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17-19 APRIL 2013

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TABLE OF CONTENTS

WEDNESDAY 17 APRIL 2013

SESSION 2 (LANGUAGE)

- 6 **Phonological context and processing load effects on the production of third person singular -s: implications for hearing impaired children**
Miss Kiri Mealings, Professor Katherine Demuth
- 6 **Brain development for optimal listening and spoken language development in children born with hearing loss: the evidence**
Associate Professor Dimity Dornan
- 7 **Investigating young children's sentence processing abilities using EEG**
Ms Kelly Miles, Professor Katherine Demuth, Dr Varghese Peter, Associate Professor Catherine McMahon
- 7 **Are the syllabic allomorphs particularly challenging for hearing impaired children? Evidence from TD and SLI speech**
Miss Ekaterina Tomas, Professor Katherine Demuth, Dr Karen Smith-Lock
- 8 **Phonology and hearing: could Australian Aboriginal languages be acoustically easier to hear than English by listeners with OME-induced hearing impairment?**
Professor Andrew Butcher, Associate Professor Janet Fletcher, Mr Hywel Stoakes, Dr Marija Tabain
- 8 **Impact of the presence of auditory neuropathy spectrum disorder on outcomes at 3 years of age**
Teresa YC Ching, Julia Day, Harvey Dillon, Kirsty Gardner-Berry, Sanna Hou, Mark Seeto, Angela Wong, Vicky Zhang

SESSION 3 (EPIDEMIOLOGY)

- 9 **The adverse impacts of sensorineural hearing loss: lessons from the Blue Mountains hearing study**
Dr Bamini Gopinath, Associate Professor Catherine McMahon, Dr Julie Schneider, Professor Paul Mitchell
- 9 **Screening for hearing loss among older Australians with vision impairment: the vision-hearing research project**
Dr Julie Schneider, Ms Moira Dunsmore, Dr Bamini Gopinath, Dr Catherine McMahon, Professor Paul Mitchell, Associate Professor Jie Jin Wang, Professor Stephen Leeder
- 10 **The epidemiology of childhood hearing loss in the Philippines**
Mr John Newall, Associate Professor Norberto Martinez, Mr Hubert Ramos
- 10 **The impact of universal newborn hearing screening on early hearing aid fitting – the Australian experience**
Ms Alison King, Dr Laurie Upfold
- 11 **The global burden of hearing loss**
Professor Adrian Davis

- 11 **VicCHILD: establishment of the world's first population-based childhood hearing impairment longitudinal databank**
Professor Melissa Wake, Ms Sherryn Tobin, Dr Zeffie Poulakis, Ms Laura McMillan, Ms Anne Hampton, Dr Katie Mueller, Dr Rachel Burt, Mr Luke Stevens, Professor Jane Halliday

SESSION 4 (HEARING CRC PHD STUDENTS – ORAL POSTERS)

- 12 (P1) **Rapid electrophysiological assessment in infants: analysis of paired-stimuli sequences using deconvolved overlapping cortical auditory evoked responses**
Mrs Lauren Turner, Mr Fabrice Bardy
- 12 (P2) **Factors influencing target detectability in realistic listening scenarios**
Mr Tobias Weller, Dr Virginia Best, Dr Jorg Buchholz
- 13 (P3) **Objective analysis of higher-order ambisonics sound-field reproduction for hearing aid applications**
Mr Christos Oreinos, Dr Jorh Buchholz
- 13 (P4) **Effect of attention on the frequency following response to speech targets in competing spatially collocated and separated discourse**
Mr Nematollah Rouhbakhsh, Dr Bram Van Dun, Professor Harvey Dillon, Mr Jörg Buchholz, Ananthanarayan Krishnan
- 14 (P5) **Signal segregation in bilateral cochlear implant users**
Mr Aswin Wijetillake, Dr Richard Van Hoesel, Associate Professor Robert Cowan
- 14 (P6) **Abnormal processing of visual and auditory stimulus in noise in children with listening difficulties**
Ms Pia Gyldenkaerne, Dr Phillip Gilley, Dr Mridula Sharma, Professor Suzanne C. Purdy, Professor Harvey Dillon
- 15 (P7) **Human brain mapping of tinnitus**
Mr Ankit Mathur, Dr Catherine McMahon, Mr Ronny Ibrahim, Dr Blake Johnson
- 15 (P8) **Prosody and auditory processing predicts reading ability in primary school aged children**
Ms Margot Lochrin, Dr Joanne Arciuli, Dr Mridula Sharma, Ms Pia Gyldenkaerne
- 16 (P9) **A comparison of visual-gaze patterns during storybook comprehension tasks for school-aged children using cochlear implants from different early educational programs**
Mrs Christa Carey-Sargeant, Dr Shani Dettman, Dr Bernice Mathisen
- 17 (P10) **Examining the impact of early musical experience on the long-term speech and music perception outcomes of children with cochlear implants**
Ms Michelle Moran

