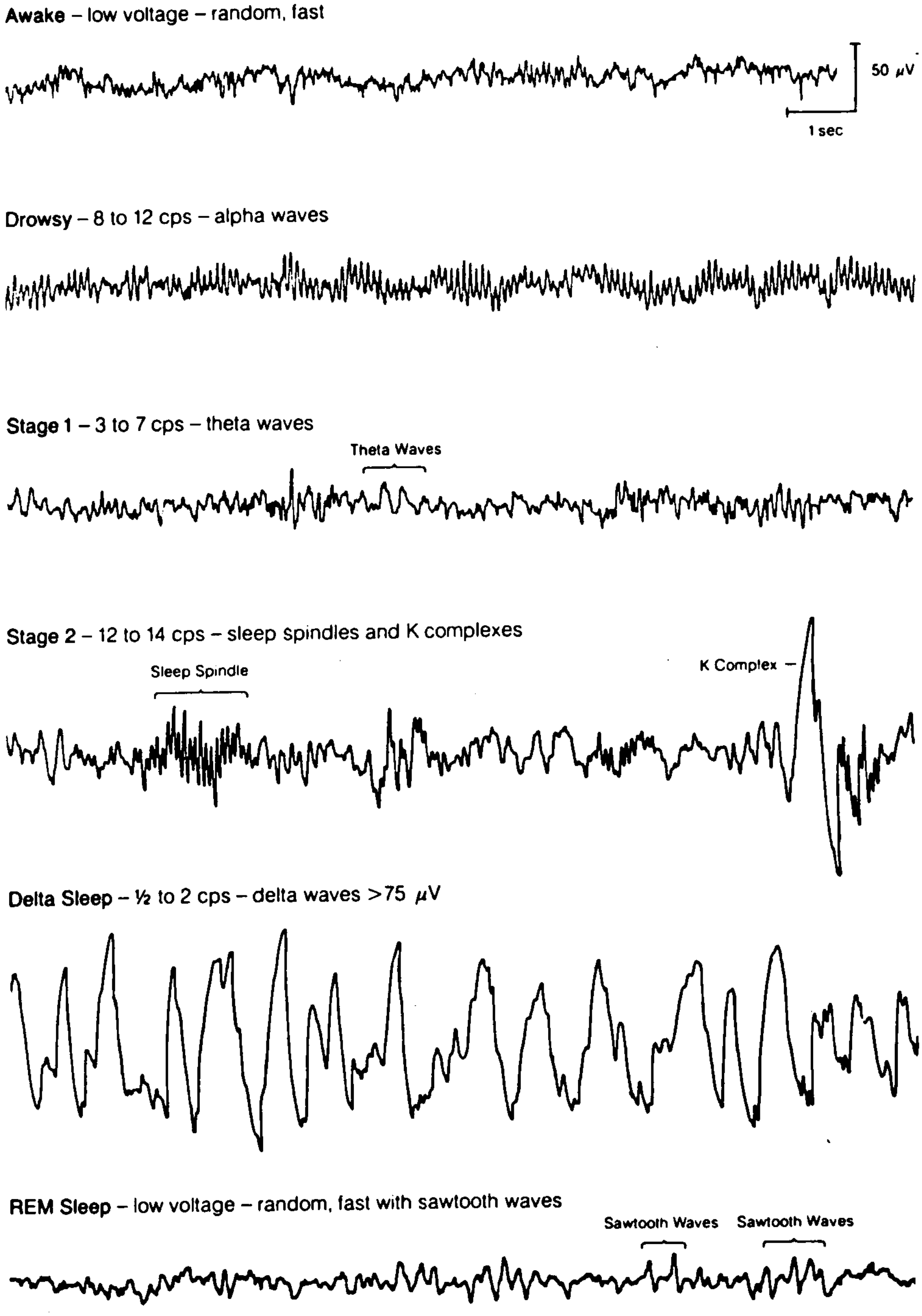

Figure 1. Brain wave patterns of the sleep cycle.

stage of sleep which lasts from one-half to seven minutes. When a person is in this stage, he/she is on the edge of consciousness, yet thoughts wander and he/she is not acutely aware of the surrounding environment. Most people deny being asleep when aroused. The waveforms present during stage 1 are known as theta waves (see Figure 1). At the end of stage 1, vertex sharp waves begin to appear as the subject moves into stage 2 of NREM sleep (Hauri 1982).

Stage 2 is marked by the presence of sleep spindles and K-complexes (see Figure 1). Sleep spindles are bursts of rapid activity at 12 to 14 hertz and lasting from one-half second to two seconds. A K-complex is a clearly defined, easy to see, slow negative EEG sharpwave followed by a positive deflection and lasts greater than a half second (Rechtschaffen and Kales 1977). Stage 2 is considered to be the first bonafide stage of sleep (Hauri 1982).

Stages 3 and 4 are the deepest stages of sleep and the waveforms present are known as delta waves (see Figure 1). There is a total lack of consciousness during delta sleep (Hauri 1982). Stages 3 and 4 are differentiated by the amount of delta waves present. In stage 3, at least 20 percent but not more than 50 percent of the epoch (sleep record) consists of EEG activity of 2 hertz or slower. The amplitudes of the waveforms are greater than 75 microvolts from peak-to-peak. In stage 4, more than 50 percent of the epoch consists of waves which are 2 hertz or slower and have amplitudes greater than 75 microvolts (Rechtschaffen and Kales 1977).

REM occurs at approximately seventy to ninety minutes after sleep onset. The REM tracing closely resembles that of the EEG patterns of stage 1 of NREM sleep. The REM tracing may contain sawtooth wave patterns in conjunction with REM. Like stage 1, the EEG in REM is low voltage and mixed frequency (see Figure 1). Sawtooth wave patterns help to distinguish REM from the theta waves found in stage 1 of NREM sleep (Hauri 1982).

In the normal hearing adult, a sleep cycle includes both REM sleep and the stages of NREM sleep. The order for the first sleep cycle includes: NREM stage 1, NREM stage 2, NREM stages 3 and 4, back to NREM stage 2, and REM. The second sleep cycle has the same order, except the amount of REM time increases, and the time for NREM stages 3 and 4 decreases or NREM stages 3 and 4 may not occur at all. For the remaining sleep time, the sleep patterns alternate between NREM stage 2 and REM sleep. The REM periods become longer and longer towards the morning, with the final one lasting from twenty minutes to an hour (Hauri 1982).

CHAPTER III

METHOD

This study was conducted at the Sleep Disorders Center at Fort Sanders Regional Medical Center, Knoxville, Tennessee. The Sleep Center is listed as an accredited institution by the Association of Sleep Disorders. It is highly sophisticated and equipped with modern, state-of-the-art instrumentation. The technical staff are well trained and certified in the area of sleep disorders.

Subjects

The subjects were five congenitally and/or prelingually hearing-impaired people ranging from sixteen to thirty-four years of age. Audiometric results indicated moderate to profound (greater than 45 dB HTL pure tone average for 500, 1000, and 2000 Hz) bilateral sensorineural losses (see Table 1). Subjects were selected from the Knoxville hearing-impaired community. Subjects received an Information Letter (see appendix A) from the investigator concerning the nature of the study. All subjects were in good health and had an I.Q. greater than 85.

Table 1. Pure-tone averages for each ear of each subject. *Limits of Beltone screening audiometer.

Mode of Communication	Hearing-Impaired Subject #	Pure-tone thresholds (dB) 500 Hz	1000 Hz	2000 Hz	PTA
Oral	#1 RE	*90	90	90	90
	LE	90	90	90	90
Manual	#2 RE	75	75	80	77
	LE	75	85	75	78
Aural/Oral	#3 RE	60	80	85	75
	LE	65	70	75	70
Aural/Oral	#4 RE	85	80	90	85
	LE	80	75	80	79
Aural/Oral	#5 RE	30	40	65	45
	LE	60	75	85	73

Subject number 1 (oral skills) was a twenty-one-year-old profoundly deaf male who used his voice to communicate with others. He did not wear a hearing aid and did not utilize any residual hearing. All receptive information was processed from visual cues of the speaker's facial expressions and lip movements. This subject did possess manual communication skills which were acquired two years earlier at college, as a foreign language option. He was not fluent in sign language nor did he regularly use it. He was educated at Central Institute for the Deaf in St. Louis, Missouri.

Subject number 2 (manual skills) was a nineteen-year-old severely hearing-impaired male who used manual communication to communicate with others. This subject acquired meningitis at six months of age. He did not wear a hearing aid and did not use his residual hearing for communication. He relied upon sign language as his means for both receptive and expressive communication. The subject reported that he gained little information from lip reading. This subject only used his voice to produce grunts and other unintelligible vocal sounds. He was educated at the Tennessee School for the Deaf in Knoxville, Tennessee.

Subject number 3 (aural/oral skills) was a seventeen-year-old severely hearing-impaired male who used his voice to communicate with other people. He wore hearing aids, thus utilized residual hearing. The subject reported that he did use lip reading to some extent, but primarily relied upon audition as his basic means of processing receptive and expressive communication. This subject had no manual communication skills. Educationally, he was mainstreamed into a regular public school classroom without an interpreter. He received Verbotonal training as a preschooler to develop auditory and speaking skills.

Subject number 4 (aural/oral skills) was a sixteen-year-old severe-to-profound hearing-impaired female who, like subject number 3, used her voice to communicate with other people. She also wore two hearing aids and utilized her residual hearing. This subject also reported that she did use lip reading to some extent, but primarily relied upon audition as her basic means of processing receptive and expressive communication. This subject had no manual communication skills. Educationally, she was mainstreamed into a regular public school classroom without an interpreter. She had also received Verbotonal training as a preschooler.

Subject number 5 was a thirty-four-year-old female with a mild sloping to profound loss at the left ear, and a moderately-severe sloping to profund hearing loss at the right ear. Her hearing loss resulted from a middle ear deformity at birth. As a child, she received oral training, but did not wear hearing aids. She was mainstreamed into the public schools and was provided with a tutor. She began wearing hearing aids, binaurally, at the age of twenty-one. While completing her undergraduate degree in deaf education, this subject developed manual communication skills. She reported that she did utilize lip reading to some extent, but primarily relied upon audition as her basic means of processing receptive and expressive communication.

Interviews and Sensory Tests

Initial interviews were conducted in the subject's home. Each subject completed the Fort Sanders Sleep Disorders Questionnaire (see appendix B). This questionnaire was used as a screening device to detect possible sleep problems. Subjects completed a case history form (see appendix C) which obtained general information concerning the subject's sleeping habits, medical and audiological history. The subjects completed the Cornell Medical Index Questionnaire as a screening device for any other medical conditions. Each subject also underwent audiometric evaluation in their home via a portable audiometer. Subjects also completed a Dream-Thought Content Questionnaire (see appendix D) devised by the investigator to obtain information on the dream and thought processes of the subjects. The subjects signed The Informed Consent Form (see appendix E) at the end of the interview. Subjects were scheduled for a sleep evaluation at The Sleep Center and a psychological evaluation at The University of Tennessee.

The subjects attended a psychological evaluation in which they received an I.Q. test by a clinical psychologist via an abbreviated portion of the WAIS-R (Wechsler Adult Intelligence Scale--Revised). The psychologist administered a verbal and performance portion of the WAIS-R in order to obtain an accurate measure of the subject's ability. The subjects were screened for possible depression and anxiety with the Institute for Personality and Ability Testing (IPAT) tests for Depression and Anxiety (see Table 2).

