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Air and Bone Conduction Thresholds of Deaf and Normal Hearing Subjects before and during the Elimination of Cutaneous-Tactile Interference with Anesthesia. Final Report.

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The study investigated whether low frequency air and bone thresholds elicited at high intensity levels from deaf children with a sensory-neural diagnosis reflect valid auditory sensitivity or are mediated through cutaneous-tactile receptors. Subjects were five totally deaf (mean age 17.0) yielding vibrotactile thresholds but with no air and bone response above 750 frequency, six control deaf with residual hearing (mean age 17.4 years); and 10 normal hearing subjects (mean age 22.4 years). All were given a subcutaneous injection of 2% xylocaine to eliminate local cutaneous-tactile interference. Five air and bone thresholds were obtained both before and during anesthesia from one ear of each subject. Air thresholds obtained by an audiometer were extinguished during the block for the totally deaf, shifted five decibels for the control deaf, and remained identical in the normal subjects; bone thresholds shifted five decibels for the totally deaf (the bone oscillator went through the whole cranium and thus was not stopped by the local anesthesia), and remained identical for the control subjects. (Author/SN)

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CONTENTS

Page

I. INTRODUCTION 1

- A. Problem 1
- B. Background 2
- C. Related Literature 4
  - 1. air conduction studies 4
  - 2. bone conduction studies 5

II. METHOD 8

- A. General Design 8
- B. Data Instrumentation 10
- C. Statistical Analysis 10

III. RESULTS 15

- A. Air Conduction 15
- B. Bone Conduction 21

IV. DISCUSSION 25

V. CONCLUSIONS AND IMPLICATIONS 29

- A. Conclusions 29
- B. Implications 30

VI. SUMMARY 31

VII. REFERENCES 33

VIII. APPENDICES

- A. Appendix A - Raw data of the three pretest thresholds and the during anesthesia thresholds for the twenty-one subjects.
- B. Appendix B - Parent permission forms.

IX. ERIC RESUME FORM

X. FIGURES

- A. Figure 1 - Scattergram of the eleven deaf subject's air conduction thresholds for pretests 2 and 3 at 125 Hz. 12
- B. Figure 2 - Scattergram of the eleven deaf subject's air conduction thresholds for pretests 2 and 3 at 250 Hz. 13
- C. Figure 3 - Scattergram of the eleven deaf subject's air conduction thresholds for pretests 2 and 3 at 500 Hz. 14

XI. TABLES

A. Table I - Pure Tone Thresholds of Priority and Control Deaf Subjects Before and During the Anesthetic Block. 16
B. Table II - Air Conduction Threshold Means and Ranges of the Priority and Control Deaf Subjects Before and During the Anesthetic Block. 17
C. Table III - Pure Tone Thresholds of Normal Hearing Subjects Before and During the Anesthetic Block. 19
D. Table IV - Air Conduction Threshold Means and Differences of the Normal Hearing Subjects Before and During the Anesthetic Block. 20
E. Table V - Bone Conduction Threshold Means and Differences of the Priority and Control Deaf Subjects Before and During the Anesthetic Block. 22
F. Table VI - Bone Conduction Threshold Means and Differences of the Normal Hearing Subjects Before and During the Anesthetic Block. 23
G. Table VII - Summary Tally of the Before and During Threshold Shifts at 250 Hz for the Twenty-One Subjects. 27
H. Table VIII - Summary Tally of the Before and During Threshold Shifts at 500 Hz for the Twenty-One Subjects. 28

I. INTRODUCTION

A. Problem. There is considerable evidence to suggest that the low frequency pure tone air and bone conduction thresholds elicited from deaf children at high intensity levels do not reflect valid auditory sensitivity but rather represent vibrotactile exteroception mediated through the cutaneous-tactile receptors. Nober (21, 22, 25, 26) provided much of the evidence to suggest the pure tone air and bone conduction thresholds obtained from severely deaf children at high intensity levels are indeed "pseudoauditory" [Nober (22)] or invalid auditory responses that actually reflect vibrotactile sensitivity. If this contention is correct, there are pertinent implications for the diagnostic, educational, and habilitative management of the deaf child. Ideally, the profile of a suspect deaf child is based on the collective data from audiologic, otologic, pediatric, and psychologic consultations but "ideal" circumstances do not always prevail and not infrequently the only quantitative data that is available during the first year are the thresholds provided by the audiologist. Unwittingly, in the course of events, major emphasis is frequently relegated to these cursory audiologic findings. While most audiologists readily concur there are marked limitations to pure tone thresholds and emphasize the pertinence of concomitant dysacusic problems and other factors not identified by the pure tones, they nevertheless indulge in tentative and unwarranted predictions from the obtained threshold data. Furthermore, these data are employed by the otologist to aid his initial diagnosis and later by the school official for enrollment into a school for the deaf [Nober (27)]. Even the hearing aid evaluation is arbitraily based on the clinical wisdom and subjective judgment of the audiologist who initially relies on his air conduction data as these are his only quantitative results [Nober (23, 24, 25)]. Yet, a prevailing, intellectual ambivalence relative to the pure tone thresholds obtained from deaf children compels audiologists to interpret the "hearing levels" with reluctance. Experience has shown the thresholds have low predictive value for speech development, language development, educational success, social interaction, etc. A crucial possibility to be resolved is whether these ostensible auditory thresholds are valid or whether they are non-auditory perceptions that inadvertently intervene to precipitate fallacious prognostications about the auditory function.

Even if it is granted that there are some limitations to the inherent values of the pure tone thresholds relative to the diagnosis and management of the deaf child, it is still necessary to learn more and explore about the validity of these measures. Nober (21, 22, 25, 26) seriously questioned the position of the skeptics and asserted that valid air and bone conduction thresholds do contain a great deal of useful and pertinent information. Valid air conduction thresholds provide essentially the same information but the transmission bypasses the conductive mechanism via the bones of the skull or face and radiatesthe stimulus energy directly to the cochlea. A difference between the air and bone thresholds of 10 dB or more connotes a significant "air-bone gap" (AC-BC) and this AC-BC gap or difference reflects the impedance loss attributed to the conductive mechanism. In essence, valid air conduction thresholds designate the degree of loss or "hearing level" and the gross site of the lesion as the conductive and sensory-neural components can be quantitatively delineated into their respective magnitude of threshold shift. Indeed, this is valuable information! Recognizing, then, that there are inherent limitations to the prognosticative scope of the pure tone thresholds, they are still markedly important for auditory assessment [Carhart (7)] especially when used in adjunct with supportive data of other specialists. If the threshold data are invalid and do not designate auditory sensitivity, then valuable and pertinent information is lost and the predictive profile becomes ambiguous.

Perhaps the prevailing skepticism relative to the value of the pure tone thresholds of deaf children may be more arbritrary than prudent and partly related to the fact that the obtained values are not always auditory but are vibrotactile as Nober (22, 23, 25, 26) has propounded. If it were possible to differentiate valid auditory sensitivity from vibrotactile sensitivity then, the prognosis relative to speech development and the other behavioral processes may be more closely related to the hearing levels. This proposal is based on the contention that prevalent weaknesses of pure tone thresholds elicited from profoundly deaf children may be partly due to their inherent limitations but also that these consistent and reliable low-frequency thresholds are often invalid and subsequently do not reflect the integrity of the auditory mechanism. It is conceivable that the valid auditory pure tone thresholds have considerable value for both the diagnosis and educational management when they actually reflect the integrity of the hearing mechanism. The vibrotactile thresholds, later to be designated cutile thresholds* (i.e., cutaneous-tactile exteroception), need to be positively identified as they may have diagnostic pertinence Bocca and Perani (6) and certainly have therapeutic, habilitative and educative ramifications. Indeed, cutile thresholds can even be employed as a quantitative index of the conditioned response of a child relative to threshold perception.

B. Background. The validity of the pure tone air and bone conduction thresholds is based on research that has been amassed through the years [Corso, et. al. (9); Dadson, et. al. (10); Harris (12); National Health Survey (20); Whitting, et. al. (38); Albrite, et. al. (1)]. These data were based on thresholds obtained at relatively low intensity levels, and not at or near the maximum output of the audiometer. However, the pure tone thresholds elicited from deaf children are obtained at levels that are marginal to discomfort where the sensations may be confounded with cutaneous-tactile interference. Yet, little or no attention has been directed to validating auditory thresholds at high intensity levels; instead, a tacit compliance prevails that the original validation on normal hearing subjects also applies to the deaf population. This study purports to investigate this assumption.

The modern audiometer calibrated to the ISO, 1964 standard can produce maximum sound pressure level (SPL) power outputs (re: .0002 microbar) reaching 135.5 dB at 125 Hz; 114.5 dB at 250 Hz; 121 dB at 500 Hz; 116 dB at 1000 Hz; 118.5 dB at 2000 Hz; 119 dB at 4000 Hz; and 118.0 dB at 6000 Hz. Energy at these intensity levels is quite penetrating and capable

*See page 26

of activating cutaneous-tactile receptors. Some of the output levels in the low frequencies approach and even surpass the threshold of discomfort where other types of sensory receptors become involved [Verrillo (30, 31); Sherrick (28)]. In many instances, pain receptors are excited as discomfort is approached; this is especially prevalent in the pathological ear with recruitment. Deaf children occasionally depict that they "feel" a pressure or a tickle rather than hear a low frequency tone. When the deaf child is conditioned to give some behavioral response to the tone stimulus, no effort is exercised to insure that he "heard" the tone rather than felt it, if this is possible. Furthermore, a congenitally deaf child who has never experienced an auditory sensation cannot make this fine, qualitative judgment with any degree of sophistication. Inadvertently, then, he is conditioned to yield valid and reliable vibrotactile thresholds that are mediated through cutaneous-tactile exteroceptors; these responses are notoriously "reliable" and should be as they reflect real sensations. To the unsuspecting audiometrist, the consistent or reliable thresholds allude to ostensibly valid hearing thresholds.

