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RESEARCH :

THE EFFECTS OF CONDUCTIVE HEARING LOSS ON LINGUISTIC PERFORMANCE AMONG ABORIGINAL CHILDREN

J. Armstrong,
Alice Springs Special School,
P.O.Box 435,
Alice Springs, 5750

For many years researchers have documented the high incidence of otitis media (middle ear disease) and hearing impairment among Aboriginal children. While basically suggesting medical intervention and socio-economic development as the main remedies of this situation, there has been some indication of a need for compensatory measures aimed at the education of these children (Stuart *et al*, 1972).

Information outlining the nature of compensatory measures to be taken has more or less extended from the area of deaf education. Those working in the area of Aboriginal hearing impairment have resorted to adapting information intended for a completely different clientele - that is, profoundly deaf European children - in an effort to minimise educational handicaps.

Recent research has now extended into the effects, if any, of recurrent otitis media and hearing loss on linguistic performance. Needleman (1977) reports research by Holm and Kunze (1969) who administered standardized speech and language tests to an experimental group (16 subjects) with histories of recurrent otitis media, and a control group of 16 matched subjects. The experimental group was found to be deficient in auditory reception and processing and the production of verbal responses. Specifically, experimental subjects performed significantly more poorly in articulation of speech sounds, understanding vocabulary as measured by the Peabody Picture Vocabulary Test (P.P.V.T.) and linguistic skills measured by the Illinois Test of Psycholinguistic Abilities (I.T.P.A.) namely, use of verbal analogies, visual analogies, correct syntactic structures and grammar and the ability to repeat digit sequences presented verbally.

Obviously, such results should, and have, prompted further investigation. Needleman and Menyuk (1977) designed a study to look at a specific area of language performance; the comprehension and production of aspects of the phonologic system. The tests included:

1) articulation in words, 2) articulation in connected speech, 3) use of word endings in varying morphologic contexts, 4) auditory discrimination in quiet, 5) noise, 6) sound blending and 7) auditory closure.

They found significant differences in the performance of the two groups in tests 1), 2) and 3), but no significant difference in performances on the last four tests. Over all, their findings showed older children to come relatively closer to the performance of the control group. Although phonological retardation was related to recurrent hearing loss, hearing impaired children seemed able to 'catch up' as they grew older.

Needleman believes that phonological difficulties could account for the educational retardation that is often observed in children with recurrent otitis media. As Ling (1972) points out, phonological abilities may improve with age, but resultant academic difficulties are not necessarily overcome.

Lewis (1976) carried out similar research with three groups of children (European control, Aboriginal control and Aboriginal experimental) using seven tests assessing aspects of auditory perception. On most tests, the European control out-performed the other two groups, with the Aboriginal control out-performing the Aboriginal experimental group. It was clear that the Aboriginal children who had suffered chronic middle ear disease did not perform as well as other Aboriginal children coming from the same community.

Lewis (1976) states that the effects of mild hearing loss can be offset by environments that "are rich in alternative intersensory stimulation" (p.390). It is considered by many, that in European terms, Aboriginal communities are impoverished in many aspects. Numerous comparisons between low socio-economic Europeans and Aboriginals always demonstrate the latter group to be more disadvantaged in some way (Kearney *et al.* 1973). Hearing impaired Aboriginal children are less able, therefore, to compensate for the hearing loss they experience.

In 1975, the author was working at an outstation school in the Northern Territory. A bilingual program was in its second year of operation. A majority of the children suffered extended episodes of chronic suppurative otitis media. There was evidence, from audiometric testing alone, that the hearing levels of some of the children implied that ossicle damage may have occurred. At the same time, attempts to teach these children to read in the vernacular, sometimes met with disappointing results. Was there a relationship between the

hearing levels of the children and their poor performance in reading as "phonological skills are a requisite for learning to read"? (Needleman, 1977, p.646).

Reading methods then in use relied heavily on auditory processing. It has since been determined that Aboriginal children incorporate heavy use of visual information in their learning strategies (Harris, 1978).

We needed to know, therefore, the type and extent of linguistic interference produced by otitis media; the influence on education; and specifically, the effect on oral language and literacy learning in English and vernacular languages.