Sleep Evaluation

On the scheduled night, the subject arrived at the Sleep Disorders Center at 8:00 p.m. Upon their arrival, subjects were given a tour of the facility and a complete explanation as to the equipment and procedures that were to be utilized. Subjects changed into pajamas, signed a medical consent form (see appendix F), and were measured for weight and height. Then, electrodes were placed on the subject; this process took nearly two hours for each subject. Just before sleep, the sleep technician

Table 2. WAIS-R I.Q. results (performance, verbal, and composite), and depression and anxiety percentile scores for each subject as reported by the IPAT tests for Depression and Anxiety.

Subject #	Psychological Results				
	Performance I.Q.	Verbal I.Q.	Composite I.Q.	Depression Score %tile	Anxiety Score %tile
#1	96	74	85	86	89
#2	110	79	94	81	89
#3	126	106	116	60	23
#4	110	98	104	94	77
#5	NA	NA	NA	53	4

WAIS-R INTERPRETATION

70-79 = borderline
80-89 = low average
90-109 = average
110-119 = high average
120-129 = superior

administered a short pre-sleep questionnaire (see appendix G) regarding the subject's state of sleepiness. When the subject was awakened in the morning, he/she completed a post-sleep questionnaire (see appendix H) regarding how they slept. After completing the post-sleep questionnaire, the electrodes were removed. Each subject departed The Sleep Center by 7:30 a.m.

Electrode Placement

At the areas of electrode placement, the skin and scalp were cleaned in order to remove excess oil and dirt to facilitate good electrode impedance. Omniclean was used to clean the designated areas and collodin gel was used to attach the electrodes. Acetone was used to remove the electrodes.

The International Jasper 10-20 system of electrode placement was used for proper electrode positioning. This system uses identifiable skull landmarks, or references, and electrodes were spaced either 10 percent or 20 percent of the total distance between a pair of skull landmarks. The 10-20 system is based on measurements from four standard points on the head: the nasion, inion, and the left and right pre-auricular points (see Figures 2 and 3).

Electrode placement was as follows:

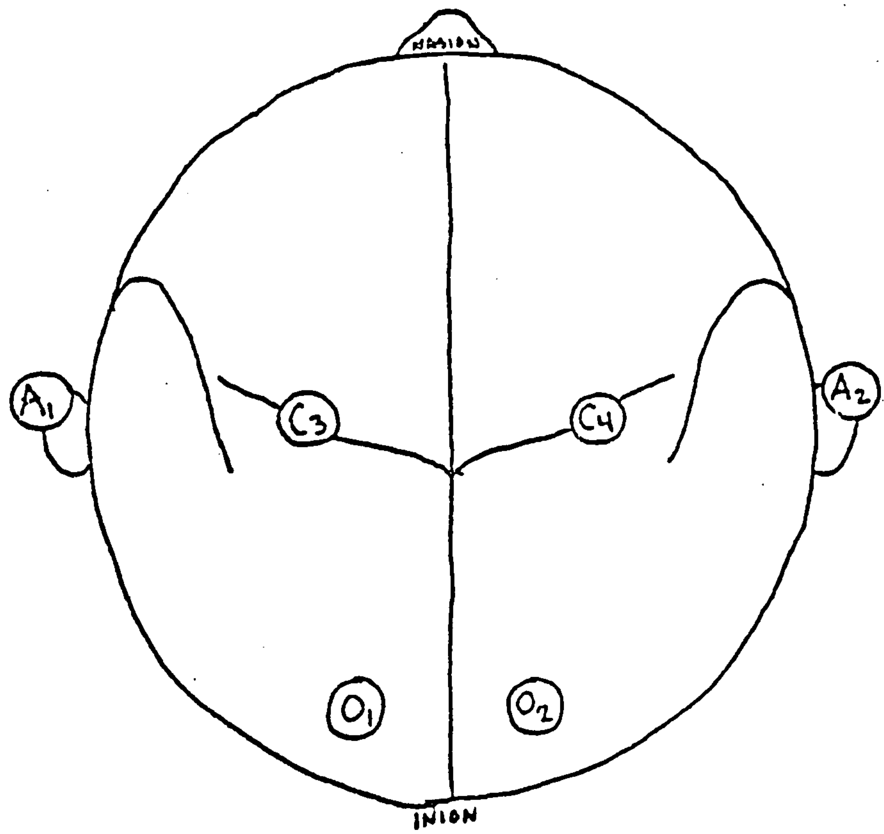

Figure 2. Electrode placement for EEG during sleep.

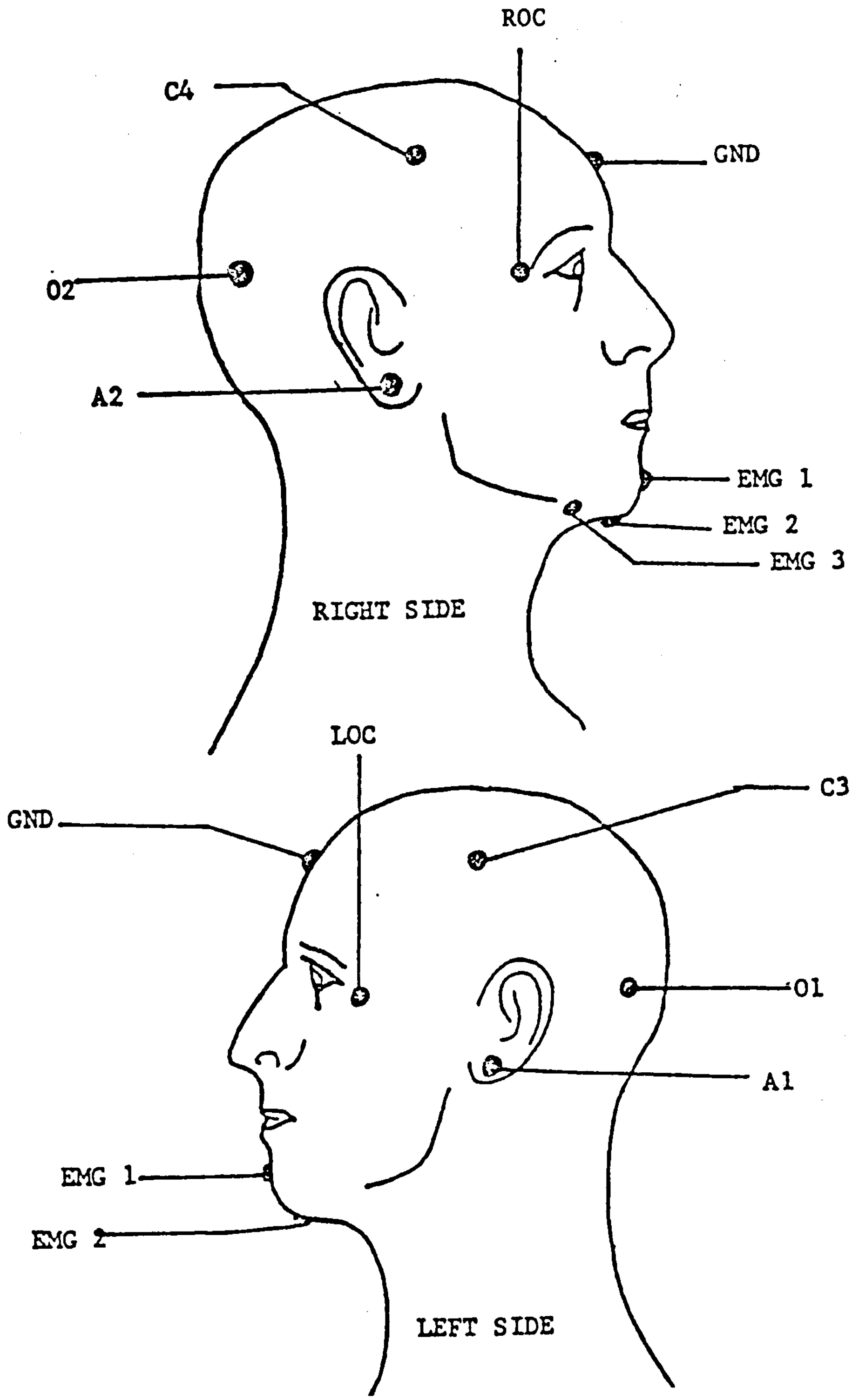

Figure 3. Lateral views of EOG, EEG, and EMG placements.

1. Two reference electrodes were placed on each mastoid. One ground electrode was placed on the forehead.
2. Four EEG electrodes were placed on the head: two on the frontal lobes (C3 and C4) and two on the occipital lobes (01 and 02).
3. To monitor EOG (eye movement) electrodes were placed at the right and left outer canthus of each eye.
4. Seven electrodes were needed to record EMG activity. Three of these were placed at the chin: one on the chin and two under the right and left sides of the chin. Two electrodes were placed at the anterior tibialis of each leg. Two electrodes were placed over the flexores digitorum (arm) to evaluate the arm and finger movements reported by Max (1935).
5. Two EKG leads were placed: one on the right clavicle and one on the lower rib cage.

Sensory receptors were placed as follows:

1. A nasal/oral thermistor was placed at the nose and mouth.
2. A thoracic respitrace band was placed around the thoracic cavity and an abdominal respitrace band was placed around the abdomen.

3. An oximeter probe was placed on the finger.

When all of the electrodes and leads were secured in place, the electrode impedance was checked. If any electrode impedance exceeded 10K ohms, the electrode was removed, reattached and rechecked.

Sleep Tests

During the study, electro-oculography (EOG) was monitored during the subject's sleep. EOG was conducted in order to aid in the scoring and to record the slow rolling eye movements which accompany stage 1 of NREM sleep and the rapid eye movement which occurs during REM sleep.

Electromyography (EMG) was monitored so that muscle activity around the chin, arm, and legs could be quantified. EMG activity at the chin was the primary indicator as to when the subject reached REM sleep.

Electroencephalography (EEG) was monitored during sleep so that information regarding bioelectric potentials which occur during brain activity could be measured. EEG differentiates between the various stages of sleep.

Electrocardiography (EKG) was monitored during the subject's sleep primarily as a safety precaution, because heart rate slows during the deeper stages of sleep.

Other parameters which were monitored included: temperature of the nasal/oral air flow; abdominal and thoracic efforts; and changes in oxygenation of the blood during respiration.

Reliability of Sleep and Dream Measures

Subject number 1 returned to the Sleep Center twenty-one days after his initial evaluation. He completed a second night with the same evaluation of sleep and dream patterns. Due to time and cost restraints, he was the only subject who was evaluated twice.

Exit Interview

Results of the sleep evaluations were recorded on The Fort Sanders Polysomnographic Technical Report (see Appendix I). After all sleep evaluations had been scored, the subjects and their parents were invited to an exit interview. Results were explained to each participant. The entire technical staff of The Sleep Center was present to answer specific questions about each subject's results. Each subject was mailed a copy of the technical report.

Instrumentation and Analysis of Polysomnogram

The physiological information which was reported in this study was recorded by a 4312 Nihon Koden polysomnograph machine, resulting in a sleep record or polysomnogram. The polysomnograph (see Figure 4) had twelve channels which recorded the signals from the various physiological sites. The leads from the electrodes were connected to an electrode junction box and routed to the polysomnograph via a shielded cable (see Figure 5).