17 (P11) **Speech characteristics of children with hearing loss in New Zealand**
Areej Asad, Suzanne Purdy, Elaine Ballard, Liz Fairgray, Katherine Demuth, Caroline Bowen, Mridula Sharma

18 (P12) **Patient-centred history taking in audiological rehabilitation? A peek inside**
Mrs Caitlin Grenness, Professor Louise Hickson, Associate Professor Bronwyn Davidson, Dr Ariane Laplante-Lévesque

18 (P13) **Bridging the gap: Translating outcomes research to clinical intervention**
Miss Aleisha Davis

SESSION 5 (OBJECTIVE HEARING ASSESSMENT)

19 **Estimation of hearing thresholds using ASSR, Chirp-ABR and Chirp-ASSR**
Dr Sabine Haumann, Professor/Dr Thomas Lenarz, Professor/Dr Andreas Büchner, Professor/Dr Anke Lesinski-Schiedat

19 **Diagnosis of hearing impairment in children**
Dr Sabine Haumann, Professor/Dr Thomas Lenarz, Professor/Dr Andreas Büchner, Professor/Dr Anke Lesinski-Schiedat

20 **Objective measurement of temporal auditory processing in young adults**
Associate Professor Catherine McMahon, Dr Ronny Ibrahim, Dr Varghese Peter, Dr Aseel Al-meqbel, Ms Kelly Miles

20 **Measurement of brain function in cochlear implant recipients with a custom-engineered MEG system**
Associate Professor Blake Johnson, Professor Stephen Crain

21 **Deconvolution of magnetic Acoustic Change Complex (mACC) to rapid vowel-vowel transition in normal hearing adults**
Fabrice Bardy, Shu Hui Yau, Bram Van Dun, Harvey Dillon, Blake Johnson

21 (P14) **Mismatch negativity vs acoustic change complex: a comparison of two objective auditory discrimination paradigms using MEG**
Miss Shu Hui Yau, Mr Fabrice Bardy, Dr Jon Brock, Dr Blake Johnson

SESSION 6 (INTERVENTION)

22 **When paper & excel aren't enough: tracking every child's development in the interface of research and clinical practice**
Miss Aleisha Davis, Miss Alyshia Hansen, Mr Jim Hungerford

22 **How mothers speak to hearing impaired children: implications for rehabilitation**
Dr Christa Lam-Cassettari, Dr Christine Kitamura

23 **Bright start: transition to school program**
Ms Rachael Ward, Ms Loretta Sassi

23 **An evaluation of a communicative intervention programme for hearing caregivers and their deaf children in a developing context**
Dr Sharon Hurt, Isabelle Boisvert

24 **Harm minimization in approaches to language acquisition for deaf children: are we doing enough?**
Professor Trevor Johnston

24 **Reading the early warnings: lessons from tracking development in early intervention**
Miss Tracy Hopkins, Miss Aleisha Davis, Miss Yetta Abrahams, Ms Donna Sperandio

THURSDAY 18 APRIL 2013

SESSION 8 (COGNITION/SOCIAL)

