Caregiver/ Teacher administered remedial program for the management of children with APD

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Overview

- Background

Treatment of APD, prevalence of APD, challenges in APD management, Need for remediation program

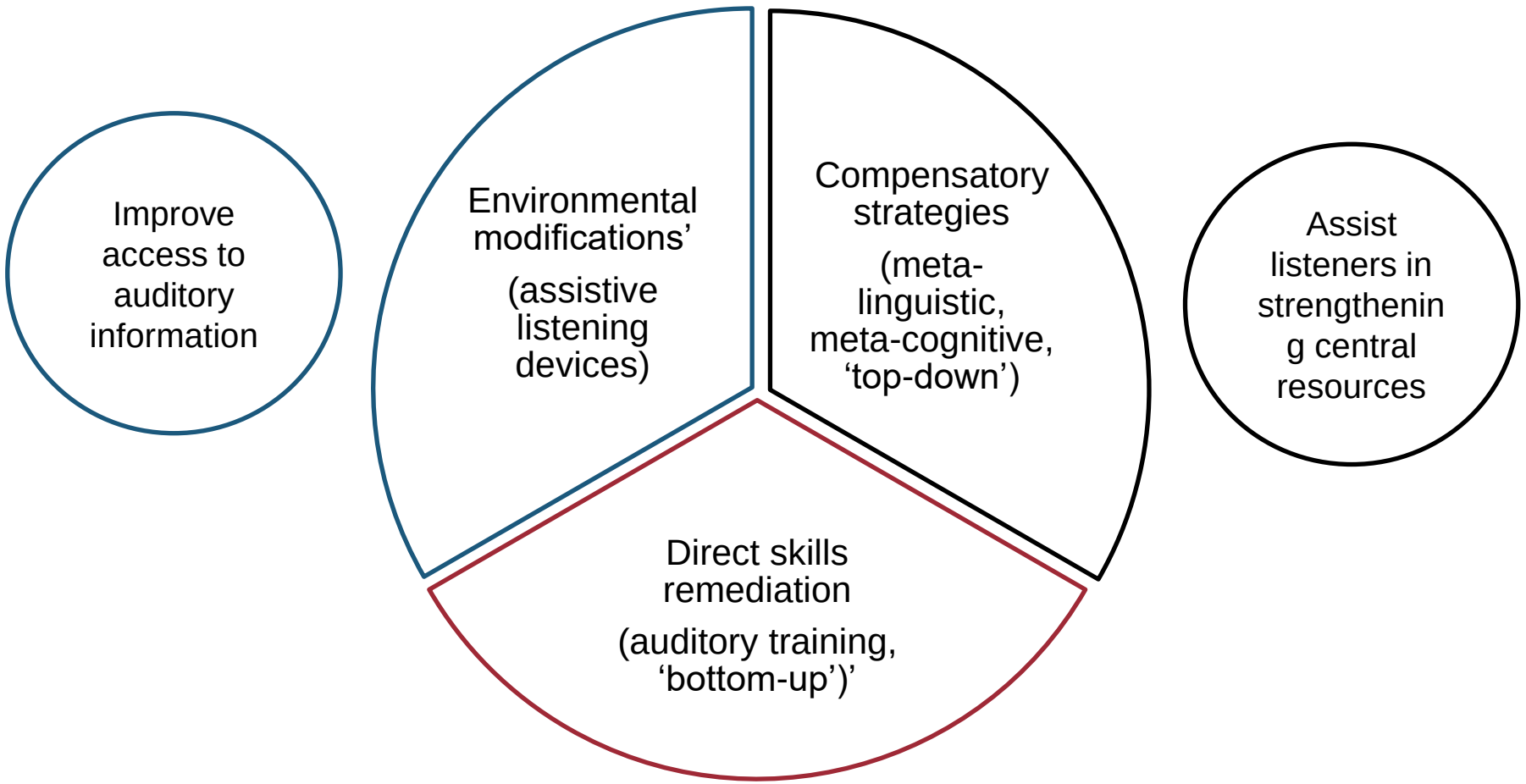
- Remediation program – CARP MAP

Description, Activities, Content Validation, Recording of the material

- Administration and measurement of cut-off scores on typically developing children
- Usefulness of CARP-MAP in children with APD
- Conclusion

Background

Treatment of APD, prevalence of APD, challenges in APD management, Need for remediation program


Improve access to auditory information
Environmental modifications'
(assistive listening devices)
Compensatory strategies
(meta-linguistic, meta-cognitive, 'top-down')
Assist listeners in strengthening central resources
Direct skills remediation
(auditory training, 'bottom-up')'

Treatment of APD

- Wide variety of treatment activities to address specific auditory deficits
- Some are computer assisted, one-on-one training, home based programs.
- Type, frequency, and intensity of therapy - individualized to the child and test results

Prevalence of APD

- Prevalence of APD in school going children was reported as 2 to 3% - Chermak and Musiek,1997
- In India, 3.2% of school-going children are at risk for APD - Muthuselvi & Yathiraj, 2009

- Prevalence of LD among school-aged children ranges from 3% to 7% - Bellis, 1996
- Percentage of children identified with dyslexia varies from 3% to 7.5% - Ramaa, 1985; Nishi, 1988

- Abnormal representation of auditory stimuli in the CANS despite normal peripheral auditory system- Cunningham et al., 2000; Hayes et al., 2003.
- APD has significant impact on language, literacy and academic achievement of children, especially when it co-occurs with LD.

It is essential to implement strategies and interventions to mitigate the adverse effects of APD

How does APD look in school?

