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Original Article

Evidence-based interventions of dichotic listening training, compensatory strategies and combined therapies in managing pupils with auditory processing disorders

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Abstract

Objective: The need to develop a measure of managing children with a single profile of auditory processing disorders (APDs), and differentiate between true and artefactual improvements necessitated the study. The study also sought to determine the efficacy of interventions – both single and combined on APD, against no-treatment. *Design*: A randomised controlled trial of interventions (RCT) was adopted. Participants were randomly allocated to each of the intervention groups or the no intervention group. The 10 weeks intervention included 45 minutes three times a week therapeutic intervention on listening with noise and sound localisation ability in the home and school environments. *Study sample*: 80 pupils (7–11 years) with a single profile of APD participated in the study. *Results*: Treatments were effective on the cocktail party and sound localisation. The best result was realised with the combined therapy (CT), and there was no significant difference in performance in the remaining treatment groups. *Conclusion*: The intervention groups were beneficial to pupils with APD and should be adopted by clinicians.

Key Words: Conditions/pathology/disorders; speech perception; adult or general hearing screening; noise; instrumentation

Introduction

Despite the lack of international consensus regarding what auditory processing disorders (APDs), also called (Central) Auditory Processing Disorders [(C) APD] is Rosen (2005), Moore et al. (2010) maintained that professional societies on both sides of the Atlantic Ocean have proposed definitions. The definitions suggested that APD involves listening difficulties caused by impaired bottom-up processing of sounds by the brain, in the central auditory system. Its characteristics include the poor perception of both speech and non-speech sounds (American Speech and Hearing Association 2005; British Society of Audiology, Auditory Processing Disorder Steering Group 2010). APD impacts on everyday life primarily through a reduced ability to listen and respond appropriately to sounds.

The rationale to evaluate APD in school-aged children is based on the premise that an impairment in auditory perception can be the underlying cause of other learning problems, such as specific reading and language disabilities. APD can lead to problems of employment and education in the future (Ebbels 2014), and reduced communication function in social situations (Johnston et al. 2009). Results from referenced articles confirmed that there are few studies and intervention implications on (C)APD students within the educational discipline, including Special Education (Patrusky 2013), while few studies have used Randomised Controlled Trials (RCT) in determining the efficacy of interventions for pupils with a single-profile of APD.

American Speech and Hearing Association (2005), Chermak and Musiek (2007), and American Academy of Audiology (2010) submitted that intervention programmes for the treatment of APD could be described in two ways: (1) ‘Bottom-up’ processing approaches such as Dichotic Listening Training, Auditory Training activities and Assistive Listening FM devices (ASHA 2005) based on the notion that the listener’s ability to encode incoming signals are deficient, and they encompass strategies that improve signal quality, focussing on how the individual with (C)APD can be enabled to hear and make use of both speech and non-speech sounds (2) ‘Top-down’ approaches such as compensatory strategies (CS), teacher/speaker adaptations and games strategies (Bellis 2003;

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Abbreviations

Auditory processing disorders	APD
Canadian ADHD resource checklist	CADDRA
Dichotic listening training	DLT
Randomised controlled trials	RCTs
Compensatory strategies	CS
American Academy of Audiology	AAA
Combined therapy	CT
British society of audiology	BSA
American speech-hearing association	ASHA

Chermak and Musiek 1997) that are based on the notion that processing are concept-driven and they focus on the listener's ability to apply rules of language and cognition to the communication event. The bottom-up and top-down approaches considered in this study are Dichotic Listening Training (DLT) and CS, respectively.

DLT of Bellis (2003), Bamiou et al. (2006), and Bellis (2008) includes binaural integration/separation activities (e.g. listening to a story using headphones and adjusting volume to a listener's ability/perception), speech-in-noise training (adding noise while listening to a story or being given instructions), sound localisation (where a sound is coming from – is it nearby or far away) and 'tracking' (locating a moving sound) training (in quiet and noise).

CS include activities on improving auditory attention (developing awareness that listening is an active process, emphasising on the behaviour of a good listener: whole-body listening); improving auditory working memory (taking-in new information that is presented orally, listening actively in order to rehearse what has been done, and attending selectively in order to repeat the information); metacognitive and metalinguistic strategies; and shared reading (an adult and the child taking turns to read).

