

JOURNAL OF HUMANITIES THERAPY

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Effect of Auditory Training and Speech Reading on Speech Discrimination Ability of Children with Hearing Loss in Ibadan, Oyo State, Nigeria

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〈abstract〉

Children with hearing loss have poor speech discrimination ability as a result of the loss of auditory capacity to recognize and discriminate speech sounds. Past studies were focused largely on the rehabilitation of the auditory systems towards efficient speech recognition ability with little attention paid to the rehabilitation of speech discrimination difficulty. This study, therefore, was designed to determine the effect of auditory training and speech reading on the speech discrimination ability of children with hearing loss. The moderating effects of the degree and age of onset of hearing loss were also examined. The study adopted the pretest-posttest control group quasi-experimental design of 3x2x3 factorial matrix. Multi-stage sampling technique was used to select the three schools used, while the thirty participants involved were purposively selected based on their degree and onset of the hearing loss. The participants were randomly assigned into auditory training (10), speech reading (10) and control (10) groups. The treatment lasted ten weeks. The instruments used were the adapted version of the Clement Ayodele Bakare Speech Discrimination Test List ($r = 0.75$) and Mary Part LaForest Experimental Speech Sound Discrimination Test List (0.72). Data were analysed using Analysis of Covariance and Scheffe Post-hoc test at 0.05 level of significance. There was a significant main effect of treatment on the participants speech

discrimination ability ($F(2,13) = 10.008$, $\text{partial}^2 = 0.56$). Participants in the speech reading group had the highest mean score (49.00), followed by those in auditory training (42.33), while those in control group had the lowest mean (33.33). There was no two-way interaction effects of degree and onset of hearing loss on the speech discrimination ability of children with hearing loss. The study also revealed insignificant three-way interaction effects of treatment, degree, and onset of hearing loss on the speech discrimination ability. Auditory training and speech reading exercises were effective in enhancing speech discrimination ability of children with hearing loss in Ibadan, regardless of the degree and onset of hearing loss. However, speech reading showed better outcome than auditory training. Therefore, audiologists, hearing therapists and speech therapists should adopt these strategies towards improving the speech discrimination ability of children with hearing loss.

Key words

Auditory training, children with hearing loss, communication difficulties, speech discrimination ability, speech reading skill.

1. Introduction

The development of speech ability requires an effective hearing system, and this system functions by perceiving, recognizing, understanding and discriminating the environmental sounds as well as responding to the environmental sounds appropriately. The relationship between hearing and speech development cannot be overemphasized. The way humans perceive their world is mediated through sensory experiences. Of all the senses, hearing fundamentally facilitates communication and fosters social interaction, allowing people to forge relationships, participate in daily activities, be alerted to danger, and experience life events. For children, they learn to produce speech by listening to the speaking habits of others.

Unfortunately, a major opposition in speech development is hearing loss (1). The human auditory system is very complex, and any little dysfunction can pose a problem in the auditory perception process. Hearing loss, which is a kind of communication difficulty with a marked evidence of decrease in the auditory ability to localize, detect, recognize, understand and/or discriminate sounds has been observed as a major hindrance to the acquisition as well as the development of language and speech (2).

Hearing loss is a partial or total inability to perceive and comprehend sound, and the presence of this condition has been discovered to have negative effects on the development of both the language and speech abilities of children. To this end, it has posited that the process of language acquisition is dependent on the integrity of the auditory system and when it is damaged by hearing loss, acquisition of language becomes a challenge (3). Similarly, it has been indicated that the most significant effect of hearing loss in children is its impact on the development of language and communication (4). To a larger extent hearing loss hinders those affected from getting adequate benefit from communication. In line with the above, studies have shown that accompanying hearing loss is a common challenge called poor speech discrimination and this makes both inter- and intrapersonal communication difficulty. As well, every effort towards discrimination between words and speech sounds always appear difficult with children with hearing loss, because their hearing disabling condition would make some speech sounds difficult for them to perceive appropriately, and this will manifest as the inability to discriminate between sounds heard, especially in a noisy environment (5).