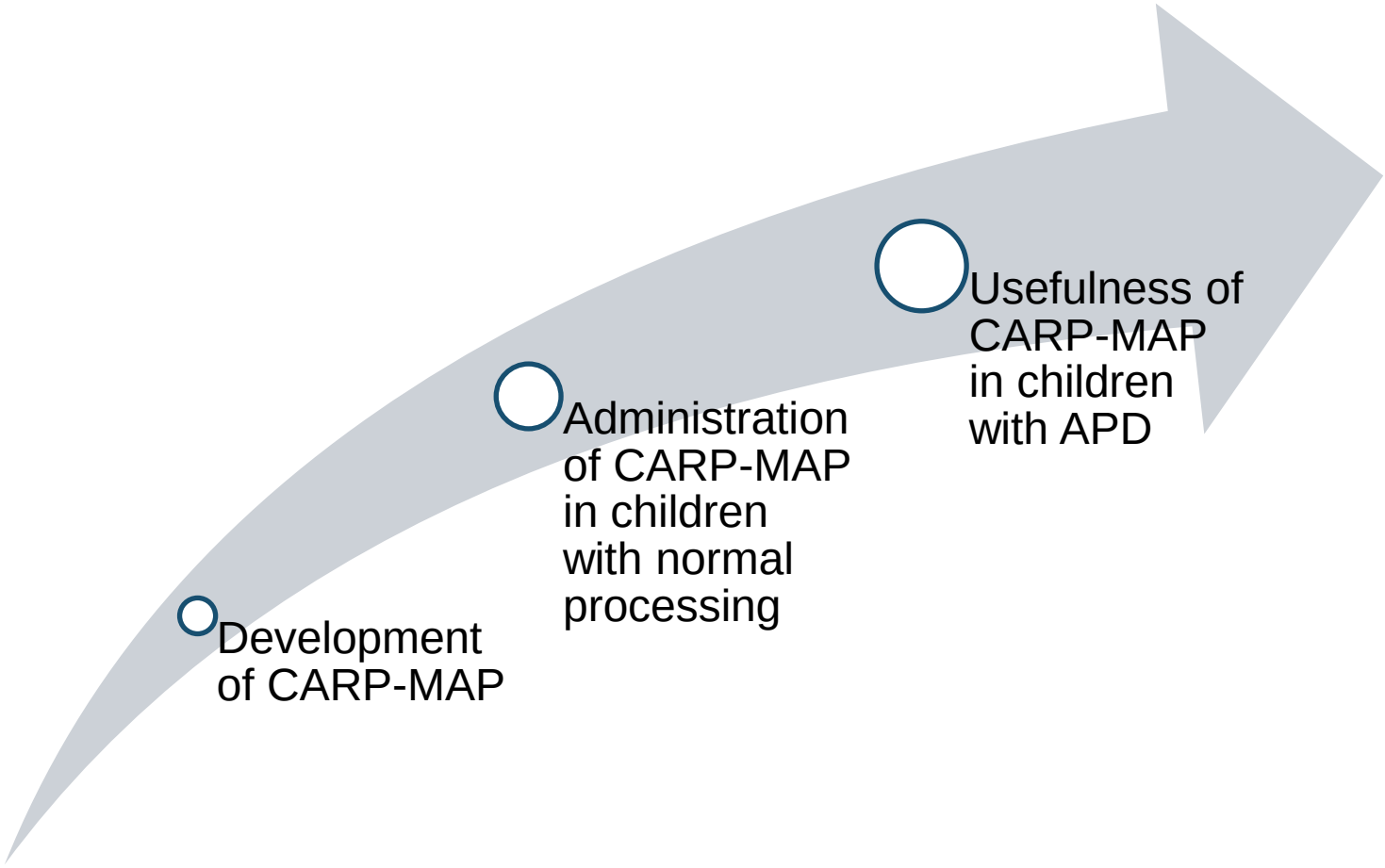
Need for CARP-MAP

- Academic challenges: Reading, writing, spelling, and social deficits observed (ASHA, 2005).
- Timely intervention crucial upon APD diagnosis confirmation.
- Effective auditory training necessitates frequent and intense sessions, often daily for weeks (Bellis, 2002; Musiek et al., 2002).
- Majority in mainstream schools, making it difficult to access personalized audiologist-provided remediation programs.

Remediation program – CARP MAP

Description, Activities, Content Validation, Recording of the material

CARP-MAP


Development of CARP-MAP
Administration of CARP-MAP in children with normal processing
Usefulness of CARP-MAP in children with APD

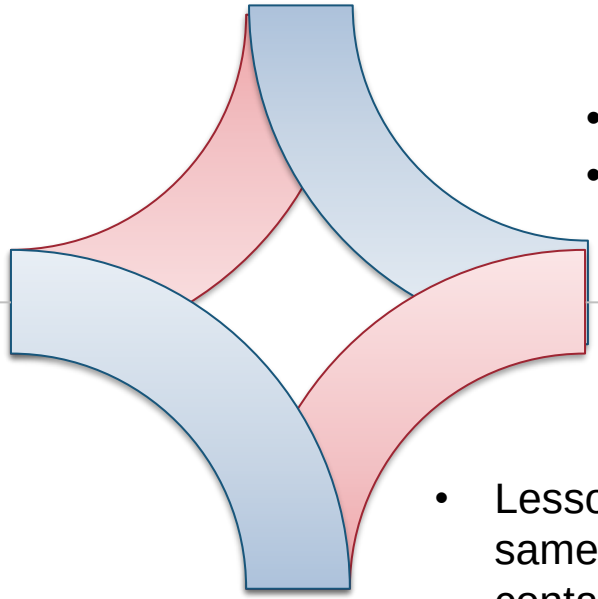
Description of CARP-MAP

Instruction Manual

Instruction, stimuli, and key for correct response

Audio files

- Recorded audio stimuli
- Lessons and corresponding activities



Worksheet/ scoring sheet

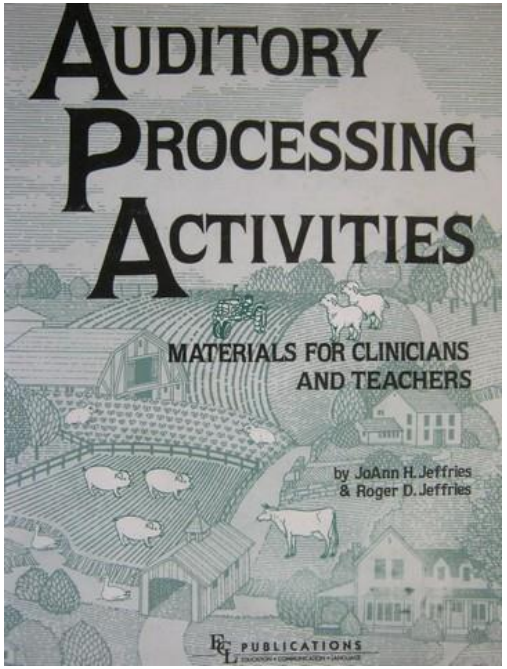
- Record responses of the child
- To monitor the progress of the child

Mid-assessment series book

- Lessons/ activities that targets the same auditory processes but contains different set of stimuli
- Done by audiologists after completion of every 3 lessons listed in manual.

Activities of CARP-MAP

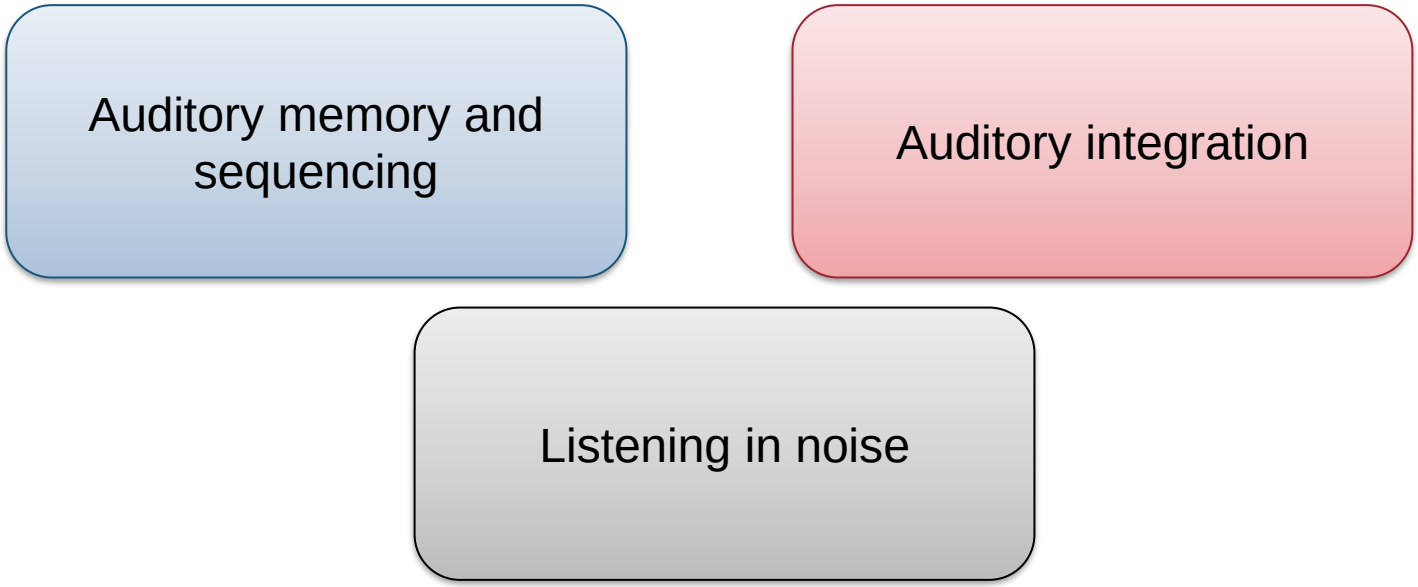
- Activities were developed and few were adapted (in Indian English) from the available resource materials.



Noise desensitization training (Maggu and Yathiraj, 2011)

Gastregi's visual training paradigm (Gastregi, 1981)

Remediation program focuses on 3 process



These processes are reported to be mostly affected in children with APD (MuthuSelvi & Yathiraj, 2009).

