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Effect of Auditory Training on Sound Discrimination among Students with Hearing Impairment in Calabar Metropolis, Nigeria

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Abstract
The study investigated the effect of auditory training on sound discrimination among students with hearing impairment in Calabar Metropolis. The study was guided by two research questions and two hypotheses. Literature was reviewed according to the variables of the study. The study adopted a pretest-posttest control quasi-experimental design. Purposive sampling technique was used to select 20 students from a population of 200 students. The instruments used were Scene Analysis Scale (SAS) and Sound Keenness Scale (SKS). The instruments were given to Special Educators, and Measurement and Evaluation experts for face validation. The reliability of the instrument was ascertained using Cronbach alpha and the coefficients of the sub scales were 0.82 and 0.88, which showed that the instrument is reliable. The questionnaire was administered to the students first as a pretest and after three weeks of instruction, the post test was administered to both groups. The data was analysed using simple percentages and Analysis of Covariance (ANCOVA). The results showed that auditory training has a significant effect on sound localization and recognition among students with hearing impairment. Based on the findings, it was recommended, among others, that students with hearing impairment should be helped with auditory training and relevant therapies.
Keywords: auditory, training, sound, discrimination, hearing, impairment, students

Introduction

Sound discrimination is the ability to detect similarities and differences when listening to sounds. It is a fundamental aspect for the correct production of speech sounds. Sound discrimination enables one to understand the environment; it also enables perception and cognitive mapping of information. Man perceived the world through sensory experience and one of the sense organs is ear, which facilitates communication and fosters social interaction, forges relationship and enables participation in daily activities. This sense organ also helps one to be alert to dangers and experience events and happenings around the world. For somebody with inability to use the ear in hearing, his life is in jeopardy, except there is early detection. Students should learn

and discriminate some specific sounds so that the speech is considered adequate when compared to the adult pattern of their mother tongue. The ability to recognize a spoken word, if it is uttered loudly enough for the ear to detect it as a sound, is a measure of how well one understands what is heard when a sound is loud enough (Kisilevsky, Hains, Brown, Lee, Cow-Perthwaite, Stutzman & Wang, 2009).

However, depending on the severity of the hearing impairment, many of the students find it difficult to differentiate sounds and this accounts for why many of them, especially those with mild severity, hardly understand what one is saying. They misinterpret virtually all that an individual says and this is why they can easily get problems with those around them (Moses, 2006). Students without hearing impairment learn how to listen naturally at a very young age; but for those with hearing loss, auditory training is provided as early intervention with auditory stimuli and coaching that helps the students learn to identify and distinguish sounds. This state of affairs has raised a lot of concern on what would have been the causes of this problem. Researchers have identified three primary factors. These factors have been thought to cause hearing loss and are classified by the point in time that they manifest. There are Prenatal (before birth), perinatal (during birth) and postnatal (after birth) factors. This researcher presumes that auditory training could help in sound discrimination such as sound localization and sound recognition among the hearing impaired in schools.

Auditory training (AT) is a term used to describe a prescribed regimen of listening exercises designed to improve an individual's ability to perceive speech sounds (Oslo, 2015). It is a process that involves teaching the brain to listen. Auditory training is designed to improve an individual's ability to perceive sound and speech. Auditory training enhances brain plasticity (the capacity of neurons in the central auditory system to alter their structure and function) in response to auditory stimulation. The repeated practice of listening to speech sounds included in auditory training exercises is believed to drive the development of more efficient neuronal pathways, thereby improving auditory processing and speech discrimination.

