Effect of Dichotic Offset Training (Dot) in Children with an Auditory Processing Disorder

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Abstract

Management of children with auditory processing disorders had gained wide importance in recent years. Various studies in the literature have shown that training children with central auditory processing problems using deficit specific intervention results in the improvement of auditory skills. The present study aimed at finding out the effectiveness of Dichotic Offset Training in children with auditory processing disorder. Twelve children who failed a screening checklist and the Dichotic CV and/or the Dichotic Digit test were included in the study. Six of them in the experimental group received Dichotic Offset Training using the training material developed by Yathiraj (2006). The children in the control group did not receive any training. The results revealed that there was statistically significant improvement after training in dichotic CV test. In dichotic digit test statistically significant improvement was seen in right ear single correct scores alone and not for left ear single correct score and double correct scores. Thus training children with binaural integration deficits using dichotic Offset Training was found to be effective.

Introduction

Auditory stimulation is so essential to development of humans that any interruption in this decoding process may have adverse effects on the overall maturation of an individual. The presence of an auditory processing problem can disrupt the decoding of auditory signals (Hanson & Ulvestad, 1979). The current definition of (C)APD explicitly recognizes both the auditory nature of the disorder and the inherent non-modularity of the central auditory nervous system. ASHA (2005) defined central auditory processing as "the perceptual (i.e., neural) processing of auditory information in the central nervous system (CNS) and the neurobiologic activity that gives rise to the electrophysiologic auditory potentials". It includes neural mechanisms that underlie a variety of auditory behaviours including localization/lateralization, performance with degraded or competing acoustic signals, temporal aspects of audition, auditory discrimination and auditory pattern recognition.

Recent reports suggest that auditory training (AT) can serve as a valuable intervention tool particularly for individuals with language impairment and central auditory processing disorder (C)APD (Chermak & Musiek, 2002). Musiek, Shinn and Hare (2002) noted that the use of AT for treatment of APD is different from the classic use of AT. Most important to this

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difference is that AT applied to APD is targeting the brain as the main site of mediation and the brain, unlike the auditory periphery is plastic.

Training for auditory integration is one such formal training program (Katz, Chertoff & Sawusch, 1984; English, Martonik & Moir, 2003). It has been shown that providing deficit specific therapy does result in improvement in auditory processing (Katz et al., 1984; Putter-Katz et al., 2002; English et al., 2003).

Binaural integration (BI) is the ability of a listener to process information presented to both ears at the same time. Poor performance in binaural integration has been found to result in difficulty in hearing in the presence of background noises or difficulty listening to two conversations at the same time (Bellis, 1996). An individual with deficit in binaural integration has been reported to have difficulty in integrating or processing information from more than one source at a time.

Binaural integration and binaural separation tasks are considered warranted when deficits are identified during dichotic evaluations. Musiek and Schochat (1998) used auditory training which involved directing the stimuli to the stronger ear at a reduced level. This sound field condition provided more cross-over between signals and greater demands on the patient than if the task was conducted under earphones. It was suggested by Musiek et al. (2002) that this procedure can also be modified using temporal offsets that lag in the poorer ear which improves the poorer ear performance.

One form of remediation for individuals with binaural integration problems is dichotic offset training, originally proposed by Rudmin and Katz (1982, cited in Katz et al., 1984). The main objective of Dichotic Offset Training (DOT) was to train the child to differentially integrate the two different stimuli which were separately given to both ears. Katz et al., (1984) studied 10 children aged 7-10 years who demonstrated difficulty on a dichotic test (SSW). They were given DOT for 15 one-hour sessions using different offset conditions (500, 100, 300, 200, 100 and 0 msec). A consistent pattern of improvement was documented for Staggered Dichotic Digit Test (SDD). However, they found a lack of statistically significant improvement on the SSW and Speech-in-Noise tests. They suggested that a battery of auditory training tasks is likely to be more beneficial than training any single skill.

Musiek and Schochat (1998) reported a case study of a 15 year old patient who demonstrated bilateral mild deficits on dichotic digits test and moderate bilateral deficits on the frequency pattern test and the compressed speech with reverberation test. A 6-week auditory training program was given that included three 1-hour sessions per week along with home training. Post auditory training performance showed higher scores on all central auditory tests.