Activities of CARP-MAP

Auditory memory and sequencing	Dichotic offset training (Auditory integration)	Noise desensitization training
• Short memory for sentences • Short memory for commands • Working memory: phonetic memory • Short term memory and sequencing of digits • Short term memory and sequencing of words • Short term memory of words • Short term memory for stories • Working memory : long term semantic memory	• To improve auditory integration using dichotic offset training for words without blends • To improve auditory using dichotic offset training integration for sentences	• To improve speech perception in noise at +15dB SNR • To improve speech perception in noise at +10dB SNR • To improve speech perception in noise at +5dB SNR • To improve speech perception in noise at +0dB SNR • To improve speech perception in noise at -1dB SNR

Auditory memory and sequencing

Auditory memory and sequencing

1. **Short memory for sentences**
2. Short memory for commands
3. Working memory: phonetic memory
4. Short term memory and sequencing of digits
5. Short term memory and sequencing of words
6. Short term memory of words
7. Short term memory for stories
8. Working memory : long term semantic memory

1. Repetition of sentences with 3 content words 
2. Repetition of sentences with 4 content words 
3. Repetition of sentences with 5 content words 

Auditory memory and sequencing

1. Short memory for sentences
2. **Short memory for commands**
3. Working memory: phonetic memory
4. Short term memory and sequencing of digits
5. Short term memory and sequencing of words
6. Short term memory of words
7. Short term memory for stories
8. Working memory : long term semantic memory

1. Following 1 step command
2. Following complex direct commands
3. Following complex indirect commands

Auditory memory and sequencing

1. Short memory for sentences
2. Short memory for commands
3. **Working memory: phonetic memory**
4. Short term memory and sequencing of digits
5. Short term memory and sequencing of words
6. Short term memory of words
7. Short term memory for stories
8. Working memory : long term semantic memory

1. Identify different words 
2. Sentence completion 
3. Phrase completion 

Auditory memory and sequencing

1. Short memory for sentences
2. Short memory for commands
3. Working memory: phonetic memory
4. **Short term memory and sequencing of digits**
5. Short term memory and sequencing of words
6. Short term memory of words
7. Short term memory for stories
8. Working memory : long term semantic memory

1. Repeat 3 digits sequence forward and backward
2. Repeat 4 digits sequence forward and backward
3. Repeat 5 digits sequence forward and backward

Auditory memory and sequencing

1. Short memory for sentences
2. Short memory for commands
3. Working memory: phonetic memory
4. Short term memory and sequencing of digits
5. **Short term memory and sequencing of words**
6. Short term memory of words
7. Short term memory for stories
8. Working memory : long term semantic memory

1. Repeat 3 words sequence forward and backward
2. Repeat 4 words sequence forward and backward
3. Repeat 5 words sequence forward and backward

Auditory memory and sequencing

1. Short memory for sentences
2. Short memory for commands
3. Working memory: phonetic memory
4. Short term memory and sequencing of digits
5. Short term memory and sequencing of words
6. **Short term memory of words**
7. Short term memory for stories
8. Working memory : long term semantic memory

1. Identify the added words
2. Identify the missing words
3. Identify missing words in the sentences

Auditory memory and sequencing

1. Short memory for sentences
2. Short memory for commands
3. Working memory: phonetic memory
4. Short term memory and sequencing of digits
5. Short term memory and sequencing of words
6. Short term memory of words
7. **Short term memory for stories**
8. Working memory : long term semantic memory

1. Answering simple story questions
2. Answering complex story questions

Auditory memory and sequencing

1. Short memory for sentences
2. Short memory for commands
3. Working memory: phonetic memory
4. Short term memory and sequencing of digits
5. Short term memory and sequencing of words
6. Short term memory of words
7. Short term memory for stories
8. **Working memory : long term semantic memory**

1. Arrange the events in order
2. State true or false
3. Identify who I am?
4. Inferences

Dichotic Offset Training

Dichotic offset training (Auditory integration)

1. **To improve auditory integration using dichotic offset training for words without blends**
2. To improve auditory using dichotic offset training integration for sentences

1. 500ms RE lag - words 
2. 300ms RE lag - words 
3. 200ms RE lag - words 
4. 100ms RE lag - words 
5. 50ms RE lag - words 

Other 5 activities with LE lag

Dichotic offset training (Auditory integration)

1. To improve auditory integration using dichotic offset training for words without blends
2. **To improve auditory using dichotic offset training integration for sentences**

1. 500ms RE lag
2. 300ms RE lag
3. 200ms RE lag
4. 100ms RE lag
5. 50ms RE lag

Other 5 activities with LE lag

Noise desensitization training

Noise desensitization training

1. To improve speech perception in noise at +15dB SNR
2. To improve speech perception in noise at +10dB SNR
3. To improve speech perception in noise at +5dB SNR
4. To improve speech perception in noise at +0dB SNR
5. To improve speech perception in noise at -5dB SNR

1. Environmental noise & words
2. Environmental noise & sentences
3. White noise & words
4. White noise & sentences
5. Multi-speech babble & words
6. Multi-speech babble & sentences
7. Single-speech babble & words
8. Single-speech babble & sentences

Instruction manual for activity 3 in lesson 1

Activity 3: Repetition of sentences with 5 content words

Instruction: I will say a sentence. Listen to it carefully and repeat the same sentence.

Practice item: When you hear sentences as "We went to the shop to get sweets and savories for Diwali", you have to say "We went to the shop to get sweets and savories for Diwali".

Instruction to the trainer: The child has to repeat all the five key words that is underlined in a sentence. A score of 1 should be given if the child repeats all the five key words in a sentence. Maximum score is 20. You can move to next activity if the child scores 9 or more out of 20.

Test item:

1. I made bread and jam for breakfast yesterday.
2. My grandma is sitting on a chair reading books.
3. Sheela and Raju sold yellow bangles at market.
4. Ravi ate a banana and cup of milk for breakfast
5. Police stopped the speeding car yesterday.
6. I had rice, sambar and pickle for lunch yesterday.
7. Arun did not like to get out of bed in the morning.
8. Our driver slowed down before the bus stop
9. On our field visit to form, we saw cows and sheep.
10. My father wore a white shirt and red tie to office.
11. We practiced to sing ten songs at music class last week.

Scoring Sheet

LESSON 1: To improve short term memory for sentences

Activity 1: Repetition of sentences with 3 content words

Instruction to the child: You will hear a sentence, listen to it carefully and repeat the same sentence.

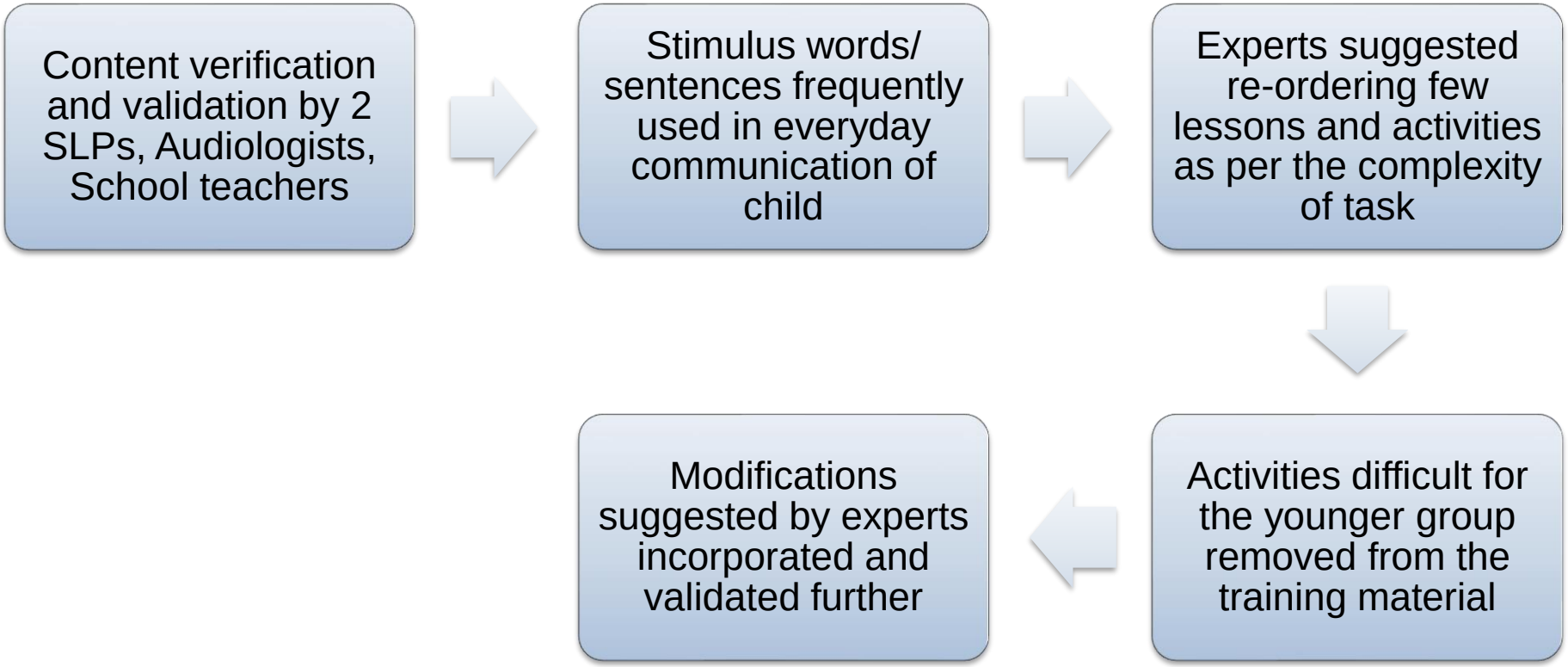
***Instruction to the trainer*:** The child has to repeat all the three key words that is underlined in a sentence. A score of 1 should be given if the child repeats all the three key words in a sentence. Maximum score is 8. You can move to next activity if the child scores 6 or more out of 8.