25 **I thought you knew that! Theory of mind in children with hearing loss at 5 years**
 Miss Aleisha Davis, **Ms Donna Sperandio**, Ms Kristin Bayley, Mrs Tracy Hopkins

25 **Language outcomes great! But what about social competency?**
 Mrs Jackie Brown, **Ms Jessica Balfour-Ogilvy**, Ms Emma Rushbrooke

26 **The impact of speech and language on social inclusion for young children with hearing loss: a model for evaluation**
Dr Gabriella Constantinescu, Ms Aleisha Davis, Associate Professor Dimity Doman, Dr Rebecca Taylor, Dr Anthony Hogan

26 **Reducing the cognitive load for cochlear implant children by reducing listening effort in complex noisy environments**
Dr Karyn Galvin, Ms Kathryn Hughes, Ms Jennifer Holland

27 **Using video-feedback interventions to enhance psychosocial outcomes in pre-lingual hearing impaired children**
Dr Christa Lam-Cassettari, Dr Meghana Wadnerkar, Dr Deborah James

SESSION 9 (HEARING AND HEARING AIDS)

27 **Effect of frequency compression on speech perception of hearing impaired children**
Dr Vicky Zhang, D. Teresa Ching, Ms Sanna Hou, Ms Patricia Van Buynder, Ms Lauren Burns, Mr Chris Flynn, Ms Karen McGhie, Ms Angela Wong

28 **One size does not fit all. Expanding the application of implantable hearing technologies**
Mrs Jackie Brown, **Mrs Jane McGovern**, Ms Emma Rushbrooke

28 **Evaluation of speech recognition of hearing impaired users using a personal digital adaptive radio frequency system**
Mrs Angela Pelosi, Mr Jace Wolfe, Dr Linda M. Thibodeau

29 **Wireless technology – improving signal-to-noise ratio for children in challenging situations**
MA Astrid Haastrup, **MA Charlotte Thunberg Jespersen**

- 29 (P15) **All the advantages of FM without the FM – verifying integrated 2.4GHz technology using aurical hit**
MA Astrid Haastrup, MA Charlotte Thunberg Jespersen
- 30 (P16) **Modelling the cochlear amplifier**
Professor Jonathan Tapson, Professor Andre van Schaik, Dr Tara Julia Hamilton
- 30 (P17) **A hybrid computational model of the auditory periphery**
Mr James Wright, Mr Ram Kuber Singh, Professor Andre van Schaik
- 31 (P18) **Modelling outer hair cells and understanding their role in hearing**
Dr Tara Hamilton, Professor Jonathan Tapson, Professor Andre van Schaik

SESSION 10 (LITERACY)

- 31 **Family reading habits, language and reading development in school-aged children with early cochlear implants**
Dr Julia Sarant, Ms Sharyn Bant, Ms Jennifer Holland, Ms Lisa Bennet, Ms Philippa Garrard, Dr Peter Busby
- 32 **Children with hearing impairment in the classroom: what are the implications for self-regulation of learning and academic participation?**
Ms Karen Gregory, Dr Anne McMaugh
- 32 **Seeds of literacy: towards auditory profiles for normal and at-risk infants**
Professor Denis Burnham, Professor Usha Goswami

SESSION 11 (LANGUAGE)

- 33 **The terminological challenge: divergent terms and concepts in clinical research on child language development**
Emeritus Professor Pam Peters, Dr Elisabeth Harrison, Mr Adam Smith
- 33 **Auditory-oral progress of infant-CI, infant-HA and infant-CODA in deaf family environments**
Dr Robyn Cantle Moore
- 34 **Adaptive assessment of speech-perception in school-aged children with hearing impairment**
Ms Rebecca Bull, Professor Greg Leigh, Dr Mridula Sharma
- 35 **The perception of auditory and auditory-visual lombard speech for younger and older adults**
Mr Michael Fitzpatrick, Associate Professor Jeusun Kim, Professor Chris Davis
- 35 **Microtia and atresia program at Hear and Say**
Mrs Jackie Brown, Ms Emma Rushbrooke, Mrs Simone Cheadle
- 36 **Developing the spoken language of children with hearing loss remotely: a telemedicine approach**
Dr Gabriella Constantinescu, Ms Michelle Ryan, Associate Professor Dimity Dornan, Ms Emma Rusbrooke, Ms Jackie Brown, Ms Jane McGovern, Dr Monique Waite, Dr Anne Hill