SUBJECTS

Two groups of children were selected from grades 3, 4, 5, 6 and post primary from the school population at Yuendumu, an Aboriginal community, 180 miles north west of Alice Springs. Selection was first made on the basis of audiological history dating back five years. (Note, selection was based on hearing levels, not ear condition). Often, lesions or infections occur in the middle ear as proven with otoscopic examination and/or impedance audiometry with little or no reduction in hearing levels. We were investigating the relationship of hearing loss to linguistic performance and therefore took hearing loss as the basis for our selection. Indeed, had our selection been based on ear condition, a control group would have been very hard to find: otitis media is too pervasive in the child population.

Children with poor attendance were excluded from the investigation, as that fact alone could greatly influence the results.

The first group, designated N.H. (non-hearing) comprised 25 children, (17 girls and 5 boys), from the five classes.

The second group, designated H (hearing), comprised 24 children, 12 girls and 12 boys, from the 5 classes.

All children were members of the same community, Walpiri being their first language. Life-styles were constant throughout the community. Children met formal English only while attending school or during brief encounters at the canteen or with European staff members.

A European control group was not chosen. Half the test battery was in the Walpiri language, while English is spoken as a

second language for the Aboriginal groups. Comparison, therefore, would not be valid.

A MODEL OF COMMUNICATION

The author proposed a basic model of communication which is by no means exhaustive, nor takes into account the complicated functions of language. It is only meant as a theoretical guide to formulating the test battery.

Model of Communication

Reception - Decoding

Encoding - Expression

The hypothesis, as with other researchers (before us) is that otitis media and hearing impairment, even though slight and intermittent, may still affect the reception of phonological component and therefore other components of language. Expression of language by such an individual may also indicate imperfections in language, either qualitatively or quantitatively. The emphasis on our testing was with how language is received and then expressed, rather than how it is processed.

Two views seem to be slowly emerging from the literature on the nature of auditory processing. One view postulates that auditory processing is a neurological function. If auditory processing problems are evident, it may be due to a neurological dysfunction. This view implies that hearing loss does not directly influence processing, but prevents auditory processing from functioning at an optimum level (Keir, 1977).

The second view (implied in Lewis' research referred to earlier), is that distortion of input will directly influence processing abilities; hence the selection of their test instruments.

Needleman's (1977) results showed no significant differences in performance on tests involving auditory processing, that is, auditory discrimination, figure-ground differentiation and auditory closure. Although useful, these tests have been done before and are not included in our test battery.

A second part of our investigation was to find any appreciable difference between performance in analytical and synthetic

aspects of perception in our subjects. Boothroyd (1975) defines these terms as:

analytic activity:	extraction of information from the auditory (or visual) stimulus
synthetic activity:	situational and linguistic context of the message, and the listener's internal knowledge.

We felt our subjects would perform as do the adventitiously deaf: that is, they would suffer a loss of analytical ability (or discrimination) without losing synthetic skills (Boothroyd, 1975). If so, our subjects may be disadvantaged by certain methods used in teaching reading that rely heavily on analysis rather than whole language - experiential approaches.

TEST INSTRUMENTS

A) RECEPTION

1. Boothroyd Isophonemic Word Lists: Used to determine discrimination curve, speech (or phoneme) reception threshold (S.R.T.) or threshold of intelligibility (Davis *et al.*, 1970). The S.R.T.(P.R.T. in this case) is an independent measure of hearing loss.

2. Walpiri single word list: (see Appendix 1). This list is based on the Boothroyd list as far as construction and marking is concerned. Because the Walpiri language has few single syllable words, we have used three syllable words and used a system of syllable scoring. Tests 1 and 2 measure the analytic aspect of perception.

3. C.I.D. Everyday Sentence Test (David *et al.* Recorded by National Acoustic Laboratory:- Lists A, B, C , D, I. 1970).

4. Walpiri "everyday" sentence lists (see Appendix 2).

Tests 3 and 4 measure the synthetic skills subjects incorporate in their listening activity.

B) EXPRESSION

5. Oral Comprehension Test - English.
6. Oral Comprehension Test - Walpiri.
7. Oral Expression Test - English.
8. Oral Expression Test - Walpiri.

The English tests were designed by Mrs L. Pearce, Senior Education Adviser - T.E.S.L. Department of Education, Alice Springs. They are being trialled with Grade 2 children at present and will undergo some revision before being administered to the research groups. They are tests in the understanding and production of acceptable forms of standard English. They are not tests of communication.