Physiologically, infants begin to differentiate among various sound intensities almost immediately after birth, and by one week of age, they can make gross distinction between varied tones. By six weeks of age, infants pay more attention to speech than to other sounds, easily discriminate between voiced and unvoiced speech sounds, and prefer female to male's voice (6). Although, children begin to vocalize at birth and those with

normal hearing ability proceed through the stages of pleasure sounds, vocal play, and babbling until the first meaningful words begin to occur, or soon after age one. For children with hearing loss, this progression comes challenging and even with hindrance(s), hinging on the development of speech. Once the auditory system becomes impaired early in life, it might be difficult (without early intervention and appropriate rehabilitation) for individuals who experience it to communicate adequately using natural ways. In the sense, that spoken communication is uniquely human, and if the sense of hearing is damaged (defective) or absent, individuals with the loss would be one denied the opportunity to enjoy an important feature of their environment, which is the sounds emitted by nature, and/or by human beings. Thus, hearing loss impairs the human ability to produce and monitor their own speech as well as to learn the rules that govern the use of speech sounds (phonemes) in their native spoken language. Hearing loss hinders the auditory ability to detect, understand and discriminate speech sounds perceived. Often times, hearing loss deprives individuals with such disabling condition the privilege of enjoying smooth communication development, while at the same time exposes them to poor speech understanding and discrimination. Thus, affecting the development of good speech and language, because speech discrimination is the ability to tell the difference between words and sounds that are similar as well as words and sounds that are different (7).

Good speech discrimination is particularly important for the development of speech and language skills. Hence, the ability to accurately perceive and understand, especially when speech is loud enough to hear comfortably is a measure of speech discrimination. Speech discrimination is a challenge art that could be linked to noise induced hearing loss, although they reported that not all patients who complained of speech discrimination performed poorly when tested (8). Presbycusis and reduced hearing perception have also been linked, to allow for a decrease in speech discrimination; this notion is hinged on the foundation that as hearing loss increases, the ability

to discriminate sounds decreases (9). Other conditions such as sensorineural hearing loss, Central Auditory Processing Disorder (CAPD), congenital and profound hearing loss are among the major causes of poor speech discrimination (1). For presbycusis, speech understanding difficulties are observed in terms of errors in the recognition of consonants especially with consonants sharing same articulatory structure (10), similar difficulties are experienced for children with hearing loss who cannot hear silent speech sounds such as /s/ /ʃ/ /f/ /t/ and /k/ (1).

Hearing loss is a major cause of communication disability globally, and has been found to affect speech perception and discrimination, as well as hinders psychosocial and intellectual development of children without early intervention. The World Health Organization in the year 2012 estimated that 360 million persons in the world are with disabling hearing loss of which 32 million of these are children. Similarly, in a research carried out in Rotterdam, Netherlands on the prevalence of hearing loss in a population-based cohort of nine to eleven years old children, it was found that 7.8% of the participants were with sensorineural hearing loss. Another research in Sub Saharan Africa accounted that for children aged between five and fourteen years, the prevalence of hearing loss was estimated at 1.9% in Sub Saharan Africa compared to 0.4% in high income countries (11). Although, in Nigeria as at 2000, the prevalence of hearing loss among school pupils was put at 13.9% constituting 15-18% of hearing loss in the general population; among the general population, 1/1000 people have one form of hearing loss or the other (12). Also, it has been reported that hearing impairment is common among primary school children in Port-Harcourt, their study revealed that 32.8% among children between ages of eleven to thirteen years and 24.2% between ages of five and seven years had slight hearing impairment (13). Similar prevalence has been reported by other studies across the country. Hence, the condition hearing loss is one in need of urgent attention as it imposes myriads of challenges on the affected individual.

In the year 2004, the National Research Council elucidated that the initial years of life are the optimal period for speech and language development and the impact of hearing loss is greater in those born with or those who develop hearing loss soon after birth (6). The body further explained that the age when the loss occurs is a major factor that influences the extent to which speech and language is affected. In adults with post lingual hearing loss, the language deficits experienced is mild compared to children. For children with prelingual hearing loss, they frequently display deficits in the articulatory and phonatory aspects of speech. Going further, it is important to consider the three periods for onset of hearing loss which are; during the first two years of life, between ages two and five, and after age five. During these periods, if intervention is delayed, the presence of disturbance in speech development leading to loss of speech skills is often experienced. In the presence of this, good articulation skills deteriorate and the need to re-establish sensory input is needed. Another major prediction for a good or poor speech and language development among children with hearing loss is the degree of loss. This may range from mild to profound: the higher the severity, the greater the impact. Authors have suggested that speech intelligibility and discrimination decreases as the degree of hearing loss increases; for example, a child with mild hearing loss might find it difficult to identify softer sounds (such as that of whispering) while moderate to severely hearing impaired children might find it more difficult to hear loud and more clearly defined noises (14).

For children, hearing is salient to learning spoken language, performing well academically, and engaging socially. Hearing loss poses a barrier to education and social integration, all which poses a problem to the acquisition and development of speech. However, with early detection, diagnosis and intervention, speech discrimination challenges can be managed; the sooner a child is identified with hearing loss, and the earlier he or she receives support services, the greater the opportunity for learning spoken language. In line with this, the Joint Committee on Infant Hearing

in the year 1994 recommended that all children with hearing loss should receive intervention by six months of age (15). Early identification and intervention are also credited with significantly reducing and improving problems associated with speech discrimination capacity.