TEST ITEM:

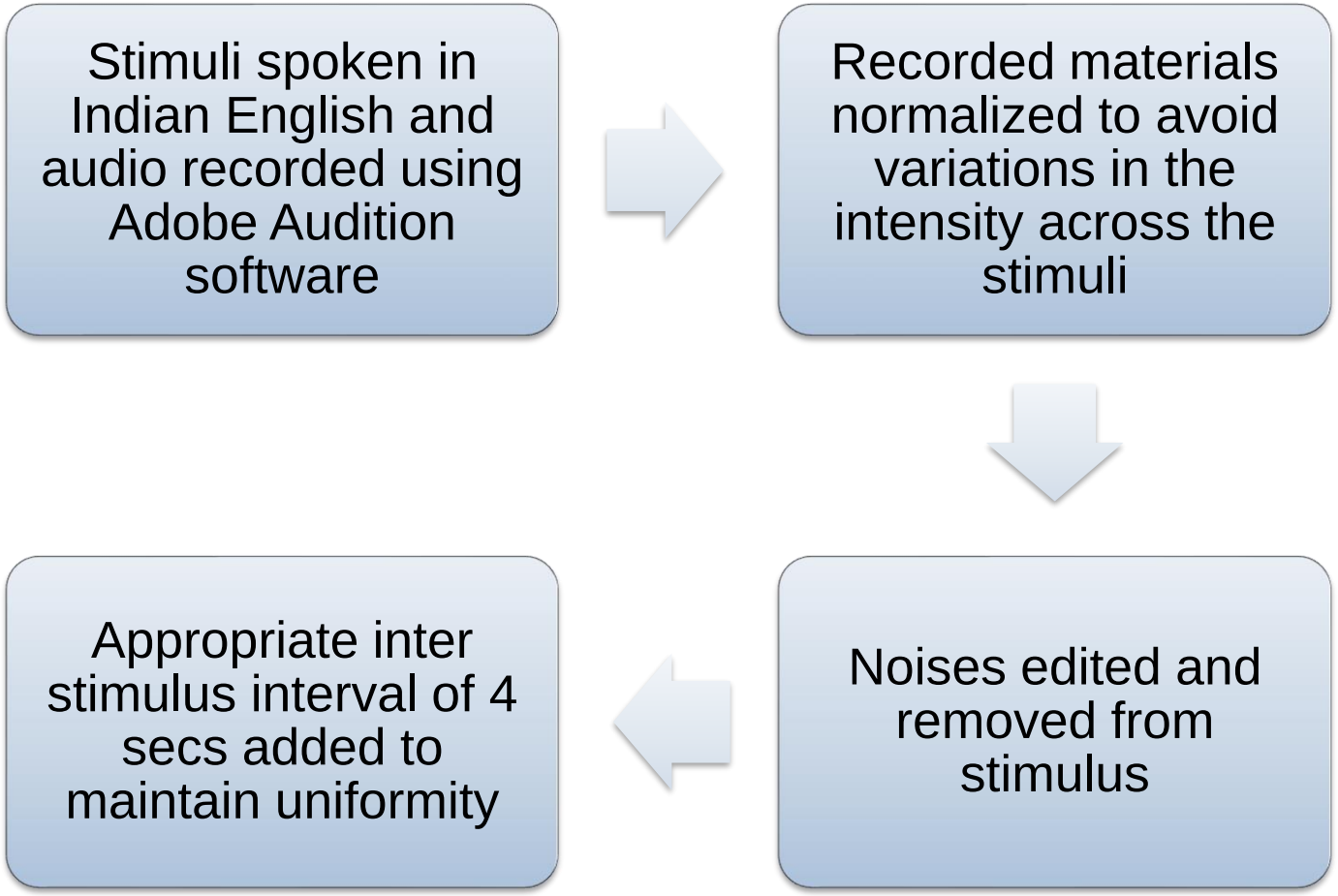
S. No	Response	Scoring
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