Musiek et al. (1990) listed reasons for conducting auditory processing assessment including to determine interventions which are helpful to the student's learning process and the general auditory and speech-specific hypotheses of auditory processing. Thus, the current study aimed to investigate the effectiveness of the use of one bottom-up (DLT), one top-down (CS), and combined therapy (CT) approaches in enhancing listening abilities in children with APD. Furthermore, the current study sought to determine the gender effect in listening among pupils with APD and examine the interactions of treatment and gender on listening abilities. The hypotheses tested were (1) main effects of treatments (DLT, CS) on the listening abilities (cocktail party effect and sound localisation ability) of pupils with APDs (participants), (2) main effect of gender and (3) interaction effects of treatment and gender on the listening abilities of the selected participants.

Methodology

Participants

Eighty (80) pupils (male and female) with a single profile of APD in Ibadan were randomly selected. 460 sus-participants were initially screened out from the list of pupils with reported listening difficulties in selected schools on the highway close to sources of environmental sounds in Ibadan, and we recruited some on private interactions and independent practice, who then had the otoscopy performed on them to know the condition of the external ear and the middle ear, be it intact or shining, and also to rule out middle ear pathologies such as impacted wax, tympanic membrane perforation and otitis external prior to audiological tests of pure-tone audiometry and tympanometry. 139 sus-participants were screened out through otoscopy and audiologically.

The remaining 321 sus-participants were screened with the Children's Auditory Processing Performance Scale (CHAPPS). 38 sus-participants were screened out at this stage (18 > −0.05 on CHAPPS, with 20 sus-participants having history of middle ear infection). Based on the diagnostic criteria, we selected for a diagnosis of APD of an aberration of 2SD of at least one ear on at least two tests of auditory processing, and an aberration on at least one linguistic test, the sus-participants were exposed to the Tests for Auditory Processing in Children (SCAN-3:C), and the Random-Gap Detection Test-Expanded (RGDT Expanded). 42 (25 through SCAN-3:C, 17 through RGDT-Expanded) sus-participants were screened out. 241 sus-participants were then diagnosed with an APD.

Following Keller et al. (2006) claim that memory, with verbal I.Q. is implicated as an underlying factor in auditory processing deficits in children diagnosed with non-verbal learning disability and language impairment, we assessed the participants for intelligence, verbal intelligence, and non-verbal intelligence on the Verbal Comprehension and Perceptual Reasoning sub-scale of the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV). Thirty-seven participants (23 FSIQ and VCI <90, 14 PRI <90) were screened out thereby. Pupils identified with an APD were further screened for reading and attention problems using the Informal Graded Word Recognition Test (IGWRT) and CANADIAN ADHD Resource Checklist (CADDRA). 41 (< 50% score on each of the four subtests) and 28 pupils were screened out for presenting with reading disorder and attention problems respectively. Thus, 135 pupils with a single profile of (C)APD were qualified for the study.

The participants later had the Rosenberg Self-Esteem Scale administered on them. The scale classified the self-esteem of the participants as either high or low. The participants were asked to choose from a box containing small cuts of paper, with numbers 1, 2, 3 or 4 written on each paper. Participants who chose 1 formed the gross (g) participants for DLT, those who chose 2 formed the (g) participants for CS, those who chose 3 formed the (g) participants for CT, while those who chose 4 formed the (g) participants for the Control Group. There were 34 (g) participants in the DLT (23 males, 11 females), 34 (g) participants in the CS (23 males, 11 females), 34 (g) participants in the CT (19 males, 15 females), and 33 (g) participants in the Control Group (20 males, 11 females). The self-esteem of the participants in each group was then analysed. In DLT, there were 13 high (7 males, 6 females) and 21 low (16 males, 5 females) self-esteem classifications, 13 high (8 males, 5 females) and 21 low (15 males, 6 females) in the CS, 14 high (7 males, 7 females) and 20 low (12 males, 8 females) in the CT, and 15 high (10 males, 5 females) and 18 low (12 males, 6 females) in the Control Group.