A study by English et al., (2003) described another form of treatment for children with deficit in dichotic learning skill. Ten children with reduced left ear Dichotic Digit Test (DDT) scores (in the age range of 5 years 10 months to 10 years 9 months) were taken as subjects. They received additional auditory training in conjunction with the left-ear-only stimulation. The training was given for 1 hour a week for 10 to 13 weeks. It was found that for most subjects providing auditory stimulation to the left ear only improved left ear dichotic deficits as measured by the dichotic digit test. From the above studies it is evident that different forms of training can be provided which would result in an enhancement in dichotic performance. Both dichotic offset training as well as stimulation of the deviant ear have shown to bring about improvement in auditory integration.

According to Rupp and Stockdell (1978) 15 to 20% of school age population have some type of language/learning disorder, 70 percent of these have some form of auditory impairment. Further, Chermak and Musiek (1997) estimated that as many as 2 to 5% of the school age population exhibit (C) APDs. In India it has been found that 3% of the children were found to have dyslexia (Ramaa, 1985). Since many of the school going children have this problem there is a need to find appropriate treatment procedures to help them develop their auditory skills and perform better academically. Many intervention procedures have been reported in literature but their efficacy has not been studied. Hence there is a need to study the effectiveness of an auditory training procedure which would enhance auditory perception. The aim of the present study is to determine the effectiveness of Dichotic Offset Training in children with low scores on the Dichotic CV and the Dichotic Digit tests.

Method

Participants

Two groups of participants were included in the present study, an experimental group and a control group. All the participants who were in the age range of 7-12 years had studied in an English medium school for at least 3 years. They had normal pure tone, immittance and speech identification findings. Further, they had normal IQ and no speech problems. Only those who failed the ‘Screening Checklist for Auditory Processing’ (SCAP) developed by Yathiraj and Mascarenhas (2002), the Dichotic CV test developed by Yathiraj (1999) and/or the Dichotic Digit test developed at AIISH were included in the study. The participant selection criteria for the control group were the same as the experimental group. While the experimental group received dichotic offset training the control group did not.

Instrumentation

A calibrated dual channel audiometer (Orbiter 922) was utilized for pure tone testing and for presenting the Dichotic CV and Dichotic Digit tests. To rule out any middle ear pathology a calibrated immittance meter (GSI Tympstar) was used. An audio CD player (Philips) was used to present test stimuli during evaluation while a portable audio CD player (Sony) with head phones was used during the training sessions.

Test Environment

All the evaluations were carried out in a two room situation which was acoustically treated as per ANSI (1991). Training was given in a quiet, distraction free environment.

Material Used

To select the participants the ‘Screening Checklist for Auditory Processing’ (SCAP) developed by Yathiraj and Mascarenhas (2002) was used. Further, to determine their binaural integration abilities they were evaluated utilizing the ‘Dichotic CV test’ developed by Yathiraj (1999) using the norms developed by Krishna (2001) and the ‘Dichotic Digit test’ developed at AIISH, with the norms obtained by Regishia (2003). The dichotic offset material developed by Yathiraj (2006) was used for the training. It consisted of 12 dichotic word lists with six lists having monosyllables without blends and six lists having monosyllables with blends. Each list had 10 word pairs. The material had 6 offset lags (500 ms, 300 ms, 200 ms, 100 ms, 50 ms and 0 ms). Each offset lag consisted of 4 word lists, two having a right ear lag and two with a left ear lag. Prior to administering the dichotic material the familiarity of the words was checked on ten children in the age range of 7 to 7 years 11 months. In addition the intelligibility of the recorded material which had been done on a computer by a female speaker with a sampling rate of 16 KHz was checked on ten adults. The material was found to be familiar to children as well as intelligible to adults.

Procedure

Participant Selection Procedure

The initial selection of the participants was done by screening for children using the ‘Screening Checklist for Auditory Processing’ (SCAP), developed by Yathiraj and Mascarenhas (2002). The checklist was administered by teachers who had a good knowledge about the abilities of the children. Twelve of those children who had scored less than 50% were taken for further evaluation. They were evaluated using dichotic CV and dichotic digit test. Half of the participants were administered the Dichotic CV first while the other half the Dichotic Digit test. Only those who failed these two tests were included in the study. The initial dichotic test scores also served as the baseline evaluation.