The functional similarities between the auditory and cutaneous-tactile receptors suggest why a subject can easily confuse the two sensations, particularly a deaf subject who is devoid of any prior experience. Studies on skin receptors indicate that there is extreme sensitivity of the integument to the type of energy propagated from intense low-frequency pure tone [Geldard (11)]. The sensitivity of the skin to vibratory stimulation has a long history dating back to Weber's 1846 (37) pressure theory, Meissner's 1859 (16) theory, and von Frey and Kiesow's 1899 (35) tension theory. More recently, Wheddal, et. al. (36) showed that sudden mechanical displacement effects the Pacinian corpuscles while Nafe and Kenshallo (18) have shown that dynamic movement is involved in touch rather than static displacement. One particular variable of interest here is "contactor area." This has been studied by a number of investigators [Nafe and Wagner (19); von Bagh (34); Holway and Crozier (13); Verrillo (30, 31] . For the most part, these studies showed that responses to mechanical displacement are mediated by more than one receptor system although the exact nature is still unresolved. Parameter displacement, velocity, and time are all crucial determinants of the threshold of any particular contact area. Most studies concur that absolute thresholds plotted as a function of contact area result in 1.5 dB slope per doubling of area. If circumference is calculated instead of area, the slope rating for sensitivity is 3 dB per doubling of area. This closely approximates the slope found in hearing when the stimulation area of the basilar membrane is increased. This physiologic parallelism reinforces the contention that hearing is a form of vibration and there is even a small functional range where the two overlap, i.e., 18-20 Hz. There are other parallelisms to audition; for example, a functional relation exists between the temporal patterns stimulus intensity for tactile sensitivity as mathematically predictable [Zwislocki (39); Verrillo (33] . There is a similar function for audition [Hughes (14); Miller (17); Zwislocki, et. al. (40)]. It is evident, then, that there is physiological evidence to suggest that the auditory and vibrotactile modalities are closely related in the low frequencies [Bekesy (5)].

C. Related Literature.

1. Air conduction studies. Nober (1963) investigated the air conduction thresholds of deaf children as a function of age and frequency relative to (1) audiogram configuration, (2) test-retest reliability, (3) percentage of "no response", (4) standard deviation and (5) standard error of measurement. His forty-two experimental subjects all had normal intelligence, ranged in age from five to fourteen years with a relatively even sex distribution, i.e., twenty males and twenty-two females. The results indicated that the audiogram configuration typically showed a sloping drop from 65 dB at 125 Hz to 95 dB at 2000 Hz (ASA, 1951). This occurred for all age groups as well as for the total group, ages pooled. Functionally, the thresholds did not show any variance with age, were at or near maximum output level of the audiometer and were quite homogeneous. Ninety per cent of the deaf children responded at 250 Hz and ninety-five per cent responded at 500 Hz. Standard deviation values were also quite small and never exceeded 10 dB while the standard error of measurement which reflects the repeatability of the test scores (or the subject's absolute consistency from test to test) never exceeded 5 dB. Nober (21) concluded that these air conduction thresholds were suspiciously reliable and showed excessive homogeneity considering the wide range of etiologies among the subjects. He reasoned that the threshold sensation level values were near the maximum output of the audiometer where the sound pressure level output is severe and approaches discomfort levels. Actually, the maximum output levels of the modern audiometer are set relative to discomfort thresholds that were ascertained from normal hearing subjects.

It became clear that perhaps the audiograms plotted for some deaf subjects were not valid hearing thresholds but designated sensitivity values that were mediated through other receptors. The work of Verrillo (30), Bekesy (4), and Sherrick (28) showed that skin sensitivity to vibratory simulation has a characteristic U-shaped curve with maximum sensitivity in the region of 250 Hz. It is pertinent that Nober (21) obtained reactions from 90% of his subjects at 250 Hz where skin sensitivity is most acute. Furthermore, Arnold (2) showed data for "feeling curves" that were similar to the Nober (21) air conduction values, i.e., 45 dB at 125 Hz, 65 dB at 250 Hz, 95 dB at 500 Hz and 100 dB at 750 Hz. Schlosser, et. al. (29) also revealed similar air conduction values for deaf children. Recently, Langenbeck (15) reported air conduction thresholds that are almost identical to the Nober (21) data.

In still another study, Nober (25, 26) placed the air conduction receiver in the palm of the hand and subsequently obtained "palmar" thresholds from 94 deaf subjects. Results showed little or no variation relative to age and a relatively narrow range of values among subjects. All 94 subjects yielded palmar thresholds at 125, 250, and 500 Hz while only one-third to one-half responded at 1000 Hz, depending on the age group. The palmar threshold values (ages pooled) were: 70 dB at 125 Hz, 80 dB at 250 Hz, and 100 dB at 500 Hz. There were no palmar thresholds at 1000, 2000, 4000, and 6000 Hz, respectively. When these values were compared to those elicited at ear level in the standard clinical manner, the palmar thresholds were 5 dB more sensitive at 125 and 250 Hz, equal at 500 Hz and poorer beyond this frequency. The proximity of the palmar and ear level thresholds were construed as further support that the ear level values reflected vibrotactile exteroception. At the low frequencies, the sound generated into the hand yielded even better thresholds; this was anticipated as the palmar integument is intrinsically more sensative to vibrotactile stimulation.

2. Bone conduction studies. Bone conduction thresholds of deaf children have also been explored. It is not uncommon to obtain bone conduction thresholds at 125, 250, and 500 Hz on children with profound sensory-neural deafness. These thresholds tend to be homogeneous like their air conduction counterparts, but occur at lower sensation level values; they allude to and precipitate significant air-bone gaps. These gaps should not occur in instances of sensory-neural deafness with no concomitant conductive involvement. On occasions, bone conduction thresholds are elicited from deaf subjects who even fail to give air conduction thresholds to maximum tonal stimulation. Total lack of responses is relatively uncommon as most deaf subjects show some sensitivity to vibrotactile stimulation in the low tones. Like their air conduction counterparts, the bone conduction thresholds are quite homogeneous, considering the vast numbers of etiologies associated with sensory-neural deafness. As valid bone thresholds designate the sensory-neural component, it would be impossible for all of these thresholds to be nearly identical. Barr (3) first noted these low frequency bone thresholds in his deaf subjects but called them "artifacts." Bocca and Perani (6) called them an "audiologic absurdity" and contended that "this peculiar behavior in bone conduction thresholds over low frequencies only concerns the frequencies between 125 and 250. . .and are almost never better than 20-30 db." These authors explained the dynamics in terms of a primitive vestibular hearing mechanism mediated through the vestibular endings in the saccule and cochlea and cited anatomic, physiologic, and clinical evidence to support their theory of "vestibular hearing." Nober (22) also demonstrated "pseudoauditory" or invalid, low frequency air-bone gaps and his data were nearly identical with those of Bocca and Perani (6). Langenbeck (15), too, revealed "feel" bone thresholds that were identical with the Nober (22) values, i.e., 25 dB at 250 Hz and 50 dB at 500 Hz (ASA, 1951). No vibrotactile bone thresholds have been reported from 1000 Hz and above.

As the Nober (22) study formed the basis of the present experiment, it will be described in further detail. Seventy deaf children ranging in age from 5-14 years were divided into three groups. One group consisted of 38 "partially deaf" children with varying degrees of residual hearing. The second group was comprised of 12 "totally deaf" children who had no demonstrable air conduction thresholds. The 50 children of these two groups all had an otologically confirmed sensory-neural diagnosis. The group of twelve totally deaf children served as the control for the partially-deaf group. A third group of twenty partially-deaf children with a mixed loss diagnosis, (conductive and sensory-neural) represented a population with valid air-bone gaps. The mixed loss group was used along with the two sensory-neural groups to compare the effects of a masking noise on valid bone conduction thresholds (mixed loss group) and invalid bone conduction thresholds (sensory-neural group). The partially deaf, sensory-neural group had a median air conduction threshold of 70 dB at 250 Hz, 80 dB at 500 Hz, 90 dB at 1000 Hz, 95 dB at 2000 Hz and a "no response" designation at 4000 Hz. The air conduction thresholds for the totally deaf group were NR designations throughout the range. However, the bone conduction values or the sensory-neural component for the two sensory-neural groups were identical, i.e., 25 dB at 250 Hz and 50 dB at 500 Hz with "no response" designations at 1000, 2000 and 4000 Hz (ASA, 1951). Logically, then, identical bone conduction thresholds of the two different sensory-neural groups could not be valid. The bone conduction values of the mixed loss group were 10 dB at 250 Hz, 30 dB at 500 Hz and 55 dB at 1000 Hz and this represented a 15-20 dB departure from the two sensory-neural groups. Also, many of the subjects gave bone conduction responses at 2000 and 4000 Hz while no subject in either of the sensory-neural groups gave a bone conduction response at 2000 or 4000 Hz.