We reduced the participants in each group to five for gender and self-esteem classifications, made possible by having a cut-out of numbers 1–5 and empty cut-outs for each group of the self-esteem classifications. The participants were then asked to select from the cut-outs. Participants who selected the numbers 1–5 became the final (net) participants for the study and assigned randomly to the training groups. The SCAN-3: C identified the ear advantage of the

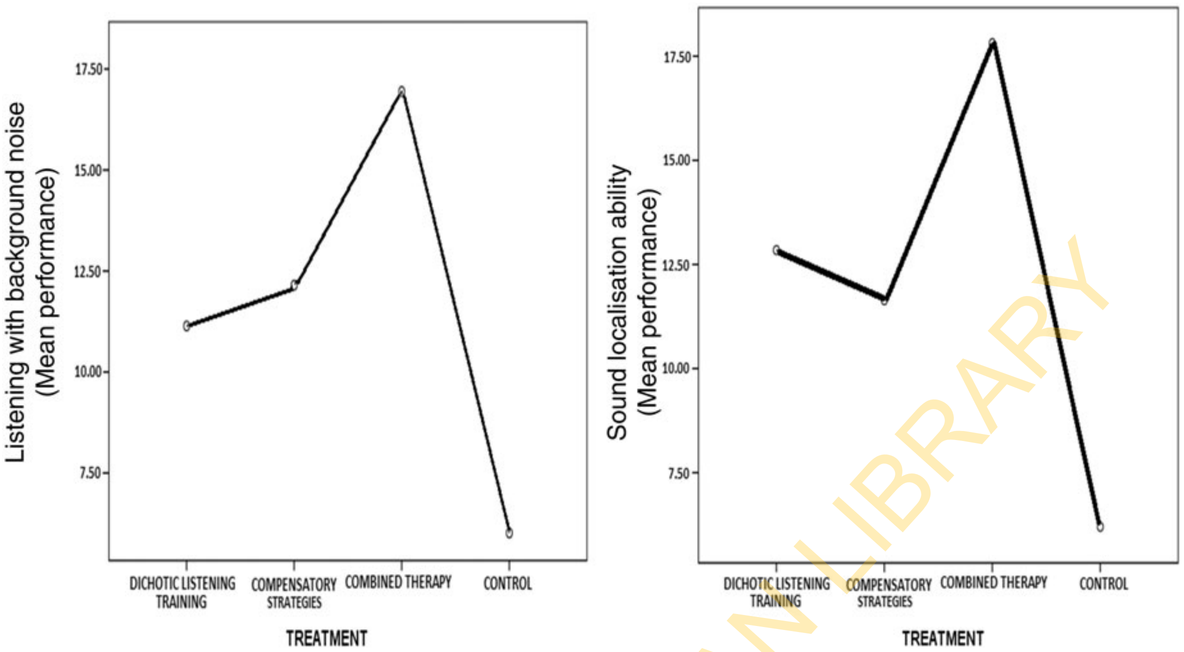

Figure 1. Mean performance when listening with background noise and sound localisation ability for the experimental and control groups.