During the test of comprehension, any verbal answer given by the child will not be judged by its structural accuracy, as the child is not necessarily expected to speak - but to indicate in some way, usually by pointing - that he has understood the tester's directions.

The oral expression test attempts to stimulate the subject into using numerous types of syntactic structures and transformations. A Walpiri version is still being developed. As the reader can appreciate, we can not simply translate these tests. English structures and parts of speech are not always universal. Work is still continuing to determine what parts of speech are significant for investigation in a test such as this.

EQUIPMENT AND PROCEDURES

We began with the Walpiri speech tests. They were administered by way of a tape recorder and Beltone 12D audiometer (calibrated to I.S.O. standard for speech).

The tape was made by four Aboriginal teachers (2 female, 2 male) from Yuendumu school. The Walpiri speech test materials were trialled first with Grade 2 pupils in the school. It was possible for many of these younger children to score 100% on both the single word and sentence tests. After revisions were made, the testing began. Intensities for the tests were 60, 50, 40 and 30 decibels I.S.O. for single word tests and 60, 50 and 40 decibels I.S.O. for the sentence tests.

The children were required to repeat the words (single words) or sentences they heard. They were encouraged to always attempt words even if unsure. Picture clues were not provided.

The procedure was explained to each child in Walpiri, and each was allowed several attempts. Testing began at 60 decibels on the left ear, then right, in descending order. Unfortunately, binaural testing or testing via speakers was not possible with our equipment.

Table 1

Mean Raw Scores and Standard Deviations on the
Walpiri Single Word Test and Walpiri Sentence Test

Test		DECIBEL LEVEL							
		60		50		40		30	
		L[#]	R	L	R	L	R	L	R
SINGLE WORD									
Hearing	$\bar{x}$	29.29	29.86	29.46	29.70	27.33	26.26	16.10	24.37
	sd	1.2	0.3	.99	0.54	3.8	6.26	10.03	8.02
Non-hearing	$\bar{x}$	27.68	27.8	24.72	25.1	17.8	17.9	7.2	13.4
	sd	4.5	6.05	9.04	8.6	11.43	12.29	10.38	12.04
SENTENCE									
Hearing	$\bar{x}$	43.3	43.1	40.3	43.16	28.1	36.1		
	sd	9.11	9.15	15.45	10.32	16.94	13.52		
Non-hearing	$\bar{x}$	34.24	40.7	33.0	37.2	15.2	25.7		
	sd	17.04	12.14	21.88	17.57	19.0	21.0		

* = $p < .05$

L = left ear; R = right ear

Child responses were recorded and listened to afterwards to ensure accuracy of scoring.

RESULTS

Table I shows the mean scores and standard deviations obtained from the two groups for left and right ear. Note that scores for the single word test were out of 30, and for the sentence test, out of 50.

The hearing group out-performed the non-hearing group in both tests at all intensities. Not all the differences were statistically significant, but, as Table I shows, several did achieve significance.

DISCUSSION

A good deal of information has arisen just from the administration of the two Walpiri speech tests. It is unfortunate that we cannot make firm conclusions without the data from the expression section of the test battery. However, the results show that -

1. The non-hearing group scored worse on the left ear than the right, particularly in the sentence tests. Although unilateral losses were common, they obviously cannot account for this factor. Test procedure may need revision since the right ear response improved after extra practice and adaptation to the intensity from the previous list given to the left ear. The right ear responses may give a more accurate indication of actual performance capabilities.

2. In almost all cases, the results of the single word lists were better than the sentence lists for both hearing and non-hearing groups. (See appendices 3 and 4 - articulation given curves for typical hearing and non-hearing group.)

We anticipated that the contextual clues and redundancy factor of the sentence lists would allow children to score higher than they would on the single word test. However, this was not the case. A number of children were able to score discrimination results only 15 to 20 decibels behind the normal, for single word, yet could only achieve a 30% score at 60 decibels, and no score at 50 decibels for the sentences!

On reviewing the test materials we postulated that the differences in performance on the two tests were due to -

a) a high redundancy of single Walpiri words when compared to English single words. English words (by comparison) are short, harder to hear and difficult to predict.

b) A high redundancy on English sentences, which are also easier to hear. Walpiri sentences, however, contain little predictable information. All the "little bits" make very marked differences in meaning - miss a section and it won't make sense. The range of possible alternatives to the missed segment is considerable.