The channels were as follows:

Channel 1--EOG (right eye)

Channel 2--EOG (left eye)

Channel 3--EEG (central leads)

Channel 4--EEG (occipital leads)

Channel 5--EMG (chin)

Channel 6--EMG (left and right anterior tibialis)

Channel 7--EMG (flexores digitorum)

Channel 8--EKG (right clavicle and lower left side of thorax)

Channel 9--Biox/oxygen (tip of index finger)

Channel 10--Nasal/Oral air flow (mouth and nose)

Channel 11--Thoracic effort (elastic band over chest)

Channel 12--Abdominal effort (elastic band over abdomen)

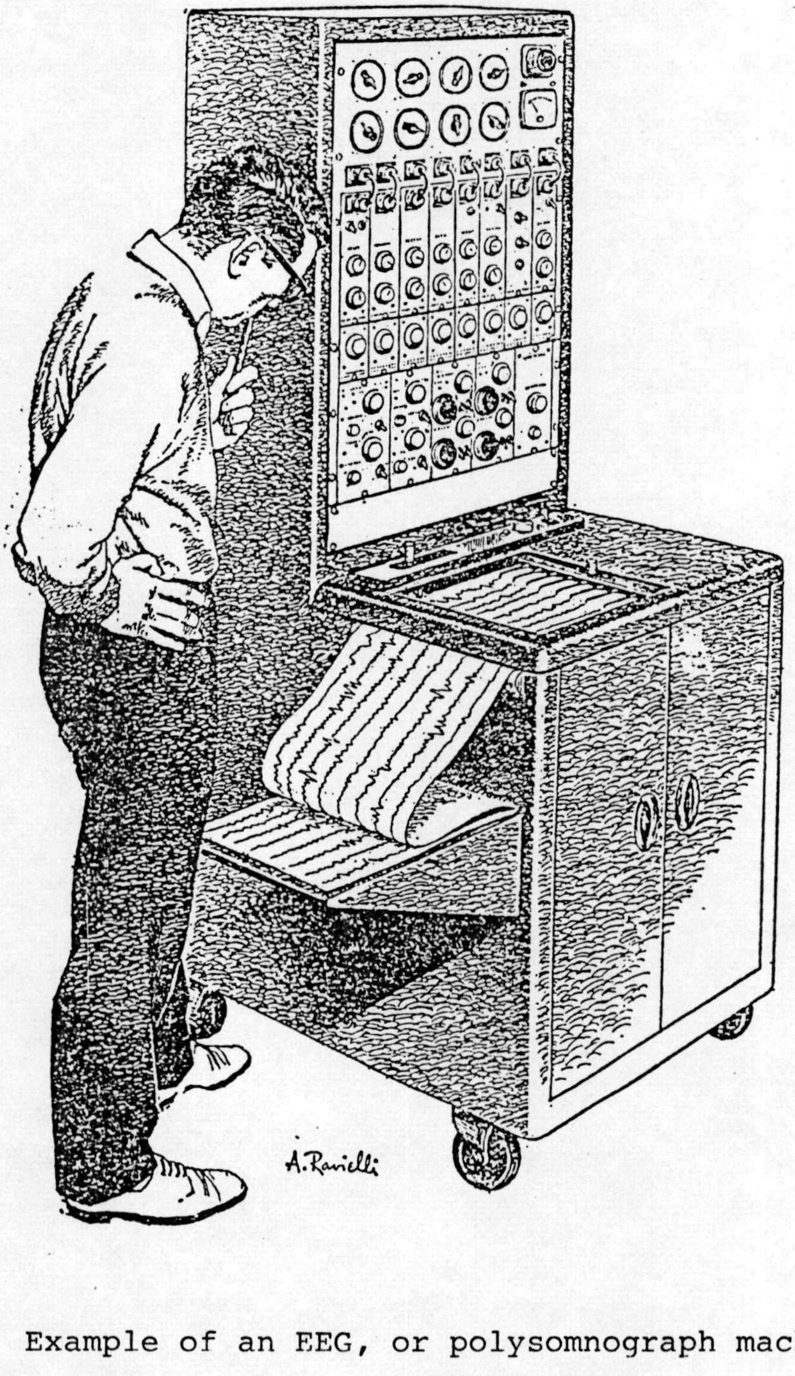

Figure 4. Example of an EEG, or polysomnograph machine.

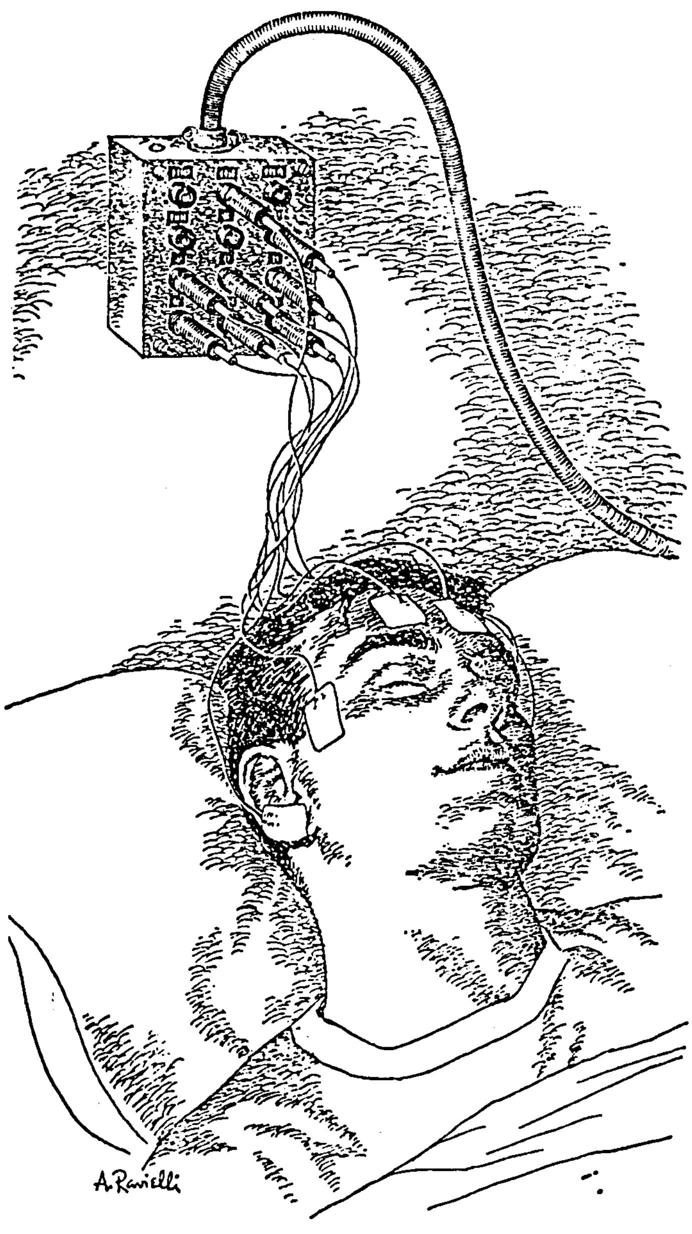

Figure 5. Shielded cable and electrode junction box.

The following instrumentation was utilized in conducting this research (see Figure 6):

camera control box--Allowed operator to manipulate positions of video camera and to make lens adjustments on camera. Located in control room.

chart recorder--Graphically plotted the percent of oxygen concentration in the subject's blood stream. Located in control room.

control box/receiver--Allowed operator to adjust the loudness of patient's voice; transmits subject's voice to technician. Located in control room.

electrode junction box--Device in which electrode leads were connected. Transferred electrical activity from electrodes to the polysomnograph, where they were recorded. Located in the subject's room.

intercom--Enabled the technician to talk to the subject from the control room.

microphone/receiver--Enabled subject to hear and talk to the technician. Located in the subject's room.

oximeter probe--Device which was attached to the end of the fingertip and projected a light ray through the skin which measured the blood/oxygen level. Located in the subject's room.

pulse oximeter--Projected a visual digital display of the percent of oxygen in the blood. Located in the control room.

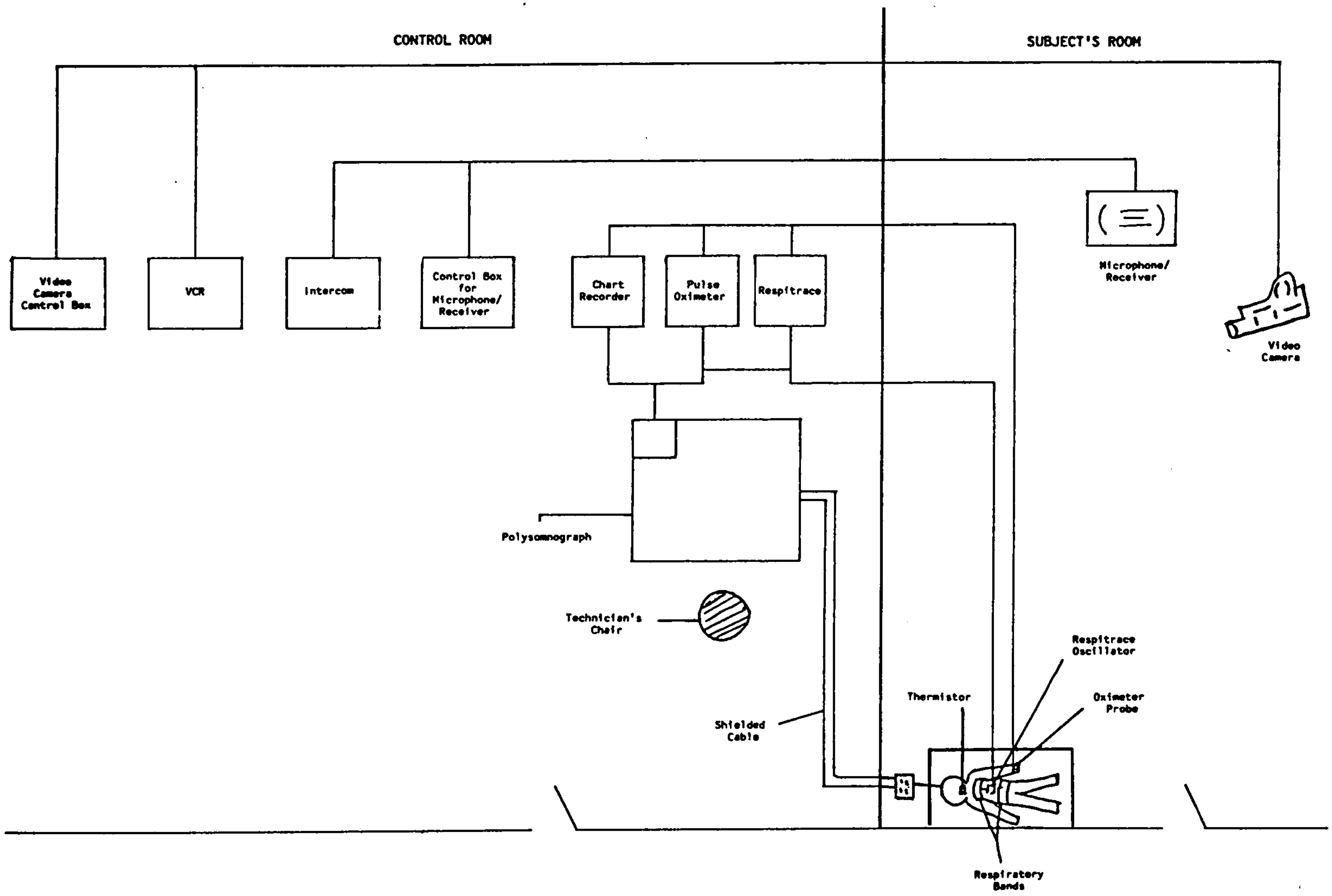

Figure 6. Instrumentation as it appears in control room and the subject's room.