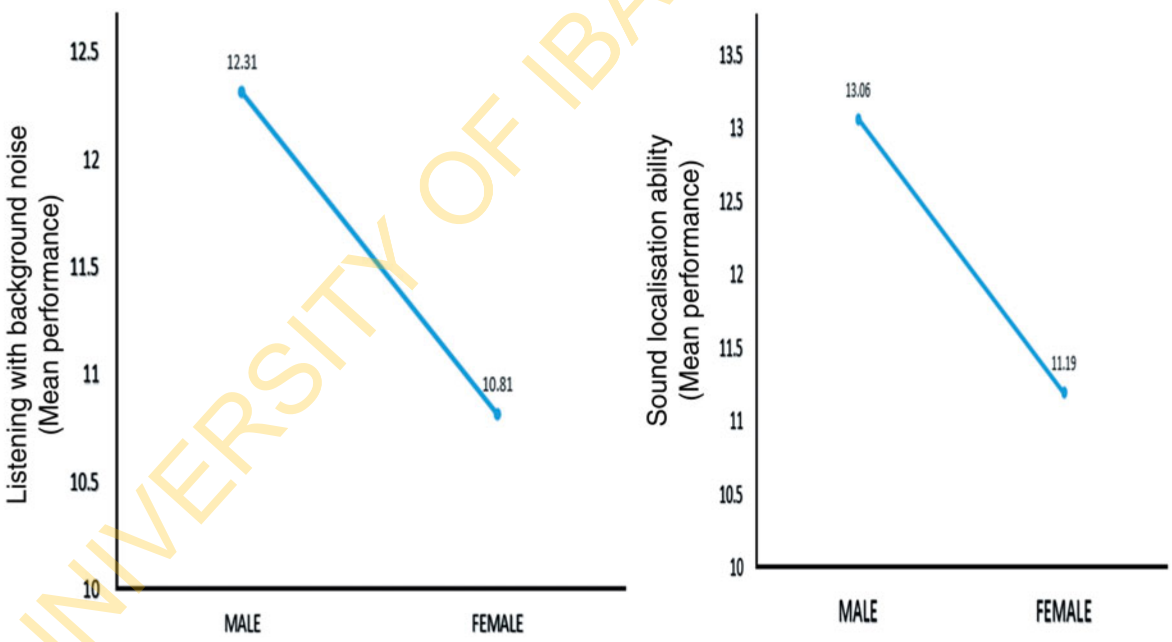

Figure 2. Mean performance of gender on listening with background noise and sound localisation ability.

participants, and the advantaged ear was 'masked' with earplug during the treatment period. Participants with atypical Right Ear Advantage had their right ear masked while the left ear was improved upon during the period of intervention, and vice versa. 48 of the participants had LEA while 32 had atypical REA. The participants were exposed to 10 weeks of therapeutic intervention sessions (one week for pre-test, eight weeks of treatment, and one week for post-test), except for the control group that were only pre and post-tested. Listening abilities were measured using verbal information/response of each participant after each intervention plan, and the results summed up and averaged where there were more than one question asked. The results on the main and interaction effects of self-esteem are being considered for another publication.

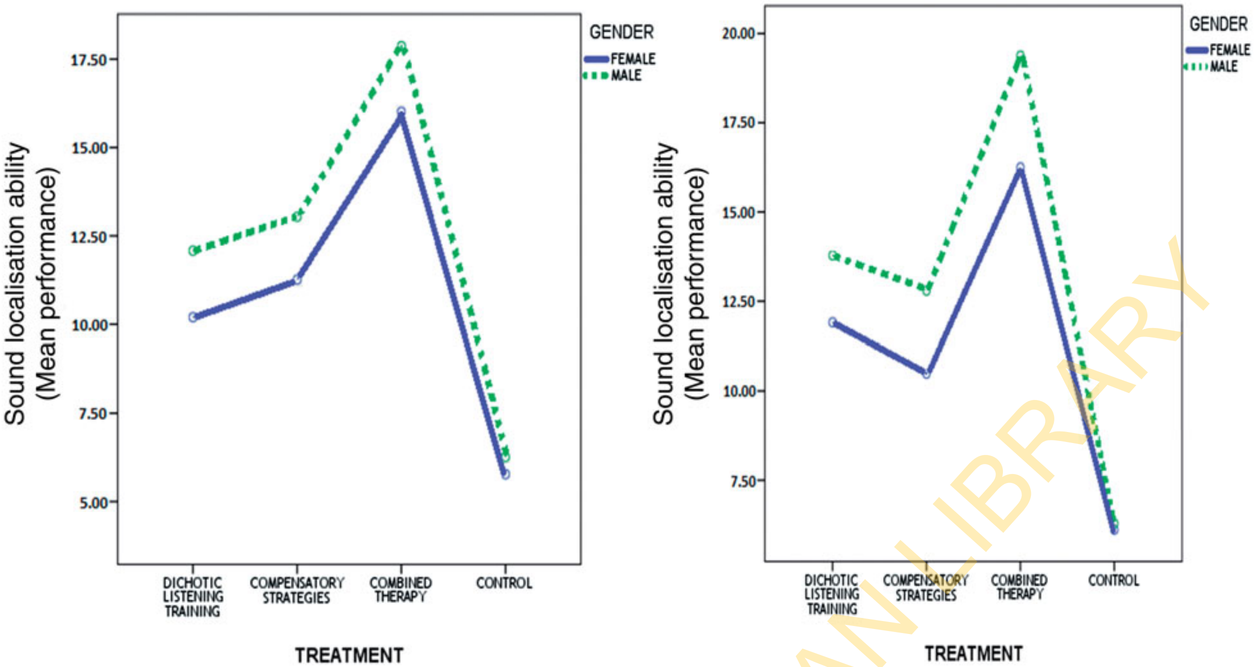

Figure 3. Mean performance of interactions of treatment and gender on listening with background noise and sound localisation ability.