Baseline Evaluation (Evaluation I)

The Dichotic CV test which consisted of 30 pairs of CV segments was administered at 50 dB HL. The children had to repeat the phonemes and the responses were written down by the clinician. The scores obtained were compared with the norms developed by Krishna (2001). Of the twelve children who were administered the test ten failed the Dichotic CV test.

The Dichotic Digit Test was presented at 40 dB SL. The children were instructed to repeat all the numbers heard regardless of the order and the responses were written down. The norms developed by Regishia (2003) were used to decide whether a child passed or failed a test. Eleven out of the twelve children failed the test.

Dichotic Offset Training:

Six of the children who failed either of the above tests were given training using the Dichotic Offset Training (DOT) material developed by Yathiraj (2006) using an audio CD player with headphones. The training was started with the easier offset lag (500 ms) and once a child obtained approximately 70% double correct scores the next lower lag material was used. If the double correct scores obtained did not reach the 70% criteria the lists were presented again in a randomized order. Gradually the offset lag was reduced and the task was made more difficult. Each child was trained using all the lag times with both monosyllable lists without and with blends. Throughout the training the children were provided feedback regarding their performance (a head nod for every correct response). On completion of the 0 ms lag lists therapy was stopped. The number of sessions required by the children varied between 10 to 15 sessions depending on the abilities of the child.

Post therapy evaluation (Evaluation II)

After completion of the 0 ms lag therapy, post therapy evaluation was done for the experimental group. For the control group evaluation II was done 15 days after evaluation I. These evaluations were done using the dichotic CV and dichotic digit test and the single correct and double correct scores were obtained. The scores obtained from evaluation I and II were tabulated and scored.

Results and discussion

A comparison of the scores obtained in I and II evaluations were done separately for the experimental group and control group and also across groups. In addition a comparison of dichotic offset scores obtained during therapy by the experimental group, was carried out.

I a) Comparison of evaluations I and II in the experimental group

The scores obtained by the experimental group during evaluation I (pre training evaluation) and evaluation II (post training evaluation) on the dichotic tests were compared using the Wilcoxon Signed ranks test. The results revealed a statistically significant difference between the evaluation I and II scores following the dichotic offset training in the experimental group. The test scores were statistically significant at 0.05 levels for both single correct and double correct scores in the dichotic CV test. For the dichotic digit test, the scores were statistically significant only for the right ear single correct scores at a 0.05 level of significance. The left single correct scores and double correct scores did not show any statistically significant improvement (Table 1 & Figure 1).

Table 1: Comparison of pre and post test scores in the experimental group

Test	Score type	Mean pre therapy score	Mean post therapy score	z value
Dichotic CV	Right single correct	8.7	15.5	-2.201*
	Left single correct	13.3	23.2	-2.01*
	Double correct	1.8	10.8	-2.207*
Dichotic digit	Right single correct	14.4	22.0	-2.201*
	Left single correct	18.2	24.3	-1.577
	Double correct	1.7	7.5	-1.826

* Significant at 0.05 level

The results revealed that the dichotic offset training given to children who had deficit in binaural integration was found to be effective in acquiring that particular auditory skill. The improvement was found to be lesser in the Dichotic Digit test when compared to the Dichotic CV test which may be because the Dichotic Digit test requires auditory memory skills also along with binaural integration.

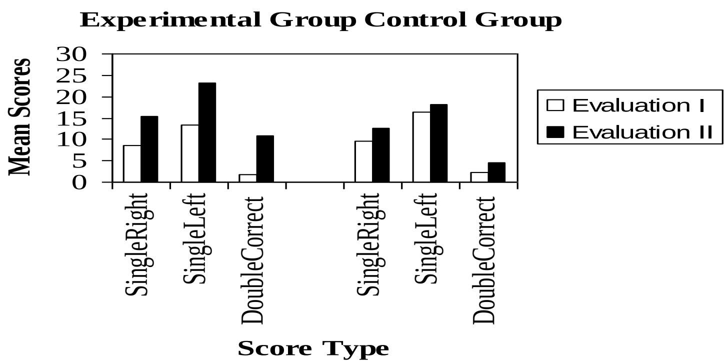

Figure 1: Evaluation I and II for Dichotic CV test for the experimental & control Group

I b) Comparison of evaluations I and II done in the control group

The scores obtained by the control group during evaluations I and II were compared using the Wilcoxon Signed rank test for both Dichotic CV and Dichotic Digit test. The results revealed that there was not much improvement seen in the Dichotic CV and Dichotic Digit test scores for the control group who did not receive any training. The Z scores obtained shows that the difference in the scores was not statistically significant (Figure 2).