Content validation of the remedial program

Content validation of the remedial program



Recording of the material



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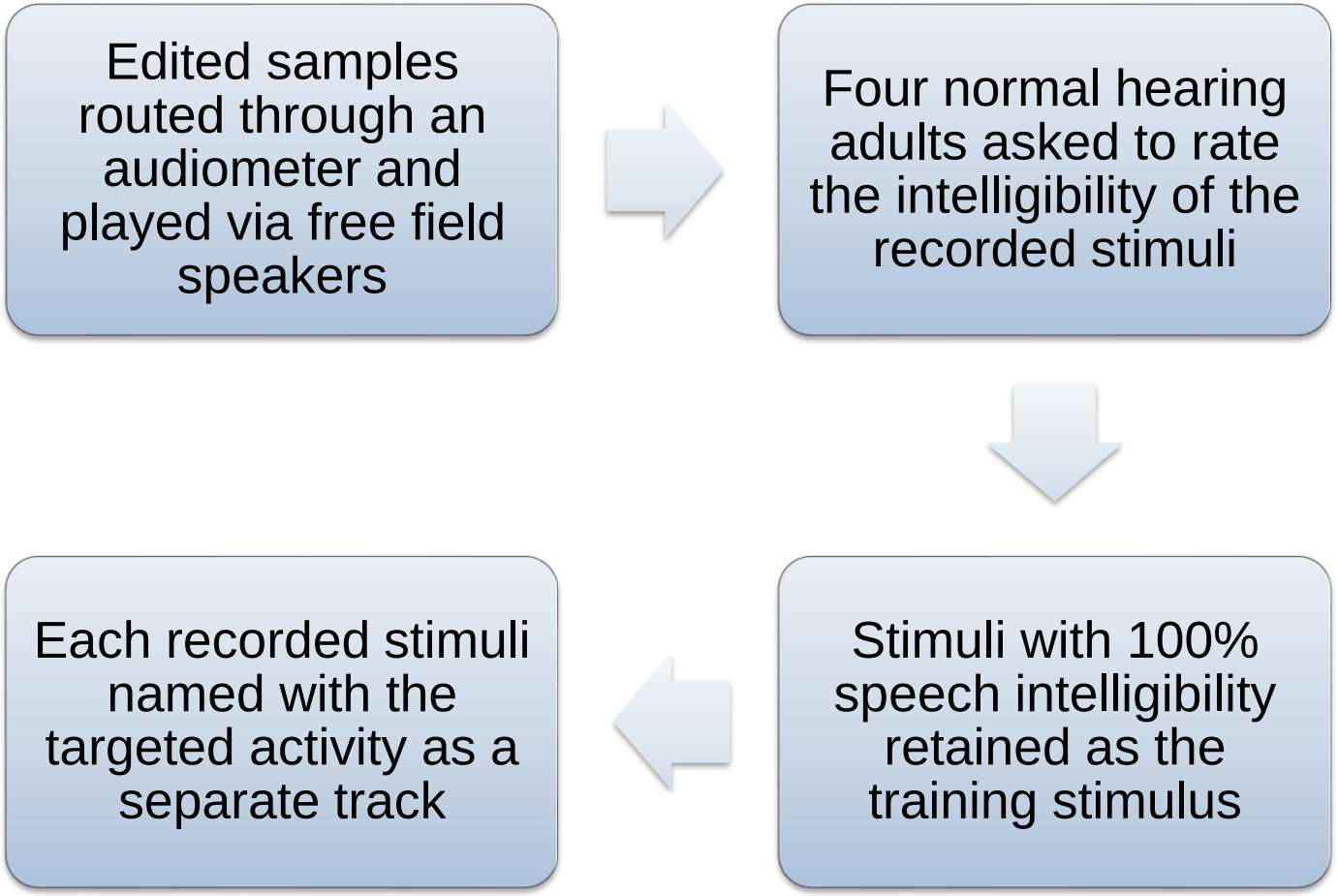
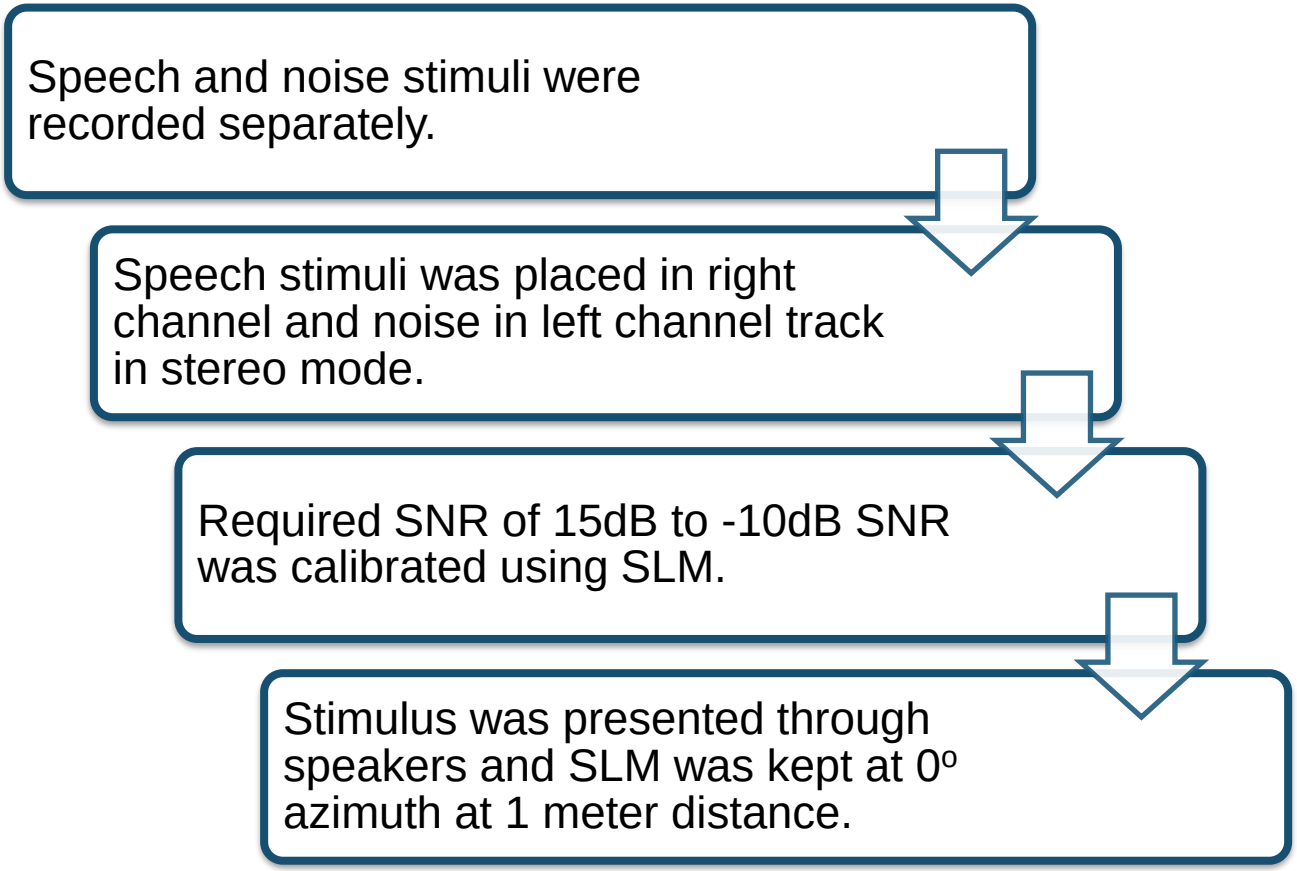


Noise Desensitization Process Activities

Noise Desensitization Process Activities



Noise Desensitization Process Activities

SLM was set to ‘A’ weighting network and average intensity value

Reference level for the speech was maintained at 60dBSPL

Amplitude of background noise was adjusted to meet the required SNR for each lesson ranging from +15dBSNR to -10dBSNR

Dichotic offset training

Dichotic offset training

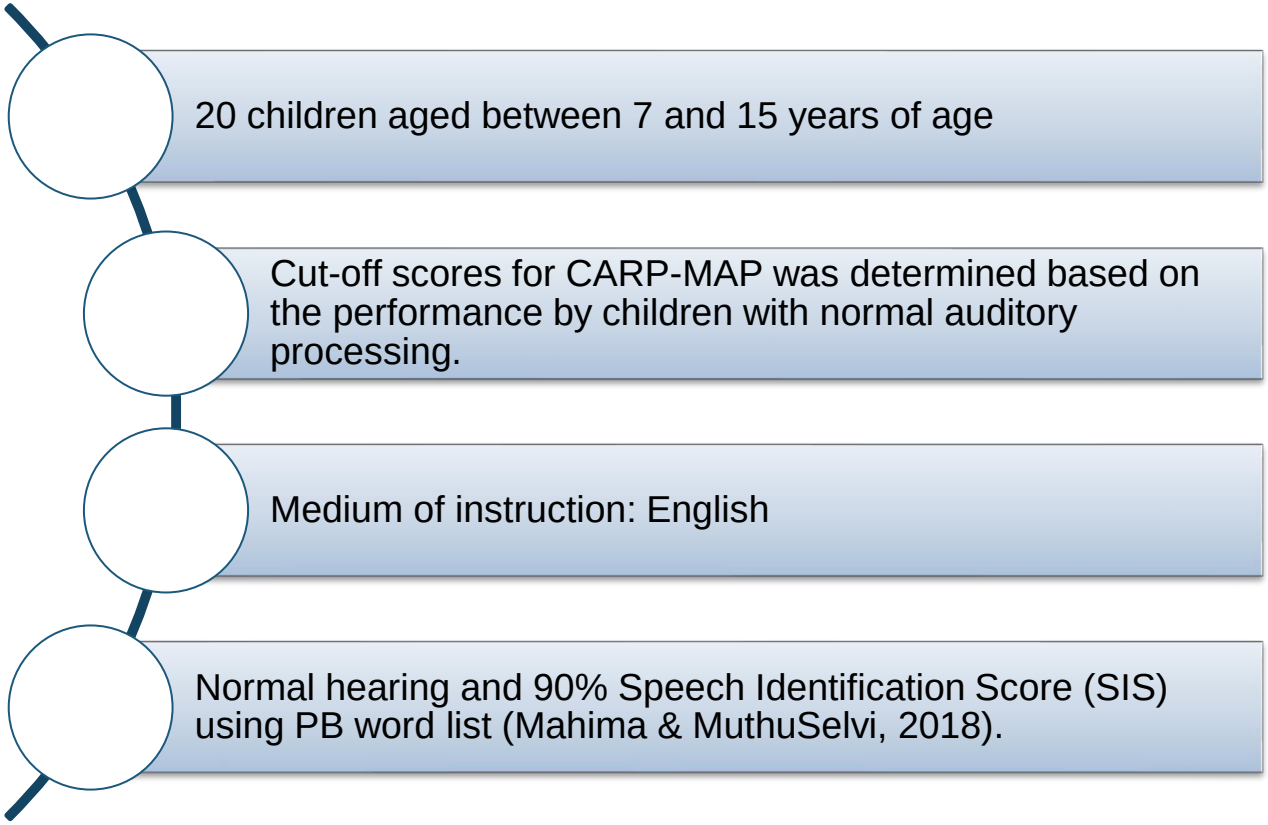
Stimuli in the dichotic offset training material were stored in stereo mode routed to right and left channel.