Intervention plans

Dichotic listening training
The DLT comprised three training packages (processes), as listed in the BSAAPDSIG (2011) viz-a-viz:

(i) binaural integration and separation training
(ii) speech-in-noise training
(iii) sound localisation training

In support of Coen-cummings and Geiger (2011) examples of DLT, the DLT programme selected for this study was done by having the participants listen to an extract from a book chapter already recorded on a Compact Disc (CD), with earplugs used to mask the better ear, so that the auditory information is presented only to the weaker ear. The extract was a 100-word limit of passages from the English language textbooks used in schools. The participants under this training were required to listen to the auditory information, and answer the questions that followed verbally. The stories used were selected from the English Language textbooks of the pupils, and were played from a laptop computer, while a 2.0 channel multi-media speaker system was connected to the system to magnify the story being played.

Binaural integration and separation activities
The binaural integration and separation training was done as a free-field training model in the school or in the home environment, and required the participants to make use of earplugs on the weaker ear, while the story was played. Questions were then asked on what they heard, both separately on the weaker ear (separation), and on both the masked and the unmasked ear (integration).

Speech-in-noise training
This was carried out with the same story played, but with a multi-talker situation to introduce competing background noise. The competing background noise was movies played via a Samsung tablet, and local radio stations broadcast from a mobile phone. Both were transmitted whilst the recorded story was played at every therapeutic session. The participants were questioned on what they heard from the story, in the multi-talker situation.

Sound localisation training
This required the participants to locate the sources of noise, which the research assistants introduced during the therapeutic sessions. The noise was different types of metal items dropped intermittently while the story was being played. The participants were tested on sound localisation and sound recognition, by being asked to identify the sources of the sounds and as well report the content of the story.

Compensatory strategies
The CS training comprised three training packages (processes), namely:

(i) improving auditory attention;
(ii) improving auditory working memory; and
(iii) shared reading

The passages used were selected from the English language school texts and were limited to 100 words each.

Improving auditory attention
This session consisted of content delivery done through a verbal presentation, but first, using the concept of whole-body listening. Thereafter, the story was read to the participants at a distance of 2 metres (for the first lesson of the first week), using gestures and reasonable body language to place emphasis on the story. The participants were then asked what they listened from the story. For the second lesson, the story was read to the participants at a distance

of 2 metres, with some words in the story emphasised and intoned, while a distraction story was read at a distance of 2.5 metres by the research assistants.

The participants were then questioned on what they heard from the story read by the researchers and the research assistants. The answers supplied were then averaged. For lesson three, the story was read at a distance of 1 metre to the participants. For the first lesson of the second week, the story was read at a distance of 1 metre to the participants with the concept of whole-body listening. In lesson two, the story was read at a distance of 1 metre, and a distraction story read at a distance of 1.5 metres; while in lesson three, the story was read at a distance of 1 metre to the participants, and the procedure used during the second week was repeated at the third week.

Improving auditory working memory

For the first lesson, the story was read to the participants with emphasis on explanation. The story was used to formulate new sentences. Before the story was explained, the participants were questioned on what they heard from the story. The second lesson required the omission of certain words while the story was read, the participants were asked to fill the gaps as they were created. Multi-talker situation was introduced and research assistants were asked to deliberately engage in a chatter. The participants were then asked what they heard from the researcher and the filtering of the chatter of the research assistant. Lesson three was done as a repetition of lessons one and two in a summary form.

Shared reading

The reading was shared between the researchers and the participants during the first lesson. At first, we read out the story to the participants. The participants were asked to verbally report what they heard from the story, and what the story was about. Then, the participants were asked to assume the position of the researcher and read the story. Also, they were required to verbally report what they heard from the story, and what the story was about. During lesson two, the story was read only by the researcher, and some words intoned and emphasised. The participants were then asked what they heard from the story, and what the story was about. The multi-talker situation was introduced as a form of a distracting model from the source of sounds (research assistants) and the research assistants were asked to deliberately engage in a chatter in order to distract the participants. Each of the intoned and emphasised words was then explained to the participants.

For the third lesson, the story was first read to the participants and some words were intoned and emphasised. Afterwards, the participants were asked to assume the position of the researcher and appropriately intone and emphasise the intoned and emphasised words by the researcher. In each of the instances, the participants were asked what they heard from the story and what the story was about.

Combined therapy

The participants in the CT group were treated using both DLT and CS all through the period of training. Three weeks were for DLT and improving auditory attention while two weeks were for dichotic training and improving auditory working memory and three weeks for DLT and shared reading. The texts used in CS were used in the CT.