Nober (22) then proceeded to determine if it was audiologically feasible to differentiate between the valid and invalid bone conduction thresholds he obtained from the sensory-neural and mixed loss groups. He hypothesized that an auditory masking stimulus should shift or increase the auditory thresholds but should not affect the non-auditory values. Consequently, all the subjects in the partially-deaf sensory-neural and mixed loss groups were given a white noise that exceeded their respective air conduction thresholds by approximately 15 dB at 250 Hz and 20 dB at 500 Hz. The results upheld the hypothesis. The sensory-neural group with the invalid or vibrotactile thresholds did not reveal statistically significant masked bone conduction shifts but the mixed loss group with the valid bone conduction thresholds shifted 15 dB at 250 Hz and 22 dB at 500 Hz. Both threshold shifts were statistically significant at a 1% level of confidence. Nober (22) concluded that it was audiologically feasible to differentiate between valid and invalid bone conduction thresholds, in some instances. However, this study only pertained to bone conduction values and further exploration is necessary for air conduction thresholds.

This study went one step further. Thirty children, selected at random from the above groups, were tested with the bone conduction oscillator on three "non-auditory" areas of the body, i.e., the fingers, ulna and clavicle. At 250 Hz, all three non-auditory areas yielded a 15 dB threshold; at 500 Hz, the ulna and clavicle both gave a 35 dB threshold while the fingers were 5 dB more sensitive. There were no bone conduction responses at 1000, 2000 and 4000 Hz for the ulna and clavicle areas but one-third of the group yielded a 50 dB threshold at 1000 Hz for the fingers. The three non-auditory areas were actually 10 dB more sensitive than the mastoid area to bone conduction at 250 Hz and 15-20 dB more sensitive at 500 Hz. This is in keeping with the air conduction thresholds described above.

In summary, this study (1) confirmed the existence of an invalid low frequency air-bone gap in instances of sensory-neural pathology, (2) suggested that artifactual, vibrotactile low-frequency bone conduction thresholds created the gap, (3) suggested an audiologic technique to help differentiate between valid and invalid bone conduction thresholds and (4) demonstrated similar and in some instances better bone conduction thresholds from non-auditory areas of the body. The background literature suggests, therefore, that the pure tone air and bone conduction thresholds elicited from some deaf children do not reflect valid auditory sensitivity. These thresholds have been designated as "pseudoauditory" in the past by Nober (22), to demonstrate that they were not valid auditory thresholds. In a subsequent study, Nober (26) employed the term "vibrotactile" in a comparative assessment of palmar and ear level thresholds where he demonstrated marked similarities. Later in this manuscript this author will contend that the term "pseudoauditory" is inappropriate as it assumes a negative attitude and dwells on what the thresholds do not represent. Furthermore, the word "vibrotactile" is a term employed by physiologists and experimental psychologists and generally pertains to a more diffuse type of stimulus perception than what is being described in this study. In the latter part of this manuscript, after the ear level thresholds have positively been identified, the term cutile will be coined by this author as an appropriate and parallel term to "audition." Cutile was derived from cutaneous-tactile exteroception to designate what these reliable and persistent low frequency thresholds actually represent.

The cardinal purpose of this study, then, is to determine whether the air and bone conduction thresholds previously referred to as invalid, pseudoauditory or vibrotactile can be eliminated by a local anesthetic block to the cutaneous-tactile receptors. Valid auditory thresholds should not vanish during this experimental condition.

II. METHOD

A. General Design. Pure tone air and bone conduction thresholds were obtained from totally deaf, partially deaf, and normal hearing subjects under two sets of conditions, i.e., before anesthesia and during anesthesia. The ultimate objective was to determine what effects a subcutaneous anesthetic block would have on the thresholds of subjects who demonstrated auditory exteroception and the subjects with non-auditory exteroception. While it was anticipated that the vibrotactile air conduction thresholds would vanish under anesthesia, it was doubtful that the effect would be as dramatic, if there are any at all, on the vibrotactile bone conduction thresholds. The latter stimulated deep sensory receptors that apparently would not be deterred by the local subcutaneous block.

Most of the deaf subjects were obtained from two nearby schools for the deaf, the Rochester School for the Deaf and the Rome School for the Deaf. In the original grant proposal, the Upstate Medical Center was to provide an otologist and anesthesiologist but this did not work out. Instead a local private otologic surgeon, Dr. Harold Wanamaker, was employed to conduct the otologic examination and anesthetic block.

The experiment was carried on basically at the Syracuse University Hearing Clinic. A soundproof suite, Model 1204 constructed by the Industrial Acoustic Corporation, served as the test room. Prior to the anesthetic block, each subject received three air and bone conduction tests. The first two pretests were given a minimum of one month apart to compare test-retest scores and choose the ear to be tested during anesthesia. The third pretest was conducted just prior to the xylocaine injection and represents the "before" (bef) test values. The thresholds obtained during the block were designated as the "during" (dur) values.

All the threshold raw data for the three pretests and the during anesthetic block values were listed in Appendix A. Only subjects with sensory-neural diagnoses and no recent history of otologic difficulty were used. Each subject received the air conduction tone at frequencies 125, 250, 750, 1000, 2000, 4000 and 6000 Hz, and bone conducted tones at 250, 500, 750, 1000 and 4000 Hz. An Eckstein Bros., Model 450 audiometer generated the pure tone determined from the air conduction thresholds of the previous tests and only one ear was selected for the before and during threshold measurements. It was not necessary, in any instance, to ever use masking.

All subjects were volunteers and fully cognizant of the research design. In addition, their parents were informed relative to the nature of the study and written permission was granted (Appendix B). Only subjects with normal intelligence were used. The subjects were divided into three groups: (1) "priority" sensory-neural deaf subjects who were suspected of having no valid auditory reserve but were yielding vibrotactile thresholds

(2) "control" sensory-neural deaf subjects who had some valid residual hearing; and (3) "control" normal hearing subjects. Actually, group 2 was not specified in the original proposal as only priority sensory-neural deaf subjects with vibrotactile sensitivity were to be anesthetized. But as the experiment progressed, it seemed expedient to include a group of "control" deaf subjects who would also receive the excessive amount of sound stimulation under anesthesia; so the latter group helped to determine if valid high intensity auditory thresholds would prevail under anesthesia as well as the valid minimal intensity thresholds of the normal hearing subjects.

The criteria for the totally deaf subjects were: air conduction thresholds of 65 dB or more at 125 Hz; 80 dB or more at 250 Hz; 100 dB or more at 500 Hz and no responses at 750, 1000 and 2000 Hz. The bone conduction values of these subjects were 30 dB or more at 250 Hz; 45 dB or more at 500 Hz and no bone conduction values at 750, 1000 and 2000 Hz. The designation priority was assigned to this group as it was relatively certain their thresholds were vibrotactile. Subjects 1-5 inclusive comprised this category (Table I). All of these subjects were males as three of the female priority subjects became fearful of the needle injection at the last moment and abstained from the study; no coercion of any type was ever employed to indulge the participation of a subject. Three left ears were used and two right ears. The age mean was 17.0 years and the range was 14.5 years to 18.4 years.

The second group of deaf subjects, i.e., subjects 6-11, yielded thresholds beyond 500 Hz for air and bone conduction. These subjects were designated as control sensory-neural deaf subjects as it was anticipated that their thresholds were valid auditory values. There were two males and four females in this group. Three left ears and three right ears were tested. The age mean was 17.4 years and the range was from 16.3 years to 18.8 years. Two additional subjects from this group also abstained when they became fearful of the needle injection. In total, sixteen deaf children were originally programmed for the study as it was anticipated that some cancellation was iminent. However, eleven deaf subjects remained for the final study.

The normal hearing control group was comprised of ten college students, i.e., seven females and three males. The age mean was 22.4 years and the range from 19.1 years to 27.2 years. It was not always possible to obtain comparable age subjects here but the differences were minor and the effects of age were conjectured to be inconsequential. Only subjects with no otologic history of abnormality were used and in only one instance did a threshold value exceed 15 dB at more than one frequency; i. e., 40 dB at 4000 Hz and 25 dB at 6000 Hz.

At the time of the actual experiment, the air and bone conduction thresholds were obtained for each subject to represent the "before" anesthesia values. Immediately afterward, the experimental ear was injected with a 2% xylocaine solution using the sterile technique employed for the stapedectomy operation. The 2% xylocaine contained adrenalin and was injected with a distribution of 1cc into the external auditory canal subcutaneously and 4cc in a circumscribed area about the auricle. Tactile sensation was tested with a pin-prick and when it was absent, the "during" audiogram was obtained. After this procedure, all subjects remained in the clinic for at least an hour as a safety precaution. No subjects manifested any adverse reactions to the anesthesia.

The air conduction thresholds were presented through earphones and the bone conduction thresholds were obtained with the bone oscillator placed in the mastoid process of the ipsilateral ear. No effort was made to control bone oscillator pressure as every attempt was made to simulate standard clinical procedures. Masking was not necessary in any instance and was subsequently not used to preclude any artifactual variables. The psychophysical method for obtaining the thresholds followed the popular procedure described by Carhart and Jerger (8). All data are expressed in sensation level decibel units re: ISO, 1964 calibration. The data are recorded in Appendix B.

B. Data Instrumentation. An Industrial Acoustic Corporation (IAC) soundproof 1204 control and test suite was constructed for this experiment. The pure tones were generated by an Eckstein Brothers Pure Tone 450 Audiometer. All the medical supplies, i.e., xylocaine, syringes, sterile solution, etc., needed for the anesthetic block and the otologic examination were provided by the otologist.