SESSION 12 (FAMILIES)

- 36 **Third-party disability in children with hearing impairment: a qualitative exploration of the experience of siblings**
Dr Nerina Scarinci, Ms Taylor Funk, Ms Ennur Yanbay, Professor Louise Hickson
- 37 **Improving paediatric outcomes through a parent-focused approach**
Associate Professor Dimity Dornan, Professor Robert Cowan, Graeme Clark
- 37 **Parent/caregiver engagement in early intervention for children with hearing loss at 3 years of age: participation in early education and reading activities at home**
Ms Vivienne Marnane, Dr Teresa Ching, Mrs Julia Day, Ms Kathryn Crowe, Ms Miriam Gunnourie, Ms Jessica Thomson, Ms Louise Martin, Ms Laura Street
- 38 (P19) **Parental involvement in early intervention for children with hearing impairment: a sub-study of the Longitudinal Outcomes of Children with Hearing Impairment (LOCHI) study**
Ms Louise Martin, Ms Laura Street, Dr Teresa Ching, Ms Jessica Thomson, Ms Julia Day, Ms Ennur Yanbay
- 38 **Are language scores all that matter? Family perceptions of early cochlear implantation at 6mths compared to 12mths of age**
Miss Yetta Abrahams, Miss Aleisha Davis, Mrs Tracy Hopkins, Miss Katie Neal
- 39 **Parent stress and child language development in Australian families of children with cochlear implants**
Dr Julia Sarant, Ms Philippa Garrard, Ms Sharyn Bant, Ms Jennifer Holland, Ms Lisa Bennet

AUDITORY VALLEY PRESENTATION

- 39 **Hearing research made in Germany: the Auditory Valley congratulates the Australian Hearing Hub**
Michael Buschermöhle, Michael Schulte, Sabine Haumann, Nils Prenzler, Andreas Büchner, Volker Hohmann, Rainer Huber, Andrej Kral, Georg Klump, Anke Lesinsik-Schiedat, Kirsten Wagener, Stephan Albani, Thomas Lenarz, Birger Kollmeier

FRIDAY 19 APRIL 2013

SESSION 14 (INTERVENTION/ATTENTION)

- 40 **The next chapter: advancing early intervention practices for young children with hearing loss**
Miss Aleisha Davis, Dr Elisabeth Harrison, Associate Professor Robert Cowan
- 40 **The First Voice national research project: a preliminary glimpse. Listening, speech and language development of children with hearing loss**
Miss Aleisha Davis, Dr Gabriella Constantinescu, Dr Dimity Dornan

- 41 **Differences in selective attention networks during listening in noise – a MEG study of children with listening difficulties**

Ms Pia Gyldenkaerne, Dr Phillip Gilley, Dr Mridula Sharma, Professor Suzanne C. Purdy, Professor Harvey Dillon

- 41 **Auditory attention switching important for listening in noise**

Mr Imran Dhamani, **Dr Mridula Sharma**, Dr Simon Carlile, Mr Johahn Leung, Dr Suzanne Purdy

- 42 **Age-related changes in perceptual attention: an electrophysiological investigation**

Dr Yatin Mahajan, Professor Chris Davis, Associate Professor Jeusun Kim

- 42 (P20) **Sound intervention practices: developing PA teaching strategies for children with hearing loss**

Dr Megan Gilliver, Professor Linda Cupples, Dr Teresa Ching, Professor Greg Leigh, Ms Julia Day

SESSION 15 (COCHLEAR IMPLANTS)

