THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

New Zealand Guidelines on Auditory Processing Disorder 2019: Diagnosis and support for preschool and school-aged children

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Ko Maungataniwha te maunga
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Ko Awanui te awa
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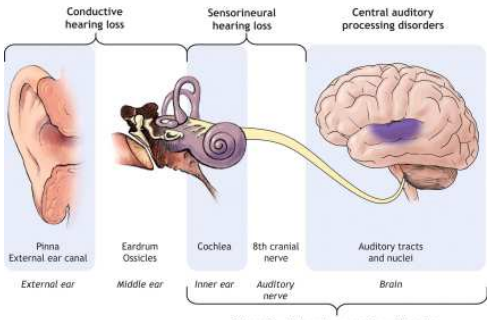


Hearing and aging
Manohar Bance
CMAJ March 27, 2007 176 (7) 925-927; DOI: https://doi.org/10.1503/cmaj.070007

Causes

- hereditary **developmental** abnormalities
- **maturational delay**
- antenatal, perinatal and postnatal factors including prematurity and low birth weight, prenatal anoxia, prenatal exposure to cigarette smoke or alcohol, hyperbilirubinemia
- **diseases, toxins** and **neurological conditions affecting the brain** including space-occupying lesions; Moyamoya disease and other cerebrovascular disorders; multiple sclerosis and other neurodegenerative diseases; bacterial meningitis; herpes simplex encephalitis; Landau Kleffner Syndrome and other seizure disorders; Lyme disease; metabolic disease; heavy metal exposure; solvent exposure
- **traumatic brain injury**
- blast injury
- **auditory deprivation**
- **aging**

(Bamiou, Musiek, & Luxon, 2001; AAA, 2010, p. 13; Witton, 2010)

European Journal of Human Genetics (2016) 24, 1137–1144

www.nature.com/ejhg

ARTICLE

Heritability of non-speech auditory processing skills

Carmen C Brewer[*,1], Christopher K Zalewski[1], Kelly A King[1], Oliver Zobay[2], Alison Riley[2], Melanie A Ferguson[2,3], Jonathan E Bird[4], Margaret M McCabe[5], Linda J Hood[6], Dennis Drayna[7], Andrew J Griffith[1], Robert J Morell[4,8], Thomas B Friedman[4] and David R Moore[2,9]

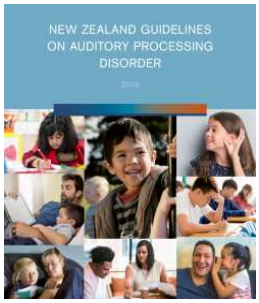
Recent insight into the genetic bases for autism spectrum disorder, dyslexia, stuttering, and language disorders suggest that neurogenetic approaches may also reveal at least one etiology of auditory processing disorder (APD). A person with an APD typically has difficulty understanding speech in background noise despite having normal pure-tone hearing sensitivity. The estimated prevalence of APD may be as high as 10% in the pediatric population, yet the causes are unknown and have not been explored by molecular or genetic approaches. The aim of our study was to determine the heritability of frequency and temporal resolution for auditory signals and speech recognition in noise in 96 identical or fraternal twin pairs, aged 6–11 years. Measures of auditory processing (AP) of non-speech sounds included backward masking (temporal resolution), notched noise masking (spectral resolution), pure-tone frequency discrimination (temporal fine structure sensitivity), and nonsense syllable recognition in noise. We provide evidence of significant heritability, ranging from 0.32 to 0.74, for individual measures of these non-speech-based AP skills that are crucial for understanding spoken language. Identification of specific heritable AP traits such as these serve as a basis to pursue the genetic underpinnings of APD by identifying genetic variants associated with common AP disorders in children and adults.
European Journal of Human Genetics (2016) **24**, 1137–1144; doi:10.1038/ejhg.2015.277; published online 17 February 2016

In order to discover any of the molecular neurogenetic causes of APD, it is essential to first identify AP traits that are demonstrably heritable and can be reliably measured. Heritability estimates (h^2) for four of the non-speech measures of spectral and temporal AP (BM, BM50, SMN, and FD) ranged from 0.61 to 0.74 in our twin cohort, providing evidence of substantial genetic influence on variance of these traits.