C. Statistical Analysis. It was decided to present all the raw data rather than to calculate a series of summary statistics. As the N is so small the data are readily available to the reader at a glance to assess and judge the total responses of the entire experimental population. In some instances, summary statistics would only conceal the obtained results due to the small N of a relatively limited sampling of subjects.

One specific issue concerned the vast number of "no response" (NR) designations. To calculate summary statistics the NR values would have to be coded with some arbitrary system. Any coding system would impose a marked bias to the data as 137 of the total 242 statistics for the deaf children were NR values; this comprised nearly forty-two per cent of the data for the deaf subjects. When the data for the priority deaf subjects are observed as a separate group, the NR values represent 79 of the 110 statistic units or nearly 72%. It becomes evident that any arbitrary coding system, no matter how justified, would necessarily bias the data. Actually, the raw data per se are quite imposing.

Furthermore, the raw data of the ten normal hearing subjects totaled 280 statistics, i.e., 140 before and 140 during units. In only five instances did threshold shifts occur so these raw data, too, were quite compelling.

The data relative to the test-retest trials of the eleven deaf subjects are presented for frequencies 125 Hz (Figure 1), 250 Hz (Figure 2) and 500 Hz (Figure 3). While each subject received three pretest pure tone tests only pretests 2 and 3 are depicted in the scattergrams as trial one basically served to aid in the selection of subjects as to their cooperativeness, eligibility, ear to be used, etc. Nevertheless, test one compared favorably with tests two and three (see Appendix A).

Figures 1, 2 and 3 represent frequencies 125, 250 and 500 Hz, respectively. The amount of clustering about the diagonal projection from the lowest vertical parameter to the highest abscissa parameter is testimony to the test-retest reliability.

The following six hypotheses were projected:

1. The air conduction thresholds elicited from the totally deaf priority subjects will be extinguished by a local subcutaneous anesthetic block.

2. The air conduction thresholds elicited from the partially deaf control subjects will not be extinguished by a local subcutaneous anesthetic block.

3. The air conduction thresholds elicited from the normal hearing control subjects will not be extinguished by a local subcutaneous anesthetic block.

4. The bone conduction thresholds elicited from the totally deaf priority subjects will not be extinguished by a local subcutaneous anesthetic block.

5. The bone conduction thresholds elicited from the partially deaf control subjects will not be extinguished by a local subcutaneous anesthetic block.

6. The bone conduction thresholds elicited from the normal hearing control subjects will not be extinguished by a local subcutaneous anesthetic block.

These six hypotheses formed the basis of the exploration and the data will be presented and evaluated relative to their outcome.

Scattergram of the Eleven Deaf Subjects Air Conduction Thresholds for Pretests 2 & 3 at 125 Hz.

Figure 1

Pretest #2

	55	60	65	70	75	80	NR
NR							3
80							
75					3		1
70			1				1
65					1		
60							
55		1					

Pretest #3

Scattergram of the Eleven Deaf Subjects Air Conduction Thresholds for Pretests 2 & 3 at 250 Hz.

Figure 2

Pretest #2

	65	70	75	80	85	90	95	NR
NR								
95							1	
90							1	
85				2	2	2		
80								
75								
70			1	1				
65		1						

Pretest #3

Scattergram of the Eleven Deaf Subjects Air Conduction Thresholds
for Pretests 2 & 3 at 500 Hz.

Figure 3

Pretest #2

	85	90	100	105	110	NR
NR						
110				2	1	
105				2		
100			2	1		
95			1			
90						
85	1					
80	1					

Pretest #3

III. RESULTS

A. Air Conduction. The pure tone thresholds of the priority and control deaf subjects before and during the administration of anesthesia are listed in Table I. Subjects 1-5 inclusive were the totally deaf priority subjects and subjects 6-11 inclusive were the control deaf subjects with residual hearing. The pure tone thresholds of the ten normal hearing subjects, i.e., 12-21 inclusive, for the before and during experimental conditions are presented in Table III. There was no premeditated order to testing the subjects; the number assigned to each subject only indicates the order that the subjects were given the local anesthesia.

a. The before (bef) anesthesia values in Table I represent the obtained threshold of the third pretest and the during (dur) values represent the threshold obtained during the anesthetic block. At 125 Hz, only one subject (2) in the priority group gave a response and this was 65 dB. Apparently, the other four subjects (1, 3, 4, 5) were not able to perceive any sensation at the maximum sensation level output of 75 dB.

In the control deaf group, only one subject (6) failed to respond at 125 Hz and the other five subjects (7-11) gave a before anesthesia mean threshold of 70 dB with a range from 60-75 dB (Table II). During the anesthetic block, priority subject number two who was the only one to respond at 125 Hz did lose this threshold value and yielded an NR designation. For the control deaf subjects, the thresholds did not vanish under anesthesia but instead the mean value increased 4 dB to 74 dB while the range remained exactly the same at 60-75 dB (Table II).

The before anesthesia threshold of the normal hearing subjects at 125 Hz (Tables III, IV) was 5 dB with a range of 0-15 dB. During the block, identical thresholds were elicited for all ten subjects (Table III) so that the experimental mean and range values were unchanged (Table IV).

b. At 250 Hz, all the priority deaf subjects responded to air conduction with a mean value of 88 dB and a range from 65-95 dB (Table II). During the anesthetic block, no air conduction thresholds were elicited from any priority deaf subject and subsequently an NR designation was listed throughout.

In contrast, the control deaf air conduction mean at 250 Hz was 80 dB and the range was identical with the priority deaf at 65-95 dB. However, during the anesthetic block, the threshold mean increased to 84 dB while the range remained at 65-95 dB. Three of the six subjects (7, 9, 10) gave a 5 dB increase and one subject (8) gave a 10 dB increase causing the 4 dB increase noted above.

TABLE I

PURE TONE THRESHOLDS OF PRIORITY & CONTROL DEAF SUBJECTS BEFORE (BEF) & DURING (DUR) THE ANESTHETIC BLOCK

PRIORITY DEAF

	125				250				500				750				1000				2000			
	AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE	
SS#	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur
1M* L**	NR	NR	--	--	95	NR	30	35	110	NR	50	55	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2M L	65	NR	--	--	80	NR	35	40	100	NR	50	55	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
3M R	NR	NR	--	--	90	NR	35	40	110	NR	45	55	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
4M L	NR	NR	--	--	90	NR	30	35	110	NR	55	60	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
5M R	NR	NR	--	--	85	NR	35	40	105	NR	55	55	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

CONTROL DEAF

	125				250				500				750				1000				2000			
	AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE	
SS#	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur
6M L	NR	NR	--	--	95	95	45	45	100	100	60	60	105	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
7F L	65	75	--	--	80	85	35	40	105	110	45	50	110	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
8F L	75	85	--	--	75	85	35	40	85	85	50	60	90	90	NR	NR	100	100	NR	NR	NR	NR	NR	NR
9F R	75	75	--	--	85	90	35	40	105	105	50	60	110	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
10F R	75	75	--	--	80	85	35	35	100	100	55	55	105	105	NR	NR	110	110	NR	NR	110	110	NR	NR
11M R	60	60	--	--	65	65	35	35	85	85	50	50	100	100	NR	NR	105	NR	NR	NR	NR	NR	NR	NR

*Male or Female
**Left or Right Ear

TABLE II

AIR CONDUCTION THRESHOLD MEANS & RANGES OF THE PRIORITY & DEAF SUBJECTS BEFORE AND DURING THE ANESTHETIC BLOCK

Priority Deaf

	Mean		Range	
Frequency	Before	During	Before	During
125	NR[a]	NR	--	--
250	88	NR	65-95	--
500	109	NR	100-110	--
750	NR	NR	--	--
1000	NR	NR	--	--
2000	NR	NR	--	--

Control Deaf

	Mean		Range	
Frequency	Before	During	Before	During
125	70[b]	74[b]	60-75	60-75
250	80	84	65-95	65-95
500	97	98	85-105	85-110
750	103	c	90-110	90-NR
1000	d	d	--	--
2000	e	e	--	--

a. Based on five subjects (1, 3, 5, 6) who responded at this frequency; only subject 2 responded.

b. Based on five subjects (7-11) who responded at this frequency; subject 6 failed to respond.

c. Not calculated as only half the subjects (8, 10, 11) gave values during the experimental trials while the other half (6, 7, 9) yielded NR designations.

d. Not calculated as only half the subjects (8, 10, 11) responded at this frequency during the pretest trials while only two subjects (8, 10) responded during the experimental trials.

e. Not calculated as only one subject (10) responded at this frequency.

The before anesthesia mean of the ten normal hearing subjects at 250 Hz was 2.5 dB with a range from 0-10 dB. During anesthesia, only two subjects showed any change, i.e., 5 dB, to increase the group mean to 3-5 dB. Again, the range was unchanged.

c. At 500 Hz, all the priority deaf subjects gave a response to air conduction with a mean value of 109 dB and a range of 100-110 dB. During the anesthetic block, none of the five subjects yielded any thresholds and so NR designations are listed in Table I.

In contrast, the control deaf before anesthesia mean at 500 Hz was 97 dB with a range of 85-105 for the six subjects. During the anesthetic block, the control deaf mean increased to 98 dB as only one subject (7) showed an increase, i.e., 5 dB. This increase also slightly modified the range, i.e., 85-110 dB.