Auditory training is evidenced by a change in a listener's ability to perform an auditory perceptual task. Auditory training is based on the assumption that whatever the degree of hearing loss, a little amount of hearing sensitivity (residual hearing) is still left. The individual is therefore, trained to maximize the residual hearing for better communication and comprehension (Mallubu, 2018). Auditory training allows the students with hearing impairment to discriminate between different sounds and to attach meaning to sounds. For example, horns evolved from loud and obnoxious noises to warning signals that alert people to dangers. Individuals with hearing loss are often able to regain some lost auditory function with the help of hearing aids. Without training, devices like hearing aids are not very useful to students. Auditory training

can help students with hearing impairment, who are sensitive to auditory stimuli, deal with the world around them; and it may also improve communication skills and help to feel more comfortable in noisy environments. It is important to note that interventions like auditory training are approaches to management that can help people cope with the environment. Effective auditory training programme may improve the use of audible speech information, enhance sound recognition, increase the effectiveness of hearing aids, and improve quality of life (Boothroyd, 2010).

Localization of sound is the process of determining the location of a sound source. The major goal of sound localization is to simulate a specific sound field, including the acoustic sources, the listener, the media and environments of sound propagation. Sound localization is the ability of students with hearing impairment to identify the location or origin of a detected sound in direction and distance. It may also refer to the methods in acoustical engineering to simulate the placement of an auditory cue. The auditory system uses several cues for localization of sound source. It is widely recognized that hearing aids and hearing assistive technologies can be key components to improving hearing and communication abilities; the critical role that auditory training can play in sound localization is often overlooked. The ability to localize sound is useful for survival, because it allows individuals to determine the location of sound sources (Chisolm, Abrams & McArdle, 2004).

Sound recognition is the acknowledgement and appreciation of sound by students with hearing impairment. A primary complaint of hearing-impaired listeners is poor speech recognition in background noise (Dennis, 2011). This issue can be quite debilitating and persists despite considerable efforts to improve hearing technology. Everyday communication frequently comprises situations with more than one talker speaking at a time. These situations are challenging since they pose high attention and memory demands, thus placing cognitive load on the listener. Hearing impairment additionally exacerbates communication problems under these circumstances.

Consciousness of what happens in the surrounding environment is strongly dependent on an individual's capacity to recognize sounds and accurately identify events related to them (Boothroyd, 2010). The human auditory system uses a number of well-identified cues to segregate and separate individual sound sources in a complex acoustical environment. The present researcher is asking, could auditory training influence sound localization and recognition among the hearing impair? It was in an attempt to answer this question that this study was carried out.

Gotring (2005) conducted a research which attempted to find out the role of games and recreational activities in learning Mathematics. The study was carried out in Jos North, Nigeria; two hundred (200) students, and thirty (30) teachers were used as the sample

size. The test of significance of relationship was computed using Z test (Z=r n-1), computed via the Pearson-Product Moment Co-relational method. After computation, r was found to be 0.638, and transformed to Z, giving Z-calculated =8.99. Z-table=0.6931 at 0.5% or 0.005 probability level. At the end, the null hypothesis: "there is no relationship between the use of Games as a method of teaching and learning mathematics," was rejected implying that there is a relationship. The findings were that games can be used to teach and learn concepts, theories, facts, models, attitudes, stances and mind sets. The findings further buttressed the fact that games and recreational activities have significant roles in learning; teachers and counsellors are not so much involved in the use of games because of ignorance. Gotring further emphasized that games and puzzles could be gainfully employed to make transfer of knowledge in subjects and trainings more effective. Gotring also agrees that games and recreational activities help a great deal in forming concepts, ideas, thoughts and attitude.

