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Intelligibility of spondees via bone conduction at elevated presentation levels

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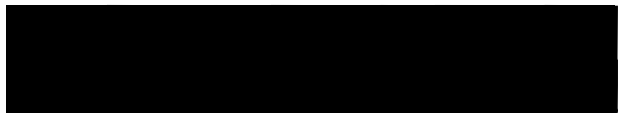## Let us know how access to this document benefits you.

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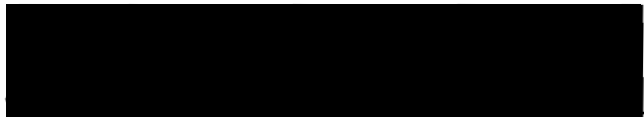https://doi.org/10.15760/etd.6034

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Science in Speech Communication: Speech and Hearing Sciences pre-

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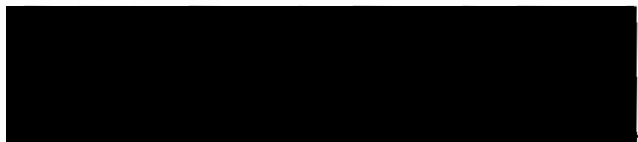
APPROVED BY THE MEMBERS OF THE THESIS COMMITTEE:

Thomas G. Dolan, Chair

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Speech reception threshold testing by bone conduction is very

useful in diagnostic audiometry. However, there are little data

regarding the CID W-1 spondee word lists used with the Radioear B-71

and B-72 and Pracitronic KH 70 bone conduction vibrators at higher

presentation levels for testing hearing impaired clients. Data are

needed in order that results of speech reception thresholds using the CID W-1 word lists via these three bone conduction vibrators at higher intensity levels can be used confidently in the clinic. More data are available for speech reception thresholds using the CID W-1 word lists via earphones.

This study compared speech intelligibility presented via bone conduction at higher intensity levels to that presented via earphone at higher intensity levels.

Twelve normal hearing adults, with thresholds artificially elevated by binaural speech noise masking to simulate a hearing impairment, were used as subjects. Recorded CID W-1 spondee word lists were presented via four transducers: Radioear B-71, Radioear B-72, and Pracitronic KH 70 bone vibrators, and a TDH-39 earphone.

Investigation of each bone conduction vibrator was accomplished by using forehead placement and using binaural speech noise masking via earphones. Investigation of the earphone was accomplished by simultaneously presenting binaural speech stimuli and speech noise masking.

Spondees from the CID W-1 word lists were presented to the subject via a transducer. A bracketing technique was used to estimate the speech reception threshold. Using the intensity level of the predetermined SRT as 0 dB, each list was presented at one of the following levels: +4, +2, 0, -2, -4, and -6.

Performance-intensity functions, the percentage of correctly identified spondees as a function of presentation level, were

obtained for each transducer. The percentage of spondees correctly identified increased with the stimulus level for all transducers.

Using linear regression, the line of best fit was calculated for each subject's data under each transducer condition. A one way analysis of variance indicated that there was a significant difference in the slopes of the performance-intensity functions of the transducers. A follow-up test for the one way analysis of variance indicated that there was a signficant difference between the TDH-39 earphone and each of the bone conduction vibrators. There were no significant differences among the bone conduction vibrators.

Results of the study suggested that CID W-1 word lists and the 50 percent criterion may be inappropriate for use with these bone conduction vibrators at higher intensity levels. Given that there was a preponderance of data points below 50 percent for the bone vibrators, a criterion of less than 50 percent might be more appropriate. Because presentation levels might be elevated for sensorineural hearing impaired listeners, their SRT performances could be affected. Consequently, the results of speech reception threshold testing via bone conduction at higher intensity levels should be interpreted with caution in clinics.

INTELLIGIBILITY OF SPONDEES VIA BONE CONDUCTION AT

ELEVATED PRESENTATION LEVELS

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by

PAMELA S. RITCHIE

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requirements for the degree of

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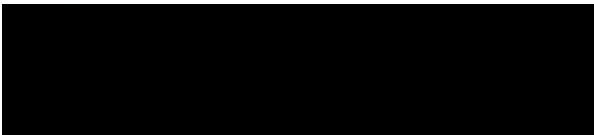
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TO THE OFFICE OF GRADUATE STUDIES:

The members of the Committee approve the thesis of Pamela S. Ritchie presented October 29, 1990.
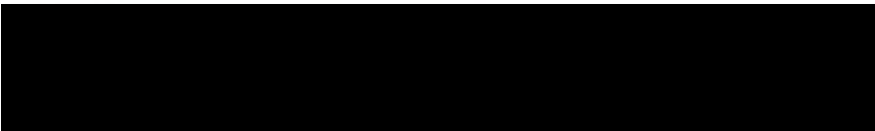