Over the years speech tests of this sort have received a good deal of criticism due to the difficulty of interpreting the results. This is partly because speech tests also 'measure' auditory closure - or that ability to identify incomplete inputs or information. Yet performance in this area is dependent on the redundancy factor of the speech material being used.

Performance in auditory closure is also dependent on the intuitive aspects of language. We can surmise that on English speech tests, our two groups would perform worse on the single word lists and better on the sentence lists compared with the Walpiri test results. However, this would be largely dependent on their knowledge of English.

The relationship between expectancies within a language and performance in reading is an interesting one. A native speaker acquires expectancies as he learns a language. He knows what type of language structure can be expected after certain parts of speech, that is, *the* or *a* following a preposition.

Pickering (1970) demonstrated that children learning English as a second language required at least three years to acquire these expectancies. It is implied that such expectancy is necessary before independent reading could be achieved.

Our results suggest that redundancy in the Walpiri language is lower than English and possibly dependent on other aspects of communication, for example, body language, visual clues. What implications exist for reading programs?

3. In all except 3 cases (for single word) and 9 cases (for sentence), children were able to achieve 96% to 100% scores at 60 decibels. Hence the failure to achieve significance at those levels.

Taking 60 decibels I.S.O. as the average conversation intensity (between 50 and 70 decibels), most of the children, except for those 9, would seem to have little trouble (from these results) at following and discriminating conversation level speech.

4. The P.R.T. (phoneme reception threshold) is a measure of the intensity level where 50% of the maximum score occurs (see Appendix 3) (Boothroyd, 1968). When compared to the discrimination threshold of normal hearing subjects (usually 20 decibels) we can calculate a measure of hearing loss close to the pure tone average between 500 and 2,000Hz. (Davis, 1970; Boothroyd, 1968). Thus, if our subject has a P.R.T. of 35 decibels - 20 decibels (P.R.T. for normal hearing subjects) = 15 decibels, (even though P.T.A. may be 40 decibels), the subject does not have a hearing loss! Most of our subjects conform to this calculation (see also Fisher, 1976).

Boothroyd (1968) states:

> Lack of correlation between the hearing losses as measured by pure tone and speech audiometry occurs with disturbingly high frequency among children and can often be traced to a failure to respond appropriately to pure tone stimulus.
>
> In the author's experience this phenomenon has always been associated with either emotional disturbance, brain injury or a history of middle ear disorders. It is quite different from malingering in that there is no attempt on the part of the patient to falsify the speech results, and it may be associated with the low arousal value of the pure tones. (p.4)

In fact, the major value of the P.R.T. (or S.R.T.) measurement is in confirming the results of pure tone audiometry (Davis *et al.*, 1970).

What our observation suggests is that these children are not responding to pure tones of low intensities.

5. Phonemic scoring has many advantages over whole word scoring (see Boothroyd, no date). The subject, however, is encouraged to attempt all words even if only a part of a word is heard clearly. Our subjects consistently failed to attempt words and sentences once they had reached, or dropped below, the threshold of intelligibility. Consequently the scores fell off dramatically once we had lowered the intensity beyond that level. The author feels this occurrence

may be brought about by conditioned attitudes within the children towards responding incorrectly. It seems safer to remain silent when not sure, than to respond incorrectly, even in a testing environment which seems to us to be non-threatening. Could this occurrence apply to pure tone testing also?

Further explanation for this phenomenon can be found in the low redundancy of the Walpiri material, in spite of their 'every day' application (see point 2). Therefore, as intensity was lowered, the subject was required to predict missed segments while the range of suitable alternative segments remained considerable.

6. Children had been placed in the non-hearing group if their history showed long-term hearing loss. A number of children from this group, when tested, had almost normal pure tone averages. Their speech test results confirmed this fact. Thus, recurrent hearing loss did not produce long term effects on reception skills. On the other hand, some children who had pure tone averages of 45 decibels or more, scored poorly on the speech tests, yet were known for their ability to converse not only in vernacular, but also in English. This is not a rare occurrence and suggests that hearing loss due to otitis media is only one factor that can influence language development.

CONCLUSION:

Lewis (1976) infers that children in a highly enriched environment, full of "alternative intersensory stimulation" (p.390) can cope much better against the effects of hearing loss as a result of otitis media. His research generalizes though, in assuming that the environments of Aboriginal children are impoverished, and that these children are liable to suffer the full effects of recurrent hearing loss.