<u>respitrace</u>--Monitored breathing efforts from the abdominal and thoracic regions. Located in the control room.

<u>respiratory bands</u>--Consisted of two bands: one was placed around the thoracic cavity and the other around the abdominal region. Every respiratory effort was detected by these bands and recorded by the respirtrace. Located in he subject's room.

<u>Respitrace oscillator</u>--Leads from the two respiratory bands were connected to this device. The signal was routed from this device via a cable to the respitrace. Located in the subject's room.

<u>shielded cable</u>--Transported lead currents from the subject's room to the control room, where they were connected into the polysomnograph machine.

<u>thermistor</u>--Sensed temperature changes of inspired and expired airflow. Consisted of two probes which were taped to the upper lip, and below one of the nostrils. Located in subject's room.

<u>video camera</u>--Attached to the ceiling of the subject's room. Used as a visual aid for the technician while monitoring the subject's sleep. Visual display appears on TV screen on polysomnograph.

video cassette recorder (VCR)--Used to tape subject's sleep for future reference and examination. Located in control room.

CHAPTER IV

RESULTS

Measurements

Table 3 displays the measurements for five hearing-impaired subjects. The hearing-impaired subjects were identified according to their oral, manual, and aural/oral communication skills. The age of each subject was included along with his/her subject number. These subject numbers were used in the Results and Discussion.

The norms were presented in brackets, e.g., (430-454). The normative values were based on normal hearing subjects who were the same age as the hearing-impaired subjects. For the adults, norms were obtained from The Henry Ford Hospital in Detroit, Michigan. For subjects under the age of twenty-one, norms were obtained from The Children's Hospital at The University of Alabama, Birmingham. In some cases, one normative value was listed, because only one subject was reported for that age category. In other cases, there was a range of values to indicate more than one subject. For some ages, no norms were available. When applicable, subjects without normative data were compared to subjects of similar age who did have normative values listed. The norms were

Table 3. Sleep evaluation results for five hearing-impaired subjects. Normative values for normal hearing populations appear in brackets ( ).

Measurements	Sleep Results Hearing-Impaired Subjects					
	Sub.#1 Oral 21 yrs		Sub.#2 Manual 19 yrs	Sub.#3 Aural/Oral 17 yrs	Sub.#4 Aural/Oral 16 yrs	Sub.#5 Aural/Oral 34 yrs
	Night 1	Night 2*				
Bed Time (p.m.)	11:12	10:54	11:15	11:11	11:20	11:51
Rise Time (a.m.)	6:38	7:01	6:17	6:15	5:47	6:21
Time in Bed (min)	446 (430-454)	487	421	424	387	339 (425-462)
Total (Min) Sleep Time	405 (405-434)	349	413	394	372	311 (394-457)
Total Sleep Efficiency %	91% (91-99%)	72%	98%	93% (94%)	96%	80% (90-100%)
Total REM Time (Min)	61	52	78	63	97	44
Total NREM Time (Min)	344	297	335	331	275	267
Early Morn Wakenings Yes-No	No	Yes	No	Yes	No	No
Wake Before Sleep (Min)	16	19	2	11	11	14
Wake During Sleep (Min)	23	11	2	14	3	62
Awake After Sleep (Min)	0	6	0	11	0	0
Awakenings Total #	4 (0-6)	5	1 (2.8)	1 (2.8)	1 (1.7)	4 (0-3)
% Stage Wake	9% (0-1%)	28%	1% (1.9%)	6% (1.9%)	3% (1.3%)	19% (0-6%)

Table 3 (continued).

Measurements	Sleep Results Hearing-Impaired Subjects					
	Sub.#1 Oral 21 yrs		Sub.#2 Manual 19 yrs	Sub.#3 Aural/Oral 17 yrs	Sub.#4 Aural/Oral 16 yrs	Sub.#5 Aural/Oral 34 yrs
	Night 1	Night 2*				
% Stage 1	17% (3-6%)	21%	12% (4%)	7% (4%)	5% (3.7%)	22% (3-6%)
% Stage 2	52% (40-51%)	49%	47% (49%)	48% (49%)	41% (49%)	55% (46-62%)
% Stage 3 and 4	16% (16-26%)	15%	22% (17%)	29% (23%)	28% (24%)	9% (7-21%)
% Stage REM	15% (22-34%)	15%	19% (22%)	16% (22%)	26% (22%)	14% (21-31%)
Latency to Stage 1 (Min)	16	19	2	11	11	14
Latency to Stage 2 (Min)	35	27	5	14	13	36 (3-11)
Latency to Persistent Sleep (Min)	29	24	2	11	11	35
Latency to REM (Min)	122 (78-99)	126	87 (134)	88 (134)	141 (115)	214 (70)
EMG Activity per hr	1 Myoclonus per Hr		Normal	2 Myoclonus per hr	Normal	Normal
EKG Activity per min	53 bts per min		65 bts per min	58 bts per min	79 bts per min	76 bts per min
Blood Oxygen %	94%		96%	96%	96%	95%
Breathing Efforts	1.8 Hypopneas per hr	1.5	.7 Hypop per hr	.9 Hypop per hr	7 Central Hypop per hr	1.5 Hypop per hr

*Night 2 was used only as estimating reliability testing.

obtained on subjects who had spent several nights at sleep centers in order to acquire reliable accounts of sleep without the influence of first night effects.

Interscorer Agreement

The sleep epochs were scored independently by two certified polysomnographic technologists at The Sleep Center. Each page of the epoch lasted for thirty seconds. The paper speed was 10 millimeters per second. Each page was scored as a particular stage of sleep or as wake. Occasionally, there was a discrepancy between the two scorers as to the stage of sleep the subject was in. The interscorer disagreement between the two scorers was always less than 10 percent for each subject [e.g., on 848 pages of sleep there were thirty-three discrepancies between the scorers or a 4 percent disagreement among the scorers for the sleep record of the aural/oral subject (#3)]. When these discrepancies arose between the two scorers, the scorers discussed the discrepancies in order to reach 100 percent agreement with each other. The interscorer agreement was high and within acceptable limits for research sleep measurements.

Test-Retest Reliability

As a reliability measure, the oral subject (#1) spent two nights at The Sleep Center. The second night was used to compare to night one for test-retest reliability. It was anticipated that first night effects would not be present on the second night, because of the subject's adjustment to the sleep condition. However, sleep efficiency was 19 percent worse (91 percent vs 72 percent) on the second night. Because of the 19 percent variability in sleep efficiency between the two nights, they were difficult to compare to each other. On his second night of sleep, the subject reported some anxiety about an exam at school on the next day. This may have been the cause for the decreased sleep efficiency.

There was less than 4 percent difference between the results for latency to REM sleep (122 vs 126 min) between the two nights of sleep. There was no difference in the percentage of REM sleep (15 percent vs 15 percent). There was a 19 percent difference in the percentage of stage 1 sleep (17 percent vs 21 percent) and a 6 percent difference in stage 2 sleep (52 percent vs 49 percent). There was a 7 percent difference in the percentage of time spent in stages 3 and 4 of sleep (16 percent vs 15 percent). He had a greater amount of stage wake (9 percent vs 28 percent) on both nights as compared to the norms. On both nights of sleep, he had a greater percentage of stage wake and a smaller percentage of REM sleep than the normative values. These findings were characteristic of first night effects. It was felt by the sleep technologists that he may have experienced a first night effect on both nights. A more reliable account of sleep may have been obtained had he not had the pressure of an exam on the next day, and had it been possible to schedule him for two consecutive nights of sleep.

Sleep Results for Hearing-Impaired Subjects: Case Studies

Due to the small number of subjects, the results were presented on a case-by-case basis. A rank ordering for each subject on each measurement can be found in appendix J. The individual results for each sleep measurement for each subject can be found on Table 3.

Subject #1

Subject #1 was a twenty-one-year-old profoundly deaf male who used oral skills and lip reading skills to understand and communicate with other people. He did not wear hearing aids, thus he did not utilize any residual hearing. As a child, he was educated at Central Institute for the Deaf in St. Louis, Missouri. He presently studies business administration at a public college. He learned sign language at college as a foreign language credit. He previously had no manual communication skills.

On The Case History Form, he reported that he sometimes had difficulty falling asleep and that he sometimes experienced disturbing dreams. He noted that he had been know to sleep walk in the past. In response to The Dream-Thought Content Questionnaire, he indicated that he only remembered his dreams when he woke up in the morning. He reported that he heard environmental sounds such as music in his dreams, and that he sometimes dreamed that he was a normally hearing person.

A psychological evaluation of the subject revealed a composite I.Q. of 85, with performance I.Q. being 96 and verbal I.Q. being 74. This subject had high levels of depression and anxiety. His percentile scores were eighty-six for depression and eighty-nine for anxiety. On his second night of sleep, this subject experienced an early morning awakening, impaired sleep efficiency, and an increased amount of wakefulness. The sleep technicians reported that these results were markers of depression. On his first night of sleep, he experienced a greater percent-age of wakefulness as compared to the norms. The markers of depression which were present on the second night may have been due to the exam in the next day.

Subject #1 was the only subject to spend two nights at The Sleep Center. The second night, twenty-one days after the first night, was used to compare to the first night as a test-retest reliability measure. There was a noticeable decrease in sleep efficiency between his first night (91 percent) and second night (72 percent). Before going to sleep, he reported that he felt nervous about his upcoming exam. The pressure of the exam may have made it more difficult for him to sleep.

On his first night at The Sleep Center, subject #1 prepared to go to sleep at 11:12 p.m. He indicated on The Pre-Sleep Questionnaire that he was very sleepy and that he was not very alert at bedtime. Results from his sleep evaluation revealed that he had the greatest amount of wake before sleep (16 min), NREM sleep time (344 min), and latency to stage 1 of sleep (16 min) as compared to the other subjects. He had a shorter latency to REM sleep (122 min) and smaller percentage of REM sleep (15 percent) as compared to the normative values (78-99 min and 22 percent-34 percent). On his second night of sleep, he had an early morning awakening. Nocturnal myoclonus (leg jerking) was present on both nights of sleep.

On the morning following the sleep evaluation, subject #1 indicated on The Post Sleep Questionnaire that he felt he had an average night of sleep and that he did not recall dreaming during the night. For his second night of sleep, he did recall that he had dreamed, but he reported that he felt less rested than usual upon awakening. He was awakened at 6:38 a.m. for the first evaluation and at 7:01 a.m. for the second sleep evaluation.

Subject #2

Subject #2 was a nineteen-year-old severely hearing-impaired male who used manual communication to communicate with and understand other people. This subject had never worn hearing aids, thus, had never utilized residual hearing. He was a senior at The Tennessee School for the Deaf in Knoxville, Tennessee.