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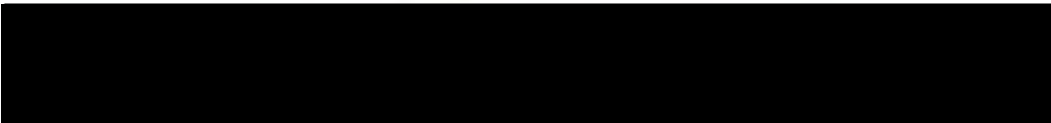

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ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

Speech reception threshold testing by bone conduction is very
useful in diagnostic audiometry. Merrell, Wolfe, and McLemore (1973)
found that bone conducted speech reception thresholds can be used to
detect and determine the amount of conductive hearing losses in young
children. Bone conducted speech reception thresholds can also be
obtained for children when valid pure tone results cannot be
measured. Their study also showed that bone conducted speech recep-
tion thresholds are in good agreement with pure tone air conduction
thresholds. Valente and Stark (1977) found that bone conduction
speech audiometry can aid in testing young children for whom pure
tone results are unobtainable or unsatisfactory. Bone conducted
speech reception thresholds can provide useful information when
analyzing pure tone and speech air-bone gaps and when diagnosing a
sensorineural hearing loss from a conductive one in young children.

According to Goetzinger and Proud (1955), bone conduction speech
audiometry has several advantages. Bone conduction speech testing
results can verify the reliability of bone conducted pure tone
results. Bone conduction speech testing is very useful in diagnosing
conductive hearing losses in children, especially when valid pure

tone thresholds are not obtainable. When speech reception testing is used in conjunction with speech discrimination testing, detailed information regarding sensorineural involvement can be obtained.

According to Stockdell (1974), in adults there is a high correlation between bone conduction pure tone averages and speech reception thresholds. There is also a high correlation between air conduction pure tone averages and bone conduction speech reception thresholds. A high correlation also exists between air conduction speech reception thresholds and pure tone bone conduction thresholds.

Information given by bone conduction speech reception thresholds and pure tone thresholds can help predict the success of otosclerosis surgery. Robinson and Kasden (1970) suggested using bone conduction speech discrimination scores to predict post-operative speech discrimination abilities for otosclerotic patients who have severe mixed hearing losses. Pre-operative air conduction speech discrimination scores are usually very low or nonexistent for these patients. However, pre-operative bone conduction speech discrimination scores are obtainable and correlate well to post-operative air conduction speech discrimination scores. The results indicated that pre-operative bone conduction speech discrimination scores are good indicators of cochlear reserve and can be confidently used to predict post-operative air conduction speech discrimination for otosclerotic patients.

One operational definition of speech reception threshold is the dB level at which a listener is able to correctly repeat 50 percent of the presented speech stimuli. Spondees are commonly used for

speech stimuli. Hudgins, Hawkins, Karlin, and Stevens (1947) defined spondees as two-syllable words that are spoken with equal stress on each syllable. For research purposes, the speech reception threshold can be determined from a performance-intensity function. This is a graph of the percentage of correct responses (performance) on the vertical axis and the dB intensity level on the horizontal axis. The slope of the curve is important in determining exactly where the 50 percent criterion level is reached (Egan, 1948). The steeper the slope and the narrower the intensity range in which the listener responds, the more precisely the 50 percent criterion can be determined.

The spondees usually used for determining speech reception thresholds in adults are the Central Institute for the Deaf W-1 spondee word lists, compiled by Hirsh, Davis, Silverman, Reynolds, Eldert, and Benson (1952). Even though the CID W-1 spondee word lists are commonly used for bone conduction speech reception thresholds, these lists were developed for speech via air conduction (Hirsh et al., 1952). Test performance via bone conduction is presumed to be the same as that via air conduction at all intensity levels. Dolan and Morris (1989) demonstrated that the Radioear B-72 and Pracitronic KH 70 bone vibrators are comparable to the TDH-39 earphone in test performance at low intensity levels. This suggests that the CID W-1 spondee word lists are appropriate to use with these bone vibrators at low stimulus intensity levels. However, these two bone vibrators and the Radioear B-71 bone vibrator may be used clinically at higher intensity levels when testing hearing impaired

clients. It is known that at high output levels, bone conduction vibrators demonstrate high distortion. If these bone vibrators are to be used for speech reception thresholds at higher intensity levels, their performance characteristics must be demonstrated to be similar to those for air conduction. This would then suggest that the CID W-1 spondee word lists are appropriate to use with the Radioear B-71 and B-72 and the Pracitronic KH 70 bone conduction vibrators at higher stimulus intensity levels.