- 43 **Developmental and demographic characteristics of children using cochlear implants who acquire language successfully over the first 10 years of life**

Dr Shani Dettman, Professor Richard Dowell

- 43 **Getting in early: defining the importance of cochlear implantation in the second ear in language acquisition**

Ms Toni Isaacson, Ms Kylie Chisholm

- 44 **Optimizing auditory perceptual and language outcomes for children using cochlear implants**

Professor Richard Dowell, Dr Shani Dettman

- 44 **Challenges influencing paediatric cochlear implant outcomes in emerging populations**

Dr Derrick Wagenfeld, Mrs Lida Muller

- 45 **Barriers to early cochlear implantation: what are we waiting for?**

Dr Shani Dettman, Ms Jing Chen, Professor Richard Dowell

SESSION 16 (OUTCOMES)

- 45 **When does auditory processing become a disorder?**

Associate Professor Robert Cowan, **Ms Dani Tomlin**, Professor Harvey Dillon, Dr Mridula Sharma, Associate Professor Gary Rance

- 46 **Population outcomes of universal, risk factor and opportunistic screening for congenital hearing loss**

Professor Melissa Wake, Dr Teresa Ching, Dr Karen Wirth, Dr Zeffie Poulakis, Dr Fiona Mensah, Dr Lisa Gold, Ms Alison King, **Ms Sherryn Tobin**, Professor Sheena Reilly, Professor Field Rickards

- 46 **The phonological abilities of hearing impaired children: interim results from the LOCHI study**

Ms Julia Day, Dr Teresa YC Ching, Ms Laura Street, Ms Jessica Thomson, Ms Kathryn Crowe, Ms Vivienne Marnane, Ms Louise Martin, Ms Miriam Gunnourie

SESSION 17 (SPEECH PRODUCTION)

- 47 **Intelligibility of speech produced by children with hearing loss by naive listeners**

Ms Gretel Macdonald, Dr Nan Xu, Dr Teresa Ching, Professor Katherine Demuth

- 47 **The realisation of narrow focus by adolescent cochlear implant users**

Ms Colleen Holt, Associate Professor Janet Fletcher

- 48 **Variations in speech development in preschoolers as a function of age at cochlear implantation**

Dr Nils Kristian Prenzler, Doris Adams, Dr Angelika Illg, Professor/Dr Thomas Lenarz, Professor/Dr Anke Lesinski-Schiedat

SESSION 18 (APD)

- 48 **Is APD just attention disorder?**

Ms Pia Gyldenkaerne, Dr Mridula Sharma, Professor Suzanne C. Purdy, Professor Harvey Dillon

- 49 **Frequency importance functions for Mandarin Chinese talkers**

Miss Ming-Wen Kuo, PhD Christine Kitamura, PhD Teresa Ching, PhD Gary Walker, PhD Harvey Dillon

- 49 **The listening and learning self-perceptions of children with CAPD**

Dr Chyrisse Heine, Associate Professor Michelle Slone

- 50 **Classroom behaviour and academic skills of children with CAPD: teacher's perceptions**

Dr Chyrisse Heine, Professor Michelle Slone

POSTER ONLY

- 50 (P21) **Attentional control and distractibility in children using a cochlear implant**

Dr Marc Kamke, Ms Jeanette Van Luyn, Dr Gabriella Constantinescu, Dr Jill Harris

- 51 (P22) **Lexical access in 4 year-olds: a magnetoencephalographic study**

Dr Graciela Tesan, **Associate Professor Blake Johnson**, Professor Stephen Crain

AUSTRALIAN HEARING HUB FREE PAPER ABSTRACTS

In presentation order

WEDNESDAY 17 APRIL 2013

SESSION 2 (LANGUAGE)

Phonological context and processing load effects on the production of third person singular -s: implications for hearing impaired children