McGowan, Nittrouer and Chenausky (2008) conducted a study on speech production in 12-month-old children with and without hearing loss. The aim was to compare speech production at 12 months of age for children with hearing loss (HL) who were identified and received intervention before 6 months of age with those of children with normal hearing (NH). The speech production of 10 children with NH were compared with that of 10 children with HL whose losses were identified (better ear pure-tone average at 0.5, 1, and 2 kHz poorer than 50 dB HL) and whose intervention started before 6 months of age. These children were recorded at 12 months of age interacting with a parent. Three properties of speech production were analyzed: (a) syllable shape, (b) consonant type, and (c) vowel formant frequencies. The 10 children with NH whose data were analyzed had all passed newborn hearing screenings at birth and later passed hearing screenings at 36 months of age consisting of the pure tones 0.5, 1.0, 2.0, and 4.0 kHz presented at 20 dB HL to each ear separately. Hearing aids were provided as soon as possible after identification. All the children, and parents of all children involved in the study reported that hearing aids were worn during all waking hours, except at bath time. At the time of data collection, no child had a cochlear implant. All were in early intervention programmes in which spoken communication was emphasized, but 3 of the children with hearing loss had spoken language input supplemented with sign language. The result showed that children with hearing loss had (a) fewer multi-syllable utterances with consonants, (b) fewer fricatives and fewer stops with alveolar-velar stop place, and (c) more restricted front-back tongue positions for vowels than did the children with normal hearing. The study concluded that even when hearing loss is identified shortly after birth; children with hearing loss do not develop speech production skills as their peers with normal hearing do at 12 months of age. This suggests that early hearing intervention should be greatly provided and encouraged. The main existing gap in this study is the lack of management

strategies. The problems and their effects have rightly been identified; but the sufferer is left without the way out. This researcher intends to fill the gap by providing auditory training that would take care of speech production skills as early as possible.

Purpose of the study

The purpose of the study is to examine the effect of auditory training on sound discrimination among students with hearing impairment in Calabar Metropolis. Specifically, the researcher sought to find out the:

i. Effect of auditory training on sound localization among students with hearing impairment.

ii. Effect of auditory training on sound recognition among students with hearing impairment.

Research questions

The following questions were raised to guide the study:

i. What is the effect of auditory training on sound localization among students with hearing impairment?

ii. What is the effect of auditory training on sound recognition among students with hearing impairment?

Hypotheses

The hypotheses were stated as follows:

Ho1: There is no significant effect of auditory training on sound localization among students with hearing impairment.

Ho1: There is no significant effect of auditory training on sound recognition among students with hearing impairment.

Methodology

The study adopted a pretest-posttest control quasi-experimental design. This is because the study involves the use of intact classes. The experiment took the following pattern:

	Groups	**Pretest**	**Treatment**	**Posttest**
Random assignment	Experimental	O_1	X	O_2
	Control	O_3	−	O_4

Where
O_1 = Pretest for Experimental Group
X = Treatment
O_2 = Posttest for Experimental Group
O_3 = Pretest for Control Group
− = Absence of Treatment
O_4 = Posttest for Control Group

The overall population of students with hearing impairment at Special Education Secondary School, Ibom Layout, Calabar is 200. A purposive sampling technique was used to select 10% of the students. A total of 20 students were selected and assigned to the experimental and control groups with 10 students in each group. The instruments used were Scene Analysis Scale (SAS) and Sound Keenness Scale (SKS). The instruments were divided into Sections A and B. Section A of the instrument was made up of the Bio-data of the respondents and Section B was made up of twenty (20) items through which the respondents responded to. The scale was a five points Likert Scale rated: Strongly Agreed (SA), Agreed (A), Undecided (U), Disagreed (D) and Strongly Disagreed (SD). An agreement with the most favourable item like SA attracts five (5) points; A attracts four (4) points; U attracts three (3) points; then D attracts two (2) points and SD was one (1) point. The instruments were design and developed by the researcher. The instruments were given to Special Educators, and Measurement and Evaluation experts for face validation. The reliability of the instrument was ascertain using Cronbach alpha and the coefficient of the sub scales showed that the instrument is reliable and can measure what it purports to measure consistently. The reliability of the Scene Analysis Scale (SAS) instrument obtained using Cronbach's Alpha coefficient indexes was 0.82 and Sound Keenness Scale (SKS) was 0.88. The questionnaire was administered to the students first as a pretest and after three weeks of instruction, which consists of Speech Therapy Tips using: picture motion, film/movies, tape recorders, flute, whistle and the likes; Audio Dance using: keyboard, talking drum, drum and more; and discussions and plenary sessions using: flashcards with mono syllabic words, disyllabic words, three letter words and simple phrases; story books; chalkboard; film/tv set, motion pictures and more. Even though those in the control group were also given hearing aids, they were not exposed to Auditory Training treatment. They were engaged meaningfully by their teachers (research

assistants) in social studies and other subjects for the period the experimental group undergo its treatment. The post test was administered to both groups. The data was analysed using simple percentages and Analysis of Covariance (ANCOVA).