The purpose of this study is to determine if the spondee word lists are appropriate to use at high intensity levels with these three bone conduction vibrators. Performance-intensity functions for the Radioear B-71 and B-72 and Pracitronic KH 70 bone vibrators will be determined at intensity levels above the normal speech reception thresholds. The slopes of these performance-intensity functions will then be compared to the slope of the performance-intensity function for air conduction at higher intensity levels using the TDH-39 earphone. Testing at higher intensity levels for the bone conduction vibrators will be accomplished by testing normal hearing adults using forehead placement and using speech noise masking to both ears via earphones. The masking noise will simulate a hearing loss in the subjects by raising their threshold values to higher intensity levels. This will allow data to be obtained for performance-intensity functions at higher intensity levels.

CHAPTER II

REVIEW OF THE LITERATURE

SPEECH RECEPTION THRESHOLD

The term speech reception threshold was first used by Hughson
and Thompson (1942) to describe the threshold of speech intelligi-
bility because they felt that the latter term was too ambiguous.
According to Hudgins et al. (1947), the speech stimuli used to deter-
mine speech reception threshold should possess the following
characteristics:

(1) Familiarity: the words should be simple and familiar.
     The words should only test speech reception threshold
     and not vocabulary or intelligence.

(2) Phonetic dissimilarity: the words should not rhyme
     or sound similar because they would require even
     finer discrimination abilities from the listener.

(3) Normal sampling of English speech sounds: the words
     should be representative of speech shoulds used in
     English.

(4) Homogeneity with respect to basic audibility: all
     words should be understood equally as well when they
     are spoken at a constant level. Homogeneity is
     important so that the percentage of correct
     responses heard will rise sharply from zero to
     100 percent in a narrow intensity range.

Egan (1948) stated that in order for test lists to detect small

changes in speech intelligibility and be convenient, the test words

should be equally difficult. If a test word is always missed or is always understood correctly by a listener, it should be omitted (Egan, 1948). If the test words are comparable in difficulty, then differences in listeners' scores will be due to the transducer that is used and not the word list (Egan, 1948).

Hudgins et al. (1947) studied the steepness of performance-intensity functions for three different types of words: (a) spondees, (b) other two-syllable words, and (c) monosyllable words. Their findings demonstrated that the steepness of the function depended upon the type of words used. The steepest function was obtained with spondees. Therefore, the 50 percent criterion level of threshold was achieved at a lower dB intensity level when using spondee word lists (Hudgins et al., 1947).

The spondee word lists used in the above study were from a phonograph record of Harvard's Psycho-Acoustic Laboratory Auditory Test No. 9 (Hudgins et al., 1947). Because of problems with word unfamiliarity and recording quality, modifications were made to the Auditory Test No. 9 by the Central Institute for the Deaf (Hirsh et al., 1952). The new CID W-1 word lists were recorded on magnetic tape, met a stricter criteria for word familiarity, and possessed a more limited vocabulary (Hirsh et al., 1952). Consequently, the improvements resulted in the performance-intensity function rising even more rapidly within an 8 dB intensity range. The 50 percent threshold is located at the steepest portion of the performance-intensity function (Hirsch et al., 1952).

SPEECH VIA BONE CONDUCTION

Most of the literature regarding bone conduction testing has to
do with calibration of instrumentation; a very small amount of the
literature deals with speech reception threshold testing. Frank
(1982) demonstrated that pure tone thresholds obtained with the
Radioear B-71 bone conduction vibrator are higher at forehead place-
ment than at mastoid placement. Beattie and Gager (1980) studied
threshold force levels using spondee words for the Radioear B-70 and
B-72 bone vibrators. The findings showed that the threshold force
levels were comparable for the bone vibrators for a 1000 Hz calibra-
tion tone. However, the voltage levels needed to drive the bone
vibrators to the threshold force level were not comparable. The
study also investigated the output limits of the Radioear B-70 and
B-72 bone conduction vibrators for bone conduction speech audiometry.
The findings suggested that bone conduction speech reception
thresholds can be obtained up to 70 dB HL before high amounts of
distortion interfere with the results.

Frank and Crandell (1986) studied the amount of sound leakage
(acoustic radiation) from the Radioear B-71 and B-72 and the
Pracitronic KH 70 bone vibrators. Results indicated that the
Pracitronic KH 70 bone vibrator had the smallest amount of acoustic
radiation at 4000 Hz, followed by the Radioear B-71 bone vibrator.
The Radioear B-72 produced the largest amount of acoustic radiation.

The Radioear B-71 and B-72 bone vibrators' amount of respon-
siveness at different frequencies was investigated by Richards and

Frank (1982). Frequency response curves consisted of three resonant peaks which declined in intensity level as the frequency was increased. Because of output voltage variations at 4000 Hz by the B-72 bone vibrator, the findings questioned the currently accepted tolerance levels for calibration (Richards & Frank, 1982).