In line with the above submission, research findings have reported that children who are born with or acquire hearing loss very early in life, and receive appropriate interventions within six months of age are at par with their hearing peers in terms of language development by the time they are five years old (15). For those children who develop hearing loss at a later age, regular pre-school and school-based hearing screening can effectively identify hearing loss soon after its onset and with appropriate intervention services, its adverse impact can be limited (12). However, measures to address such difficulties have been put in place. Appropriate sensory aids, cued speech, gestural cues, aided language stimulation, auditory training, speech reading and the use of amplification devices such as hearing aids as well as cochlea implant are some of the evidence-based strategies/tools that have been employed in habilitating and rehabilitating persons with poor speech discrimination (16; 17; 1). Intervention for hearing-related difficulties begins with the assessment of auditory acuity, appropriate diagnosis and eventual adoption of appropriate management technique. The choice of habilitation and rehabilitation technique is dependent on quite a number of factors. Some of which include site of lesion, age of onset, and manifestation of the signs and symptoms. Although a number of management techniques have previously been employed and found useful, research into these techniques and development of evidence-based management techniques are still needed. Auditory training and speech reading are among the aural rehabilitation strategies that can be employed in the management of speech discrimination challenges experienced by children with hearing loss.

Auditory training, which is used as an intervention in this study, could be explained as a process which allows the child with hearing loss to

discriminate between different sounds and match meaning with sounds (1). Auditory training as an intervention strategy is capable of revolutionizing a range of language or listening impairments such as those related with hearing loss like auditory processing disorder, sensorineural hearing loss and conductive hearing loss (18). The authors further stated that using simple sounds for auditory training is capable of providing a wide range of improvements in receptive language skills and literacy. A continuous use of auditory training provides the child with an opportunity to configure and reconfigure the brain to receive auditory stimuli and identify as well as distinguish between sounds. Auditory training follows a purposeful and systematic presentation of sound in a way that the listeners are taught to make perceptual distinction between these sounds (19). Past studies have shown that auditory training obviously improves speech understanding; yet only an estimated 10 percent of audiologists recommend auditory training (20; 21). Lack of time and reimbursement and most importantly, the absence of compelling research have been identified as the reason for the statement mentioned above (22; 23; 21). Consequent upon the observation, a study was designed to determine the effectiveness of intensive auditory training on auditory skills and speech intelligibility of prelingual cochlear implanted adolescents and adults using the modified version of the Arabic rehabilitation programme, was conducted on 30 patients divided into two groups according to intensiveness of the auditory training. The findings revealed, in the postoperative assessment a significant difference comparing the two groups in spondee discrimination, sentence identification and high context sentence recognition at the 18-month assessment. A significant mean difference for speech intelligibility scores was also found between the two groups. Sequel to the finding, evidence of a significant improvement was detected in the auditory skills and degree of speech intelligibility of the participants (24).

Another evidence-based management strategy that has been noted to assist those with hearing loss is speech reading. This refers to the perception of

speech by interpreting visually available movements of the face, mouth, and the tongue (25; 26). It is the art of being able to see speech sounds. It uses clues such as facial expressions, gestures and surroundings to help understand what is being said. It presents the ability to take what is observed in the movement of a speaker lips along with accompanying facial expressions as well as body language, and to gain an enhanced understanding of a verbal communication. In curbing the menace of poor speech understanding through speech reading, Centre for Disease Control and Prevention in the year 2018 reported that speech reading has been discovered to be a building block that helps a child with hearing loss understand speech. Hence, 40% of the sounds, approximately, in the English Language can be seen on the lips of a speaker in good conditions, and this enables the children watch the movements of a speaker's mouth and face to understand what the speaker is saying (27).

Overtime, speech reading has been used as a tool for managing speech discrimination problems in the realm of auditory perception, discrimination and understanding. To this end, the possibility of utilizing speech reading to discriminate languages has been proven as an effective strategy towards rehabilitating speech discrimination difficulties of individuals with hearing loss. Consequently, a study has been conducted to confirm that speech reading is particularly useful for bilingual speakers, as the participants rehabilitated were able to discriminate between two languages during the postoperative assessment (28).

Based on this observation, Marshall and Bacon in the year 1981 routinely collated audiological data to predict the speech discrimination scores of patients with varying degrees of sensorineural hearing loss. The researchers examined those within the ranges of mild to severe sensorineural hearing losses within the ages of fourteen and ninety-four years. The listeners with hearing impairment were noted to have sloping hearing losses within the high frequency thresholds usually worse than the low frequency. From the result of the research, patients with mild hearing losses of cochlear origin

are expected to have good speech discrimination, and age was also noted as a determining factor for the patient on speech discrimination scores (9). Although, in a contrast vein, another study which was designed to investigate the speech recognition performance of persons with mild to moderate sensorineural hearing loss reported a kind of insignificant improvement in the speech discrimination with the use of speech reading skill. The researchers noted the speech discrimination problems amongst these persons with the study revealing little or no difference in the speech discrimination scores, due to differences in the degree of hearing loss and age of onset of hearing (29). This necessitated the use of age of onset and degree of hearing loss as moderating variables in this study.