Our tests so far, in the vernacular, suggest that many children have coped extremely well linguistically, in spite of the fact that they have had chronic suppurative otitis media, since the age of three months in many cases. The environments they grow up in are certainly impoverished materially, but not necessarily linguistically.

Environment appears to regulate a child's linguistic performance. Language problems in school can often be traced back to insufficient interaction between a child and his parents (Tough, 1976). Research to date also suggests that the effects of recurrent hearing loss can be offset by a stimulating home environment.

While not intending to minimize the educational effects of hearing loss, perhaps we need to return to the source of linguistic stimulation: the home.

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(See Appendix 1, 2, and 3 on following pages).

APPENDIX 1 - WALPIRI WORD LIST

List 1	*List 2*	*List 3*	*List 4*
wanarri	pajarni	kankarlu	rdakangka
kunjuru	witangka	mirrirni	nyanungu
ngajurna	lawalku	yanumpa	karntangku
watiya	nyarrpara	warlura	wantiki
yarrpirni	mangarri	jangarnka	jimanta
ngawarra	jukurrpa	kangkarni	pirrjirdi
mardarnu	yampimi	nalija	wajirli
mirdiji	ngarlkirdi	ngulangka	yingkirni
parnkami	mingkirri	pangurnu	lungkarda
kurriji	purami	karija	kulungku

List 5	*List 6*	*List 7*	*List 8*
watakj	karlimi	ngapiri	yarlparu
pukulyu	nyanjaku	yakuju	jamana
karnarla	manulpa	pirnkingka	jaraku
nyangulu	kangurnu	miyiki	kakarda
kulpaja	jaakarri	kuturu	yarrkayi
turlkami	kutulku	kajirna	malirdi
marnpirni	yarlkirnl	wardinyi	yapangku
purlaja	rdarrungka	rdangkarlpa	jitirni
katjrni	rdirrkirnl	jukana	yulyurrpa
warrarda	kantaku	kurtirdi	jurdungka

APPENDIX 2 - WALPIRI SENTENCE LIST

List A

1. Wapami karna manyu-wana
2. Nata kanpa nguna yamangka
3. Purlkangku karla yinyi maliki-ki kuyu
4. Kaji wati yanirni kapurlupa payirni
5. Ngurrju-mayinpa
6. Kajinpa warlu mani, marna-wiyi manta
7. Nyarrpa-jarri kanpa wuraji-wurajiji warrki-jangka?
8. Kajilpa turaki yantarlarni, kuyu kapurna payimani
9. Nyampu-nyarlupa yarnkaja
10. Yirkiyirla yanta kuja

List B

1. Ngapa walyka jurlyurl-wantinjaku
2. Nyiya ku lparna yakarra-parkiyarla mungalyurruju?
3. Nyampu-nyangku nyuntu kuju karliji
4. Nyapa ka wanti
5. Nyarrpara kanpa yani?
6. Yantarni Kajirnangku wangkami
7. Yulanja-wangu nyinaya, kapurnangku pakarni
8. Kurdu ka yani ngurra-kari-kirra ngati-nyanu wangu
9. Kuyu-wangu lku ka karrimi ngurrangka
10. Yarnunjukurna gnipiri-ji yungka

List C

1. Jukurrarlu yantarni yarlipala kurrlu-jurra
2. Agurrju lku rna
3. Natirli nganja mukau, panu-kariji mardaka
4. Yalumpuju jungarni
5. Nyangu-rnalu-jana yapa-paty taarnurla
6. Murru-murru ngulaju, wapanja-wangu ngarninja-wangu
7. Yungkaju mangarri manu jara
8. Nuwu warungka-jarriya, kangkarniji kartaku ngaju-nyangu
9. Nuwu maliki tiji-manta kardiya-kurlangu
10. Piji jalanguju yukangka

List D

Ngulajuki yanirlipa

2. Palkarni-wangu, ngulaju pipa kijika
3. Wirlinyinpa yani turakingka
4. Kurdu-kurdu yantarly pingka-nyayirni warna-kujaku
5. Ngajulu kapurnangka kanyi yakuju
6. Ngapa karna purda-nyanyi karlinja-kurra

7. Pirli-kirra karlijarra yani kanyarla ku
8. Jaji-nyanu-rlu ka-jana kurdu-patu mardarni
9. Nuwu kijika, kapu rdilydi wantimi
10. Wiyarrpa, kulungku pakarnu