Using an Oticon A 20 bone vibrator with a Bruel and Kjaer artificial mastoid, Srinivasan (1974) demonstrated a signficant correlation between bone conduction speech reception threshold and (a) air conduction speech reception threshold, (b) air conduction pure tone average, and (c) bone conduction pure tone average. In this study, Srinivasan (1974) also tested a normal hearing group, a conductive hearing loss group, and a sensorineural hearing loss group. A significant difference between the air conduction and bone conduction speech reception thresholds was found for the conductive hearing loss group. Air conduction and bone conduction speech reception thresholds were comparable for the normal hearing and sensorineural hearing loss groups. Occasionally, a noticeable difference between air and bone conduction speech reception thresholds was found for individuals with a noise-induced hearing loss. From these results, the author concluded that the Oticon A 20 bone vibrator and the Bruel and Kjaer artificial mastoid were useful clinically.

Edgerton, Danhauer, and Beattie (1977) investigated bone conduction speech reception thresholds and pure tone averages of the Radioear B-70A bone vibrator. The results were compared to air conduction speech reception thresholds and pure tone averages and found to be in close agreement. The study also investigated the

performance-intensity functions for spondee words presented via the Radioear B-70A bone vibrator. The findings demonstrated the Radioear B-70A bone vibrator's performance-intensity function was comparable to that via air conduction.

Valente and Stark (1977) studied bone conduction speech reception thresholds in young children using CID W-1 spondee word lists. The bone conduction speech reception threshold results showed that there is a 40 dB HL dial readout when routing the speech stimuli to the bone conduction vibrator. For a direct comparison of the bone conduction speech reception threshold to the pure tone average, a correction factor of 40 dB HL is subtracted from the bone conducted speech reception threshold. The study also found that bone conduction speech reception thresholds were very similar to bone conducted pure tone averages at .5, 1, and 2 kHz in children. Therefore, bone conducted pure tone averages can be predicted from bone conducted speech reception thresholds.

Stockdell (1974) studied speech audiometry in adults. The findings showed a 38 dB HL dial readout when speech stimuli was routed through the bone conduction vibrator. Subtraction of a 38 dB correction factor from the bone conduction speech reception threshold was used for comparison to the pure tone average. Bone conduction pure tone averages and speech reception thresholds were highly correlated as were bone conduction pure tone averages and air conduction speech reception thresholds in adults. The high correlation suggests that the bone conduction pure tone averages may be a better indicator of speech reception thresholds for sensorineural hearing losses. Speech

discrimination testing by bone conduction and air conduction was also investigated. However, because of presentation level, little correlation between the two was noted.

Barry and Gaddis (1978) investigated the output limitations of the Radioear B-70A bone conduction vibrator for adult speech discrimination scores. The mean percentage of correct responses began to decrease at 70 dB HL and was 50 percent at 80 dB HL. At 90 dB HL subjects became very uncomfortable from the heat and vibration emitted from the bone conduction vibrator. The study also investigated the transfer function for the Radioear B-70A bone conduction vibrator based on a 500 Hz calibration signal. The output became nonlinear after 50 dB HL. Significant total harmonic distortion was evident at 60 dB HL and by 80 dB HL was 100 percent. The study concluded that the maximum output for the Radioear B-70A bone conduction vibrator was 55 dB HL with less than 10 percent total harmonic distortion. Even though normal hearing subjects showed good speech discrimination up to 70 dB HL, individuals with sensorineural hearing losses or poor speech discrimination abilities would not be properly evaluated at levels above 55 dB HL.

Miller (1964) reported a technique for identifying feigned unilateral hearing losses by using bone conducted speech stimuli with air conduction masking noise. With forehead placement of the bone conduction vibrator, both cochlea may be stimulated. If air conduction masking noise is presented binaurally, the speech reception thresholds of both cochlea will be increased; if air conduction masking noise is presented monaurally, only the masked ear threshold

will be increased. First a patient's bone conduction speech recep-
tion threshold level is determined. Binaural masking noise is pre-
sented and gradually increased during patient repetition of spondees.
The level at which the patient stops responding is recorded.
Monaural masking noise is next presented to the "poor" ear and grad-
ually increased during patient repetition of spondees. The level at
which the patient ceases responding is again recorded. Monaural
masking noise is presented to the "better" ear and the same procedure
is followed. Comparison of the results indicated the technique is
good for determining true unilateral hearing losses and possibly
aiding in determination of a conductive component to a hearing loss.

Kasden and Robinson (1973) investigated bone conduction speech
discrimination scores for patients with other conductive hearing loss
pathologies. The authors wanted to determine if these scores would
indicate the amount of cochlear reserve for this type of patient.
The results showed little difference between air conduction and bone
conduction scores for non-otosclerotic conductive hearing loss
patients. The authors concluded that the difference between air and
bone conduction scores for otosclerotic patients is due to ossicular
fixation affecting the frequency response and impedance of the middle
ear.