Presentation of results

Research Question One: What is the effect of auditory training on sound localization among students with hearing impairment?

To answer this question, simple percentages were used and the result is presented in table 1.

Table 1: Extent of Sound Localization among Students with Hearing Impairment

Extent	Experimental Group		Control Group	
	Pre-Test (%)	**Post-Test (%)**	**Pre-Test (%)**	**Post-Test (%)**
Low	10(100)	0	10(100)	7(70)
Moderate	0	3(30)	0	3(30)
High	0	7(70)	0	0
TOTAL	10(100)	10(100)	10(100)	10(100)

Table 1 shows the extent of sound localization among students with hearing impairment before and after exposure to auditory training and those not exposed. Before intervention, students in both experimental and control groups had low scores (100%) in sound localization. But after intervention, the experimental group had 30% of the students moved to moderate extent and 70% moved to a high extent in sound localization. While students in the control group still had 70% low sound localization, while 30% were with moderate sound localization. This implies that auditory training enhances the sound localization of students with hearing impairment from low to a high extent after intervention.

Ho1: There is no significant effect of auditory training on sound localization among students with hearing impairment.

The independent variable is auditory training while the dependent variable is sound localization. To test the hypothesis, analysis of covariance (ANCOVA) was used and the result showed is presented in table 2.

Table 2: Analysis of Covariance (ANCOVA) of Sound Localization Post-test Mean Scores between Students with Hearing Impairment in Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F	p-value	Partial Eta Squared
Corrected Model	42.050[a]	1	42.050	5.890	.026	.247
Intercept	5346.450	1	5346.450	748.919	.000	.977
Groups	42.050	1	42.050	5.890	.026	.247
Error	128.500	18	7.139			
Total	5517.000	20				
Corrected Total	170.550	19				

a. R Squared = .247 (Adjusted R Squared = .205)

Table 2 shows the summary of Analysis of Covariance (ANCOVA) of sound localization post-test mean scores between students with hearing impairment in experimental and control groups. The post-test mean and standard deviation of students with hearing impairment in experimental group was 17.80±2.70 while the control group had 14.90 ±2.64. In addition, the calculatd F is 5.89, and p-value is less than .05. Since p-value of 0.026 is less than .05, there is a significant mean score difference between students with hearing impairment in experimental and control groups on sound localization after intervention. The researcher thus rejects the null hypothesis. This implies a statistically significant effect of auditory training on sound localization among students with hearing impairment.

Research Question Two: What is the effect of auditory training on sound recognition of students with hearing impairment?

To answer this research question, simple percentages were used and the result is presented in Table 3.

Table 3: Effect of Auditory Training on Sound Recognition among Students with Hearing Impairment

Extent	Experimental Group		Control Group	
	Pre-Test (%)	Post-Test (%)	Pre-Test (%)	Post-Test (%)
Low	10(100)	0	10(100)	8(80)
Moderate	0	6(60)	0	2(20)
High	0	4(40)	0	0
TOTAL	10(100)	10 (100)	10(100)	10 (100)

Table 3 shows the extent of sound recognition among students with hearing impairment before and after exposure to auditory training and those not exposed. Before intervention, students in experimental and Control groups had low scores (100%) in sound localization. The experimental group, after intervention, had 60% of the students moved to moderate extent and 40% moved to high extent. While students in the control group had 80% remained with low sound recognition while 20% moved to moderate sound recognition. This implies that auditory training enhances the sound recognition of students with hearing impairment from low to a moderate extent after intervention.

Ho2: There is no significant effect of auditory training on sound recognition among students with hearing impairment.

To test this hypothesis, analysis of covariance (ANCOVA) was used, and the result is as summarized in table 4.