As mentioned above, the researchers have continuously researched into whether the impact of the degree of hearing loss on the speech discrimination ability among children with hearing loss might vary according to the degree. Minimal hearing loss may have difficulty hearing faint or distant speech sounds but would perform higher in speech discrimination task compared to those with moderate hearing loss, severe hearing loss and profound hearing loss. It is important to note that children ability and early intensive intervention will determine the degree that sounds detected will be discriminated and processed into meaningful output. Age is another important factor in the determination of the auditory perception of an individual. As the ear is a vulnerable organ, it is prone to neural degeneration and structural changes as humans grow older and that many older adults constantly experience great challenges in understanding speech especially in demanding listening conditions, although they can hear speech sounds (30).

It has hence been confirmed that proper speech perception particularly speech discrimination is a problem of the aged population, however children who are yet to experience this structural and neural degeneration have also been identified as been prone to this problem. In fact, it can be concluded that speech perception is a common problem for children with pre-lingual

hearing loss, and this has been confirmed by a study on 60 children with pre-lingual sensorineural hearing loss (31). It was also identified, through the use of various monosyllabic words and disyllabic words to note the benefits of the cochlear implants as it allowed maximum development of auditory skills.

Speech discrimination plays a critical role in a child's language and reading skill development. For example, a child with hearing loss might experience problem in observing the difference(s) in pronunciation between "sister" and "sitter" as well as "cat" and "cot". Hence, such a child would be experiencing difficulty in remembering the sequence of words as well as having some challenges in writing appropriately (32). Sensorineural hearing loss has been found to have negative influence on the auditory functioning of the children. Also, it reduces the ability to hear faint sound or discriminate speech; speech is exceptionally difficult to hear, in most cases if there are any competing sounds such as background noise even when speech is loud enough to hear, it may still be unclear or sound muffled (32; 33). Owing to the importance of speech discrimination, the achievement of phonemic awareness and literacy becomes a challenge for a child with hearing loss. For instance, if a child reads a book about flowers, which includes a section about bees, such a child would need to recognize that the word "bees" is made up of three sounds "b" "ee" and "zz" (32). Hence, auditory deprivation early in life has been observed having serious consequences for subsequent communication, intellectual and psychosocial development of children with prelingual hearing loss, which is the main reason for this study.

Despite research-based interventions in the management of hearing related conditions, there is a need for the implementation of Evidence-based practices (EBPS) in the field of Speech- Language Pathology and Audiology. This also calls for the advancement of a purely empirical research work towards finding an appropriate rehabilitative (therapeutic) strategies to resolve the speech discrimination challenges experienced by the

children with hearing loss. Hence, this study is designed to determine the effect of auditory training and speech reading exercise on the speech discrimination ability of children with hearing loss in Ibadan, Oyo State, Nigeria, while the moderating effect of degree of hearing loss, and age of onset were also examined.

II. Purpose of the Study

The study examined the effect of auditory training and speech reading exercises on the speech discrimination ability of children with hearing loss in Ibadan, Oyo State, Nigeria. Specially, the study examined the influence of auditory training and speech reading exercises on the performances of the participants, who were subjected to speech discrimination test administered. It also determined the interaction effects of degree of hearing loss and age of onset on the performance of the participants on the speech discrimination test.

III. Hypotheses

The following hypotheses were tested in this study at 0.05 level of significance:

- H₀₁: There is no significant main effect of treatments on the speech discrimination ability of children with hearing loss.
- H₀₂: There is no significant effect of degree of hearing loss on speech discrimination ability among children with hearing loss.
- H₀₃: There is no significant effect of age of onset on speech discrimination skills among children with hearing loss.

Ho4: There is no significant interaction effect of treatments and degree of hearing loss on speech discrimination ability among children with hearing loss.

Ho5: There is no significant correlation effect of treatments and age of onset on the speech discrimination ability among children with hearing loss.

Ho6: There is no significant interaction effect of degree of hearing loss and age of onset on the speech discrimination ability of children with hearing loss.

Ho7: There is no significant interaction effect of treatments, degree of loss and age of onset on the speech discrimination ability among children with hearing loss.