Robinson and Kasden (1977) studied otosclerotic patients who had
undergone stapedectomies. Hearing evaluations performed one week
after surgery indicated that these patients had mid to high frequency
sensorineural losses and decreased speech discrimination scores when
compared to pre-operative audiometric results. However, pre- and

post-operative bone conduction speech discrimination scores remained very similar, indicating that cochlear reserve was maintained. The study indicated that comparison of pre- and post-operative bone conduction speech discrimination scores could reliably predict the outcome of stapedectomy surgery.

CHAPTER III

METHODS

SUBJECTS

Twelve normal hearing adults were selected from the PSU student population. Their hearing thresholds, as determined by air and bone conduction testing, were 20 dB HL or lower with no air-bone gaps greater than 10 dB (American National Standards Institute, 1969) at the frequencies .25, .5, 1, 2, 3, 4, 6, and 8 kHz.

INSTRUMENTATION AND STIMULI

Recorded CID W-1 word lists were used as stimuli. The six word lists were dubbed from A to F on cassette tapes from Auditec vinyl discs. The lists were comprised of the same 36 spondees that were arranged in different sequences. Instrumentation included the following in the order of connection: (a) a Proton 740 stereo cassette tape player for presentation of the CID W-1 word lists, (b) a Beltone 2000 clinical audiometer, and (c) a transducer. The transducer was the TDH-39 earphone for obtaining air conduction speech reception thresholds and the Radioear B-71, Radioear B-72, or the Pracitronic KH 70 bone conduction vibrator for obtaining bone

conduction speech reception thresholds. Figure 1 gives the schematic
diagram of instrumentation for both bone and air conduction testing.

a.
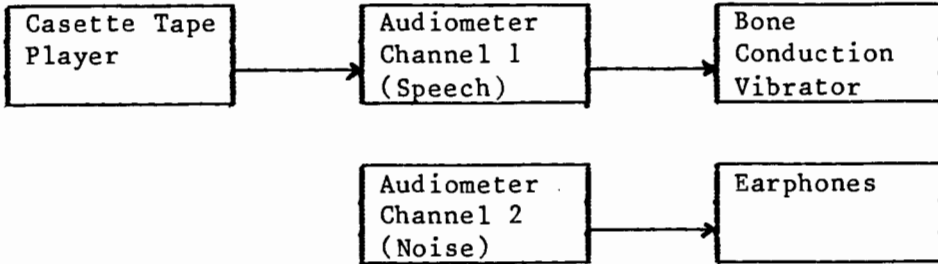
b.
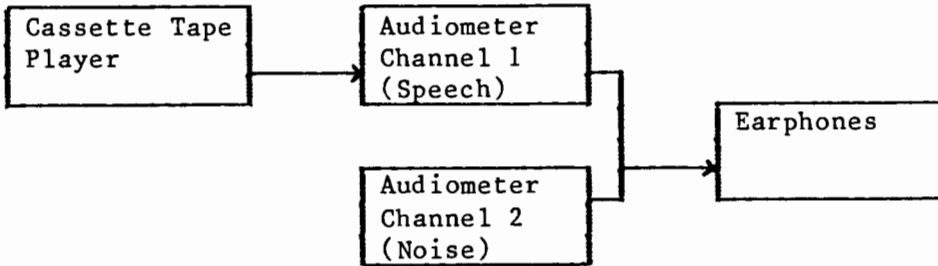
Figure 1. Schematic diagram of instrumentation for (a)
bone conduction and (b) air conduction testing.

CALIBRATION

Pre- and post-session calibration of the TDH-39 earphone and the
Radioear B-71 and B-72 and Pracitronic KH 70 bone vibrators was per-
formed with a Bruel and Kjaer sound level meter type 2230 and a Bruel
and Kjaer artificial mastoid. A Bruel and Kjaer force gauge was used
to monitor the amount of force coupling the bone vibrator to the
forehead. The VU meter of the Beltone audiometer was checked each
session with a 1000 Hz calibration tone recorded on a cassette tape
to achieve the proper output levels.

PROCEDURES

For the experimental testing, each subject was seated in a sound-treated room. Instructions were read to the subject. During bone conduction testing, TDH-39 earphones were placed on the subject's ears and a bone vibrator was placed on the subject's forehead. In order to raise the subject's speech reception threshold by bone conduction, binaural speech noise masking was used during presentation of speech stimuli. The bone vibrators were coupled to the forehead with a force of 550 grams (ANSI, 1969). During air conduction testing, TDH-39 earphones were placed on the subject's ears, and binaural speech noise masking was presented simultaneously with the binaural speech stimuli. The order of transducers was counter-balanced across subjects.