Reference

Keith, W. J., Purdy, S. C., Baily, M. R., & Kay, F. M. (2019). New Zealand Guidelines on Auditory Processing Disorder. New Zealand Audiological Society.

https://www.audiology.org.nz/assets/Uploads/APD/NZ-APD-GUIDELINES-2019.pdf



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Kōkako are well known for their beautiful song. In one story, Māui asked the different birds for water. The kōkako agreed, and filled its ears with water. Māui rewarded the bird by stretching its legs so it could move with swift hops. The 'water' can be seen in the kōkako's blue wattles.
https://teara.govt.nz/en/nga-manu-birds/page-5

He manu hou ahau, he pī ka rere.
I am like a fledgling, a newborn bird just learning to fly

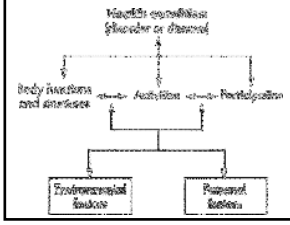
Kimiora Raerino (2007) "This whakatauki was the dying words of Ngāti Awa and Ngai Tūhoe chief Te Mautaranui."
https://core.ac.uk/download/pdf/56361231.pdf

Overall approach

- WHO International Classification of Functioning, Disability and Health
- Multidisciplinary, Holistic – screening, diagnosis, treatment
- Practical, affordable, accessible tools for screening and assessment
- Evidence based (validity, sensitivity, specificity)
- International peer-review

DEFINITION OF APD

Auditory processing disorder is a generic term for hearing disorders that result from atypical processing of auditory information in the brain. Auditory processing disorder is characterised by persistent limitations in the performance of auditory activities and has significant consequences for participation.
(Adapted from Canadian Guidelines (CISG, 2012).



https://www.clinicaldata.nzblood.co.nz/resourcefolder/selectdhb.php

What does APD sound like?

https://www.soundskills.co.nz/_literature_104671/Click_to_listen_to_an_Audio_Simulation_of_APD.mp3

Prevalence

A Report Prepared for the Ministry of Health and Ministry of Education

Auditory Processing Disorder: New Zealand Review

Authors: Jo Esplin and Craig Wright
Peer Reviewed by Professor Suzanne Purdy, The University of Auckland, New Zealand.

February 2014

https://www.health.govt.nz/system/files/documents/publications/auditory_processing_disorder.pdf

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PACIFIC ISLANDS FAMILIES STUDY

- *N*=920 11-yr old children from Auckland Pacific Islands Families: Hearing study: 34% with APD
- *N*=462 18-yr olds tested 7% meet APD criteria, based on 2 of the 4 tests used at the 11 yr phase (data collection completed Dec 2019)

PURDY SC, TAYLOR S, SCHLUTER PJ, TAUTOLO EL-S, IUSITINI L, AHMAD Z, SUNDBORN G, PATERSON J. Hearing and ear status of Pacific children aged 11 y ears living in New Zealand: the Pacific Islands Families Hearing Study. *International Journal of Audiology* Epub 27 Sept 2018

PATERSON, JE, PURDY SC, TAUTOLO EL-S, IUSITINI L, SCHLUTER PJ, SISK R. The association between hearing impairment and problem behaviours in 11-y ear-old Pacific children living in New Zealand, *Ear and Hearing* Epub 19 Sept 2019

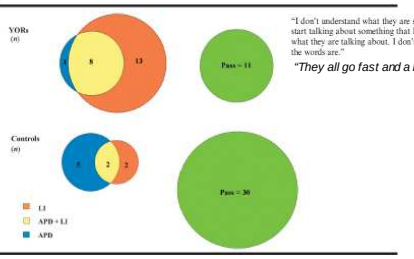
APD and language impairment in 14-17 yr old NZ youth offenders and remandees

Figure 1. Number of participants in each group with auditory processing disorder (APD), language impairment (LI), or both. YORs = youth offenders and remandees.

27%

vs.

18%



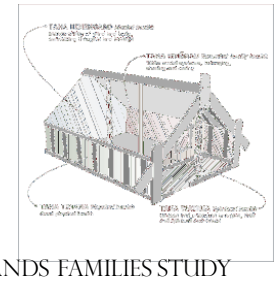
"I don't understand what they are saying ... they start talking about something that I don't even know what they are talking about. I don't even know what the words are."

"They all go fast and a bit quiet."