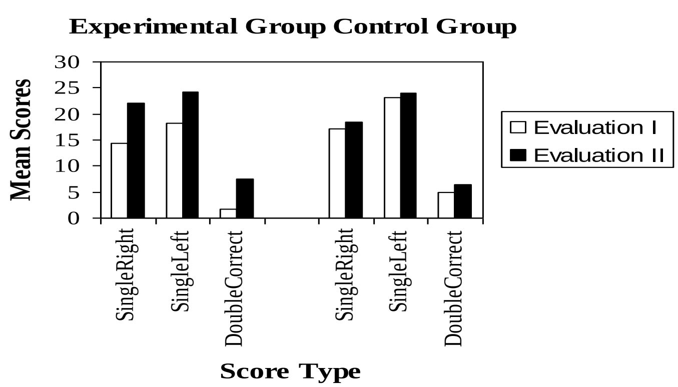

Figure 2: Evaluation I and II for the Dichotic Digit Test for experimental and control group

Thus it can be construed that without Dichotic Offset Training the individuals with poor auditory integration skills do not show any marked variation in their performance. The finding of the present study is similar to that of Katz et al., (1984) who also reported that children who did not receive Dichotic Offset Training did not show an improvement in performance. Besides the improvement seen using Dichotic Offset Training a study by English et al., (2003) showed that even training those with poor dichotic scores in one ear resulted in improvement in dichotic scores. In their study the poorer ear was stimulated and improvement was seen in left ear alone.

II) Comparison of evaluation I and II across groups

The scores obtained were compared between the experimental and control groups, separately for evaluations I and II (Table 2). For evaluation I the mean scores for both the groups did not vary much for the Dichotic CV and the Dichotic Digit test. However, for evaluation II, there were variations in the mean scores for the Dichotic CV test but not much for the Dichotic Digit Test.

To compare the mean scores between the experimental and control groups for evaluations I and II, non-parametric Mann-Whitney test was carried out. From Table 3 it is evident that there was no significant difference between the experimental and control group for evaluation I in the Dichotic CV and the Dichotic Digit Test. However in evaluation II there was a statistically significant difference across the groups in the Dichotic CV test. The left single correct score showed a significant difference at the 0.05 level whereas the right single correct score and double correct score showed a significant difference at 0.1 level.

Table 2: Mean and standard deviation scores for both the groups on I and II evaluations

Evaluation	Test	Score Type	Experimental group		Control group	
			Mean	SD	Mean	SD
Evaluation I	Dichotic CV	RE	8.7	4.5	9.6	3.9
		LE	13.3	7.7	16.3	6.6
		DC	1.9	3.6	2.3	4.8
	Dichotic digit test	RE	14.4	5.0	17.1	4.7
		LE	18.2	10.2	23.3	4.9
		DC	1.7	2.4	4.8	8.7
Evaluation II	Dichotic CV	RE	15.5	3.3	12.5	2.3
		LE	23.2	2.7	18.2	4.5
		DC	10.8	5.0	4.7	4.4
	Dichotic digit test	RE	22.0	3.2	18.4	4.5
		LE	24.3	4.3	24.1	5.9
		DC	7.5	8.4	6.5	7.3

The Dichotic Digit test did not show any significant difference when compared across the groups. Thus it can be concluded that following training the experimental group showed a significant difference which was not observed in the control group on a test that purely tapped auditory integration (dichotic CV). In contrast, the test that tapped both auditory integration and auditory memory (dichotic digit test) did not show such an improvement.