List I

1. Nyarrpararla Kapurnalu jalangu ngunami
2. Ngayaki karlarra-jangka karlupa ngarni
3. Kapunpa miyalu wirri-jarri kajinpa miyi warrarda ngarni
4. Nyiya-jangka kula lu yani Lajamanu-kurra
5. Nyuru purlapa-wangulku
6. Jirrama-kari kapala karrimirra
7. Nyiya kanpa wurruly-mardarni marnangka
8. Nyiya-jangka kanpa nyuntu warrarda yani kamparru
9. Ngajulu kapurna ngapurlu winjirni
10. Murnmaju witi-jarriya

List G

1. Kapurnangku nyanyi karlarlu-jangkarlu
2. Ngakarnangku nyanyi
3. Ngurrparna ngurrju-maninjaku kurlardakuju
4. Karriya yalumpurla-juku kajirnangku ngarrirni
5. Nyampuju tampa wiri-jalu kujarna purraja

7. Lwarna kulu-wangu
8. Yaruju-jarriya
9. Jungarrayirliji ngarrurnu nuwu-nganta wantija Nyirrpingka
10. Nyampuju parraja nyuntuku

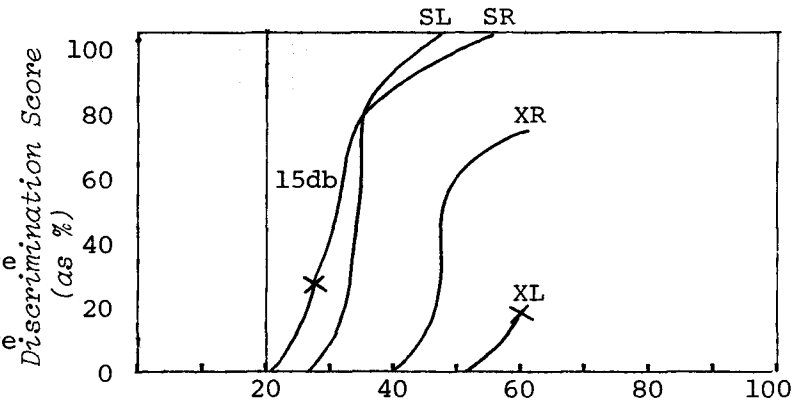
APPENDIX 3 - ARTICULATION GAIN CURVES OF TYPICAL CHILD IN NON-HEARING GROUP

SL = Single Word Score (Left Ear)

SR = Single Word Score (Right Ear)

XR = Sentence Score (Right Ear)

XL = Sentence Score (Left Ear)



Hearing level in Decibels (I.S.O.Standard).

		Single Word		Sentence
S.R.T.	L)	35 db	L)	58 db
S.R.T.	R)	31 db	R)	45 db

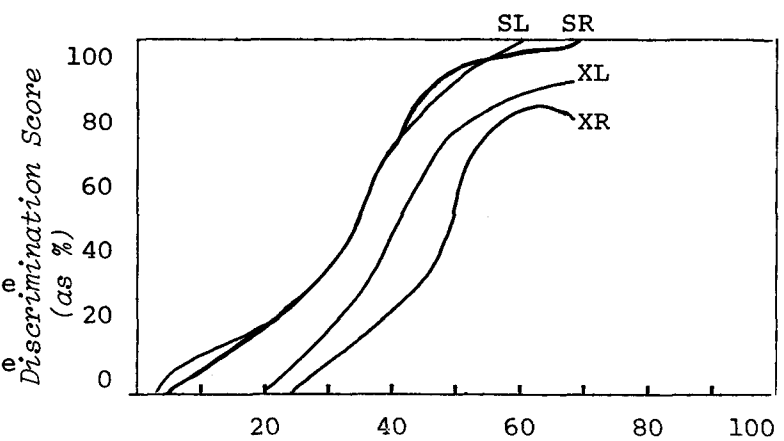
APPENDIX 4 - ARTICULATION GAIN CURVES OF TYPICAL CHILD IN HEARING GROUP

SL = Single Word (Left Ear)

SR = Single Word (Right Ear)

XR = Sentence Score (Right Ear)

XL = Sentence Score (Left Ear)



Hearing level in Decibels (I.S.O. Standard)

		Single Word		Sentence
S.R.T.	L)	20 db	L)	35 db
S.R.T.	R)	20 db	R)	32 db