Lount, Purdy, Hand. J Speech, Language, & Hearing Research • Vol. 60 • 121–135 • Jan 2017

Health official: show me that this matters for their NCEA Level 2 [school exam] results and I will take it to the Board"

"The kids usually say I don't get the concept of it and then that makes me quite annoyed"; "Um, sometimes I get lonely when people don't want to play with me" (children with APD)



"She has no idea what she was meant to have done and we said that to the teacher and she called her lazy to us and made us angry" (father of child with APD)

PACIFIC ISLANDS FAMILIES STUDY HEARING ASSESSOR: "IF I HEAR ONE MORE TEACHER SAY 'I'M

PIF Parent: "Why did the school not tell me?"

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IDENTIFYING APD

Checklists of symptoms and comorbidities provide a simple and effective method of identifying children and adults who should be referred for diagnostic assessment.

- *A recommended checklist is shown.*

Questionnaires can also be useful.

- *Recommended questionnaires suitable for identification of children for referral in New Zealand are the TEAP, LIFE-7, APDQ and ECLiPS.*

Auditory Processing Disorder Referral Checklist

Checklist of key symptoms of auditory processing disorder (APD) or comorbidities that can be used to identify individuals who should be referred for APD assessment

Symptoms of hearing or listening problems not consistent with results of basic hearing assessment:

- difficulty following spoken directions unless they are brief and simple
- difficulty attending to and remembering spoken information
- slowness in processing spoken information
- difficulty understanding in the presence of other sounds
- being overwhelmed by complex or "busy" auditory environments e.g. classrooms, shopping malls
- undue sensitivity to loud sounds or noise
- poor listening skills
- preference for loud television volume
- insensitivity to tone of voice or other nuances of speech

Presence of other factors:

- brain injury
- neurological disorders affecting the brain
- history of frequent or persistent middle ear disease (otitis media, 'glue ear')
- difficulty with reading or spelling
- suspicion or diagnosis of dyslexia
- suspicion or diagnosis of language disorder or delay.

TEAP Questionnaire

- performs well in local and international studies
- next slide from functional disability study (Keith, Purdy, Baily, Leung) shows every child with APD scored below the cut-off score of 6

Main Teacher Concerns

A4. This child has difficulty following multistage oral instructions

A1. If listening in a room where there is background noise such as others talking, children playing etc., this child has difficulty hearing and understanding

B1. This child appears to have trouble picking up new spoken information and may require several repetitions in order to understand the material

TEAP individual scores

Listening/following instructions: Qu A1-A4

1 less difficulty
0 same amount of difficulty
-1 slightly more difficulty
-2 more difficulty
-3 considerably more difficulty
-4 significantly more difficulty
-5 cannot function at all

Speech/Language/Recall: Qu B1-B6

0 Yes
1 No

Cut-off line at 6 used to distinguish children with difficulties as per TEAP rating scale of same/less difficulty (Qu A1-A4) or "No" (Qu B1-B6)

NOTE: A few "false positives" amongst children without APD (solid bars)

Normal range 25-75%	6.5-10
Below 10-24%	6.49-2.8
Sig below 0-9%	<2.8

PRE-ASSESSMENT

- *It is recommended that pre-assessment of children includes non-verbal cognitive ability and language assessments.*

If comprehensive pre-assessment information on language and cognitive ability is not available, audiologists and special education personnel can screen non-verbal intelligence, language, and phonological awareness using the TONI-4, the CELF-5 Screener, and the PIPA, QUIL, CTOPP or TAPS-4.

Attention can be screened by questionnaire (e.g. Lack of Attention Scale of the MBC), or by test (e.g. TEA-Ch or IVA CPT-2).

Auditory short term memory can be screened using the TAPS-4.

- *The COVD QOL questionnaire is recommended to screen for children who should be referred for assessment by a behavioural optometrist.*

The MoCA can be used for cognitive screening of adults.

DIAGNOSIS

Audiologists are the only professionals qualified to diagnose APD.

Diagnosis is based on all available information, not just test scores.

Diagnosis should be limited to a "provisional" diagnosis, or a diagnosis of "at risk for APD" in cases where there is incomplete information due to age or other factors.

SELECTED TESTS

Mainstream clinical practice favours the test battery approach.

- *APD tests recommended as suitable for use by audiologists in New Zealand are shown in Table 3.*

https://www.hearingpro.com.au/hearing-tests-melbourne/auditory-processing-assessments/

How young can we diagnose and treat?