Components of the combined therapy

Dichotic listening training and improving auditory attention

Binaural integration/separation activities and improving auditory attention. For lesson one of the first week, the concept of whole-body listening was initially introduced. The story used was played and distraction model was introduced. The concept of whole-body listening used is as described in the CS.

Speech-in-noise training and improving auditory attention. For lesson two, the story used was played, and noise was introduced as speech-in-noise. The speech-in-noise involved the multi-talker situation, involving the research assistants engaging in a chatter by reading a distraction story at a distance of 2 metres to the participants. The concept of whole-body listening was also introduced. The participants were then questioned both on the story, and on the noise interruptions.

Sound localisation training and improving auditory attention. For lesson three, the story was played to the participants and noise which included varying degrees of metal objects dropped intermittently with whole-body listening was introduced. The participants were then questioned on both the story and the sound.

Binaural integration/separation activities and improving auditory attention

During the first lesson of the second week, the first lesson, the story was read to the participants at a distance of 1 metre, using whole-body listening. Afterwards, the participants were asked what they heard from the story and what the story was about.

Speech-in-noise training and improving auditory attention

For lesson two of the week, the story was read to the participants at a distance of 1 metre and a distraction story read at a distance of 1.5 metres as a form of speech-in-noise. The participants were then questioned on what they heard from the researcher and what they think the story was about. The method used in the second week was also used during the third week.

Sound localisation training and improving auditory attention

For the third lesson, the story was played and noise was introduced as a competing background noise in the form of metal objects dropped at intervals. The participants were then asked what they heard from the story and what they thought the story was about, about the items dropped, and where the noises were coming from.

Binaural integration/separation activities and improving auditory working memory

The sessions here included several methods towards achieving the purpose of the treatment design. For the first lesson of the first week, the story was played for the participants and new sentences were formulated, prior to which participants were asked what they heard from the story and what the story was about.

Speech-in-noise training and improving auditory working memory

In lesson two, the story was read, and noise was introduced as a form of speech-in-noise using the multi-talker situation. Some words were omitted during the reading and participants were asked to supply the missing words in the gaps created. The participants were questioned on the multi-talker and the missing words supplied.

Sound localisation training and improving auditory working memory

The two-phased lesson required the combination of the two lessons. The first phase had the story played with different degrees of sounds introduced, and participants were asked questions on their sound localisation ability. The second phase comprised the story read with some words missing. The participants were asked to supply the missing words. This procedure was repeated for the second week of the DLT and improving auditory working memory.

Binaural integration/separation activities and shared reading

For the first lesson of the first week, the story was first read to the participants and the participants were asked what they heard from the story. The participants were then asked to read the story themselves and then asked what they remembered from the story and what the story was about.

Speech-in-noise training and shared reading

In lesson two, the multi-talker situation was introduced and some words were intoned as the story was being read to the participants, with emphasis placed on the intoned words and explanation given to the meaning of the words. Thereafter, the participants were asked to take a turn with the researcher and assume the position of the researcher by reading the story. In each of the instances, the participants were questioned on what they heard from the story and what the story was about, and also on the multi-talker.

Sound localisation training and shared reading

The same session for lesson two was followed for lesson three, except that the objects dropped at specific intervals were substituted for speech-in-noise training. The participants were then asked questions on what they heard from the story, what they thought the story was about, about the items dropped and where the noise was coming from.

Procedure for the control group

The participants in the control group were not exposed to any of the treatment packages during the period of training but were pre-tested and post-tested. Twenty children that were randomly assigned participated in the control group.

Research design

The research design was a randomised controlled trial of interventions (RCT) with a $4 \times 2 \times 2$ factorial matrix.

Table 1. Descriptive statistics shows the differences in the cocktail party effect and sound localisation ability of participants exposed to DLT, CS, CT and control.

Dependent variable	*Treatment*	*Mean*	*Std. error*
Listening with background noise	Dichotic listening training	11.140	0.312
	Compensatory strategies	12.151	0.301
	Combined therapy	16.942	0.305
	Control	6.017	0.322
Sound localisation ability	Dichotic listening training	12.845	0.279
	Compensatory strategies	11.641	0.268
	Combined therapy	17.813	0.272
	Control	6.201	0.288

Table 2. LSD post-hoc analysis of mean differences in listening ability based on treatment.