Lags were introduced appropriately to either right or left channel as specified in the lesson.

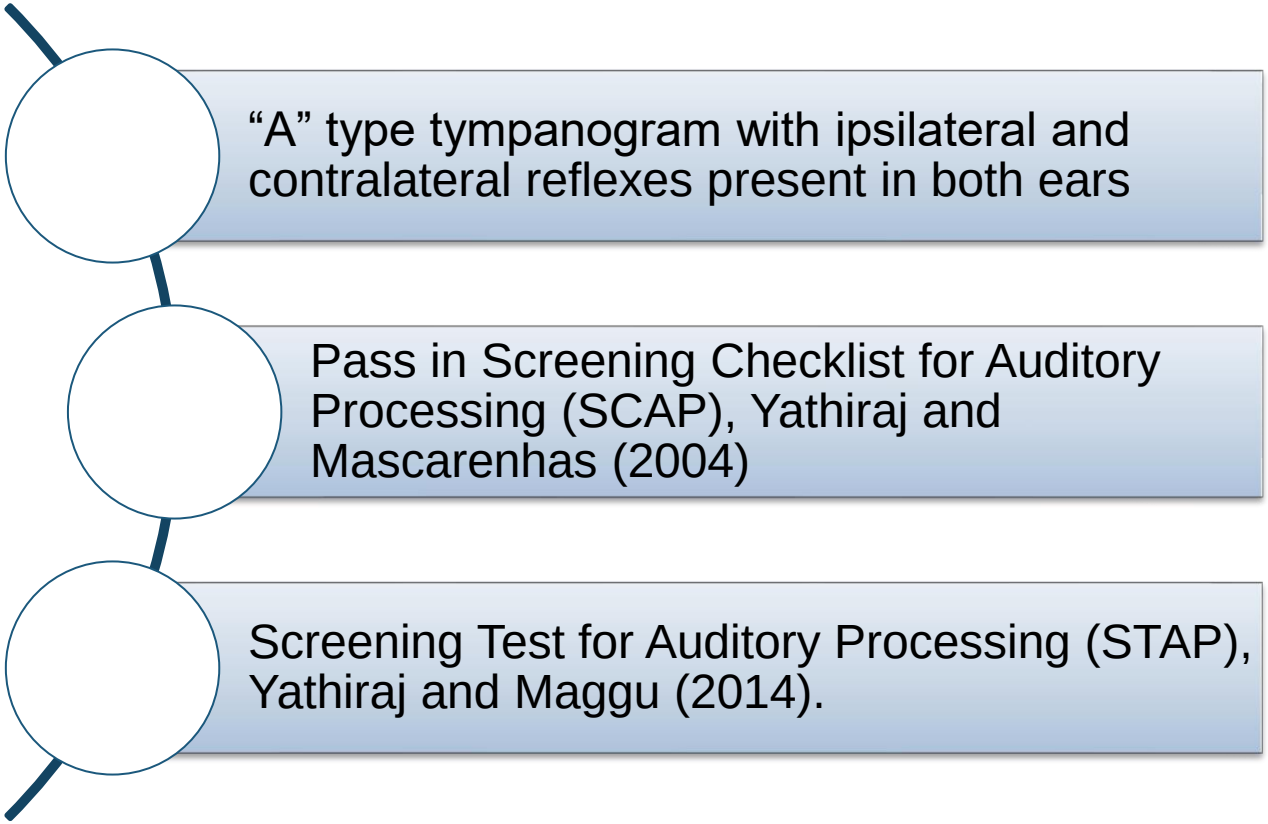
All these recording material were saved in mp3 format.

Administration of the developed remedial program on typically developing children (normative)

Administration of the developed remedial program on children with normal auditory processing abilities



Administration of the developed remedial program on children with normal auditory processing abilities



Procedure

CARP-MAP was administered to determine the cutoff score to progress to the next activities

This was carried out by an audiologist in a quiet room.

Recorded stimulus were presented through calibrated headphones via laptop

The participants are expected to provide responses orally

Each participant needed 4 to 5 sessions to finish the CARP-MAP activity.

Measurement of cut-off scores on CARP-MAP

Memory and sequencing

Mean percentage was calculated for 25 activities

However, tasks such as repeating 5-content-word sentences and forward-backward 5-word sequences displayed lower mean scores, around 50%.

Typically developing participants excelled in 15 activities, achieving a mastery level of 80-90%.

Some tasks, including identifying added words and repeating longer sequences, presented moderate scores (70-80%).

Noise desensitization

Noise Desensitization	SPIN scores decreased as background noise complexity increases from environmental to cafeteria noise.
	Lower Signal-to-Noise Ratios (SNRs) also correlate with reduced SPIN scores.
	SPIN scores were higher for word-based tasks compared to sentence-based ones. Participants had difficulty in single-speech babble background noise, regardless of SNR.

Noise desensitization

Noise Desensitization

SPIN scores remained high at +15 dBSNR (over 90%), gradually decreasing to above 80% at +10 dBSNR and +5 dBSNR, and dropping further to between 60% and 70% at 0 dB and -5 dBSNR.

Notably, no activity had a mean score lower than 50%, suggesting that participants generally performed adequately across different noise conditions and SNRs.

Dichotic offset training

Typically developing group's mean scores decreased as lag duration reduced

Sentences in dichotic listening had lower scores compared to words.

Lag durations of 300 ms and 500 ms	• The typically developing group achieved scores exceeding 90%.
Lag durations of 200 ms to 100 ms	• Scores between 80% and 90% were obtained
Lag durations of 0 ms and 50 ms	• Scores were from 60% to 80%

Similarly, for dichotic offset training using sentences, a mean score between 60% and 80% was observed.

Dichotic offset training

Benichov et al., 2012 reported that adults perform better in sentences - *linguistic cues and cognitive abilities*

In current study, children struggled with sentences, consistent with McCreery et al., 2020.

Activities were reorganized with words preceding sentences.

Using sentences in dichotic listening led to poorer performance than using words, similar to earlier study by Prachi & Yathiraj, 2000.

Dichotic offset training

So, no changes were recommended for dichotic offset training activities.

These mean scores were used to organize activities from easy to difficult within each subsection.

They also served as cutoff scores to progress to more challenging tasks for the intervention group of participants with APD.

Contd.

- Cutoff scores for most CARP-MAP activities (63 out of 96) fell in the 80 to 100% range, while some (26 out of 96) had cutoffs between 60 and 80%.

- This indicates that cutoff scores varied depending on activity difficulty, highlighting the need for normative cutoffs specific to each activity.

- Earlier studies (Priya & Yathiraj, 2007; Maggu & Yathiraj, 2011; Aarabi et al., 2016; Kumar et al., 2021) have set an arbitrarily cutoff ranging from 60–80% which may not be appropriate for the current study

Contd.

- To maintain participant engagement and motivation during interventions, it's essential to design activities with increasing complexity.

- Initially, activities within each subsection were created with varying difficulty levels.

- Cut-off scores were then employed to establish the relative difficulty order within each subsection, allowing for necessary adjustments in the activity sequence.