IV. Methodology

This study adopted a pretest-posttest control group quasi-experimental research design with a 3x2x3 factorial matrix. Multi-stage sampling was adopted. At first, Ibadan metropolis was classified in accordance with the distribution of schools for children with special needs, and thus three Local Government Areas were randomly selected from Ibadan metropolis. One school was selected randomly from each local government area. Thereafter, one primary school for the children with hearing loss was purposively selected from each of the three local government areas. Thirty Pupils (10 per School) were purposively selected from the schools based on the degree of hearing loss (moderately-severe and severe hearing loss), and onset of hearing loss (pre-lingual and post-lingual hearing loss). The schools were randomly assigned to treatments on the basis of equal allocation: Auditory training (10) Speech reading (10) and control (10) groups. The treatment lasted ten weeks including a week each for pretest and posttest evaluation. The participants were trained and evaluated with the use of adapted version

of the Clement Ayodele Bakare Speech Discrimination Test List (0.75) and Pat Laforest Experimental Speech Sound Discrimination Test list (0.72). The Experimental groups 1 and 2 were exposed to auditory training and speech reading exercise respectively, based on the use of items on the two discrimination test lists, while those in the control group were restricted only to the conventional method of training. After the treatment, the pretest and posttest scores were subjected to statistical analysis. Data collected were analysed using Analysis of Co-variance (ANCOVA) and Scheffe post hoc test and t-test at 0.05 level of significance.

VII. Results

H₀₁: There is no significant effect of treatments (auditory training and speech reading), and conventional method on the speech discrimination skills among children with hearing loss.

Table 1: Summary of 3x2x3 Analysis of Covariance (ANCOVA) Post-test Speech Discrimination ability of children with Hearing Loss.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4904.129 ^a	13	377.241	2.970	.021	.707
Intercept	2138.827	1	2138.827	16.837	.001	.513
Pretest	.796	1	.796	.006	.038	.800
Age of onset	14.445	1	14.445	.114	.040	.697
Severity	268.935	2	134.468	1.059	.370	.117
Treatment group	2542.790	2	1271.395	10.008	.002	.556
Age of onset * Severity	13.909	2	13.909	.109	.745	.007
Age of onset * Treatment	8.847	2	4.423	.035	.966	.004
severity * Treatment	439.620	4	219.810	1.730	.009	.578

Age of onset * Severity * Treatment	211.226	4	105.613	.831	.643	.094
Error	2032.538	16	127.034			
Total	49500.000	30				
Corrected Total	6936.667	29				

R Squared = .707 (Adjusted R Squared = .469)

The result in Table 1 shows that there was significant main effect of treatments on the speech discrimination ability of children with hearing loss ($F_{(2;13)} = 10.008$, $p < 0.05$, $\eta^2 = 0.556$). This means that there existed significant difference in the mean scores of the level of the speech discrimination ability of children with hearing loss exposed to auditory training and speech reading when compared with the control group. Hence, hypothesis one was rejected on the ground that there was significant difference between pretest and posttest scores. It is therefore, concluded that there was significant main effect of treatments on the speech discrimination ability of children with hearing loss, depicting that auditory training and speech reading techniques are effective for improving speech discrimination ability of children with hearing loss. To further provide information on improvement of speech discrimination ability of children with hearing loss, among the three groups (Auditory training, Speech reading and Control), it is evident to ascertain the direction of the differences and determine the magnitude of the mean scores of the participants in each of the three groups. Thus, Scheffe Post-hoc Analysis was conducted and the result is presented in Table 2.

Table 2: Scheffe Post-hoc Analysis showing significant differences in the treatment Groups.

Treatment group	N	Subset for alpha = 0.05		
		1	2	3
Auditory training	10	42.33*		
Speech Reading	10		49.00*	
Control	10			33.33*
Sig.		1.000	1.000	1.000

The result in the Table 2 reveals that there was significant difference in the post-hoc mean scores as regards the level of improvement of speech discrimination ability of children with hearing loss exposed to treatment. The participants in auditory training (Mean = 42.33) improved in speech discrimination ability more significantly than those in the control group (Mean = 33.33). In addition, the result indicated that there was significant difference in the post-hoc mean scores in the level of improvement of speech discrimination ability of children with hearing loss exposed to speech reading technique and control group. The participants in speech reading exercise (Mean = 49.00) improved in speech discrimination ability more significantly than those in the control group (Mean = 33.33). This implies that there was significant difference between the mean score of participants in auditory training, speech reading techniques and those in the control group. Hence, auditory training and speech reading were more effective than control the conventional strategy used with those in the control group. The results obtained, have indicated that speech reading exercise had the greatest potency of improving speech discrimination ability of children with hearing loss than auditory training.

H₀₂: There is no significant main effect of the degree of hearing loss on speech discrimination ability of children with hearing loss.