	Treatment	*1*	*2*	*3*	*4*
Cocktail party effect	Dichotic listening training		1.01*	5.08*	5.12*
	Compensatory strategies			4.79*	6.13*
	Combined therapy				10.92*
	Control				
Sound localisation ability	Dichotic listening training		1.20*	4.96*	6.64*
	Compensatory strategies			6.17*	5.44*
	Combined therapy				11.62*
	Control				

*Significant at $p < 0.01$.

Statistical analysis

The multi-variate analysis of co-variance (MANCOVA) was used to determine the effectiveness of the treatments, while the Fisher's LSD was used to compare the performance of the interventions.

Results

Exposure to treatment had a significant effect on the children with APD's listening abilities (MANCOVA: Wilks' Lambda = 0.02, $F_{(1,61)} = 14.72$, $p < 0.001$). Treatment had significant effect on the cocktail party effect $F_{(1,61)} = 194.43$, $p < 0.001$, $\eta^2 = 0.91$ and sound localisation ability $F_{(1,61)} = 279.31$, $p < 0.001$, $\eta^2 = 0.93$. Participants in the CT group had the highest average score on the cocktail party and sound localisation ability (Table 1, Figure 1). Evaluating by models, CS was preferable for the cocktail party effect, and DLT was preferable for sound localisation. There was a significant difference in performance between the combined treatment (therapy) and other treatment groups while observed differences were not noticed between the DLT and the CS (Table 2).

Gender significantly impacted cocktail party effect, $F_{(1,61)} = 16.62$, $p < 0.001$, $\eta^2 = 0.12$, and sound localisation, $F_{(1,61)} = 32.41$, $p < 0.001$, $\eta^2 = 0.35$ (Figure 2). The difference in mean score gender performance was significant on the cocktail (LSD =1.50, $p < 0.01$) and sound localisation (LSD =1.87, $p < 0.01$) in favour of the males. Treatment and gender interacted on sound localisation $F_{(3,61)} = 5.45$, $p < 0.001$, $\eta^2 = 21$, but not on

Table 3. LSD post-hoc analysis of mean differences based on interaction between treatment and gender.

Dependent variable	*Treatment*	*(I) Gender*	*(J) Gender*	*Mean difference (I − J)*	*Std. Error*
Cocktail party effect	Combined therapy	F			
			M	−0.190	0.846
	Compensatory strategies	F	F		
			M	−1.363	0.806
	Control	F	F		
			M	−0.335	0.809
	Dichotic listening training	F	F		
			M	2.240*	0.883
Sound localisation ability	Combined therapy	F	F		
			M	2.103*	0.485
	Compensatory strategies	F	F		
			M	2.096*	0.462
	Control	F	F		
			M	0.821	0.463
	Dichotic listening training	F	F		
			M	0.192	0.506

*Significant at $p < 0.01$.

the cocktail party effect $F_{(3,61)} = 1.29$, $p > 0.005$, $\eta^2 = 0.01$ (see Table 3) even though the males still performed better (Figure 3).

Discussion

The result of the significant main effect of treatments means the treatments under study were effective. The participants in the experimental groups performed better in different degrees than participants in the no-treatment control group. The reasons for the CT superseding in the effects were because the treatments were combined and the faults associated with an initial treatment were eroded in the other treatment, making sure best clinical practice is put in place. For example, while language is being enhanced, the integrity of the ear to receive stimuli is being improved upon. This accounted for the variance experienced in the other treatment groups.

The CS being better than DLT in the cocktail party effect means that for children with APD, use of language could enable them to focus on a particular conversation and attend to the speaker, as they have been instructed to do. However in DLT, the recorded messages sound similar to the interrupting messages, making it difficult to distinguish between the two. These findings, therefore, substantiate the submissions of Parthasarathy (2013) that for APD intervention to be even more beneficial to the students, both bottom-up and top-down treatments (interventions) should be considered and incorporated. The finding that DLT is better than CS in enhancing sound localisation ability in children with APD means that in its overall integrity, the human ear could localise sounds and receive messages to the ear better when the messages were recorded than when verbal speech is being introduced, which will aid inattention to environmental stimuli. This supports the general auditory hypothesis that APDs affect both speech and non-speech sounds.

A significant main effect of gender in the cocktail party explains the gender influence in listening, as males were better in listening with the 'cocktail party effect'. This means males with APD are more aware of their environment during a listening period than the females. That means they could vividly pick out words from a side conversation while grabbing the content of what is being delivered to them from a direct speaker. Females, on the other hand, were better off only while concentrating on a task and may not be able to attend to other interfering conversation(s), which could cause further distractions. Therefore, these findings support the finding of Cherry (1953) and further lend credence to earlier finding of Rogers et al. (2003) where it was realised that males tolerated significantly louder background noise than their female counterparts.