During the case history, he reported that the etiology of his hearing impairment was meningitis, which he acquired at six months of age. He reported that he usually did not have any trouble falling asleep, but frequently experienced disturbing dreams. In response to The Dream-Thought Content Questionnaire, he indicated that he remembered his dreams almost every night, and that he communicated through sign language in his dreams. He also reported that he could "feel" environmental sounds in his dreams (i.e., vibrations from airplanes or music) and that he sometimes dreamed that he was a normally hearing person.

A psychological evaluation of the subject revealed a composite I.Q. of ninety-four, with performance I.Q. being one-hundred ten and verbal I.Q. being . This subject had high levels of anxiety and depression. His percentile scores were eighty-one for depression and eighty-nine for anxiety. The only marker of depression which was reflected in his sleep was a shortened latency to REM sleep.

On the night of his sleep evaluation, subject #2 prepared to go to sleep at 11:15 p.m. On The Pre-Sleep Questionnaire, he noted that he was only a little tired at bedtime.

Results from his sleep evaluation revealed that he slept longer than the other subjects (6.9 hours) and had the highest sleep efficiency (98 percent). He was the only subject to have a smaller percentage (1 percent) of stage wake than the normative values (1.9 percent) for his age range. He had the shortest latency to stage 2 sleep (5 min) and persistent sleep (2 min). He also had the shortest latency to REM sleep (87 min) which was less than the normative values (134 min). He spent 19 percent of his sleep in stage REM, which was less than the normative values (22 percent). There was no remarkable EMG activity present at the flexores digitorum during REM sleep for this subject.

He was awakened at 6:17 a.m. the next morning. On The Post Sleep Questionnaire, he reported that he felt that he slept deeply and was more rested than usual upon awakening. He indicated that he did not recall dreaming on the night of the sleep evaluation.

Subject #3

Subject #3 was a seventeen-year-old severely hearing-impaired male who used his voice to communicate with others. He wore two hearing aids and utilized his residual hearing. He reported that he relied upon audition as his basic means of processing receptive and expressive communication. He had no manual communication skills. He was a senior at a public high school and did not require the assistance of an interpreter or tutor. He received Verbotonal training as a preschooler to develop auditory and speaking skills.

His case history revealed that hearing loss was common in his family. He indicated that he sometimes experienced leg cramps while sleeping. He reported that he usually did not have difficulty falling asleep. On The Dream-Thought Content Questionnaire, he noted that he dreamed about once a week, and he was the only subject to report that he did not occasionally dream that he was a normally hearing person.

Psychological evaluation of the subject revealed a composite I.Q. of 116, with performance I.Q. being 126 and verbal I.Q. being 106. He had percentile scores of sixty for depression and twenty-three for anxiety. Markers of depression which were present during his sleep evaluation were: shortened latency to REM sleep, increased percent of wakefulness, and an early morning awakening.

On the night of his sleep evaluation, subject #3 prepared to go to sleep at 11:11 p.m. On The Pre-Sleep Questionnaire, he indicated that he had a strenuous day and that he was a little tired at bedtime.

Results from his sleep evaluation revealed that subject #3 had a greater percentage of stages 3 and 4 sleep (29 percent) than the other subjects and the normative values (23 percent). He also had an early morning awakening. He had a shorter latency to REM sleep (88 min) than the norms (134 min) and a smaller percentage of stage REM (16 percent) than the normative values (22 percent). Nocturnal myoclonus (leg jerking) was present during the night. He experienced a six-to-seven second abnormal discharge of EEG activity which was atypical and resembled neurological activity similar to epileptic patients. He reported no history of epilepsy. Alpha intrusion into deep sleep was noted on his sleep record.

He was awakened at 6:15 a.m. the next morning. On The Post-Sleep Questionnaire, he indicated that he remembered awakening during the night and that he recalled that he had dreamed. He felt that he had an average night of sleep.

Subject #4

Subject #4 was a sixteen-year-old severe-to-profound hearing-impaired female who used her voice to communicate with other people. She wore hearing aids and utilized her residual hearing. She reported that she relied upon audition as her basic means of processing receptive and expressive communication. She had no manual communication skills. She was mainstreamed into the public schools without an interpreter. She did use a Telex auditory trainer in the classroom. She received Verbotonal training as a preschooler.

On The Case History Form, she reported that the etiology of her hearing loss was unknown. She noted that she rarely had difficulty falling asleep, and that she was a sound sleeper. On The Dream-Thought Content Questionnaire, she indicated that she seldom remembered her dreams. She stated that she sometimes dreamed that she was a normally hearing person.

Psychological evaluation of subject #4 revealed a composite I.Q. of 104, with her performance I.Q. being 110 and verbal I.Q. being 98. She had percentile score of ninety-four for depression and seventy-seven for anxiety.

She had the highest level of depression among the subjects. Even though this subject had the highest level of depression as revealed by the depression test, the sleep technicians reported no markers of depression present in her sleep results.

On the night of her sleep evaluation, she prepared to go to sleep at 11:11 p.m. On her Pre-Sleep Questionnaire, she indicated that she was sleepy and not very alert at bedtime.

Results from her sleep evaluation revealed that she was the only subject to have a greater percentage of REM sleep (26 percent) than the norms (22 percent). She had the greatest amount of total REM sleep time (97 min). She had the smallest percentage of stages 1 (5 percent) and 2 (41 percent) sleep as compared to the other subjects. She had a greater percentage of stages 3 and 4 sleep (28 percent) as compared to the normative values (24 percent). Hypopnea events (decreased airflow) which appeared to be central in nature, as opposed to obstructive, were noted. Alpha intrusion into deep sleep was present on her sleep record.

She was awakened at 5:47 a.m. On The Post-Sleep Questionnaire, she indicated that she could remember that she had dreamed. She reported that she thought she had slept deeply and that she felt about the same as usual upon awakening.

Subject #5

Subject #5 was a thirty-four-year-old female with a mild sloping to profound loss at the left ear, and a moderately-severe to profound loss at the right ear. Her hearing loss was the result of a middle ear deformity at birth. As a child, she was mainstreamed into the public schools and was provided with a tutor. She did not begin wearing hearing aids until age twenty-one. She learned sign language during college, but did not use sign language as her primary mode of communication. She reported that she did utilize lip reading to some extent, but relied primarily on audition as her basic means of processing receptive and expressive communication.

On The Case History Form, she noted that she had spinal bifida. In relation to sleep, she reported that in the past, she had been known to sleep walk. She indicated that she normally did not have difficulty falling asleep or awakening during the night. On The Dream-Thought Content Questionnaire, subject #5 was the only subject to report that she could call out for help during a disturbing dream. She also noted that she sometimes dreamed that she was a normally hearing person.

A psychological evaluation of subject #5 revealed percentile scores of fifty-three for depression and four for anxiety. These were the lowest scores for any of the subjects. An I.Q. examination was not administered to this subject. Markers of depression which were present on her sleep record were impaired sleep efficiency and an increased percentage of wakefulness.

On the night of the sleep evaluation, she prepared to go to sleep at 11:51 p.m. Her Pre-Sleep Questionnaire revealed that she was not tired or sleepy at bedtime.

Results from her sleep evaluation revealed that she had the greatest amount of wake during sleep (62 min), total number of awakenings (four), percentage of stage wake (19 percent), stage 1 (22 percent), and stage 2 (55 percent) as compared to the other subjects. She was however within the norms for stage 2 sleep (46 percent-62 percent), but above the norms for the other above listed measurements. She had the greatest latency to stage 2 sleep (36 min), persistent sleep (35 min), and REM sleep (214 min). She had the shortest total sleep time (311 min), REM time (44 min), and NREM time (267 min). She also had the smallest percentage of REM sleep (14 percent). While she had the smallest percentage of stages 3 and 4 sleep (9 percent), she was the only subject to fall within the norms (7 percent-21 percent) for this measurement.

Subject #5 did not have good sleep efficiency with a score of 80 percent. She reported that she was distressed at the time of the sleep evaluation. This may have affected her sleep. Her percentage of REM sleep (14 percent) was less than the norms (22 percent-34 percent) and her latency to REM sleep (214 min) was considerably greater than the norms (70 min). A sinus arrthymia (irregular heart beat) was noted during the night. Alpha intrusion into sleep was present on the sleep record.

She was awakened at 6:21 a.m. On The Post-Sleep Questionnaire, she felt that it took her longer than usual to fall asleep. On the whole, she indicated that she had an average night of sleep.

Summary of Results

The only common denominator which was shared by the five hearing-impaired subjects was a higher percentage of stage 1 (theta waves) than the normative values for each subject. This means that all of the subjects remained in stage 1 of sleep longer than the norms.

The two aural/oral teenagers (subjects #3 and #4) had several similarities in their sleep architecture. Areas of similarity were: less number of awakenings, higher percentage of stage wake, higher percentage of time spent in stage 1, less percentage of stage 2 sleep, greater percentage of delta sleep, less than one minute in difference for latency to stage 1 and stage 2, persistent sleep, and wake before sleep.

The manual teenager (subject #2) shared a resemblance to the aural/oral teenagers (#3 and #4) in that he also had a smaller number of awakenings than the norms, more percentage of sleep time spent in stage 1, smaller percentage of time spent in stage 2, and a greater percentage of time spent in delta sleep as compared to the norms. He was the only subject to have a smaller percentage of stage wake than the norms.

The oral subject (#1) and the adult aural/oral subject (#5) appeared to have a number of similarities. They had a greater percentage of time spent in stages wake and 1, which was noticeably higher than the other subjects. Their results matched within 7 percent for the percentage of time spent in stages 2, 3, and 4 of sleep. They both had a smaller percentage of stage REM than the norms. The amount of time it took for these two subjects to reach persistent sleep was markedly higher than the other subjects.

The aural/oral (#3, #4, and #5) all had alpha waves intruding into their deep sleep.

CHAPTER V

DISCUSSION

Limitations of the Study

A confounding factor in this study may have been first night effects. According to Freemon (1972), first night effects occur when a person sleeps in a new environment for the first time. The person may feel some anxiety or uneasiness about sleeping in unfamiliar surroundings. Some typical characteristics of first night effects are: the person spends more time awake, has a shorter percentage of REM sleep, and has longer latencies to the first periods of delta sleep and REM sleep. In accordance with first night effects, subjects did spend more time awake than the norms. The only exception was the manual subject (#2). With the exception of an aural/oral subject (#4), subjects had a shorter percentage of REM sleep as compared to the normative data. The oral subject (#1) and two aural/oral subjects (#4) and (#5) had longer latencies to REM sleep. The manual subject (#2) and the other aural/oral subject (#3), had shorter latencies to REM sleep. Even though sleep efficiency was good for most subjects, they were not within normal limits for many of the measurements listed above which suggested the occurrence of first night effects. However, without a reliability measure taken on each subject, first night effects can not be positively included or excluded from this study.

The oral subject (#1) spent two nights at The Sleep Center. The second night was used as a test-retest reliability measurement. There were twenty-one days between the two test nights, and on the second night of sleep he may have experienced some anxiety about an examination at school the next day. He had a decrease in sleep efficiency on the second night of sleep (91 percent vs 72 percent). This decrease in sleep efficiency may have been due to anxiety about his exam. Because of the decrease in sleep efficiency, it was difficult to compare the second night to the first night of sleep as a reliability measure. More reliable results may have been obtained had he been evaluated for two consecutive nights of sleep and without the pressure of a pending examination. Because of financial resources, he was the only subject to have an opportunity to be studied on two separate nights at The Sleep Center.