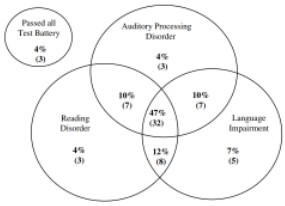
EARLY DETECTION

- *Early detection of and intervention for auditory processing difficulties are recommended.*

Tests suitable for use with younger children by audiologists in New Zealand are shown in Table 4 and include SCAN-3:C from 5 years of age and the ASA and CELF Pre-School 2 (User Level B) if below 5 years.

Language and literacy difficulties common in APD

Figure 6. Venn diagram showing the distribution of difficulties for the 68 children.

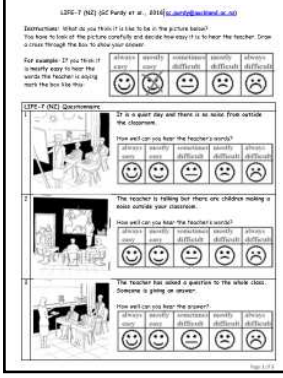


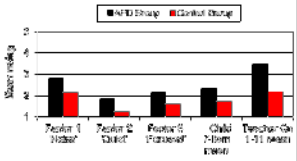
Sharma M, Purdy SC, Kelly AS. Co-morbidity of auditory processing, language, and reading disorders. *Journal of Speech-Language-Hearing Research*, 52, 706–722, 2009

DIAGNOSIS IN THE PRESENCE OF COMORBIDITIES

Children with comorbidities, including other types of hearing disorders, can and should be assessed for APD by audiologists experienced in APD assessment.

Children's self-perceived difficulties





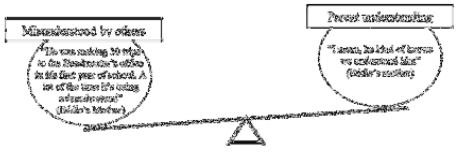
N=83 control group vs. *N*=60 APD

PURDY SC, SHARMA M, MORGAN A. Measuring perceptions of classroom listening in typically developing children and children with auditory difficulties using the LIFE-UK questionnaire. *Journal of the American Academy of Audiology,* 29(7), 656-667, 2018.

Effects on parents & children

Lawton S, Purdy SC, Kalathottukaren RT. Children Diagnosed with Auditory Processing Disorder and Their Parents: A Qualitative Study about Perceptions of Living with APD. *J Am Acad Audiol.* 2017:28(7)

- Parents are worried and need support
- Children show positive and negative coping behaviours



- "**She has a meltdown, cause it's the frustration** more than anything so we know now not to interfere and she calms down and we just go back to scratch and do it again''
- **"Um, worried about how he's going to deal with a situation. Worried about what someone's going to think. Worried about whether he's going to get in trouble, maybe."**
- "She often doesn't take in what you're saying and **the natural thing to do is to repeat, to repeat, to repeat, to repeat and it's not getting through and she didn't cope with the general system of learning because the school system** . . . has to work that way, as one system and one system only."

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MANAGEMENT

Management comprises:

- direct treatment of the hearing disorder with amplification and auditory training (the responsibility of audiologists)
- treatment of accompanying or consequential effects such as language disorder, phonological and reading problems, and coping difficulties (principally the responsibility of speech-language therapists and learning support personnel)
- referral to other professionals as required
- provision of information and support.

MULTIDISCIPLINARY TEAM APPROACH

Many professionals may be involved, alongside parents, in the management of APD in children. In addition to audiologists, professionals potentially involved include speech-language therapists, classroom teachers, psychologists, SENCOs, RTLBs, AoDCs, ATCs, other learning support personnel, SPELD teachers, medical practitioners, and occupational therapists. Hearing therapists may be involved in supporting adults with APD.

As the professionals responsible for diagnosing APD, and providing first treatment, audiologists carry case management responsibility for clients with APD.

https://www.audiology.org.nz/assets/Uploads/APD/NZ-APD-GUIDELINES-2019.pdf

Suggested treatment approach – see Guidelines for evidence review

- auditory training
- amplification

→ Audiologist + Education Adviser in school

- language therapy

incl phoneme recognition and discrimination, phonemic awareness, phonological awareness, phonics, prosody, language

→ SLT, Teachers…

Language–based auditory training to improve hearing ability

- hearing in competition (dichotic)
  - dichotic training for bilateral dichotic deficit
  - dichotic training for interaural asymmetry (amblyaudia) e.g. ARIA
- hearing in competition (diotic)
  - including spatial perception deficit (SPD) e.g. SoundStorm
- auditory enrichment with mildly amplified whole language:
  - audiobooks
  - remote microphone hearing aids

https://www.nomadagency.com.au/portfolio-item/soundstorm-ipad-application/

Remote microphone hearing aids (RMHAs)