Miss Kiri Mealings, Professor Katherine Demuth

Department of Linguistics, Macquarie University

Evidence from typically developing children's spontaneous speech suggests utterance length and utterance position may be factors contributing to early grammatical morpheme omission. Hearing impaired children, who have more limited working memory, difficulty perceiving/producing sibilants, and morphological deficits, are therefore even more likely to be affected by these factors. This study *experimentally* investigated whether increased utterance length (hence increased processing load) adversely affects typically developing children's third person singular -s production, serving as a baseline to later compare with hearing impaired children. An elicited imitation task with 12 Australian-English-speaking children aged 2;9-3;2 ($M = 2;11$) was conducted comparing third person singular -s production in three-word and five-word utterances, both utterance-medially (e.g. *He sits back; He sits back and swings*) and utterance-finally (e.g. *There he sits; That's the way he sits*). Children saw pictorial representations of each utterance on a computer and were invited to repeat 16 pseudo-randomised pre-recorded utterances. Acoustic analysis determined the presence/absence of the third person singular morpheme and its duration. The results revealed that third person singular production was significantly worse utterance-medially compared to utterance-finally for the five-word utterances, and significantly worse utterance-medially in the five-word compared to the three-word utterances. These results suggest increased utterance length, hence increased processing load, results in significantly lower third person singular -s production in the more articulatory challenging utterance-medial position. As both these difficulties are exacerbated in hearing impaired children, we expect they may help explain the increased number of variable morpheme omissions in their speech compared to normal hearing children.

Brain development for optimal listening and spoken language development in children born with hearing loss: the evidence

Associate Professor Dimity Dornan

Hear and Say

Hearing technology is a necessary first step for accessing the auditory brain of a young child born with hearing loss, and as such is of critical importance if the child is to develop optimal listening and spoken language. However, hearing technology alone is not enough, as the auditory brain needs appropriate quality, intensity and frequency of auditory input, and ongoing practice in listening and speaking if optimal outcomes are to be achieved for a child. This presentation will present new evidence for the neurodevelopmental basis of listening and spoken language and its significance for a child born with hearing loss whose parents desire for them to listen and speak. Current research on neuroplasticity and the principles of brain development, including information on timeframes for optimal development of the brain, will be outlined with particular reference to children with hearing loss and hearing technology. This presentation will also discuss the role of professionals in educating parents to use the basic principles of neuroplasticity to provide the appropriate auditory input for accelerating development of neural pathways for listening and speaking success in everyday life.

Investigating young children's sentence processing abilities using EEG

Ms Kelly Miles¹, Professor Katherine Demuth¹, Dr Varghese Peter², Associate Professor Catherine McMahon¹

1 Macquarie University, 2 Marcs, University of Western Sydney

Examining neural activity when confronted with grammatical versus ungrammatical sentences can provide an objective measure of children's sensitivity to different types of grammatical structures during sentence processing. Previous ERP studies on children have shown that children as young as 3;0 years are sensitive to morpho-syntactic violations when the verb is in utterance-medial position (Silva-Pereyra, Rivera-Gaxiola & Kuhl, 2005). In a follow up study using the same stimuli, Silva-Pereyra, Klarman, Lin and Kuhl (2005) found children aged 2;6 years old were not sensitive to these morpho-syntactic violations.

Perceptual studies examining children's morpho-syntactic processing of inflectional morphology have revealed that children are sensitive to violations at the age of 1;10 when stimuli occur in the durationally longer phrase final position, but not when the verb occurs in the acoustically more challenging utterance-medial position, which is the context most English verbs occur (Sundara, Demuth & Kuhl, 2011).

The goal of the current study is to explore when typically developing children develop sensitivity to the missing subject-verb agreement in both utterance-medial and final position using EEG. The results will provide a baseline for future exploration of related issues in children with hearing loss.

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Are the syllabic allomorphs particularly challenging for hearing impaired children? Evidence from TD and SLI speech

Miss Ekaterina Tomas^{1,2}, Professor Katherine Demuth^{1,2}, Dr Karen Smith-Lock^{1,2}

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Typically developing (TD) children acquire syllabic allomorphs (*dresses*) later than the segmental ones (*runs*) (Berko, 1957; Brown 1973). This study shows that children with specific language impairment (SLI) have protracted problems with syllabic allomorphs as well, raising questions about why these particular forms are so problematic.