The results from Table 1 show that there was a significant main effect of the degree of hearing loss on speech discrimination ability of children with hearing loss ($F_{(2; 13)} = 12.06, p < 0.05, \eta^2 = 0.117$). This means that there existed a significant difference in the mean scores of the speech discrimination ability of children with hearing loss based on their degree of hearing loss. Hence, hypothesis two was rejected because there was significant difference between pretest and posttest scores of the participants. To further provide information on the improvement in speech discrimination ability of children with hearing loss based on their degree of hearing loss, it is imperative to ascertain the direction of the differences; and determine

the magnitude of the mean scores of the participants along degree of severity. Thus, the Scheffe Post-hoc Analysis was conducted and the result is presented in Table 3:

Table 3: Scheffe Post-hoc Analysis showing significant differences in the degree of hearing loss.

Degree of hearing loss	N	Subset for alpha = 0.05		
		1	2	3
Moderate	1	47.23*		
Severe	13		42.13*	
Profound	16			40.33*
Sig.		1.000	1.000	1.000

Table 3 indicates that there was a significant difference in the post-hoc mean scores in the level of improvement of speech discrimination ability of children based on their hearing loss. The children with moderate hearing loss had post-test score of 47.23, while those with severe degree of hearing loss had 42.13 and those with profound degree of hearing loss had 40.33. This shows that there was a significant main effect of the degree of hearing loss on speech discrimination ability of children with hearing loss.

H₀₃: There is no significant main effect of age of onset on speech discrimination ability of children with hearing loss.

The results in Table 4 show that there was significant main effect of age of onset of hearing loss on speech discrimination ability of children with hearing loss ($F_{(1; 13)} = 4.114, p < 0.05, \eta^2 = 0.697$). This depicts that there was significant difference in the mean scores of the speech discrimination skills among children with hearing loss. Hence, hypothesis two was rejected on the ground that there was significant main effect of age of onset on speech discrimination ability of the participants. To further elucidate on improvement of speech discrimination ability of children with hearing loss between the

two levels of age of onset (pre-lingual and post-lingual), it is important to put forward the direction of the differences and determine the magnitude of the mean scores of the participants along with age of onset. Thus, the t-test analysis was conducted and the result is presented in Table 5

Table 5: T-test showing difference between mean scores of age of onset (pre-lingual and post-lingual)

Variable	N	Mean	SD	Df	t	p
Pre-lingual	20	40.00	15.985	28	6.578	<0.05
Post-lingual	10	48.50	14.907			

The results in Table 5 reveal that there was significant difference between the post-treatment mean scores of children with hearing loss based on their age of onset. Thus, the participants with post-lingual hearing loss had better mean score (48.50) compared with those with pre-lingual (40.00) hearing loss. The findings indicate that those with post-lingual hearing loss benefitted better from the treatments compared to those with pre-lingual hearing loss.

Ho4: There is no significant interaction effect of treatments and degree of hearing loss on speech discrimination ability of children with hearing loss.

The results in Table 4 establish insignificant interaction effect of treatment and degree of hearing loss on speech discrimination ability of children with hearing loss ($F_{(2, 13)} = 1.73, p > 0.05, \eta^2 = 0.018$). This implies that there was no significant interaction effect of treatments and degree of hearing loss on speech discrimination skills of children with hearing loss. Hence, hypothesis four is accepted because the significant level (0.109) is greater than 0.05, giving an indication that there was no significant interaction effect of the treatment and degree of hearing loss on speech discrimination ability of children with hearing loss.

H05: There is no significant interaction effect of treatments and age of onset on the speech discrimination ability of children with hearing loss.

The results in Table 4.1 show that there was no significant interaction effect of treatment and age of onset on the speech discrimination ability of children with hearing loss ($F_{(2; 13)}=0.04$ $p>0.05$, $\eta^2=0.1004$). This therefore, indicates that there was no significant interaction effect of treatments and age of onset on the speech discrimination ability of children with hearing loss. Hence, hypothesis five is accepted, because the significant level, (0.97) is greater than 0.05, indicating that there is no significant interaction effect of treatment and age of onset of hearing loss on the speech discrimination ability of children with hearing loss.

H06: There is no significant interaction effect of degree of hearing loss and age of onset on the speech discrimination ability of children with hearing loss.

The results in Table 1 also indicate that there was no significant interaction effect of degree of hearing loss and age of onset on the speech discrimination ability of children with hearing loss ($F_{(4; 13)} = 0.11$, $p > 0.05$, $\eta^2 = 0.01$). Thus, it indicates that there was no significant interaction effect of degree of hearing loss and age of onset on the speech discrimination ability of children with hearing loss. Hence, hypothesis six is accepted, because the significant level (0.75) is greater than 0.05 as the norm. This infers that the two moderating variables (degree of loss and age of onset) are not likely to predict the outcome of speech discrimination skills ability of children with hearing loss.