The findings that males could easily locate sources of sounds and get the content of information more than females in a listening task means that males are more adept at listening when a distractor variable such as sound is presented at varying degrees and from different locations. This could be interpreted to mean that males are better in audio-spatial tasks than females (Zundorf et al. 2011). This supports earlier finding that when several sounds were presented simultaneously, and participants had to focus on, and localise only one sound, while ignoring the distractors, men are more accurate in their location estimates than their female counterparts. This indicates that men demonstrate an advantage over women in spatial auditory tasks (Zundorf et al. 2011). This finding further corroborates earlier findings and in the detection of attended odd balls presented from one of two speaker locations in peripersonal space, where auditory discrimination tasks were used and where subjects either held speakers or rested their hands (Simon-Dack et al. 2009).

The results of this study on the interaction effect of treatment and gender viz-a-viz the cocktail party effect showed that the male gender predominated in all the intervention plans meaning that when there is intermittent noise when information is delivered, and persons with APD trained to listen to speech in the presence of noise, using either a bottom-up or a top-down approach, boys will outperform girls. This is to show that the cocktail party effect is gender-peculiar, as a similar result was discovered when the main effect of gender was determined (see Table 4). This is to confirm that the male gender is better off in audio-spatial abilities than the female gender.

Treatment and gender interactions on sound localisation ability favoured the male gender, and was predominant in all the groups, with the exception of the control group, where the interaction was

Table 4. LSD post-hoc analysis of mean differences based on gender.

Dependent variable	*Gender*	*Mean difference (I – J)*	*Sig.*
Cocktail party effect	Female		
	Male	1.50*	0.000
Sound localisation ability	Female		
	Male	1.87*	0.000

*Significant at $p < 0.01$.

more or less the same for the genders. This could then be interpreted as that when there is an intervention plan of either bottom-up or top-down in order to improve the sound localisation abilities of children with APD, such training will favour the male gender, even though there appears to be no significant difference in the sound localisation abilities of both genders when they are not exposed to any training. This finding is therefore consistent with the result of Neuhoff et al. (2009) where a male advantage was noticed in the perception of sound and motion toward the listener.

Conclusions and future directions

Persons with APD experience problems in listening to degraded speech, speech accompanied by background noise (cocktail party effect), detecting and localising sound, identifying the sources of sound, separating the sound from the competing background noise, and finally interpreting and discriminating the sounds. Based on this, the current study enhanced the listening ability of children with APD in the cocktail party effect and in sound localisation, through therapeutic interventions of DLT, CS, and CT framed from existing theories of information processing, which are the bottom- up model and top-down model respectively. CS was more effective in enhancing listening in the cocktail party effect, while DLT was better in improving sound localisation ability. However, the CT was more effective in both.

The study was limited in several areas. The study did not classify the disorder into specifics and only pupils between the ages of 7 years 0 months through 11 years 11 months with a single profile of the disorder were considered. Therefore, it is suggested that future researchers should probe into the effects of these therapeutic interventions on pupils with dual profiles of the disorder, and on individuals with specific disorders of auditory processing. Other interventions listed on the BSAAPDSIG (2011) could be tried in order to determine their effectiveness, either on single-profiled individuals or on dual-profiled individuals. The effects of these interventions could be determined on individuals who are not in-schooled, and other moderating variables aside gender considered. Also, the combination of the treatments should be varied. This study used the natural environment of the participants for the experiments, however, future researchers are encouraged to conduct the experiment in a clinical setting, or a variance of both clinical and natural setting.

This study has contributed to existing body of knowledge in the sense that it has proven that DLT, CS training and combined therapies are effective in enhancing listening abilities of pupils with APDs, and that gender in one way or the other could affect listening abilities in different conditions. The study has shown the significant contributions of the variables identified and implications consequent of the study to teachers, the clinician, and the therapists. Teachers should sit pupils with APD where they could visibly see the teacher's face. Clinicians should adopt interventions based on the gender of the individual to be helped – females with a top-down approach and with intensive sound localisation training and males with a bottom-up approach, except when the treatment would be combined which is combined treatments are recommended, where the individual would improve on language ability and also detection of sounds.

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