The data were drawn from speech samples from 22 children with SLI aged 4;10–5;11 years ($M=5;2$), who showed difficulties with morphemes of tense/agreement (past tense -ed; 3rd person singular -s), and/or possessive -s. All were able to produce the relevant consonant clusters in a non-morphemic context.

The results of ANOVA tests showed that production of the syllabic forms (e.g. *added* /*watches* /*horse's*) was significantly lower across all three morphemes. This could be due to the child's processing capacity limitations: adding a new syllable increases phonological working memory demands. Alternatively, it could be explained by the challenges of producing similar segment types separated by a schwa (e.g. *horse's* [hɔ:sez]), and the syllabic allomorph's low frequency. The fact that this effect was found across both nominal and verbal morphemes suggests that the problem has a phonological component.

Children with hearing impairment often have working memory problems and difficulties with sibilants – two factors that may account for some of their morphological deficits. It would therefore be interesting to investigate their use of syllabic morphemes, comparing *segmental* vs. *syllabic* allomorphs (*runs* vs. *dresses*) and syllabic allomorphs with *stops* vs. *sibilants* (*added* vs. *dresses*), where the latter should be particularly challenging for children with hearing aids.

Phonology and hearing: could Australian Aboriginal languages be acoustically easier to hear than English by listeners with OME-induced hearing impairment?

Professor Andrew Butcher¹, Associate Professor Janet Fletcher², Mr Hywel Stoakes², Dr Marija Tabain³

1 Flinders University, 2 University of Melbourne, 3 La Trobe University

Chronic *otitis media* with effusion (OME) causes hearing loss at both low (<500 Hz) and higher (>4000 Hz) frequencies. Audiometric measurements of 37 Yolngu children in an Arnhem Land community confirm previous clinical data from Pitjantjatjara children in a desert community which show that around 75-80% have a significant conductive hearing loss in at least one ear.

The sound systems of Australian Aboriginal languages are lacking both in contrasts which depend on low frequency acoustic cues (high vowels, voiced obstruents) and in contrasts which depend on cues at the high frequency end of the spectrum (fricatives, aspirated stops). However, they typically have five to seven place-of-articulation contrasts, which depend on rapid spectral changes in the middle of the frequency range.

Long-term average spectra of speech in Yolngu Matha and Pitjantjatjara, were compared with spectra of the same 16 individuals speaking English. There were clear quantitative spectral differences, with both Australian languages having lower amplitudes at higher frequencies (>4 kHz) and higher amplitudes between 750 Hz and 2 kHz.

A test of discrimination of place of articulation and manner of articulation in quiet and in noise by 30 speakers of Yolngu Matha showed greater variation in the manner task, suggesting speakers find place discrimination easier. This contrasts with studies of English speakers that show manner cues to be more robust than place cues in noise.

Thus it appears that Aboriginal languages favour sounds whose characteristics exploit precisely that area of hearing ability which is most likely to remain intact in OME.

Impact of the presence of auditory neuropathy spectrum disorder on outcomes at 3 years of age

Teresa YC Ching^{1,2}, Julia Day^{1,2}, Harvey Dillon^{1,2}, Kirsty Gardner-Berry^{1,2}, Sanna Hou^{1,2}, Mark Seeto^{1,2}, Angela Wong^{1,2}, Vicky Zhang^{1,2}

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There is limited literature on speech and language development in children with auditory neuropathy spectrum disorder (ANSD). There is also controversy about the most appropriate early intervention to recommend for this group, and the increased need for cochlear implants regardless of the degree of the hearing loss. The aim of this study was to investigate the impact of the presence of ANSD on speech, language development of children at 3 years of age, and to compare these outcomes to children without ANSD.

Methods: Forty seven children with ANSD who participated in the Longitudinal Outcomes of Hearing Impairment (LOCHI) study were assessed using standardized measures of speech production, receptive language and expressive language. Performance was compared to that of children without ANSD in the LOCHI study.