There were no known norms of sleep patterns for hearing-impaired subjects. The normative data used in this study were obtained on normal hearing subjects at each age level. These reported norms were not influenced by first night effects. The norms were based on subjects who had been evaluated for several consecutive nights of sleep. Thus, first night effects were noted and not included in the final result for the norms.

Because of the small number of hearing-impaired subjects (five) and only one night of measurement, the conclusions of the study were limited. It was not possible to obtain enough subjects to form different groups of hearing-impaired communicators, thus the results were presented in a case-by-case presentation.

Comparison to Other Studies

The Stojanovic and Guberina study (1975) was supported in that the manual subject (#2) did have a shorter percentage of REM sleep and longer latency to REM sleep as compared to the normative values for hearing people in his age range. However, with the exception of the aural/oral (#4), all hearing-impaired subjects had a smaller REM percentage of sleep than the norms. None of the hearing-impaired subjects fell within the norms for latency to REM sleep. The aural/oral subject (#3) had a smaller latency to REM sleep than the norms, and aural/oral subjects (#4) and (#5) had a longer latency to REM sleep than the norms. The Stojanovic and Guberina findings indicated that there was no difference between the percentage of REM sleep and latency to REM sleep for aural/oral subjects and normal hearing subjects.

In comparing the manual subject (#2) to the Robinson and Dawson results (1975), the manual communicator (#2) did not remain awake for a greater percentage of time than the norms, nor did he spend less time in delta sleep than the norms for hearing subjects. In fact, this study revealed that the manual communicator spent more time in delta sleep than the normative values for hearing-impaired people in his age range. Robinson and Dawson reported that manual subjects spent less time in NREM sleep than hearing subjects. The current study did not have norms for total NREM sleep. The manual communicator (#2) had no early morning wakenings. The Robinson and Dawson study had the same finding in that manual communicators had fewer morning awakenings than normally hearing people.

There was no EMG activity of the flexores digitorum (arm and finger movement) during REM sleep for any of the subjects, including the manual subject (#2). This finding was not consistent with Max (1935) who reported that increased muscle activity was noted for manual communicators at the arm and finger during the dream stage of sleep. Max suggested that manual communicators displayed characteristics of the use of sign language while dreaming. Subject #2 (manual) did not show any significant EMG activity characteristic of the use of sign language during the REM stage.

There were many differences between the current study and each of the individual studies discussed above. The current study did have the same findings as Stojanovic and Guberina in that both studies suggested that the manual communicators did have a shorter percentage of REM sleep and a longer latency to REM sleep as compared to the norms. However, the aural/oral subjects in this current study did not have normal REM percentages or latencies to REM as did the aural/oral communicators in the Stojanovic and Guberina study. The results of this current study were, for the most part, different than the results obtained by Robinson and Dawson. Their only similarity was that manual communicators may have fewer early morning awakenings than normally hearing people. This current study was not in agreement with the Max study in that the manual communicator (#2) did not display any significant amount of EMG activity which would suggest the effort of using sign language during dreaming.

Perhaps the most noticeable difference between this current study and the ones that preceded it was the difference in the number of control subjects and hearing-impaired subjects who participated. The previous studies had control subjects and more hearing-impaired subjects than this current study. Consequently, the previous studies were able to make a more accurate interpretation of their results as compared to their own norms. The previous studies were also able to account for first night effects by having their subjects evaluated several times at a sleep center. This current study, unfortunately, was unable to evaluate subjects for several consecutive nights of sleep. However, the current study was afforded the advantage of modern and sophisticated instrumentation, making it possible to monitor more sleep parameters than in the past. The current study was also the only study to attempt to evaluate the sleep architecture of all three types of hearing-impaired communicators (oral, manual, and aural/oral).

Alpha Intrusion

Perhaps the most interesting discovery of the study was that all three of the aural/oral subjects experienced alpha intrusion into their deep sleep. This was 60 percent (three out of five) of all hearing-impaired subjects. People with alpha intrusion often feel as if they are tired and did not get a good night sleep. Only one subject (#4) reported that she often woke up tired and exhausted. Members of the technical staff at The Sleep Center reported that alpha intrusion was not seen on a regular basis. At most, it was observed in 2 to 3 percent of all cases seen at The Sleep Center. Alpha intrusion can be characteristic of drug use (barbituates), but the possibility of drug use among the aural/oral subjects (#3, #4, and #5) was unlikely. They were all excelling in school and appeared to be socially stable. However, a blood test was not conducted prior to the sleep evaluation to rule out the influence of drugs. Nevertheless, this high incidence of alpha intrusion in the aural/oral subjects peaked the interest of the investigator and is an area where more research should be conducted. This is the only study thus far to report alpha intrusion into sleep among aural/oral hearing-impaired subjects.

Psychological Evaluation

As shown on Table 2 (p. 24) all subjects had a composite I.Q. of 85 or greater. For all of the subjects, the performance I.Q. was greater than the verbal I.Q. The psychologist who administered the tests reported that hearing-impaired people normally achieve better performance scores than verbal scores. Unlike the verbal portion of the test, the performance portion was not based on language skills. The performance tasks were finding missing parts of a picture (e.g., a door without a doorknob) and arranging colored cubic blocks into complex patterns.

The two aural/oral teenagers (subjects #3 and #4) had higher composite I.Q. scores than the oral subject and manual subject. They also had better verbal scores than the other two subjects. This may be because of the use of residual hearing which may allow the aural/oral subjects to achieve higher levels of verbal comprehension.

Subjects with the greatest amount of hearing loss (oral #1, manual #2, and aural/oral #4) had the highest levels of depression and anxiety. For example, aural/oral subject #4 fell in the ninety-fourth percentile for depression and seventy-seventh percentile for anxiety. This meant that only 6 percent of the normative population felt more depressed and 23 percent felt more anxious. The subjects were not tested to determine whether or not their depression and anxiety was due to their deafness. They may have been depressed and anxious whether they had a hearing impairment or not. These psychological impressions were certainly consistent with psychological results found in other deaf people in other studies.

It was noted that subject #4 (aural/oral) had the highest percentage of REM sleep and greatest level of depression as compared to the other subjects and the normative values. These findings may be in agreement with Evans (1983) who suggested that people with high levels of frustration and anxiety may need more dream sleep to work out their problems. All subjects, except for aural/oral subject (#4), had at least one marker of depression which was reflected in their sleep architecture. The following markers of depression were noted: early morning awakenings, shortened REM latency, impaired sleep efficiency, and increased percentage of wakefulness.

Conclusions

1. All three of the aural/oral subjects (#3, #4, and #5) had alpha wave intrusions. The manual and oral subjects did not have alpha intrusion into deep sleep.

2. With the exception of one aural/oral subject (#4), the percent of stage REM (dream) was less than the norms. In other words, hearing-impaired subjects spent less time in the REM stage of sleep than the normative populations.

3. The latency to REM sleep was either shorter or longer for hearing-impaired subjects than the norms.

4. With the exception of the older (thirty-four years) aural/oral subject (#5), the sleep efficiency of the subjects was within normal limits.

5. The aural/oral subject (#5) had an extreme sleep architecture. She was either at the bottom of the rankings or the top of the rankings (see appendix J) for many measurements.

6. The results for the current study were, in some cases, different from the other three existing studies.

7. It was not possible to determine the extent of first night effects and how they may have influenced the results of the study.

8. The manual subject (#2) and the two younger aural/oral subjects (#2 and #4) had some similarities in their sleep architecture. The oral subject (#1) and the older aural/oral subject (#5) had similarities in their sleep architecture.

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APPENDIXES

APPENDIX A

INFORMATION LETTER

INFORMATION LETTER

My topic of research will be to compare the sleep cycles and dream patterns of manual and aural/oral deaf individuals to each other, and to people without a hearing loss. I find this topic to be extremely unique and highly interesting. It is the first of it's kind in the United States. In order to complete this study, I will need help from the Deaf Community in obtaining subjects.

The subjects will volunteer to :

1) Attend an interview with me in which some questions on sleep and general health will be asked. You will also receive a very short hearing test.
2) To attend a free psychological evaluation which will include an I.Q. test, and two other short tests. This evaluation will be conducted at the Health and Physical Education Recreation Building on the University campus. The testing will be conducted by a psychologist.
3) You will be on call to arrive at The Sleep Disorders Center at Fort Sanders Regional Medical Center for one night of sleep analysis. You will need to remain overnight at the Center and may leave the next morning as needed.

Sleep studies are painless---no needles are used. Several small sensors will be placed on your scalp, face, chest, abdomen, arms, and legs. These sensors will monitor your brain waves, eye movements, breathing efforts, heart rate, and muscle activity

Transportation to all three sessions will be provided if needed. If desired, there is a place for you to shower at the Sleep Center before you leave the next morning. I will stay at the Center all night with you and say "Good Morning" when you wake up! If you use sign language, I am knowledgeable in sign language and will be able to talk with you. The people at the Sleep Center are competent professionals and are highly trained; this is their job and they do it every day.

In exchange for participating in this study, you will receive all the results from your sleep evaluation and all other testing at no cost to you. A sleep evaluation normally costs about $600.00. You will receive all that interesting information about your sleep for free! All it will cost you is your time. Plus, you will be involved in one of the most unique audiological projects in the Country!

I am really excited about working on this project. If you are interested, I will be happy to sit down and tell you more about the details of the study. I have to finish the whole thing by November 1, 1988! If you can help, please contact me. Your time and help will be most appreciated.

Thank you,

Rex Banks

Rex Banks
Graduate Student, Audiology
University of Tennessee

1820 Melrose Ave
Knoxville, Tn 37916
974-4343

APPENDIX B

FORT SANDERS SLEEP DISORDERS CENTER

SLEEP DISORDERS QUESTIONNAIRE

FORT SANDERS SLEEP DISORDERS CENTER
SLEEP DISORDERS QUESTIONNAIRE

__________ Patient's Name ____
last first middle

Address ____

Phone ______________ Date of Birth ______________ Sex: M F (circle)

Marital Status __________ Number of Children __________ Ages __________

Occupation ______________________

Name of Person Referring You to the Sleep Center ______________________

Address ____

1. What is your height? ....__________inches
2. What is your weight? ....__________pounds
3. What is your neck size? ....__________inches
4. Give the year of your last physical examination ....__________
   Results of this exam ______________________________________
5. Have you now or ever in the past experienced any health problems associated with the below listed areas?

	Yes	Type of Problem	Dates	Phys., Clinic or Hospital
a- mental health				
b- head or nervous system				
c- eyes, ears, nose, mouth, throat				
d- heart, circulation				
e- breathing (lungs)				
f- stomach, digestive				
g- urine, kidney				
h- sexual				
i- bones, joints, arms, legs				
j- diabetes, glands				
k- blood pressure				
l- weight problems				
m - other				

15. Have you had any previous evaluations, examinations or treatment for this sleep problem or any other problem with your sleep? ☐ yes ☐ no

If so, briefly describe the evaluation, treatment and results. ____________

____

____

16. Have you used any medication (prescribed or otherwise) to help your sleep problem? .... ☐ yes ☐ no

Name	Amount	Frequency	How Long Used?	How Useful?	Physician

17. If employed, what are your usual working hours? ....start ________AM/PM

Do you ever change work shifts? never infrequently regularly

18. Write in the times you usually go to bed and get up on weekdays.

go to bed ________AM/PM
get up ________AM/PM

19. Write in the times you usually go to bed and get up on weekends.

go to bed ________AM/PM
get up ________AM/PM

20. Do you have a regular bed partner?................. ☐ yes ☐ no

21. On the average, how long does it take you to fall asleep at night after you turn out your bedroom lights?.............................. ________ mins.