Spondees from the CID W-1 word lists were presented to the subject via a transducer. With the first randomly chosen word list, a bracketing technique was used to estimate the speech reception threshold (SRT). The bracketing technique consisted of presenting one spondee 8-10 dB above the subject's estimated SRT. If the subject responded correctly, a second spondee was presented at the same level. The subsequent presentations were attenuated in one dB steps with two spondees given at each level. When the subject missed one spondee, two more spondees were presented at the same level. The level where two out of four spondees were repeated correctly was then determined. This was considered the subject's estimated SRT. Then, using the intensity level of the pre-determined SRT as 0 dB, each

list was presented at one of the following levels: +4, +2, 0, -2, -4, and -6. The order of levels was randomized for each subject. The number and percentage of correct responses were calculated for each subject.

Unmasked bone conduction SRTs were also obtained for each bone conduction vibrator with each subject. This information allowed calculation of the dB amount that the threshold of speech intelligibility was raised for each bone conduction vibrator by the speech noise masking.

CHAPTER IV

RESULTS

Masking noise was presented binaurally to 12 subjects at 40 dB
HL in order to simulate a hearing loss and thereby raise the SRT.
The amount of shift in SRT was determined for each listener by
obtaining the estimated SRT in quiet and in noise and then
subtracting the two estimates. The mean threshold shifts are given
in Table I. The mean shift in SRT was greatest for the TDH-39
earphone (36.5 dB) and the mean shift in SRT was smallest for the
Pracitronic KH 70 bone vibrator (23 dB).

TABLE I

MEAN SHIFT IN SRT IN dB

	Earphone	KH 70	B-71	B-72
Mean Shift	36.5	23.00	24.50	25.50
Standard Deviation	2.5	3.09	4.49	5.94

Note: The amount of shift in SRT was determined for each listener
       by obtaining the estimated SRT in quiet and in noise and then
       subtracting the two estimates (n = 12).

Figure 2 shows one subject's performance-intensity functions
for the TDH-39 earphone, Radioear B-71 and B-72 bone conduction
vibrators, and the Pracitronic KH 70 bone conduction vibrator. The
ordinate is the percentage of spondees correctly identified; the

abscissa is the presentation level relative to the estimated SRT.
The percentage of spondees correctly identified increased with the
stimulus level for all transducers. The function for the earphone
appears slightly steeper than those for the bone conduction vibrators.
The poorest performance was seen for the B-72 bone vibrator, as
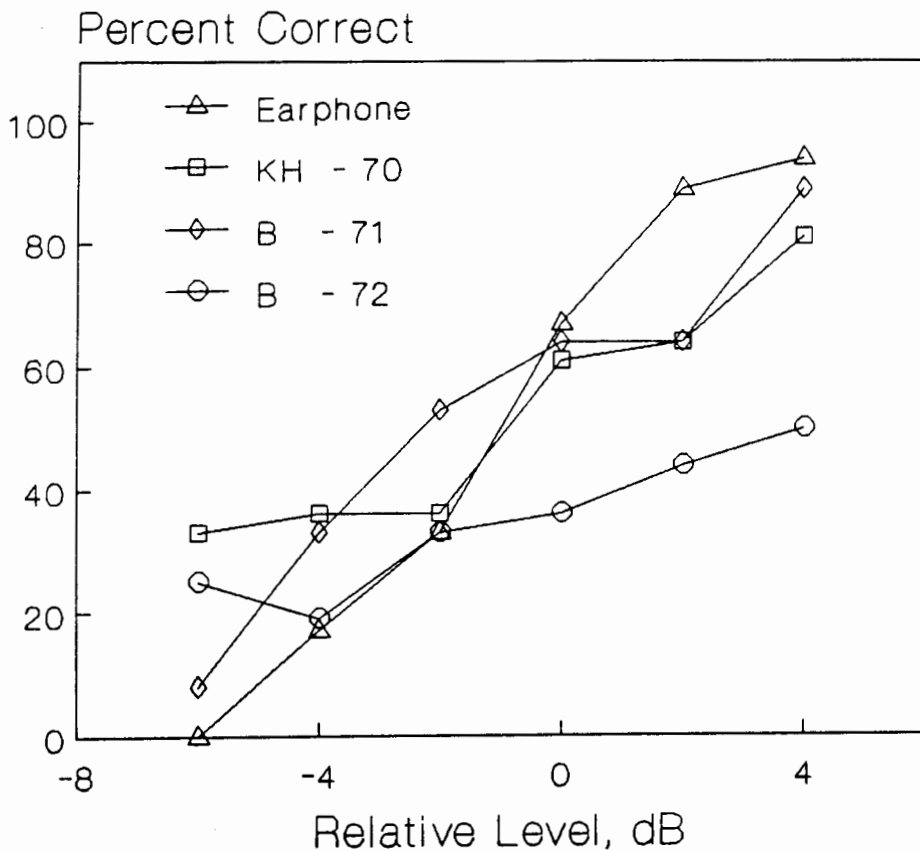demonstrated by a maximum of 50 percent at the highest presentation
level.