H07: There is no significant interaction effect of treatments, degree of loss and age of onset on the speech discrimination ability of children with hearing loss.

The results in Table 4 reveal further that there was insignificant interaction effect of treatments, degree of loss and age of onset on the

speech discrimination ability of children with hearing loss ($F(4,13) = 0.831$, $p > 0.05$, $\eta^2 = 0.94$). It is therefore important to conclude that there was no significant interaction effect of treatment, degree of loss and age of onset on the speech discrimination ability of children with hearing loss. Hence, hypothesis seven is accepted, because the significant level of 0.643, is greater than 0.05. In essence, the treatment options, degree of loss and age of onset did not determine the speech discrimination ability of children with hearing loss.

Discussion of findings

Effect of treatments on the speech discrimination ability of children with hearing loss

This study found a significantly positive effect of auditory training and speech reading exercises on speech discrimination ability of children with hearing loss. This implies that the therapeutic interventions of auditory training and speech reading exercises were effective in enhancing the speech discrimination ability of children with hearing loss. However, speech reading exercises is more effective than auditory training therapeutic intervention. This finding corroborates the earlier findings, that speech reading exercise is particularly useful in enhancing the speech discrimination ability among children with hearing loss (28). Similarly, earlier findings have established the usefulness of speech reading exercise in aiding and improving speech comprehension ability. In line with this observation, a study was initiated by Shindo, Kaga and Tanaka in the year 1991 to assess the ability of four participants with word deafness and auditory agnosia, and the study found out that the participants were able to discriminate speech effectively through the reading of the lips of the speakers (34). Also, this study is in conformity with recent research findings that auditory training and speech reading are therapeutic options which are effective in enhancing the speech discrimination abilities of children with hearing loss (1; 18). Although, as the age of the children with hearing loss increases, their word

recognition and speech discrimination ability will systematically decrease in line relation to decline along the auditory systems leading to a reduction in the ability to perceive sounds and discriminate speech correctly (35)

Main effect of the degree of hearing loss on speech discrimination ability of children with hearing loss

The finding of this study revealed the degree of hearing loss of participants as an important factor in the improvement of their speech discrimination. Participants who had profound hearing loss had less improvement compared to those with severe hearing loss, while those with severe hearing loss had less improvement compared to those with moderate hearing loss. The findings of this study also supported that of a past study which routinely collated the performance of their samples (participants) to audiologically predict the speech discrimination scores of patients with varying degrees (9). The findings supported that, speech discrimination performance be determined by degree of hearing. Contrastively, this study disagreed with earlier study which investigated the speech recognition performance of persons with mild- to- moderate and sensorineural hearing loss and that there was no significant difference in the speech discrimination scores of the participants (29).

Main effect of age of onset on speech discrimination ability of children with hearing loss

The findings of the study reveal that age of onset had significant positive effect on the speech discrimination ability of children with hearing loss. This study corroborates the earlier findings that age of onset is a determining factor for speech discrimination deficiency which has been evidenced in the performance of children with hearing loss (31). Similarly, the findings of this study also corroborated past findings that those with post lingual hearing loss benefitted better than other age of onset of hearing loss, and that listening challenges, speech perception and speech discrimination problems are common challenges experienced by any individual with hearing loss as age increases (30; 36).

Interaction effect of treatments and degree of hearing loss on speech discrimination ability of children with hearing loss

The findings of the study indicate that there was no significant interaction effect of treatments and degree of hearing loss on speech discrimination ability of children with hearing loss. The finding was in support of past findings that speech reading exercise had positive effect on the speech discrimination ability of children, even with the high degree of hearing loss (37). Thus, the participants benefitted from the treatment options as significant improvement in the areas of speech perception and discrimination skills were recorded. In similar findings, a significant increase was reported in the overall speech discrimination ability of the participants who were exposed to auditory training (38). The improvement in speech discrimination ability was associated with high intelligence, and that the children with hearing loss exhibited improved speech discrimination ability after being exposed to auditory training.

Interaction effect of treatments and age of onset on the speech discrimination ability of children with hearing loss

The findings reveal also that there was insignificant interaction effect of treatment and age of onset on the speech discrimination ability of children with hearing loss. This finding negates the findings of a past study which found that auditory training significantly on the speech recognition ability of children with hearing loss, in the sense that the treatment had a significant interaction effect with age of onset (1). The findings showed an interaction effect of treatment on speech detection, discrimination and recognition abilities of the participants. Similarly, it has been found that age of onset has implication for the language development of children with hearing loss. It serves a determinant for language development such as vocabulary development, grammatical comprehension, word production and syntax (39). Therefore, this finding creates a need for further study in this direction of evaluating the interaction effect of any of the treatment options and age of onset of hearing loss on the speech recognition, speech

understanding and speech discrimination ability of children with hearing loss.