The before anesthesia mean of the normal hearing subjects at 500 Hz was 1.5 dB and the range, 0-10 dB. During the block, identical thresholds were obtained from all ten subjects (Table III) so that the mean and range values were unchanged (Table IV).

d. At 750 Hz, none of the priority deaf subjects gave a before threshold or an experimental block threshold and so NR designations are listed throughout (Table I).

In contrast, all of the control deaf subjects yielded before anesthesia air conduction thresholds at 750 Hz with a mean value of 103 dB and a range of 90-110 dB. During the anesthetic block only three of the six control deaf subjects (8, 10, 11) maintained the same before anesthetic threshold value while the other three subjects (6, 7, 9) gave an NR designation during the anesthetized condition. This was the first intra-group deviation.

The before anesthesia mean of the normal hearing subjects at 750 Hz was 0.5 dB and the range, 0-5 dB. Again, there were no threshold shifts during the block condition for all ten subjects (Table III) so the mean and range values were unchanged (Table IV).

e. At 1000, 2000, 4000 and 6000 Hz none of the priority deaf subjects yielded any thresholds. But some of the deaf control subjects gave scattered and questionable responses. Subject eight gave the same 100 dB threshold to the before and during anesthesia condition; the subject 10 gave a 110 dB threshold before and during anesthesia while subject 11 yielded a before 105 dB threshold that disappeared during anesthesia. Subject 10 gave a 110 dB response at 2000 Hz which was also maintained during anesthesia. Table I does not list any values for 4000 and 6000 Hz as none were ever elicited for the eleven subjects.

TABLE III

PURE TONE THRESHOLDS OF NORMAL HEARING SUBJECTS BEFORE (BEF) AND DURING (DUR) THE ANESTHETIC BLOCK

	125				250				500				750				1000				2000				4000				6000			
	AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE		AIR		BONE	
SS#	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur	Bef	Dur
12F L	10	10	--	--	5	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
13F R	15	15	--	--	10	10	10	10	10	10	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
14F L	0	0	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
15M R	5	5	--	--	5	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
16F L	10	10	--	--	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
17M R	0	0	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
18F L	10	10	--	--	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0	0	0	0	0	0	0	0	0	--	--
19F R	0	0	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
20F L	0	0	--	--	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--
21M R	0	0	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	40	40	40	25	35	--	--

TABLE IV

AIR CONDUCTION THRESHOLD MEANS AND DIFFERENCES OF THE NORMAL HEARING SUBJECTS BEFORE & DURING THE ANESTHETIC BLOCK

Frequency	Before	During	Difference
125	5.0	5.0	0
250	2.5	3.5	1.5
500	1.5	1.5	0
750	0.5	0.5	0
1000	0.5	0.5	0
2000	0	0	0
4000	0[a]	0[a]	0
6000	0[a]	0[a]	0

a. Based on nine subjects, subject 10 was the only normal subject who exhibited a loss above 2000 Hz.

At 1000 Hz all but one normal hearing subject (18) gave a before anesthesia 0 dB threshold and this one threshold was 5 dB. During the block, the values were identical throughout (Table III). The same held true for 2000 Hz where both the before and during thresholds were exclusively 0 dB throughout. Also, at 4000 and 6000 Hz, the 0 dB value prevailed throughout for the before and during anesthesia conditions, with the exception of subject 21. In this instance, there was a 40 dB sensory-neural threshold at 4000 Hz and a 25 dB sensory-neural threshold at 6000 Hz for both the before and during conditions.

b. Bone conduction. The bone conduction thresholds showed a markedly different trend for the priority deaf subjects as all five subjects maintained their bone thresholds during anesthesia. Apparently, the effect of the xylocaine was "superficial" as it did not penetrate into the deeper receptor areas that bone conduction reaches. At 250 Hz, all five priority subjects gave before anesthesia bone conduction thresholds with a mean value of 32 dB and a range of 30-35 dB (Table V). During anesthesia, these values increased 5 dB in each instance to a mean value of 37 dB and a range of 35-40 dB (Table V).

The control group bone conduction mean was 37 dB and a range of 35-45 dB (Table III). During the anesthetic block, the mean was decreased 1 dB to 36 dB with the same range of 35-45 dB (Table V). Here there was not a uniform increase of 5 dB per subject as half of the subjects (6, 10, 11) failed to show any change (Table I).

The before anesthesia bone conduction mean of the ten normal hearing subjects at 250 Hz was 2.5 dB and the range was 0-10 dB. During the block, two subjects (16, 20) had a 5 dB threshold increase to alter the mean 1.5 dB to 3.5 dB.

At 500 Hz, all five priority deaf subjects responded with a mean bone conduction value of 51 dB and a range of 45-55 dB. During the anesthetic block, there was a mean 5 dB increase to 56 dB with a range from 55-60 dB. Subject 5 did not show any threshold shift while subjects 1-4 inclusive had threshold shifts.

The six control deaf subjects gave a before anesthesia mean of 52 dB with a range between 45-60 dB. The anesthetic block mean was 56 dB with a range of 50-60 dB. Again, subjects 6, 10 and 11 did not show any threshold shifts while subjects 7, 8, and 9 had threshold shifts. This same pattern occurred at 250 Hz and for the same subjects.

The before anesthesia bone conduction mean of the ten normal hearing subjects at 500 Hz was 1 dB based on the 0 dB thresholds of all but two subjects (13, 18); the latter two subjects each had a 5 dB threshold. During the anesthetic block, all of the thresholds remained exactly the same so the mean and range values were unchanged (Table VI).

TABLE V

BONE CONDUCTION THRESHOLD MEANS AND RANGES OF PRIORITY & CONTROL DEAF SUBJECTS BEFORE & DURING THE ANESTHETIC BLOCK

Priority Deaf

	Mean		Range	
Frequency	Before	During	Before	During
250	32	37	30-35	35-40
500	51	56	45-55	55-60
750	NR	NR	--	--
1000	NR	NR	--	--
2000	NR	NR	--	--

Control Deaf

	Mean		Range	
Frequency	Before	During	Before	During
250	37	36	35-45	35-45
500	52	56	45-60	50-60
750	NR	NR	--	--
1000	NR	NR	--	--
2000	NR	NR	--	--

TABLE VI

BONE CONDUCTION THRESHOLD MEANS AND DIFFERENCES OF THE NORMAL HEARING SUBJECTS BEFORE & DURING THE ANESTHETIC BLOCK

Frequency	Before	During	Difference
250	2.5	3.5	1.5
500	1.0	1.0	0
750	0.5	0.5	0
1000	0.5	0.5	0
2000	0	0[a]	0
4000	0[a]	0	0

At 750, 1000, 2000 and 4000 Hz, there were no bone threshold responses for the five priority deaf subjects as there were no air conduction thresholds with these same subjects. The six control deaf subjects also did not yield any bone thresholds at these four frequencies.

The before anesthesia bone conduction mean of the ten normal hearing subjects at 750 and 1000 Hz were 0.5 dB as one subject (18) yielded a 5 dB threshold while the other nine thresholds were 0 dB. At 2000 Hz all the thresholds were exclusively at 0 dB. At 4000 Hz, all the thresholds, except subject ten, were at 0 dB; subject ten had a sensory-neural shift of 40 dB at 4000 Hz. During the xylocaine block, all the thresholds maintained their identical levels so that there were no shifts at 750, 1000, 2000 and 4000 Hz, respectively.

IV. DISCUSSION

At 125 Hz five of the six control deaf subjects with residual hearing yielded before anesthesia threshold in contrast to only one of the five priority deaf subjects. It may be that lack of a threshold value at 125 Hz is an additional clue that the subject is totally deaf, assuming that the remaining audiogram follows the prescribed pattern discussed earlier Nober (22) .

The conjecture that some of the thresholds elicited from deaf children at high intensity output are vibrotactile looms to a focus at frequencies 250 and 500 Hz for air conduction. The priority deaf threshold mean of 88 dB disappears in each instance at 250 Hz as well as the mean value of 109 dB at 500 Hz as no subjects' thresholds were elicited during the block. The relatively comparable 80 dB mean for the control deaf group at 250 Hz only increased 4 dB for air conduction during the anesthetic block and 1 dB at 500 Hz. Clearly, then, the threshold shifts of the priority and control deaf groups during anesthesia were quite different. Tables VII and VIII give a summary tally of these before and during threshold shifts at 250 and 500 Hz, respectively, for the twenty-one subjects. It is also particularly pertinent that none of the priority deaf subjects yielded any air conduction thresholds beyond 750 Hz while several of the control deaf subjects responded beyond this frequency. About half of these thresholds disappeared during the block. While it is still unclear as to why some of the higher frequency thresholds of the control deaf subjects vanished during the block, it is reasonable to assume that eliciting threshold responses at 750 Hz and above may be another critical factor to determine whether the obtained hearing thresholds are valid or not.

The stability of the normal hearing thresholds to maintain at the identical hearing levels during the anesthetic block adds further evidence that valid auditory threshold prevailed under the experimental condition.