Figure 2. One subject's performance-intensity functions
for four transducers. The ordinate is the percentage of
spondees correctly identified and the abscissa is the
presentation level, in dB, relative to the estimated SRT.

Using linear regression, the line of best fit was calculated for each subject's data under each transducer condition. The data were equalized along the X axis so that the 50 percent point of the line of best fit was aligned with 0 dB. Figure 3 shows the resulting equalized group data for each transducer. The line of best fit to the group data is shown in each plot. Again, as the presentation level increased, the percentage of correct responses increased for each transducer.
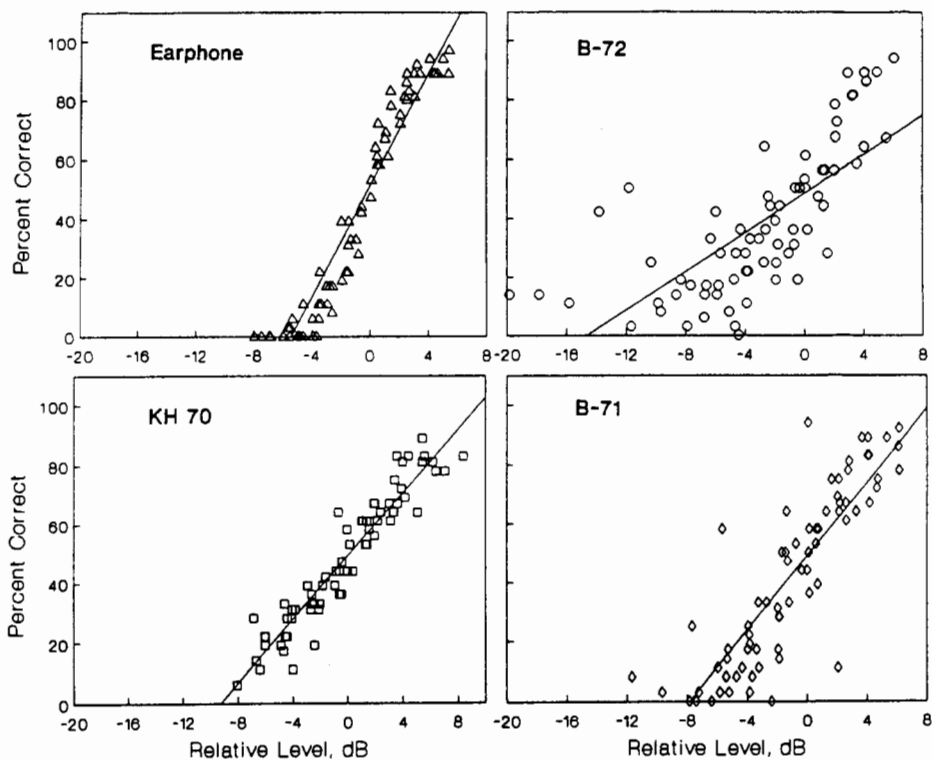

Figure 3. Lines of best fit for equalized group data for four transducers. The ordinate is the percentage of spondees correctly identified and the abscissa is the equalized (see text) presentation level, in dB.

The mean slopes of lines of best fit to individual data are given in Table II. The highest slope is seen for the TDH-39 earphone (9.47 percent per dB). The lowest slope is seen for the Pracitronic KH 70 bone vibrator (5.49 percent per dB). Among the bone conduction vibrators, the slope is highest for the Radioear B-71 bone conduction vibrator (7.26 percent per dB).

TABLE II

MEAN SLOPES IN PERCENTAGE OF SPONDEES CORRECTLY IDENTIFIED
PER dB AND STANDARD DEVIATIONS FOR
INDIVIDUAL DATA

	Earphone	KH 70	B-71	B-72
Mean Slope	9.473	5.485	7.262	5.565
Standard Deviation	1.025	1.006	1.535	2.251

Note: n = 12

A one way analysis of variance indicated that there was a significant difference in the performance-intensity slopes of the transducers ($p < .05$). A follow-up Scheffé F test indicated that there was a significant difference between the TDH-39 earphone and each of the bone conduction vibrators ($p < .05$). There were no significant differences among the bone conduction vibrators. Tables III and IV show the results of the analysis.