Interaction effect of degree and age of onset of hearing loss on the speech discrimination ability of children with hearing loss

The finding shows that there was no significant interaction effect of degree of hearing loss and age of onset on the speech discrimination ability of children with hearing loss. This study corroborates the earlier finding that auditory training aided the language simulation of children with speech perception deficit (1; 40). Other research works have also established no relationship between the degree of hearing loss, and the effectiveness of the treatment option adopted (36; 37; 41). These studies concluded that the efficiency and potency of the treatment options are dependent on the degree of loss. Thus the treatment options could be effective with the use of amplification devices (auditory trainer, and/or hearing aid), and the speech reading exercise could make use of sense of vision in place of the sense of hearing. Thus, speech discrimination ability of children with hearing loss could be effectively enhanced through the therapeutic intervention of auditory training and speech reading exercises.

Interaction effect of treatment, degree of, and age of onset of hearing on the speech discrimination ability of children with hearing loss

The findings indicate that there was no significant interaction effect of treatments, degree of, and age of onset of hearing loss on the speech discrimination ability of children with hearing loss. This implies that interaction of the treatments, degree of, and age of onset of hearing loss did not improve speech discrimination ability of children with hearing loss. Although, past studies claimed that treatment options had an interacting effect on speech recognition and speech detection but not on speech discrimination, while at the same time confirmed the efficiency of speech reading exercise on children with hearing loss regardless of age of onset and degree of hearing loss (1; 28). Hence, this study provides evidence-based justification for the use of these treatment options (auditory training and

speech reading techniques). Overall, the treatments were effective in improving the speech discrimination ability of children with hearing loss, while the degree of hearing loss and age of onset do not interact with the treatments towards improving the speech discrimination ability of children with hearing loss.

VIII. Conclusion

The study investigated the effect of auditory training and speech reading exercises on the speech discrimination ability of children with hearing loss in Ibadan, Nigeria. Based on the findings of the study, it has been affirmed that auditory training and speech reading exercises are effective rehabilitative options towards improving the speech discrimination ability of the children with hearing loss, regardless of their degree of hearing loss and age of onset of the auditory disabling condition. Both the auditory training and speech reading techniques have the capability to enhance the speech discrimination ability of people with hearing loss. The rehabilitation options also accommodate the use of amplification device(s) and integration of visual sensory organ during the course of rehabilitation. Therefore, the rehabilitation options are helpful in strengthening both the hearing and visual abilities of children with hearing loss, and this makes the rehabilitation options to be considered as viable techniques in rehabilitating speech discrimination ability. Hence, auditory training and speech reading exercise are necessary rehabilitation options that should be employed to rehabilitate the children with hearing loss, especially towards enhancing their speech discrimination ability as well as to encourage them to engage in continued communication. These two rehabilitative options have shown effectiveness in the rehabilitation of speech discrimination ability of children with hearing loss irrespective of the degree of, and age of onset of the

hearing loss.

IX. Recommendations

This study has shed light on the effectiveness of auditory training and speech reading exercise in mitigating the presence of poor speech discrimination among children with hearing loss, as well as the need to (re)instating children with hearing loss into the communication world. Based on the findings of the study, the following recommendations are made:

1. Children with poor speech discrimination problems resulting from hearing loss should be rehabilitated or habilitated through auditory training or speech reading techniques. They should be particularly helped through speech reading exercise, as it has been proven that this therapeutic option was effective, regardless of severity, degree of hearing loss and the age of onset; while auditory training would be more effective for those with better hearing conditions or among those using amplified devices such as hearing aids.

2. Speech reading technique should be incorporated into the curriculum for children with hearing loss as this does not only provide them with an alternative communication, but also allay the feelings of insecurity between the children with hearing loss and their hearing counterparts. It would also help smoothen and ease their lives outside the four walls of the classroom.

3. Regular hearing screening should be mandated for all school-aged children to serve as a check against the deterring effect of hearing loss.

4. Caregivers, parents and guardians should also be educated on proper hearing conservation principles.

5. Early intervention services towards a better hearing education, and psycho-social adjustment and development should be appropriately considered.

6. Counselling programmes should be introduced for parents and caregivers of children with hearing loss to help provide useful information about appropriate rehabilitative mechanism to suit each child with hearing loss

7. Audiologists, Speech-Language Pathologists and special educators should continue to create awareness and sensitize parents and guardians of children with hearing loss on the importance of aural rehabilitation. This would enable them to explore all rehabilitative options available to assist their children with hearing or speech difficulties towards a better communication educational progress and psychosocial development.

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