There was universal unanimity for all twenty-one subjects concerning the stability of the bone conduction thresholds not to disappear during the anesthesia. Apparently, the energy radiated from the bone oscillator penetrates quite deeply and in a diffuse manner to extend beyond the limited province of a superficial anesthetic block. This is why the bone conduction thresholds of the priority deaf did not disappear during the block. The low frequency translational vibrations and the medium to high frequency compressional vibrations activate the cranial and facial bones in varying degrees. The general 5 dB shift of the priority and control deaf bone thresholds during anesthesia is difficult to interpret. It is tempting to attribute the threshold shifts to the physiologic modification of the subcutaneous area due to the acute and excessive fluid infiltration but about half of the control deaf bone thresholds were unchanged and nearly all of the normal hearing subjects' bone thresholds were unaltered during the block.

On the basis of the data presented above, there is compelling evidence that many of the ostensible auditory thresholds obtained at high intensity levels from deaf children are mediated through the cutaneous-tactile receptors. This author elects to coin the term cutile perception to denote cutaneous-tactile exteroception as a parallel term to auditory perception. The term "pseudoauditory" as used by Nober (22) in the past is inappropriate as it dwells on the negative aspect of obtained thresholds and tacitly insinuates they should not occur. Indeed, these thresholds do and should occur as they are reliable and valid measures of another intervening modality. The term cutile thresholds denotes what the thresholds are rather than what they are not.

The term "vibrotactile" has also been used in the past by Nober (26) as a borrowed expression from physiological psychologists. However, in the instance of deaf children, we are dealing with a specific type and degree of vibrotactile sensitivity rather than the broader spectrum to which they allude. Also, the failure of the bone thresholds to disappear during the local block to the cutaneous-tactile receptors, as did their air conduction counterparts, is further testimony that the term "vibrotactile" can be ambiguous. Perhaps designating these thresholds as cutile is more helpful as it identifies the values that have been elicited.

In a recent survey conducted by this author at two schools for the deaf, it was found that approximately 25% of the children yielded cutile thresholds that reflected total deafness. As this group represents approximately one-fourth of the total population, intensive exploration is warranted. What are the relations between total deafness and speech development, language development, voice patterns, articulation scores, etc.? Are there social and educational and therapeutic implications? If the children with valid auditory thresholds are experimentally isolated from the children with vibrotactile thresholds, will the pure tone thresholds of the former be more predictive? This study would need to be conducted relative to age and the sundry other variables that can affect the total picture.

TABLE VII

SUMMARY TALLY OF THE BEFORE AND DURING THRESHOLD SHIFTS AT 250 Hz FOR THE TWENTY-ONE SUBJECTS

	Vanished	10dB	5 dB	0 dB
Priority Deaf	5			
Control Deaf		1	3	2
Normal Hearing				10

TABLE VIII

SUMMARY TALLY OF THE BEFORE AND DURING THRESHOLD SHIFTS AT 500 Hz FOR THE TWENTY-ONE SUBJECTS

	Vanished	10 dB	5 dB	0 dB
Priority Deaf	5			
Control Deaf			1	5
Normal Hearing				10

V. CONCLUSIONS AND IMPLICATIONS

A. Conclusions. All six hypotheses were confirmed by the experiment:

1. The air conduction thresholds elicited from the five priority deaf subjects suspected of total deafness universally were extinguished by the local subcutaneous anesthetic block to the cutaneous-tactile receptors. This was interpreted as supportive that the obtained air conduction thresholds were not valid auditory sensitivity values.

2. The air conduction thresholds elicited from the five partially deaf control subjects with some valid residual hearing were not extinguished by the local subcutaneous anesthetic block to the cutaneous-tactile receptors. This was interpreted as supportive that the obtained air conduction thresholds represented valid auditory sensitivity values. The comparative differences between these values and those of the priority group were the most critical aspect of the entire study.

3. The air conduction thresholds elicited from the normal hearing control subjects were not extinguished by the local subcutaneous anesthetic block to the cutaneous-tactile receptors. Actually, these thresholds manifested remarkable stability and were virtually unchanged in nearly all instances. These data were interpreted as supportive evidence that valid auditory thresholds were unaffected by the subcutaneous block to the cutaneous-tactile receptors.

4. The bone conduction thresholds elicited from the totally deaf priority subjects were not extinguished by the local subcutaneous block to the cutaneous-tactile receptors. Bone conduction radiates its energy throughout the entire cranium and facial structures as well as thoracic areas. It would be impossible for a local block to eliminate all sensations from such diffuse transmission. Perhaps the most expeditious way to eliminate these cutile bone thresholds in some subjects is with masking as described by Nober (22).

5. The bone conduction thresholds elicited from the partially deaf control subjects were not extinguished by the local subcutaneous anesthetic block. In some isolated instances there were minor 5 dB shifts but these were fragmentary and did not follow any pattern.

6. The bone conduction thresholds elicited from the normal hearing control subjects were not extinguished by the local subcutaneous anesthetic block. For the most part, these thresholds were virtually unchanged by the infiltration of the xylocaine fluid subsequently exhibiting extreme stability.

In summary, it was concluded that the affirmation of the above six hypotheses was impressive supportive evidence that the thresholds obtained from many deaf children are not auditory but rather are cutile thresholds mediated through the cutaneous-tactile receptors.

B. Implications. Cutile thresholds may possibly have an incidence as high as 25% for the deaf school age population. The contributions that cutaneous and tactile exteroception collectively can provide toward better communication might be explored further. It would seem feasible that an electromechanical modification of the hearing aid receiver could be experimentally implimented to give simultaneous air and bone conduction stimulation by tightly coupling the receiver to the external auditory meatus. In essence, the receiver would be constructed as an ear insert.

Perhaps, the extreme emphasis often placed on auditory training may not be the most efficatious approach to auditory rehabilitation with totally deaf subjects. Indeed, the research of investigators relative to speech intelligibility and the enhancement attributed to tactile reinforcement supports the necessity for further investigation of this avenue of perceptual experience for the deaf child. It is necessary to review the audiograms of deaf children and re-evaluate their management in light of a more accurate assessment of their auditory sensitivity. The relation between the speech and language development, articulation and voice, intelligibility, educational and social proclivity, etc., should be evaluated relative to whether the children are totally deaf or have some residual hearing. It is important to ascertain just how important a small amount of hearing reserve is during the formative and school age years.

Finally, there is virtually a dearth of audiologic information about the psychophysical aspects of the auditory function relative to the preschool and school age deaf populations. Intensive and extensive research should be inculcated to assess these children for evaluative, habilitative and educative purposes. This author has recently submitted a continuation research proposal to implement and continue to expedite research in this area.

VI. SUMMARY

The purpose of this study was to explore whether the low frequency pure tone air and bone conduction thresholds frequently obtained at high intensity levels from deaf children reflect valid auditory sensitivity or vibrotactile exteroception that is mediated through the cutaneous-tactile receptors. There is a prevailing contention that the pure tone thresholds are not of any real value in assessing the general management of the deaf child. However, this contention was questioned as many of the so called "auditory" thresholds are not valid. In order to differentiate between auditory and non-auditory thresholds, the ears of both deaf and normal hearing subjects were anesthetized with subcutaneous injections of 2% xylocaine to determine if the vibrotactile thresholds of suspect audiograms would disappear when the receptors were blocked. It is established that subjects with hearing have no significant air or bone conduction threshold shifts from a local anesthesia. A comprehensive review of the literature relative to the air and bone conduction studies on deaf children revealed suspect audiogram in many instances. Not infrequently, air-bone gaps were created which were otologically and audiologically unfounded as well as logically absurd.

The experimental design compared the during anesthesia and anesthesia air and bone conduction thresholds for eleven deaf subjects and ten normal hearing subjects. The eleven deaf subjects were further delineated into five "priority deaf" subjects whose thresholds were suspected to be vibrotactile and six "control deaf" subjects whose auditory thresholds were valid. These two deaf groups were comparable in age and hearing levels and supplied by two schools for the deaf. The normal hearing subjects served as a control for low intensity threshold responses before and during the anesthetic block.

An otologic surgeon gave the otologic examination prior to the anesthetic block and also injected the 2% xylocaine and adrenalin subcutaneously into the appropriate area. After each ear was sufficiently blocked, the "during" anesthesia air and bone conduction were obtained. Every precaution was exercised to maintain precise audiometer calibration; the tests were administered in a specially constructed IAC 1204 suite to preclude any kind of environmental interference.

Results indicated that the air conduction thresholds disappeared during the anesthetic block for the "priority" deaf subjects with suspect vibrotactile thresholds. On the other hand, the air conduction thresholds of the control deaf subjects with residual hearing merely shifted about 5 dB but did not disappear during anesthesia. Accordingly, the anesthetized thresholds of the normal hearing subjects remained identical and didn't even shift the 5 dB. In several instances, there were isolated departures from the general trend for the control deaf group but these did not occur with any semblence of regularity and furthermore were too sparse to be interpreted. The over-all data yielded compelling evidence as all of the air conduction thresholds of the priority group disappeared during anesthesia while there were no parallel threshold shifts for the control deaf subjects with residual hearing or for the normal hearing subjects.

The bone conduction thresholds of the priority deaf subjects did not vanish during the anesthetic block in contrast to their air conduction counterparts; instead they shifted approximately 5 dB. This was anticipated as the bone oscillator generates its energy throughout the cranium and its adjacent structures. The local subcutaneous block was too restricted to deter this kind of diffuse activity. The control deaf subjects and the normal hearing subjects displayed the same inconsequential shift patterns for anesthetized bone conduction as for air conduction. In essence, then, the bone thresholds remained identical during the experimental block conditions.