Table 3: Comparison of mean scores across the groups

Test	Group	Score Type	Evaluation I Mean scores	Significance	Evaluation II Mean scores	Significance
Dichotic CV	Experimental	RE	8.666	NS	15.500	0.124**
	Control	RE	9.583		12.500	
	Experimental	LE	13.333	NS	23.166	0.036*
	Control	LE	16.333		18.166	
	Experimental	DC	1.833	NS	10.833	0.091**
	Control	DC	2.333		4.666	
Dichotic Digit Test	Experimental	RE	14.416	NS	22.000	NS
	Control	RE	17.083		18.416	
	Experimental	LE	18.166	NS	24.250	NS
	Control	LE	23.250		24.083	
	Experimental	DC	1.666	NS	7.500	NS
	Control	DC	4.833		6.500	

* Significant at 0.05 level; ** Significant at 0.1 level

III) Comparison of dichotic offset scores in the experimental group:

The scores obtained by the experimental group during the dichotic offset training were also analyzed. The scores obtained at each of the lag times for the monosyllables without blends (Figure 3) and with blends (Figure 4) were analyzed. The double correct scores obtained during the therapy sessions were compared across various offset lags. This was done separately for the training material having a right lag and that having a left lag. For each of the conditions the baseline scores obtained at the start of the training were compared with the scores obtained at the end of the training for a particular lag time.

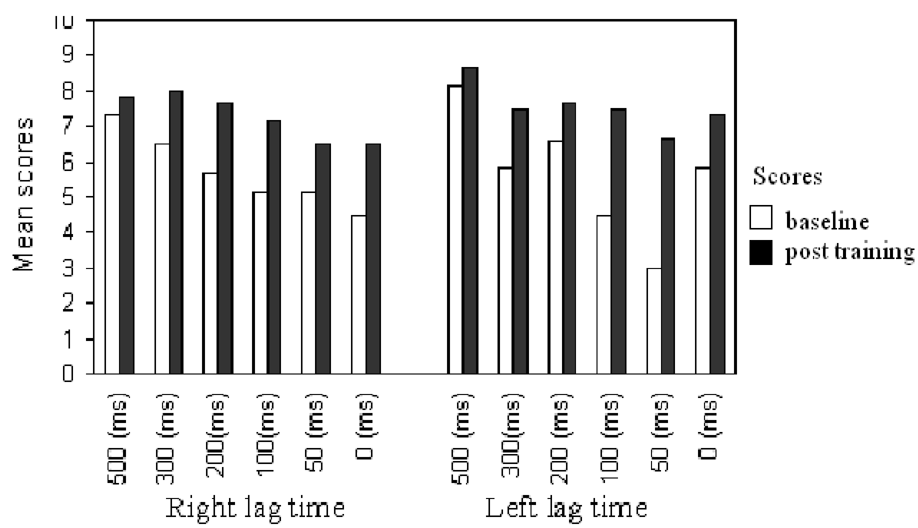

Figure 3: Double correct scores for monosyllables without blends, for varying lag times

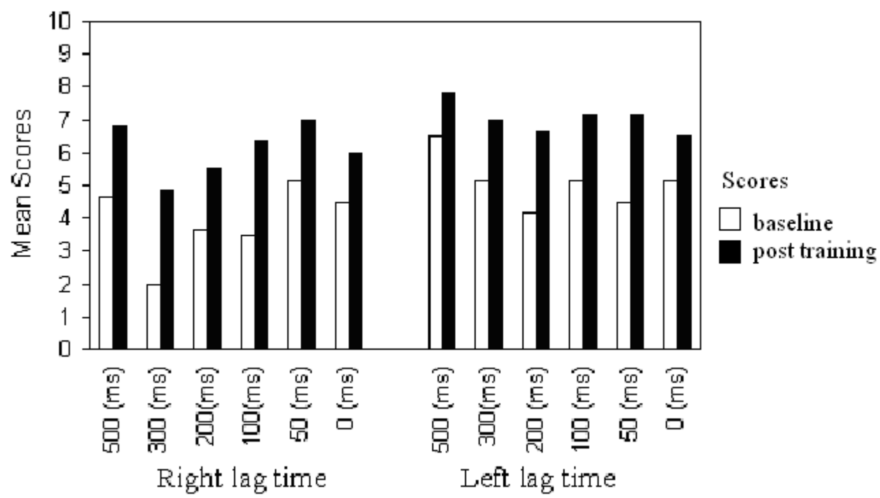

Figure 4: Double correct scores for monosyllables with blends, for varying lag times

From Figures 3 and 4 it can be observed that for all the lag conditions, material type (non-blends and blends) and ear of lag, there was an improvement in performance with training. The improvement seen during therapy was greater for the monosyllables without blends than for the monosyllables with blends. The Mann-Whitney test was carried out to check for overall changes between the baseline performance and the post therapy scores for each lag time. A statistically significant response was observed only for the 100 msec lag time. For other lag times, though there was an improvement, it was not statistically significant.