Usefulness of CARP-MAP in children with APD

Usefulness of CARP-MAP in children with APD

- Seven participants with APD received a home-based intervention program after obtaining consent from their caretakers.
- Caretakers were provided with necessary materials, including audio files, worksheet, mid-assessment series, and a manual containing activities/ scoring for the intervention.
- The home-based intervention occurred at mutually convenient times, with a minimum of 2 to 3 weekly sessions lasting 45 minutes to an hour each.

Usefulness of CARP-MAP in children with APD

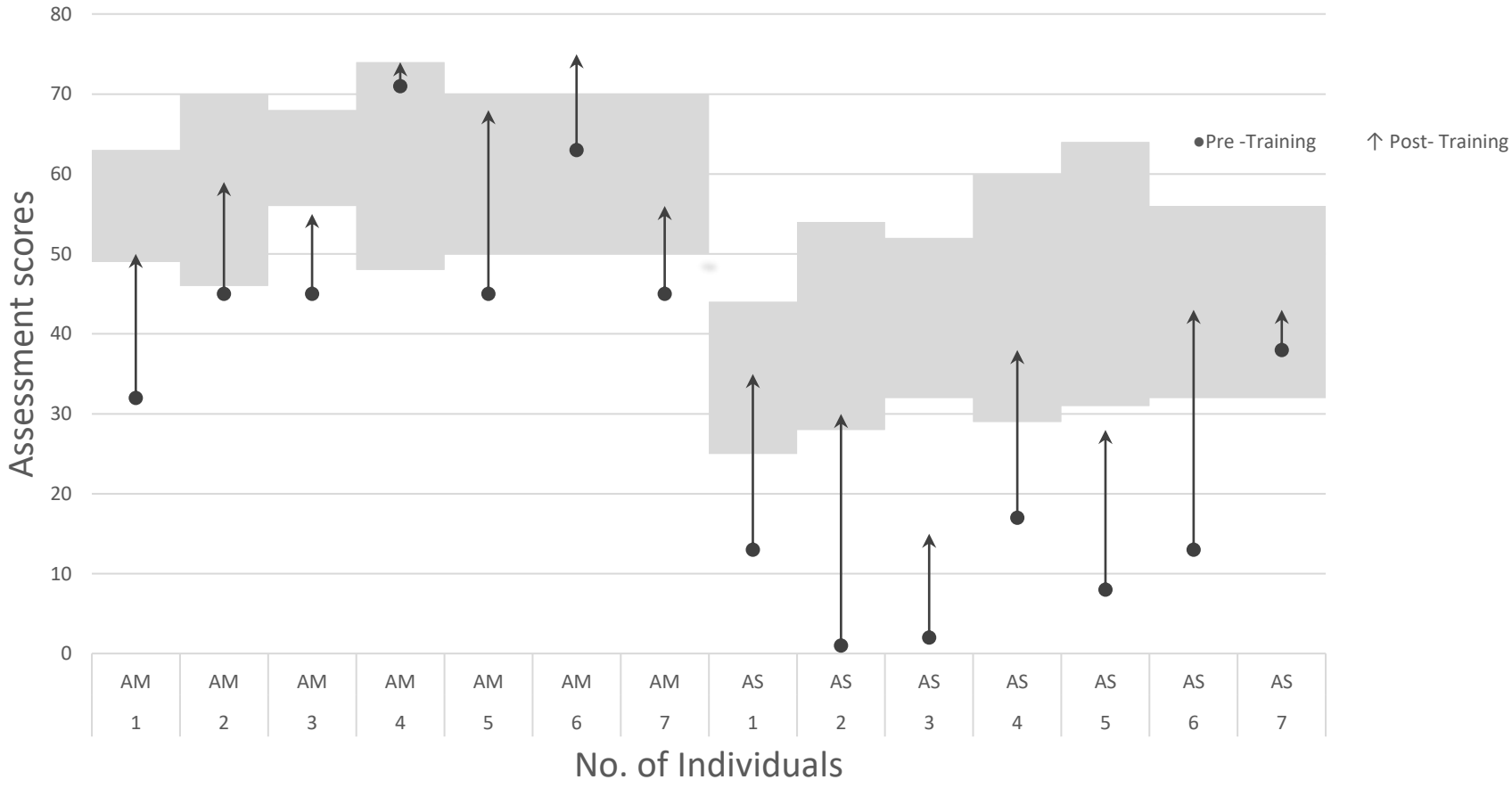
- Audiologists monitored and supported the intervention through platforms like whatsapp, Zoom or gmeet.
- Mid-assessment series helped evaluate skill mastery, and activities were repeated if needed.
- Intervention spanned 2-3 months followed by a post intervention APD assessment.
- Pre and Post training of APD test battery scores of the participants in the intervention group were statistically compared using a non-parametric Wilcoxon signed-rank test to check for improvement after intervention.

Comparison of Pre and Post assessment scores after administering CARP-MAP for children with APD

- Auditory memory and speech in noise were administered to six participants who had deviant scores on auditory memory, sequencing, and speech in noise tests.

- Dichotic off-set training listed in CARP-MAP was provided to three participants who had below-age-appropriate scores on the dichotic CV test.

Comparison of Pre and Post assessment scores after administering CARP-MAP for children with APD



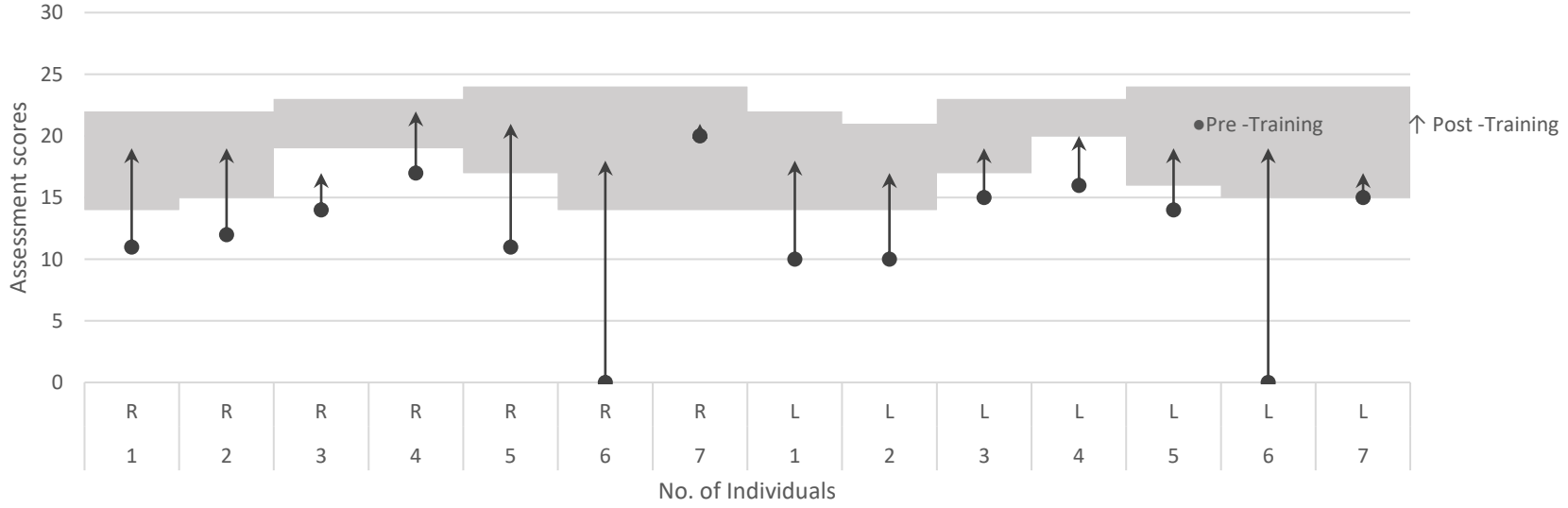
Comparison of Pre and Post assessment scores after administering CARP-MAP for children with APD

- Improvements noted in auditory memory/ sequencing skills following intervention
- Most participants achieved age-appropriate scores post intervention.
- On Wilcoxon signed rank test significant improvements were observed in auditory memory ($z=-2.207$, $p=0.027$) and auditory sequencing ($Z=-2.201$, $p=0.028$) scores.