22. What do you ordinarily do just prior to turning out the lights and attempting to go to sleep (eg. reading, TV, bath, etc.)?________________

____

23. On the average, how often do you wake up during the night? ... ________ times

24. Do you wake up too early in the morning and are unable to return to sleep?

☐ yes ☐ no

25. On the average, how long are you actually asleep at night?_____hrs._____mins.

26. How do you ordinarily awaken?....................
__ spontaneously
__ alarm clock
__ other

27. How difficult is it for you to awaken and get out of bed after sleeping?
very difficult, difficult, sometimes difficult, no problem

How long does it take you to be alert and functioning after sleeping? ______mins.

28. Do you nap or return to bed after arising?............. ☐ yes ☐ no

If yes, how many times per day ____. Average length of nap.____hrs.____mins.

29. Are you bothered by sleepiness during the day?......... ☐ yes ☐ no

30. Do you feel you get too much sleep at night?........... ☐ yes ☐ no

31. Do you feel you get too little sleep at night?......... ☐ yes ☐ no

32. Do you usually feel tired during the day?.............. ☐ yes ☐ no

If yes, what do you attribute this to? ________________________________

33. Do you find yourself falling asleep when you don't mean to? ☐ yes ☐ no

If yes, describe.________________________________

34. Have you ever (a) suddenly fallen......................... ☐ yes ☐ no

(b) experienced sudden bodily weakness... ☐ yes ☐ no

If you have suddenly fallen or experienced weakness, were you aware of the things around you?............... ☐ yes ☐ no

Was the fall or weakness brought on by any particular event or feeling?.................................... ☐ yes ☐ no

If so, briefly describe.________________________________

35. Have you ever experienced weakness or paralysis upon:

(a) going to sleep............................... ☐ yes ☐ no

(b) awakening from sleep.......................... ☐ yes ☐ no

How often does this occur?............................ _______ times/week

36. Have you ever experienced seeing things or hearing voices or noises that weren't real:

(a) on going to sleep . . . . ☐ yes ☐ no

(b) during the night . . . . ☐ yes ☐ no

(c) on awakening from sleep . . . . ☐ yes ☐ no

(d) during the day . . . . ☐ yes ☐ no

37. Do you have difficulty breathing at night? ☐ yes ☐ no

If yes, briefly describe. ____

____

How often? ______________ time/night. How did you become aware of this?

____

When did this first occur? . . . . (age)_____ yr

38. Have you been told you snore while asleep?. . . . . ☐ yes ☐ no

39. Does the snoring disturb:

(a) a bed partner (or someone in the same bedroom) . . . . ☐ yes ☐ no

(b) someone in the next room . . . . ☐ yes ☐ no

40. Have you ever experienced upon lying in bed before sleep or on awakening from sleep a restlessness of legs, "nervous legs", "creeping crawling" sensation of legs, or twitching? (Circle appropriate sensation) . . . . ☐ yes ☐ no

How often does this occur? . . . . _____ times/week

How long does the sensation last?. . . . . _____ mins/duration

Does anything relieve the sensation (eg. getting out of bed, taking medication, massage, etc.)? ______________________________

At what age did you first experience this? . . . . (age) ______ yr

41. Has anyone ever told you that your arms or legs jerk or twitch while you are apparently asleep? . . . . yes no

If yes, how often during the night does this occur? . . . _____ times/night

And how many nights per week does this happen? . . . . . . _____ times/week

At what age did this first come to your attention? . . . . (age) ______ yr

Does this seem to awaken you from sleep? . . . . ☐ yes ☐ no

42. Have you ever experienced doing something without being aware at the time of the action? . . . . ☐ yes ☐ no

If yes, please describe briefly. ____________________

____

How often does this occur? . . . . _____ times/week

43. Do you know or do others tell you that you (circle letter of all that apply:

	times/wk	age started	last occurred	treatment
a. talk while apparently asleep				
b. walk while apparently asleep				
c. grit teeth while apparently asleep				
d. wet the bed during sleep				
e. wake up screaming or seemingly afraid				
f. have disturbing dreams				
g. have unusual movements while apparently asleep				
h. awaken during the night with headaches				
i. (males) have erections of penis while asleep				

For any of the letters you circled above, indicate the appropriate column on the chart:

1. How many times per week the problems occurs or occurred.
2. At what age it began.
3. When it last occurred.
4. Any treatment you have received for this problem.

44. Has any one in your family been known to have any sleep problems?

☐ yes ☐ no

If yes, please list type of problem (eg. trouble getting to sleep, too sleepy, bed wetting, etc.) and relationship of this person to you.

Type of Problem	Relationship	Treated?

APPENDIX C

CASE HISTORY

CASE HISTORY

NAME
AGE
SEX
OCCUPATION

Were you born with a hearing impairment?

Is there a history of hearing loss in your family?

Do you know the cause of your hearing loss?

Do you have any other physical handicaps?

Do you have a history of middle ear infections?

Have you ever had surgery on your ears?

Are you presently taking any medications?

Do you experience tinnitus?

Do you experience dizziness or a feeling of being off balance?

Have you ever worn hearing aids?

Do you communicate with signs only, speech only, or both sometimes?

How do family, friends, and others communicate with you?

Has anyone ever told you that you snore while you are sleeping?

Are you aware of any leg jerking or spasms while you are sleeping?

Have you ever experienced sleep walking?

Do you have difficulty going to sleep or frequent awakenings?

Do you frequently have disturbing dreams?

APPENDIX D

DREAM-THOUGHT CONTENT QUESTIONNAIRE

DREAM - THOUGHT CONTENT

QUESTIONNAIRE

1.) If you were to think about a sentence in your mind, how would the sentence be expressed in your mind?

   (A) You would read the sentence on someone's lips in your mind.
   (B) You would see someone or yourself signing the sentence in your mind.
   (C) The sentence would appear in written form.
   (D) You would hear the sentence.

2.) Do you dream? If yes, how often do you remember your dreams?

3.) Are your dreams usually sad or happy dreams?

4.) How do you communicate in your dreams and how do people communicate with you?

5.) Do you ever hear any environmental noises in your dreams? For example, do you hear airplanes, trains, car horns, etc...?

6.) If you are having a bad dream, are you ever able to call out for help or scream?

7.) If you were to spell a word in sign language in your mind, what color would the background be behind your hands?

8.) When you are thinking, would you say your thoughts are more auditory or visual?

9.) Do you ever dream that you are a hearing person?

APPENDIX E

INFORMED CONSENT

INFORMED CONSENT

DREAM AND SLEEP PATTERNS OF AURAL/ORAL AND MANUAL DEAF PEOPLE

Investigators:

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PURPOSE

The purpose of this study will be to compare the rapid eye movement (REM) and non-rapid eye movement (NREM) sleep patterns of manual deaf who do not use audition and voice, with oral deaf who do use audition and voice to communiate. Both of these groups will be compared to data collected on normal hearing people. This study will also measure the EMG patterns of possible arm and finger movements for both groups. Additional information will be gathered on the content of the dreams to identify any similarities or differences, with regard to communication, between the two groups.

METHODS-SUBJECTS

To be eligible to participate in this study, the subjects must have a bilateral sensorineural hearing loss of at least 85 dB HTL (500, 1000, and 2000 Hz frequency average). The subjects will consist of manual communicators and aural/oral communicators. They will range from ages fifteen to thirty. They will not have any other physical handicap other than hearing impairment, and will have an I.Q. of at least 85. Subjects will not be taking any form of medication.

The hearing subjects will have hearing within normal limits (pure tone thresholds at 25 dB or below). They will meet the same criterion as the hearing-impaired groups.

METHODS-TESTING

The subjects will volunteer to:

1) To attend an interview with the investigator in which some questions on sleep and general health will be asked. At that time they will also receive a hearing screening.
2) To attend a free psychological evaluation which will be conducted by a psychologist. The evaluation will include an I.Q. test, and screening for signs of depression and anxiety. This evaluation will be conducted at the Health and Physical Education Recreation Building on the University of Tennessee campus.
3) The subjects will be on call to arrive at the Sleep Disorders Center at Fort Sanders Regional Medical Center at approximately 7:30 p.m. for a complete sleep study. The subjects will need to remain overnight at the Center and may leave the next morning as needed.

PROPOSED BENEFITS

In turn for their participation in the study, the subjects will receive a complete, free sleep evaluation which normally costs $600.00. They will also receive a medical, psychological, and hearing screening at no cost. They will receive the results of all tests if desired. This study may provide the investigator with some understanding of deafness and its social/psychological implications. Subjects will not be paid for their participation.

PROPOSED RISKS AND PRECAUTIONS

The risk factor in this study is at an absolute minimum. Sleep studies are painless---no needles are used. Several sensors will be placed on the subject's scalp, face, chest, abdomen, and legs. The sensors will monitor brain waves, eye movements, breathing efforts, heart rate, and muscle activity. The skin will need to be cleaned and the placement of electrodes requires some rubbing of the skin on the designated areas. The hair will also need to be clean as electrodes will also be placed on the scalp. The next day, the subject may need to scrub his scalp in order to wash out all of the electrode gel.

I, ________________________________ willingly participate in this study designed to evaluate and compare sleep and dream pattens between manual and aural/oral deaf to each other and to hearing people. I consent to the testing measurements needed to complete this study. I elect to participate in this study at my own risk.

I understand that the information from my tests may be used for research purposes and publications but that my identity will not be revealed. The results from my evaluation will be available to me after the completion of my individual sleep analysis. I also understand that I may ask questions during any part of the procedures.

I hereby release from any and all liability, The University of Tennessee, Fort Sanders Regional medical Center, students, and employees for any injury or ailment incurred as a result of this project. In case of an emergency, I understand that i will receive immediate referral to the Emergency Room at Fort Sanders and that I will be responsible for all costs incurred. The study has been explained to me and I understand the explanation.

I am aware that I may withdraw my consent and discontinue at any time without penalty or prejudice to me. My participation in this study will not affect any current or future contact with the Hearing and Speech Center at the University of Tennessee.

PARTICIPANT DATE

WITNESS DATE

APPENDIX F

FORT SANDERS SLEEP DISORDERS CENTER

CONSENT FOR SPECIAL PROCEDURE

FORT SANDERS SLEEP DISORDERS CENTER
Knoxville, Tennessee 37916
(615) 971-1375

CONSENT FOR SPECIAL PROCEDURE

DATE ______________________ TIME ______________________ AM / PM

I authorize the performance upon ______________________
(myself or name of patient)

of the following procedure ______________________

to be performed under the direction of Dr. ______________________.

The nature and purpose of the procedure, possible alternative methods of treatment, the risks involved and the possibility of complications have been fully explained to me. No guarantee or assurance has been given by anyone as to the results that may be obtained.

I authorize administration of such medications as deemed necessary by the physician for the procedure.

I consent to the taking of video tape pictures with soundtrack during my nocturnal polysomnogram recording, on the date indicated above, by Fort Sanders' Sleep Disorders Center.

I waive all rights that I may have to any claim for payments or royalties in connection with any exhibition, televising, or other showing of this video tape which is taken for the purpose of medical education and knowledge, regardless of whether such exhibition televising, or other showing is under philanthropic, commercial, institutional or private sponsorship and irrespective of whether a fee of admission or film rental is charged.

