

**Intervention for Children with Auditory Processing Disorder (APD):
The Effectiveness of Bottom-Up and Top-Down Interventions**

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DECLARATION AND ETHICS STATEMENT

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

The research proposal for this study was approved by the Flinders University Clinical Research Ethics Committee (approval number 426.10). This research was conducted in accordance with the National Health and Medical Research Committee's guidelines on human experimentation. Participant confidentiality was assured.

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DEDICATION

For Subu, Elliot and Caleb

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LIST OF ABBREVIATIONS

A	Vargha-Delaney A
ADD	Attention Deficit Disorder
ADHD	Attention Deficit Hyperactivity Disorder
AIT	Auditory Integration Training
ALNLRAC	Assessment of Lexical and Non-Lexical Reading Abilities in Children
ALNLRAC-IW-RS	Irregular Word Reading Raw Score of the Assessment of Lexical and Non-Lexical Abilities in Children
ALNLRAC-IW-ZS	Irregular Word Reading z -Score of the Assessment of Lexical and Non-Lexical Abilities in Children
ALNLRAC-NW-RS	Non-Word Reading Raw Score of the Assessment of Lexical and Non-Lexical Abilities in Children
ALNLRAC-NW-ZS	Non-Word Reading z -Score of the Assessment of Lexical and Non-Lexical Abilities in Children
ALNLRAC-RW-RS	Regular Word Reading Raw Score of the Assessment of Lexical and Non-Lexical Abilities in Children
ALNLRAC-RW-ZS	Regular Word Reading z -Score of the Assessment of Lexical and Non-Lexical Abilities in Children
AP	Auditory Processing

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APD	Auditory Processing Disorder
Ax	Assessment
BM0	Backward Masking with a Zero-Millisecond Gap
BM50	Backward Masking with a 50-Millisecond Gap
CELF-4	Clinical Evaluation of Language Fundamentals (4 th Ed)
CI	Confidence Interval
CON	Control Group (STUDY 2)
CTOPP	Comprehensive Test of Phonological Processing
CTOPP-PA-CR	Phonological Awareness Composite Raw Score of the Comprehensive Test of Phonological Processing
CTOPP-PA-CS	Phonological Awareness Composite Standard Score of the Comprehensive Test of Phonological Processing
CTOPP-PM-CR	Phonological Memory Composite Raw Score of the Comprehensive Test of Phonological Processing
CTOPP-PM-CS	Phonological Memory Composite Standard Score of the Comprehensive Test of Phonological Processing
CTOPP-RN-CR	Rapid Naming Composite Raw Score of the Comprehensive Test of Phonological Processing
CTOPP-RN-CS	Rapid Naming Composite Standard Score of the Comprehensive Test of Phonological Processing

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CCVC	Consonant-Consonant-Vowel- Consonant
CVC	Consonant-Vowel-Consonant
CVD	Consonant Vowel Discrimination
CVCC	Consonant-Vowel-Consonant-Consonant
DDT	Dichotic Digits Test
DRC	Dual Route Cascade
ERP	Event Related Potential
FD	Frequency Discrimination
FD-DIFF group	Frequency Discrimination Difficulty Group (STUDY 1)
FD-DINO-TS	Dinosaur Task Threshold Score
FD-SOUND-TS	SoundsPod Threshold Score
FD-WNL group	Frequency Discrimination Within-Normal-Limits Group (STUDY 1)
FD-PP group	Frequency Discrimination Intervention and Phonological Processing Intervention Group (STUDY 2)
FM	Frequency Modulated
FR	Frequency Resolution
ISI	Inter-Stimuli Interval

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MCAR	Missing Completely At Random
MMF	Mismatch Field
MMN	Mismatch Negativity
PEST	Parameter Estimation by Sequence Testing
PP	Phonological Processing
PP group	Phonological Processing Intervention Group (STUDY 2)
PP-I-LS	Phonological Processing Intervention-Specific Literacy Score
PPVT-4	Peabody Picture Vocabulary Test (4 th Ed)
PPVT-RS	Peabody Picture Vocabulary Test Raw Score
PPVT-SS	Peabody Picture Vocabulary Test Standard Score
RAP	Rapid Auditory Processing
RAN	Rapid Automatic Naming
RCPM	Raven's Coloured Progressive Matrices
SAT	Simon Arrow Task
SAT-CONT-ER	Error Rate of the Control Condition of the Simon Arrow Task
SAT-CONT-RT	Reaction Time of the Control Condition of the Simon Arrow Task
SAT-REV-ER	Error Rate of the Reverse Condition of the Simon Arrow Task

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SAT-REV-RT	Reaction Time of the Reverse Condition of the Simon Arrow Task
SAT-CONGR-ER	Error Rate of the Conflict Congruent Condition of the Simon Arrow Task
SAT-CONGR-RT	Reaction Time of the Conflict Congruent Condition of the Simon Arrow Task
SAT-INCONGR-ER	Error Rate of the Conflict Incongruent Condition of the Simon Arrow Task
SAT-INCONGR-RT	Reaction Time of the Conflict Incongruent Condition of the Simon Arrow Task
SCORE-RS	!Score Subtest Raw Score of the Test of Everyday Attention in Children
SD	Standard Deviation
SM	Simultaneous Masking with Target Tone Presented in Continuous Noise
SMN	Simultaneous Masking with Spectral Notch
TEA-Ch	Test of Everyday Attention for Children
TR	Temporal Resolution
TROG	Test of Reception of Grammar
TROG-RS	Test of Reception of Grammar Raw Score