Pre and Post assessment comparison of individual participant with APD's speech in noise scores

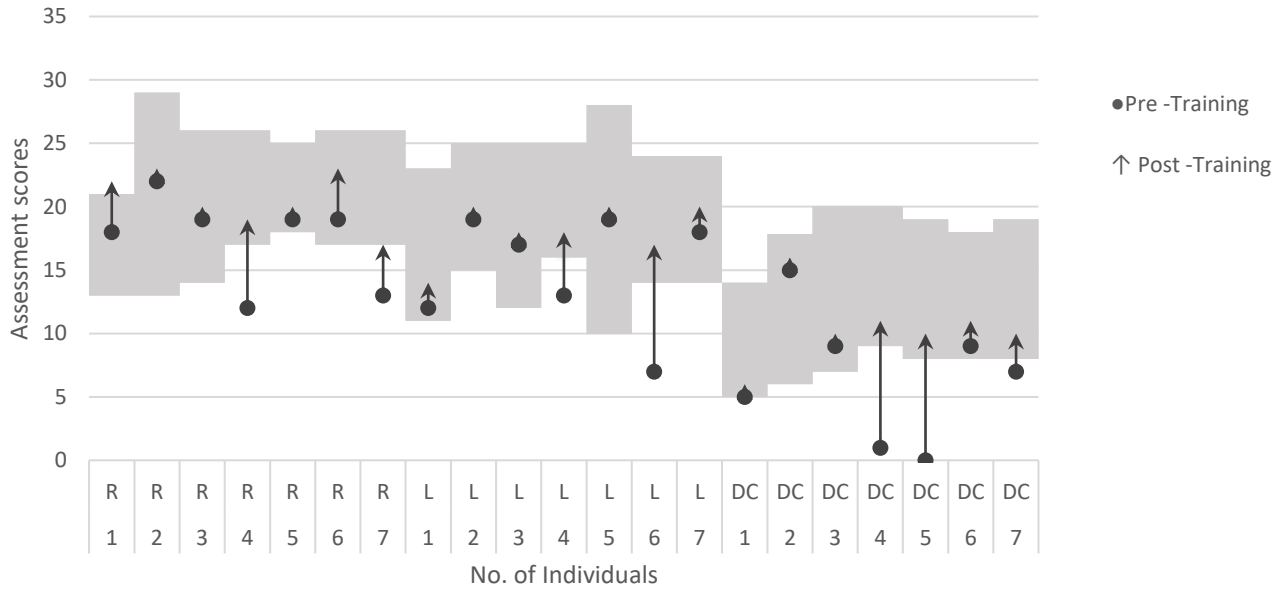
- Most participants with APD, except one, achieved age-appropriate scores in SPIN following training.

- Improvement in SPIN scores was statistically significant, both in right ear (Z = -2.201; p = 0.028) and left ear (Z = -2.207; p = 0.027) when comparing pre- and post-training evaluations.

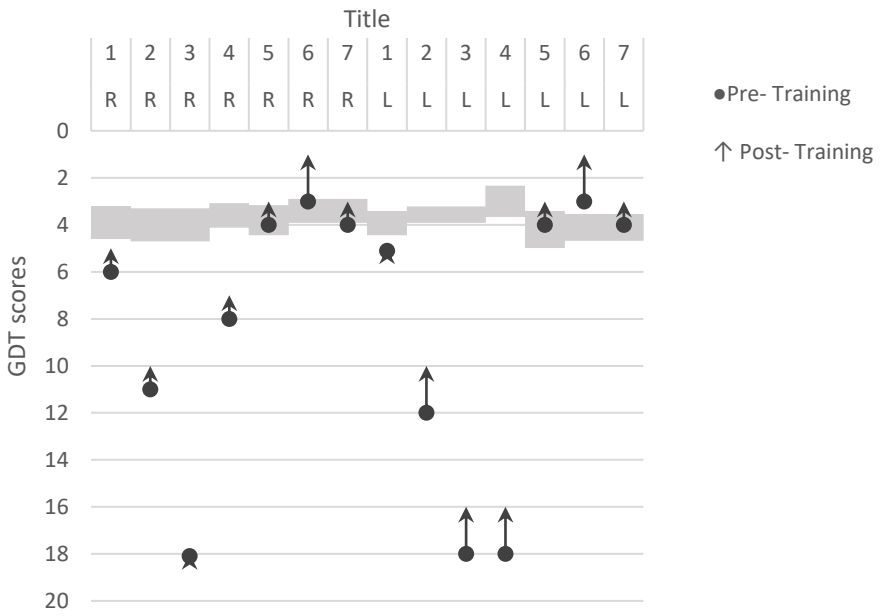


Pre and Post assessment comparison of individual participant with APD's single correct scores of right(R), Left ear (L) and Double correct (DC) Scores on Dichotic CV

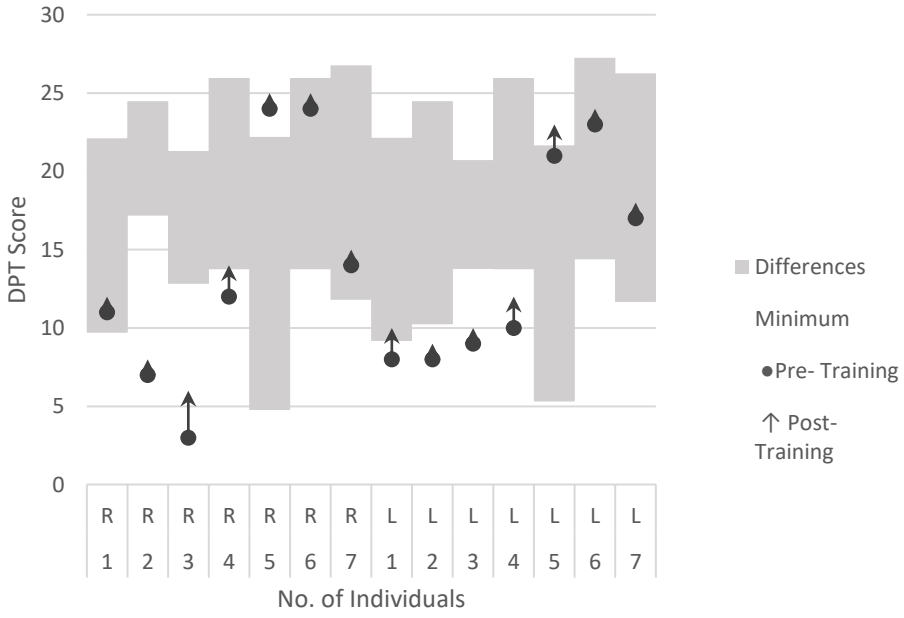
- There was improvement in single and double correct scores in dichotic CV after intervention.
- All three participants acheived age-appropriate scores with statistically significant improvement in dichotic CV scores (Z = - 2.439; p = 0.015)



Comparison of gap detection threshold of individual participants with APD between pre and post training



Comparison of Duration Pattern Test (DPT) scores



Comparison of Gap Detection and Duration Pattern Scores

- Gap detection threshold and duration pattern test scores showed slight improvements after APD intervention.

- No significant differences in gap detection threshold ($p = 0.083$) or DPT scores for the right ear ($p = 0.66$) and left ear ($p = 0.063$) between pre- and post-training.

- Results reveal that auditory memory/ sequencing training, noise desensitization training, and dichotic offset training provided for participants with APD were found to be effective in acquiring these skills.

Conclusion

- CARP-MAP is a caregiver/teacher administered remedial program developed for children with APD.
- It focusses on auditory memory and sequencing, noise desensitization, and dichotic offset training.
- CARP-MAP was administered on children with normal auditory processing to establish mean scores and cutoffs across the lessons and also in children with APD.
- Results demonstrated varying scores based on the activity complexity. CARP-MAP can be easily carried out by parents of children with APD at home.
- Case studies demonstrated significant improvements in children's auditory skills, highlighting the effectiveness and accessibility of CARP-MAP for children with APD.

Thank You