I grant this consent as a voluntary contribution in the interest of medical education and knowledge only.

I waive any and all claims for any invasion of my private rights giving this consent for this picture.

______________________ (Witness)

______________________ (Patient)

______________________ (Date)

______________________ (Relationship)

APPENDIX G

PRE-SLEEP QUESTIONNAIRE

PRE-SLEEP QUESTIONNAIRE

Name________________________ Date____________ File #____________

1. Did you take any naps today? yes____ no____

(list time and lenth of nap)
1.________/________ 3.________/________
2.________/________ 4.________/________

2. Have you taken any PRESCRIPTION MEDICATIONS today?

(list name and time taken)
1.________/________ 5.________/________
2.________/________ 6.________/________
3.________/________ 7.________/________
4.________/________ 8.________/________

Have you taken any MEDICATIONS this past week? yes____ no____
Have you taken NON-PRESCRIBED MEDICATIONS today? yes____ no____
(diet pills, cold remedies, aspirin, etc.)
1.______________ 3.____________
2.______________ 4.____________

3. Have you had any alcohol today? yes____ no____
what______________ when______ amount________

4. Have you had any liquids other than water in the past 5 hours (such as tea, coffee, carbonated drinks, etc.)? yes______ no______
1. What__________ when__________ amount__________
2. What__________ when__________ amount__________

5. Have you felt ill today, or do you feel ill now? yes____ no____
If so, give time and describe______________________________

6. Did anything out of the ordinary happen today? yes____ no____
If so, describe______________________________

7. Did you feel sleepy today? yes____ no____ When?____________________

8. Did you have a physically active day? yes____ no____

9. What time did you eat your last meal? ____________________
Compared to usual, was it less_____ the same_____ , or more_______

10. How sleepy do you feel right now?
not at all_____ a little_____ quite a bit_____ extremely_____

11. How tired do you feel right now?
not at all_______ a little_____ quite a bit_____ extremely _____

12. How alert do you feel right now?
not at all_____ a little_____ quite a bit ____ extremely_______

COMMENTS:____
____
____

APPENDIX H

POST-SLEEP QUESTIONNAIRE

POST-SLEEP QUESTIONNAIRE

1. Did you take any MEDICATIONS last night? yes_____ no_____
   (list name and time taken) 1.__________/______ 3.__________/______
   2.__________/______ 4.__________/______
2. How long did it take you to fall asleep last night? hours_______ min._______
   Is that longer_____ the same______ or shorter_____ than usual?
3. Did you have difficulty falling asleep? yes____ no____
   why?____
   ____
4. How many times did you wake up during the night? __________________
5. Did you have difficulty falling back to sleep? yes_____ no_____
   Why?____
   ____

   Is this a normal pattern for you? yes____ no____
6. How long did you sleep last night? hours_____ min._____
   Compared to usual, was this longer_____ the same_______ or shorter_____
7. Did you dream last night? yes____ no_____ do not remember____
   Were your dreams pleasant______ unpleasant ______ or do not remember_____
8. How deeply do you felt you slept last night?
   very deep_____ deep____ average____ light____ very light____
9. How did you feel when you woke up?
   more rested than usual_____ less rested than usual________ about the same_____
10. How would you rate the QUALITY of you sleep last night?
    very good_____ good_____ average_____ bad_____ very bad_____
11. How sleepy do you feel right now?
    not at all_____ a little_____ quite a bit_____ extremely______
12. How tired do you feel right now?
    not at all_______ a little_____ quite a bit_____ extremely ______
13. How alert do you feel right now?
    not at all_____ a little_____ quite a bit ____ extremely_______
14. Did sleeping in the sleep lab affect your sleep patterns in any way? yes____ no____
    If so, describe how____

COMMENTS:____

____

____

____

____

APPENDIX I

FORT SANDERS SLEEP DISORDERS CENTER

POLYSOMNOGRAPHIC TECHNICAL REPORT

FORT SANDERS SLEEP DISORDERS CENTER

POLYSOMNOGRAPHIC TECHNICAL REPORT

		1	2	3
DATE:______________	TEST: NPSG (Complex)	__	__	__
NAME:______________	NPSG/Sample	__	__	__
SD#:______ UNIT #______	NPSG/NPT	__	__	__
AGE:______ SEX: M F	MSLT	__	__	__
HEIGHT:____ WEIGHT______	OTHER______	__	__	__
IDEAL WEIGHT:__________	NECK SIZE:__________			

REFERRING DOCTOR:______________________________

CHIEF COMPLAINT:______________________________

____

____

MEDICATIONS:__________________________________

____

PARAMETERS MONITORED

1	2	3		1	2	3	
__	__	__	EEG	__	__	__	Resp. Efforts
__	__	__	EMG	__	__	__	SaO2
__	__	__	Leg Movements	__	__	__	EKG
__	__	__	Airflow	__	__	__	Other

TECHNICAL OBSERVATIONS:_________________________

____

____

ABG RESULTS:

	NOC # 1:	NOC #2:	C-PAP:		NOC #1:	NOC#2	C-PAP:
PH	______	______	______	B.E.	______	______	______
PcO2	______	______	______	SaO2	______	______	______
PO2	______	______	______	CO2	______	______	______
BICARB	______	______	______	BIOX	______	______	______

SLEEP PARAMETERS:	NOC #1:	NOC #2:	C-PAP	NORMS FOR AGE
BEDTIME.................				
RISE TIME...............				
TIME IN BED (MIN).......				
TOTAL SLEEP TIME........				
SLEEP EFFICIENCY........				
WAKE BEFORE SLEEP`......				
WAKE DURING SLEEP.......				
WAKE AFTER SLEEP........				
NUMBER OF AWAKENINGS....				
% STAGE WAKE............				
% STAGE 1...............				
% STAGE 2...............				
% STAGE 3-4.............				
% STAGE REM.............				
LATENCY TO STAGE 1......				
LATENCY TO STAGE 2......				
LATENCY TO PRESIS SLEEP.				
LATENCY TO REM..........				

COMMENTS:

****

MULTIPLE SLEEP LATENCY TEST REPORT

NAP #	SLEEP LATENCY	REM LATENCY		PERCENT	
		ABSOLUTE	RELATIVE	ASLEEP	AWAKE
1.					
2.					
3.					
4.					
5.					

MEAN SLEEP LATENCY ____________ (A value of less than 5 is considered abnormal).

SLEEPINESS INDEX ____________ (# of possible naps divided into 100, multiplied by the # of naps slept. A value of 75 or greater is considered abnormal).

Number of REM Sleep Episodes ____________ (A value of greater than 1 is indicative of narcolepsy).

****

MYOCLONUS:	NOC#1:	NOC2:	C-PAP:		NOC1:	NOC2:	C-PAP:
.....Number				....Myoclonus Index			
.....w/Arousal							
.....w/Awakening				....Index w/ Arousal			

NAME ______________________________

	NOC # 1:	NOC # 2:	C-PAP:
ECG......Rate Awake (at rest)			
......Rate Asleep.........			
Assoc. w/resp. events.....			
......Bradycardia.........			
......Tachycardia.........			

ECG COMMENTS: ______________________________

RESPIRATIONS:	NOC # 1:	NOC # 2:	C-PAP:
.........Rate Awake..........			
.........Rate Asleep.........			

RESPIRATORY COMMENTS: ______________________________

		NOC # 1:	NOC # 2:	C-PAP:
TYPE/APNEA	STAGE	NUMBER	NUMBER	NUMBER
OBSTRUCTIVE	NREM			
	REM			
CENTRAL	NREM			
	REM			
HYPOPNEA	NREM			
	REM			

	NOC # 1:		NOC # 2:		C-PAP:	
Typical length of events (secs)	REM ___	NREM ___	REM ___	NREM ___	REM ___	NREM ___
Longest event (seconds)........	REM ___	NREM ___	REM ___	NREM ___	REM ___	NREM ___

	NOC # 1:	NOC # 2:	C-PAP:
# of events with SaO2 range 96%-90%			
# of events with SaO2 range 89%-80%			
# of events with SaO2 range 79%-70%			
# of events with SaO2 below 69%			

	NOC 1:	NOC 2:	C-PAP		NOC 1:	NOC 2:	C-PAP
Lowest SaO2 (NREM):				Total Number:			
Lowest SaO2 (REM):				APNEA INDEX:			
Baseline SaO2:				Predominately:			

RESPIRATORY COMMENTS: ______________________________

SOME MARKERS OF DEPRESSION
(FOR INSOMNIA PATIENTS)

	NOC # 1: YES	NOC # 1: NO	NOC # 2: YES	NOC # 2: NO	NOC # 3: YES	NOC # 3: NO
1. Early morning awakening						
2. Shortened REM latency						
3. Impaired sleep efficiency						
4. Increased % wakefulness						
5. Increased REM						
TOTAL:						

****

NOCTURNAL PENILE TUMESCENCE RESULTS

NIGHT	LENGTH OF REM EPISODE	TOTAL ERECTION TIME	MAX. TIP CIRCUMFERENCE CHANGE	MAX. BASE CIRCUMFERENCE CHANGE

COMMENTS: ____________________

Technologist: ____________________

APPENDIX J

RANK ORDERING OF SLEEP MEASUREMENTS

RANK ORDERING
OF RESULTS
1 = HIGHEST NUMBER
5 = LOWEST NUMBER

MEASUREMENTS	SUB.#1 ORAL 21 YRS	SUB.#2 MANUAL 19 YRS	SUB.#3 AURAL/ORAL 17 YRS	SUB.#4 AURAL/ORAL 16 YRS	SUB.#5 AURAL/ORAL 34 YRS
	NIGHT 1				
TIME IN BED	1	3	2	4	5
TOTAL SLP TIME	2	1	3	4	5
SLP EFFICIENCY	4	1	3	2	5
TOTAL REM TIME	4	2	3	1	5
TOTAL NREM TME	1	2	3	4	5
WAKE BEFORE SLP	1	5	2.5	2.5	2
WAKE DURING SLP	2	5	3	4	1
WAKE AFTER SLP	2.5	2.5	1	2.5	2.5
# OF AWAKENINGS	1	2.5	2.5	2.5	1
% STAGE WAKE	2	5	3	4	1
% STAGE 2	2	3	4	5	1
% STAGE 3 AND 4	4	3	1	2	5
% STAGE REM	4	2	3	1	5
LATENCY STG 1	1	5	3.5	3.5	2
LATENCY STG 2	2	5	3	4	1
LAT PERSIS SLP	2	5	3.5	3.5	1
LAT TO REM SLP	3	5	4	2	1

VITA

Rex Darron Banks was born on June 26, 1965, in the friendly little town of Hartsville, South Carolina. Being the son of a naval officer, he relocated many times during the early years of his education. When the family settled in Gulfport, Mississippi, at the age of twelve he would meet his first "deaf person." Little did he know that this encounter would inspire his future educational goals. He went on to become an interpreter for the deaf at his church in Gulfport and to teach the Sign Language Club at school. He graduated from Gulfport High School in 1983 and continued his education at The University of Mississippi. He earned a Bachelor of Arts in Communicative Disorders in the Fall of 1986. In May of 1989, he completed a Master of Arts in Clinical Audiology at The University of Tennessee, Knoxville, with strong aspirations to continue forward in serving and hoping to come closer in understanding the lives of hearing-impaired people.