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TROG-SS	Test of Reception of Grammar Standard Score
TOJ	Temporal Order Judgement
VD intervention	Visual Discrimination Intervention
VD-PP group	Visual Discrimination Intervention and Phonological Processing Intervention Group (STUDY 2)

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Figure 6.25: Mean PP-I-LS of the FD-PP and PP groups across Ax2 and Ax3**Error! Bookmark not defined.**

Figure 6.26: Mean CTOPP-PA-CS of the FD-PP and PP groups across Ax2 and Ax3**Error! Bookmark not defined.**

Figure 6.27: Mean ALNLRAC-NW-ZS of the FD-PP and PP groups across Ax2 and Ax3 (Phase 2)..... **Error! Bookmark not defined.**

Figure 6.28: Mean ALNLRAC-RW-ZS of the FD-PP and PP groups across Ax2 and Ax3 (Phase 2)..... **Error! Bookmark not defined.**

Figure 6.29: Mean ALNLRAC-IW-ZS of the FD-PP and PP groups across Ax2 and Ax3 (Phase 2)..... **Error! Bookmark not defined.**

Figure 6.30: Mean ALNLRAC-NW-ZS of the VD-PP and PP groups across Ax2 and Ax3 (Phase 2)..... **Error! Bookmark not defined.**

Figure 6.31: Mean ALNLRAC-RW-ZS of the VD-PP and PP groups across Ax2 and Ax3 (Phase 2)..... **Error! Bookmark not defined.**

Figure 6.32: Mean ALNLRAC-IW-ZS of the VD-PP and PP groups across Ax2 and Ax3 (Phase 2)..... **Error! Bookmark not defined.**

Figure 7.1: A model depicting a possible representation of the interrelationship between FD, other AP abilities and reading. **Error! Bookmark not defined.**

ABSTRACT

The current recommendation for interventions for Auditory Processing Disorder (APD) is that they should involve both ‘bottom-up’ interventions that target specific auditory processing (AP) deficits and ‘top-down’ interventions targeting other cognitive abilities (e.g., language and reading) that might be impeded (ASHA, 2005; BSA, 2011b; Chermak, 1999; Chermak, & Musiek, 2007). To date, empirical research in this area is limited. The current thesis sought to investigate this recommendation empirically through two studies concerning a prominent AP ability, namely frequency discrimination (FD).

STUDY 1 aimed to investigate whether children with APD who also demonstrated FD difficulty would have poorer reading, language, auditory-sustained attention, and executive control than children with APD who had age-appropriate FD. Sixteen children with APD (aged 7;5 to 10;6), eight with FD difficulty (FD-DIFF group), and eight with age-appropriate FD (FD-WNL group) were tested for word reading, phonological processing (PP) (which included phonological awareness, phonological memory and rapid naming), language, auditory-sustained attention, and executive control. The FD-DIFF group showed significantly poorer non-word reading, regular word reading, and phonological awareness than the group with age appropriate FD. However, there were no group differences regarding irregular word reading, phonological memory, rapid naming, receptive language, auditory-sustained attention, and executive control. These findings suggest that FD seems to affect decoding skills that are required during reading, i.e., the non-lexical reading process in the dual route model of reading (Coltheart, Rastle, Perry, Langdon, & Zeigler, 2001), and is relatively independent of the lexical reading process, or sight word reading. Also, FD seems to be independent of language, attention, and executive control.

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STUDY 2 sought to investigate the outcomes of two intervention programs in children with APD, when administered in isolation or in combination. The interventions were: 1) a bottom-up intervention program to improve FD - the FD intervention (McArthur et al., 2008), and 2) a top-down intervention program to improve PP - the PP intervention (Rajkowski, 2003). An important focus of this study was to investigate whether prior FD intervention would enhance the outcome of the subsequent PP intervention. Generalisation of potential intervention effects of both intervention programs was also studied: 1) generalisation to another task that involved the same ability targeted during intervention, and 2) generalisation to overall language and reading abilities.

Nineteen children with FD and PP difficulties (aged 7;5 years to 9;9 years), who were also diagnosed with APD, were randomly allocated to one of four groups: 1) a group that undertook six weeks of FD intervention followed by six weeks of PP intervention – the FD-PP group; 2) a group that undertook six weeks of visual discrimination intervention (VD intervention)¹ followed by six weeks of PP intervention – the VD-PP group; 3) a group that undertook six weeks of PP intervention with no prior interventions – the PP group; and 4) a no-intervention control group – the CON group.

The findings showed that FD intervention resulted in significant intervention-specific improvement. However, there was no generalisation to a similar task of FD, or to language and reading abilities. PP intervention also resulted in significant intervention-specific improvement. There was partial support for the generalisation to a similar PP task and non-word reading. However, there was no generalisation to regular word reading, irregular word reading and language comprehension. Interestingly, when combined with prior FD intervention, significant generalisation of the PP intervention effect was observed for phonological awareness, non-word, and regular word reading. Therefore, the results

¹ The VD intervention was included as an active comparison to the FD intervention but in the visual modality.

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demonstrate that prior FD intervention had enhanced the PP intervention outcome for the measures that are related to the non-lexical reading process.

In conclusion, the present findings support the assertion that FD might affect the non-lexical reading process. Prior remediation of FD difficulty could enhance the effect of subsequent reading-related interventions for non-lexical reading. These findings support the recommendation that interventions for APD should incorporate both bottom-up and top-down interventions.