Table 4: Analysis of Covariance (ANCOVA) of Sound Recognition Post-test Mean Scores between Students with Hearing Impairment in Experimental and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	432.450[a]	1	432.450	115.663	.000	.865
Intercept	3001.250	1	3001.250	802.712	.000	.978
Group	432.450	1	432.450	115.663	.000	.865
Error	67.300	18	3.739			
Total	3501.000	20				
Corrected Total	499.750	19				

a. R Squared = .865 (Adjusted R Squared = .858)

Table 4 shows the Summary of Analysis of Covariance (ANCOVA) of Sound Recognition Post-test Mean Scores between Students with Hearing Impairment in Experimental and Control Groups. The post-test mean and standard deviation of students with hearing impairment in experimental group was 16.90± 2.64 while the control group had 7.60±0.70. In addition, the F-calculated is 115.66, and the p-value is less than .05. Since the p-value (0.000) is less than 0.05, therefore there is a significant mean score difference between students with hearing impairment in experimental and control groups on sound recognition after intervention. The researcher rejects the null hypothesis. This implies that there is a statistically significant effect of auditory training on sound recognition among students with hearing impairment.

Discussion of findings

Findings from research question one, as summarized in Table 1, showed the extent of sound localization among students with hearing impairment before and after exposure to auditory training and those not exposed to auditory training. Before intervention, students in experimental and Control groups had low scores in sound localization. But after intervention the experimental group moved from low extent to high extent; while students in the control group were low, and majority were still low at post-test. The result from hypothesis one displayed the summary of Analysis of Covariance (ANCOVA) of Sound Localization Post-test Mean Scores between Students with Hearing Impairment in Experimental and Control Groups. The post-test mean and standard deviation of students with hearing impairment in experimental group had a significant mean score difference between students with hearing impairment in experimental and control groups on sound localization after intervention. The researcher accepts the alternative hypothesis and rejects the null hypothesis. This implies that auditory training enhances the sound localization of students with hearing impairment to a high extent after intervention. This result synchronized the study of Chisolm, Abrams and McArdle (2004), who opines that though it is widely recognized that hearing aids and hearing assistive technologies can be key components to improving hearing and communication abilities, the critical role that auditory training can play in sound localization is often overlooked.

Result on research question two in table 3 revealed the extent of sound recognition amongst students with hearing impairment before and after exposure to auditory training and those not exposed. Before intervention, students in both experimental and control groups had low scores in sound localization. After intervention, majority of the students in the experimental group moved from low extent to a high extent; while majority of students in the control group that were with low extent still remained at low extent. The result of testing of hypothesis two presented in Table 4 shows the Analysis of Covariance (ANCOVA) of sound recognition post-test mean scores

between students with hearing impairment in experimental and control groups. The post-test mean and standard deviation of students with hearing impairment in experimental group had a significant mean score difference between students with hearing impairment in experimental and control groups on sound recognition after intervention. The researcher accepts the alternative hypothesis and rejects the null hypothesis. This implies that auditory training enhances the sound recognition of students with hearing impairment to a moderate extent after intervention. This strengthens the position of Boothroyd (2010) who opined that an effective auditory training programme may improve the use of audible speech information, enhance sound recognition, increase the effectiveness of hearing aids, and improve quality of life.

Conclusion

Based on the findings of the study it was concluded that auditory training has a significant effect on sound localization and recognition among students with hearing impairment. Auditory skills are tremendously critical in the development of receptive language and expressive language. To effectively communicate, whether a hearing loss is present or not, a person needs to access the acoustic information, employ attention and intention correctly to interpret the acoustic and linguistic information and use this information effectively. This process is more a challenge to individual with hearing loss, hence auditory training.

Recommendations

Based on the findings, it was recommended that:

i. Students with hearing impairment should expose themselves to programmes such as Auditory Training and relevant therapies. Therefore teachers, counsellors and parents should have this vital role of administering Auditory Training (counselling and therapy programme) on students with hearing impairment.

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