Conclusion

Based on the results of the present study it can be concluded that the Dichotic Offset training (DOT) is found to be effective in helping the children with deficits in binaural integration. No significant improvement was found for the control group in both the Dichotic CV and Dichotic Digit tests. The experimental group showed significant improvement ($p < 0.05$) in both the single and double correct scores in the Dichotic CV test following training. In the Dichotic Digit test the significant improvement was found only for right ear single correct score ($p < 0.05$) and not for left ear single correct and double correct score. It can be concluded that the improvement is more for a dichotic test that taps only binaural integration and not a test that taps both binaural integration and auditory memory.

References

ANSI. Maximum permissible ambient noise levels for audiometric test rooms, ANSI S3.1. New York: American National Standards Institute (ANSI), 1991.

ASHA (2005). (Central) auditory processing disorders (Technical report). Available at www.asha.org /members/deskref-journals/deskref/default.

Bellis, T.J., (1996). *Assessment and Management of Central Auditory Processing Disorders in the Educational Setting: From Science to Practice.* San Diego, CA: Singular.

Chermak, G.D. & Musiek, F.E., (1997). *Central Auditory Processing Disorders*: *New Perspectives*. San Diego, CA: Singular.

Chermak, G.D. & Musiek, F.E., (2002). Auditory Training: Principles and Approaches for Remediating and Managing Auditory Processing Disorders. *Seminars in Hearing,* 23(4), 297-308.

English, K., Martonik, J. & Moir, L. (2003). An auditory training technique to improve dichotic listening, *Hearing Journal*, 56(1), 34-38.

Hanson, D.G. & Ulvestad, R.F., (1979). Otitis media and child development. *Annals of Otology, Rhinology and Laryngology*, 88 (Suppl.60), 1-111.

Katz, J., Chertoff, M. & Sawusch, J., (1984). Dichotic training. *Journal of Auditory Research*, 24, 251-264.

Krishna, G. (2001). Dichotic CV tests – Revised: Normative Data on Children, Independent project done as part fulfillment for the Degree of Master of Science, Submitted to the University of Mysore, Mysore.

Musiek, F.E. & Schochat, E., (1998). Auditory training and central auditory processing disorders: A case study. *Seminars in Hearing*, 19, 357-366.

Musiek, F. E., Shinn, J. & Hare, C., (2002). Plasticity, Auditory Training, and Auditory Processing Disorders**.** *Seminars in Hearing*, 23(4), 263-275. Guest Editor: Chermak, G.D.

Putter-Katz, H., Said, L.A., Feldman, I., Meran, D., Kushmit, D., Muchnik, C. & Hildesheimer, M., (2002). Treatment and evaluation indices of Auditory Processing Disorders. *Seminars in Hearing*, 23(4): 357-363.

Ramaa, S., (1985). Diagnosis and remediation of dyslexia. Ph.D. Thesis, University of Mysore, Mysore.

Regishia, A., (2003). Effect of maturation on Dichotic tests: A comparison of Dichotic Digit and Dichotic Consonant Vowel test, Independent project done as part fulfillment for the Degree of Master of Science, Submitted to the University of Mysore, Mysore.

Rupp, R.R. & Stockdell, K.G., (1978). *Speech protocols in Audiology*. New York: Grune & Stratton.

Yathiraj, A., (1999). The Dichotic CV Test. Unpublished Material developed at the Department of Audiology, AIISH, Mysore.

Yathiraj, A. & Mascarenhas, K. (2002). Effect of Auditory stimulation of central auditory processes in children with APD. A project funded by the AIISH research fund.

Yathiraj, A., (2006). The Dichotic Offset Training Material. Unpublished Material developed at the Department of Audiology, AIISH, Mysore.