The spread of data points clustered closely around the line of best fit for the TDH-39 earphone and the Pracitronic KH 70 bone vibrator. The greatest spread of data was seen for the Radioear B-72 bone vibrator. The mean Pearson product-moment correlation

TABLE III

ONE-WAY ANALYSIS OF VARIANCE FOR SLOPES OF LINES OF BEST FIT

One Factor ANOVA-Repeated Measures for X_1 . . . X_4

Source	df	Sum of Squares	Mean Square	F-test	P Value
Between Subjects	11	29.61	2.692	.482	.9021
Within Subjects	36	201.009	5.584		
Treatments	3	126.294	42.098	18.594	.0001
Residual	33	74.715	2.264		
Total	47	230.619			

Note: Reliability estimates for: all treatments = -1.074
single treatment = -0.149

TABLE IV

FOLLOW-UP TESTS FOR THE ONE-WAY ANALYSIS OF VARIANCE

One Factor ANOVA-Repeated Measures for X_1 . . . X_4

Comparison	Mean Diff.	Fisher PLSD	Scheffe' F-Test	Dunnett t
Earphone vs. KH 70	3.988	1.25*	14.048*	6.492
Earphone vs. B-71	2.211	1.25*	4.318*	3.599
Earphone vs. B-72	3.907	1.25*	13.485*	6.36
KH 70 vs. B-71	-1.777	1.25*	2.789	2.893
KH 70 vs B-72	-0.081	1.25	.006	0.131
B-71 vs B-72	1.696	1.25*	2.542	2.761

*Significant at 95 percent

coefficients, r, are given in Table V. The highest correlation was
seen for the TDH-39 earphone (mean r = .9682), while the poorest
correlation was seen for the Radioear B-72 bone vibrator (mean r =
.8833).

TABLE V

MEAN PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS (MEAN r) FOR
PERCENTAGE OF SPONDEES CORRECTLY IDENTIFIED VERSUS
INTENSITY LEVEL IN dB

	Earphone	KH 70	B-71	B-72
Mean r	.9682	.9506	.9125	.8833

Note: n = 12

CHAPTER V

DISCUSSION

This study compared the intelligibility of speech presented via
bone conduction at higher intensity levels to that presented via
earphone at higher intensity levels. Binaural speech noise masking
was used to artifically elevate the speech reception thresholds of 12
subjects and simulate a hearing impairment.

Performance-intensity functions were obtained for Radioear B-71,
Radioear B-72, Pracitronic KH 70 bone conduction vibrators, and a
TDH-39 earphone. The performance-intensity function for each bone
vibrator did not rise as steeply as the function for the earphone.
The results indicated that there was a significant difference between
the slope of the function for the TDH-39 earphone and for each of the
bone conduction vibrators at higher intensity levels. Of the three
bone conduction vibrators, the performance-intensity function for the
Radioear B-71 demonstrated the steepest slope. However, the results
of the one way analysis of variance revealed no significant dif-
ference among the slopes for the three bone vibrators.

According to Hirsh et al. (1952), the performance-intensity
function, when using CID W-1 word lists, should rise at a rate of 8

percent per dB in an intensity range of 8 dB. The steeper the slope and the narrower the intensity range between intelligibility and non-intelligibility of the word, the more accurately the SRT can be determined. The results of this study indicated that the slopes of the functions for the Radioear B-71, B-72, and Pracitronic KH 70 bone conduction vibrators rose at a lower than desirable rate at higher intensity levels.

A possible explanation for the lower slopes could be distortion. Output distortion at higher intensity levels for bone conduction vibrators has been demonstrated by Bary and Gaddis (1978). A majority of subjects in the present study (62 percent) thought that speech was clearer and easier to understand through the earphone. The Radioear B-71 bone vibrator was judged to provide the clearest speech by 23 percent of the subjects, while each of the other bone vibrators was preferred by only 8 percent of the subjects.

The results of this study suggest that the CID W-1 word lists and the 50 percent criterion might be inappropriate for use with these bone vibrators at higher intensity levels. Given that there was a preponderance of data points below 50 percent for the bone vibrators, a criterion of less than 50 percent might be more appropriate. Because presentation levels might be elevated for sensorineural hearing impaired listeners, their SRT performances could be affected. Consequently, the results of speech reception threshold testing via bone conduction at higher intensity levels should be interpreted with caution in clinics.

These findings, performed at higher intensity levels, differ from those of Dolan and Morris (1989). Their study compared the intelligibility of speech presented via bone conduction to that presented via earphone at low intensity levels. The results of their study suggested that the CID W-1 word lists are appropriate to use with the Radioear B-72 and the Pracitronic KH 70 bone conduction vibrators at low intensity levels. Also, the mean slope for the earphone was slightly steeper than that in the findings of Dolan and Morris (1989). An explanation could be that the masking noise in the present study caused the subjects to focus on the task and thereby improve their performances.

To determine effects of distortion on speech intelligibility, this study should be repeated using other types of bone conduction vibrators, such as the Oticon A 20, so that their performance-intensity functions can be compared to that of the TDH-39 earphone.

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