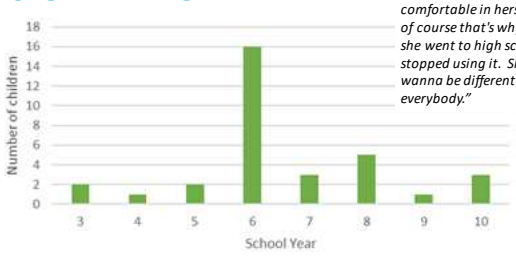
- teacher-worn transmitter/microphone (RM system)
- child/adult with APD wears hearing aid receiver

http://www.ouramazingjourneytn.com/?p=167

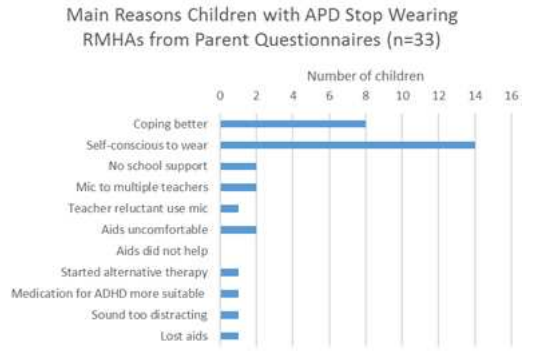
https://www.phonak.com/com/en/hearing-aids/accessories/roger-focus.html

School year when children stop wearing their RMHAs

"So by year, what year seven-eight, when everybody was comfortable with it, the teachers were comfortable, she was comfortable in herself. But of course that's why when she went to high school she stopped using it. She didn't wanna be different from everybody."



48% of children stop wearing the RMHAs at Year 6 (*N*=33) (average age 10.8 yrs; SD 1.9; range 7-15 yrs)



Key points

- NZ Guidelines provide comprehensive evidence based information for identifying, diagnosing and treating APD
- APD is a relatively common, but treatable condition
- Evidence base strongest for remote microphone technology, but there are evidence-based treatments for specific auditory skills (spatial listening, dichotic listening, speech perception in noise, phonological processing, auditory discrimination)
- Co-morbid conditions such as dyslexia, developmental language disorder and attention deficit disorder should also be addressed
- Multi-disciplinary team that includes educational psychologists key to effective management

Educational psychology

Hear the voice of the child and whānau

Assess and manage cognition and behaviour

Address psychosocial impact on child and family

Educational support of children and teachers

Refer to audiology for assessment and amplification-based treatments

Refer for language assessment

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Reference Group on Auditory Processing Disorder

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Ehara taku toa i te toa takitahi, ēngari he toa takimano e.

My strength is not mine alone, but that of many.

Ngā mihi nui
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ABSTRACT

Auditory processing disorder (APD) is a generic term for hearing disorders that result from atypical processing of auditory information in the brain. The overall **prevalence** in children in New Zealand is estimated at 6.2%. The New Zealand Guidelines on Auditory Processing Disorder were developed and published in 2019 with the support of the NZ Audiological Society and the Ministries of Education and Health (Keith et al., 2019). APD can affect learning and academic achievement, psychosocial development and participation. Some **APD symptoms** are similar to symptoms of other types of hearing disorders, but APD differs in that it is not detected by standard hearing tests. **APD should be suspected** when there are reports of poor hearing and auditory comprehension in some circumstances despite normal pure tone hearing test results. Children with APD may have difficulty following spoken directions unless they are brief and simple. APD frequently **co-occurs** with developmental language and reading disorder. APD is diagnosed by audiologists using specialised audiological tests as recommended in the Guidelines. Assessment and management of cognitive, learning and language abilities by relevant professionals such as educational psychologists are also recommended. The Guidelines encourage APD testing below the traditional age of seven years, using tests that have been developed for younger children. **Recommended evidence-based management of APD** includes treatment of auditory discrimination and other processing difficulties; treatment of accompanying or consequential effects such as language disorder, phonological and reading problems, and coping difficulties; further referral if required; and the provision of information and support. Psychologists, speech-language therapists (SLTs), teachers, learning support personnel and other professionals may need to be involved in treatment along with audiologists.

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