It was concluded that the air and bone conduction thresholds obtained from many deaf children at high intensity levels are mediated through the cutaneous-tactile receptors and was designated by this author as *cutile* thresholds. Cutile perception is a more appropriate parallel term to auditory perception than terms like "pseudoauditory" or "vibrotactile" as used in the past. The former alludes to a negative connotation and the latter is too general and diffuse for audiologic purposes. *Cutile* perception stresses the positive aspect that these thresholds are reliable and valid; they *do* and *should* occur and should not be confused with general vibrotactile sensitivity.

The cutile thresholds were found in approximately 25% of the children at two schools for the deaf by this author. This study suggests that audiologists take a more critical look at the auditory function in general and of certain groups of subjects in particular. It might prove fruitful to differentiate between the totally deaf children and deaf children with some hearing reserve to relate auditory sensitivity to language, articulation and voice, intelligibility, educational and social abilities, etc. Perhaps the current emphasis on auditory training is less appropriate for the totally deaf group. Even a technical modification of the hearing aid or any electroacoustic amplifying device is needed. Finally, it was recommended that this study should be extended to investigate the audiologic function of the deaf child as there is a remarkable dearth of systematic studies on the functional integrity of his auditory mechanism.

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APPENDIX A

RAW DATA OF THE THREE PRETEST THRESHOLDS AND THE DURING ANESTHESIA THRESHOLDS FOR THE TWENTY-ONE SUBJECTS

NAME RD

BIRTHDATE 1/8/49

GROUP Priority 1

EXPER. EAR Left

SCHOOL Rome

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	75	NR	100	NR	105	110	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	NR	NR	95	NR	110	110	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3 (Before)	NR	--	95	--	110	--	NR	--	NR	--	NR	--	NR	--
Anest. (During)	NR	--	NR	--	NR	--	NR	--	NR	--	NR	--	NR	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	30	40	50	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	35	35	50	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3 (Before)	30	--	50	--	NR	--	NR	--	NR	--	NR	--
Anest. (During)	35	--	55	--	NR	--	NR	--	NR	--	NR	--

NAME JP

BIRTHDATE 8/20/50

GROUP Priority 2

EXPER. EAR Left

SCHOOL Rochester

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	70	70	75	80	95	90	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	70	75	70	85	100	95	NR	100	NR	105	NR	110	NR	NR
Pre 3	65	--	80	--	100	--	NR	--	NR	--	NR	--	NR	--
Anest.	NR	--	NR	--	NR	--	NR	--	NR	--	NR	--	NR	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	30	40	55	45	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	30	35	55	45	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	35	--	50	--	NR	--	NR	--	NR	--	NR	--
Anest.	40	--	55	--	NR	--	NR	--	NR	--	NR	--

NAME CH

BIRTHDATE 3/11/49

GROUP Priority 3

EXPER. EAR Right

SCHOOL Rochester

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	NR	75	NR	90	NR	110	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	NR	70	NR	85	NR	105	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	--	NR	--	90	--	110	--	NR	--	NR	--	NR	--	NR
Anest.	--	NR	--	NR	--	NR	--	NR	--	NR	--	NR	--	NR

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	--	30	--	50	--	NR	--	NR	--	NR	--	NR
Pre 2	--	30	--	50	--	NR	--	NR	--	NR	--	NR
Pre 3	--	35	--	45	--	NR	--	NR	--	NR	--	NR
Anest.	--	40	--	55	--	NR	--	NR	--	NR	--	NR

*Left ear bone conduction not tested

NAME TR

BIRTHDATE 6/29/49

GROUP Priority 4

EXPER. EAR Left

SCHOOL Rochester

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	75	NR	85	NR	110	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	75	NR	85	NR	105	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	NR	--	90	--	110	--	NR	--	NR	--	NR	--	NR	--
Anest.	NR	--	NR	--	NR	--	NR	--	NR	--	NR	--	NR	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	35	NR	55	NR	55	NR	NR	NR	NR	NR	NR	NR
Pre 2	30	35	55	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	30	--	55	--	NR	--	NR	--	NR	--	NR	--
Anest.	35	--	60	--	NR	--	NR	--	NR	--	NR	--

NAME SR

BIRTHDATE 3/17/51

GROUP Priority 5

EXPER. EAR Right

SCHOOL Rome

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	NR	NR	90	90	105	105	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	NR	NR	90	85	100	100	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	--	NR	--	85	--	105	--	NR	--	NR	--	NR	--	NR
Anest.	--	NR	--	NR	--	NR	--	NR	--	NR	--	NR	--	NR

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	35	35	55	60	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	40	35	55	50	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	--	35	--	55	--	NR	--	NR	--	NR	--	NR
Anest.	--	40	--	55	--	NR	--	NR	--	NR	--	NR

NAME RR

BIRTHDATE 5/28/50

GROUP Control 6

EXPER. EAR Left

SCHOOL Rochester

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	75	NR	90	NR	100	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	75	75	90	90	95	105	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	NR	--	95	--	100	--	NR	--	NR	--	NR	--	NR	--
Anest.	NR	--	95	--	100	--	NR	--	NR	--	NR	--	NR	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	40	NR	55	NR	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	40	40	60	60	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	45	--	60	--	NR	--	NR	--	NR	--	NR	--
Anest.	45	--	60	--	NR	--	NR	--	NR	--	NR	--

NAME MP

BIRTHDATE 1/28/53

GROUP Control 7

EXPER. EAR Left

SCHOOL Rochester

LEGEND NR=No Response

AIR CONDUCTION

TESTS	125		250		500		750		1000		2000		4000	
	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	65	65	80	80	110	105	105	105	110	110	NR	NR	NR	NR
Pre 2	70	NR	85	90	105	105	110	110	110	110	NR	NR	NR	NR
Pre 3	65	--	80	--	105	--	110	--	NR	--	NR	--	NR	--
Anest.	75	--	85	--	110	--	NR	--	NR	--	NR	--	NR	--

BONE CONDUCTION

TESTS	250		500		750		1000		2000		4000	
	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	30	35	50	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	35	35	50	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	35	--	45	--	NR	--	NR	--	NR	--	NR	--
Anest.	40	--	50	--	NR	--	NR	--	NR	--	NR	--

NAME PM

BIRTHDATE 10/5/49

GROUP Control 8

EXPER. EAR Left

SCHOOL Rochester

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	70	70	70	80	80	85	90	95	100	95	NR	NR	NR	NR
Pre 2	75	70	70	75	80	85	90	95	100	95	NR	NR	NR	NR
Pre 3	75	--	75	--	85	--	90	--	100	--	NR	--	NR	--
Anest.	85	--	85	--	85	--	90	--	100	--	NR	--	NR	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	35	20	50	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	35	25	50	50	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	35	--	50	--	NR	--	NR	--	NR	--	NR	--
Anest.	40	--	60	--	NR	--	NR	--	NR	--	NR	--

NAME JH

BIRTHDATE 8/2/51

GROUP Control 9

EXPER. EAR Right

SCHOOL Rochester

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	75	75	85	85	105	100	110	110	NR	NR	NR	NR	NR	NR
Pre 2	75	75	85	85	110	105	110	NR	NR	NR	NR	NR	NR	NR
Pre 3	--	75	--	85	--	105	--	110	--	NR	--	NR	--	NR
Anest.	--	75	--	90	--	105	--	NR	--	NR	--	NR	--	NR

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	35	35	60	55	60	NR	NR	NR	NR	NR	NR	NR
Pre 2	35	30	50	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	--	35	--	50	--	NR	--	NR	--	NR	--	NR
Anest.	--	40	--	60	--	NR	--	NR	--	NR	--	NR

NAME DM

BIRTHDATE 4/1/49

GROUP Control 10

EXPER. EAR Right

SCHOOL Rome

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	80	70	90	80	110	105	105	105	105	105	105	105	NR	105
Pre 2	75	75	90	85	105	100	105	105	105	105	NR	NR	NR	NR
Pre 3	--	75	--	80	--	100	--	105	--	110	--	110	--	NR
Anest.	--	75	--	85	--	100	--	105	--	110	--	110	--	NR

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	45	35	60	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	35	35	55	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	--	35	--	55	--	NR	--	NR	--	NR	--	NR
ANEST.	--	35	--	55	--	NR	--	NR	--	NR	--	NR

NAME GH

BIRTHDATE 12/8/50

GROUP Control 11

EXPER. EAR Right

SCHOOL Rome

LEGEND NR=No Response

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	55	55	70	75	95	90	100	100	105	105	105	NR	NR	NR
Pre 2	55	55	65	70	90	85	100	100	105	NR	105	NR	NR	NR
Pre 3	--	60	--	65	--	85	--	100	--	105	--	NR	--	NR
Anest.	--	60	--	65	--	85	--	100	--	NR	--	NR	--	NR

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	35	40	50	55	NR	NR	NR	NR	NR	NR	NR	NR
Pre 2	35	40	50	50	NR	NR	NR	NR	NR	NR	NR	NR
Pre 3	--	35	--	50	--	NR	--	NR	--	NR	--	NR
Anest.	--	35	--	50	--	NR	--	NR	--	NR	--	NR

NAME MW

BIRTHDATE 2/4/48

GROUP Normal 1

EXPER. EAR Left

SCHOOL Syracuse Univ.

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	10	10	5	10	0	5	0	0	0	0	0	0	0	0
Pre 2	10	10	5	5	0	0	0	0	0	0	0	0	0	0
Pre 3 (Before)	10	10	5	5	0	0	0	0	0	0	0	0	0	0
Anest. (During)	10	--	5	--	0	--	0	--	0	--	0	--	0	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	5	5	0	0	0	0	0	0	0	0	0	0
Pre 2	5	5	0	0	0	0	0	0	0	0	0	0
Pre 3	5	0	0	0	0	0	0	0	0	0	0	0
Anest.	5	--	0	--	0	--	0	--	0	--	0	--

NAME AW

BIRTHDATE 3/17/46

GROUP Normal 2

EXPER. EAR Right

SCHOOL Syracuse Univ.

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	15	15	10	10	10	10	0	0	0	0	0	0	0	0
Pre 2	15	15	10	10	10	10	0	0	0	0	0	0	0	0
Pre 3	15	15	10	10	10	10	0	0	0	0	0	0	0	0
Anest.	--	15	--	10	--	10	--	0	--	0	--	0	--	0

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	10	10	10	5	0	0	0	0	0	0	0	0
Pre 2	10	10	10	5	0	0	0	0	0	0	0	0
Pre 3	10	10	10	5	0	0	0	0	0	0	0	0
Anest.	--	10	--	5	--	0	--	0	--	0	--	0

NAME JS

BIRTHDATE 5/11/46

GROUP Normal 3

EXPER. EAR Left

SCHOOL Syracuse Univ.

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**
Pre 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	0	--	0	--	0	--	0	--	0	--	0	--	0	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**
Pre 1	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	0	--	0	--	0	--	0	--	0	--	0	--

NAME WC BIRTHDATE 6/3/42 GROUP Normal 4

EXPER. EAR Right SCHOOL Syracuse Univ.

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	5	5	5	5	0	0	0	0	0	0	0	0	0	0
Pre 2	5	10	0	5	0	0	0	0	0	0	0	0	0	0
Pre 3	5	5	5	5	0	0	0	0	0	0	0	0	0	0
Anest.	--	5	--	5	--	0	--	0	--	0	--	0	--	0

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	5	5	0	0	0	0	0	0	0	0	0	0
Pre 2	5	5	0	0	0	0	0	0	0	0	0	0
Pre 3	5	5	0	0	0	0	0	0	0	0	0	0
Anest.	--	5	--	0	--	0	--	0	--	0	--	0

NAME BW BIRTHDATE 1/9/48 GROUP Normal 5

EXPER. EAR Left SCHOOL Syracuse Univ.

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	10	10	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	10	10	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	10	10	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	10	--	0	--	0	--	0	--	0	--	0	--	0	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	5	--	0	--	0	--	0	--	0	--	0	--

NAME TG BIRTHDATE 4/1/44 GROUP Normal 6

EXPER. EAR Right SCHOOL Syracuse Univ.

AIR CONDUCTION

TESTS	125 L	125 R	250 L	250 R	500 L	500 R	750 L	750 R	1000 L	1000 R	2000 L	2000 R	4000 L	4000 R
Pre 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	--	0	--	0	--	0	--	0	--	0	--	0	--	0

BONE CONDUCTION

TESTS	250 L	250 R	500 L	500 R	750 L	750 R	1000 L	1000 R	2000 L	2000 R	4000 L	4000 R
Pre 1	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	--	0	--	0	--	0	--	0	--	0	--	0

NAME SH BIRTHDATE 11/12/40 GROUP Normal 7

EXPER. EAR Left SCHOOL Syracuse Univ.

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	10	10	5	5	5	5	5	5	5	5	0	0	0	0
Pre 2	10	10	5	5	5	5	5	5	5	5	0	0	0	0
Pre 3	10	10	5	10	5	5	5	5	5	5	0	0	0	0
Anest.	10	--	5	--	5	--	5	--	5	--	0	--	0	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	5	5	5	5	5	5	5	5	0	0	0	0
Pre 2	5	5	5	5	5	5	5	5	0	0	0	0
Pre 3	5	5	5	5	5	5	5	5	0	0	0	0
Anest.	5	--	5	--	5	--	5	--	0	--	0	--

NAME GP

BIRTHDATE 5/3/47

GROUP Normal 8

EXPER. EAR Right

SCHOOL Syracuse Univ.

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	--	0	--	0	--	0	--	0	--	0	--	0	--	0

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	--	0	--	0	--	0	--	0	--	0	--	0

NAME JK

BIRTHDATE 6/7/45

GROUP Normal 9

EXPER. EAR Left

SCHOOL Syracuse Univ.

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	0	--	0	--	0	--	0	--	0	--	0	--	0	--

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	0	0	0	0	0	0	0	0	0	0	0	0
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0
Anest.	5	--	0	--	0	--	0	--	0	--	0	--

NAME TG

BIRTHDATE 9/23/40

GROUP Normal 10

EXPER. EAR Right

SCHOOL Syracuse Univ.

AIR CONDUCTION

	125		250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	0	0	0	0	0	0	0	0	0	0	0	0	40	40
Pre 2	0	0	0	0	0	0	0	0	0	0	0	0	40	35
Pre 3	0	0	0	0	0	0	0	0	0	0	0	0	40	40
Anest.	--	0	--	0	--	0	--	0	--	0	--	0	--	40

BONE CONDUCTION

	250		500		750		1000		2000		4000	
TESTS	L	R	L	R	L	R	L	R	L	R	L	R
Pre 1	0	0	0	0	0	0	0	0	0	0	40	40
Pre 2	0	0	0	0	0	0	0	0	0	0	40	40
Pre 3	0	0	0	0	0	0	0	0	0	0	40	40
Anest.	--	0	--	0	--	0	--	0	--	0	--	40

APPENDIX B

PARENT PERMISSION FORM

Dear Parent:

The Audiology and Education of the Deaf Division of Special Education at Syracuse University has recently received research support from the United States Office of Education to conduct a study regarding the hearing thresholds of deaf children. There is reason to believe that the hearing thresholds recorded on deaf children at very loud levels may not be real hearing thresholds, but rather, skin vibration thresholds. The child confuses these because of his lack of experience with real sound and is simply trained to raise his hand when some "experience" occurs. Audiologists have assumed in the past that the child "heard" the tone but there is reason to believe some deaf children just "feel" the tones rather than hear them.

The information as to whether some deaf children actually hear or feel the sound is crucial for hearing aid fitting, speech therapy, and auditory training. Undoubtedly, you can see the implications to knowing whether your child has real hearing or receives skin vibration sensations instead.

In order to conduct this study your child has been chosen because he has a particular kind of loss. These are not too common and so we ask for your indulgence and permission to test him further so we can learn more about his hearing.

The tests would include the following:

1. Two pretests at his own school (20 minutes each).
2. Two hearing tests at Syracuse (1 hour total) - both on the same day.
3. A complete medical ear examination at Syracuse by an otologist (½ hour).

This means your child would be picked up by a private car and driven to Syracuse. The complete procedure at Syracuse would involve about two hours. Then he would be returned by private car to school of origin. Actually, the driving consumes most of the time. Only the one day is required at Syracuse. The two tests at his own school are performed prior to coming to Syracuse.

After the child is given the first hearing test at Syracuse he receives a small injection of xylocaine behind the ear lobe to reduce the skin sensitivity in the ear region. This is done exactly as the dentist does it in routine visits. There is no danger and only the mild discomfort of a quick pin-prick. The xylocaine is given by a trained physician assigned to the project. The purpose is simply to see if the hearing thresholds change after the skin vibration sensitivity is eliminated for 10-15 minutes. Sterile conditions are maintained. This is all there is to it. Once again, I reiterate, the only discomfort is the momentary pin-prick of the needle, and this is a micro-needle that is nearly painless.

I certainly hope that you will give permission for your child to participate in this study with crucial implications to the future management of deaf children. Please return this letter with your signature to your principal.

Thank you very much,

E. Harris Nober, Ph.D.
Project Director
Administrator, Audiology and Education of the Deaf Programs

CHECK ONE:

I give ___ , do not give ___ permission for ______________ (Name of child) to participate.

____
(Parent's Signature)

EHN/smk

[illegible]

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION
WASHINGTON 25, D.C.

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DATE OF RESUME

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15. ABSTRACT (250 words max.)

An exploration of whether low frequency air and bone thresholds elicited at high intensity levels from deaf children reflect valid auditory sensitivity or are mediated through cutaneous-tactile receptors. Twenty-one subjects comprised of five "priority deaf" subjects (totally deaf), six "control deaf" subjects (residual hearing) and ten "normal" hearing were given a local subcutaneous injection of 2% xylocaine to eliminate local cutaneous-tactile interference. Results indicated the air thresholds extinguished during the anesthetic block only for priority deaf with subjects with vibrotactile thresholds and not for the control deaf with residual hearing or the normal hearing. Minor isolated departures occurred for some control deaf but without regularity. Bone thresholds remained stable for all three groups as the local block was too restricted for diffuse bone propogation.

Conclusions: Air and bone thresholds of many profoundly deaf children are not auditory but mediated through cutaneous-tactile receptors. This author coined the term cutile to designate cutaneous-tactile exteroception as a parallel for auditory exteroception. Adjectives like "pseudoauditory," "vibrotactile," "invalid hearing," etc., are negative whereas cutile thresholds clearly identifies what they represent. Approximately 25% of school age deaf have cutile audiograms. Implications for evaluation, rehabilitation and educational management are crucial. Intensive audiologic research is warranted.

16. RETRIEVAL TERMS (Continue on reverse)

17. IDENTIFIERS