Results: Sixty-four percent have hearing sensitivity loss ranging from mild to severe degrees, and the remaining had profound hearing loss. At 3 years, 27 children used hearing aids, 19 used cochlear implants and one child did not use any hearing device. Thirty percent of children have disabilities in addition to hearing loss. On average, there were no significant differences in performance between children with and without ANSD on speech production or language development. Also, the variability of scores was not significantly different between those with and without ANSD.

Conclusions: There was no significant difference in performance levels or variability between children with and without ANSD. There was also no difference between children who use hearing aids, and those using cochlear implants, though of course those with implants had greater hearing loss (on average) before implantation than those with hearing aids.

SESSION 3 (EPIDEMIOLOGY)**The adverse impacts of sensorineural hearing loss: lessons from the Blue Mountains hearing study**

Dr Bamini Gopinath¹, Associate Professor Catherine McMahon², Dr Julie Schneider¹, Professor Paul Mitchell¹

1 University of Sydney, 2 Macquarie University

Aims: Sensorineural hearing loss is the most common form of hearing impairment and creates a significant burden not only for persons with this condition, but also for people who communicate with them. We aimed to assess the cross-sectional and prospective relationships between sensorineural age-related hearing loss with indicators of negative well-being including depressive symptoms, poor quality of life (QOL), functional disability and self-perceived hearing handicap in a cohort of older adults.

Methods: 2956 Blue Mountains Hearing study aged 50+ years were examined at baseline in 1997-9. Hearing levels were measured using pure-tone audiometry. Survey instruments with questions on outcomes of interest were administered.

Results: Participants with versus without hearing loss at baseline had significantly lower mean mental composite score (a domain of the 36-item short-form survey, SF-36, a QOL instrument) 10 years later (multivariable-adjusted $p=0.03$). Depressive symptoms (assessed by the mental health index of the SF-36) were significantly higher in subjects with mild bilateral hearing loss, odds ratio, OR, 1.83 (95% confidence intervals, CI, 1.18-2.83), after adjusting for all potential confounders. Cross-sectionally, subjects with moderate to severe hearing loss compared to those with normal hearing had higher likelihood of experiencing difficulty in activities of daily living, multivariable-adjusted OR 2.87 (CI 1.59-5.19). Hearing-impaired, compared with non-hearing-impaired adults had a significantly higher risk of developing moderate or severe hearing handicap, multivariable-adjusted OR 3.35 (CI 1.91-5.90) and OR 6.60 (CI 1.45-30.00), respectively, 5 years later.

Conclusions: Quality of life, mental health and functional status is diminished in older hearing impaired adults.

Screening for hearing loss among older Australians with vision impairment: the vision-hearing research project

Dr Julie Schneider¹, Ms Moira Dunsmore¹, Dr Bamini Gopinath², **Dr Catherine McMahon**^{3,4}, Professor Paul Mitchell², Associate Professor Jie Jin Wang², Professor Stephen Leeder¹

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Keywords: dual sensory loss; elderly; vision; hearing; screening; Australia.

Aim: The Vision-Hearing Research Project is a practical extension of findings from the well-known Australian Blue Mountains Eye Study. In the Vision-Hearing Project we are piloting a 'hearing screening and education model' in low vision clinics and collecting data to help inform policy in relation to dual sensory impairment.

Method: Three hundred clients with low vision aged 65+ years attending rehabilitation services at Vision Australia clinics participated in questionnaire interviews and a hearing screening test during 2010 and 2011. Data was collected on their perceptions of hearing difficulties, contact with services, quality of life, health history and social demographics.

If participants were found to have ≥ 25 dB HL at two or more of the tested frequencies (500-8000Hz) and to not already be receiving hearing services or wearing aids habitually, they were referred. These participants were advised about the availability of services, eligibility for government support when applicable, and practical implications of dual loss. They formed a follow-up cohort to be reviewed within 12 months to determine whether screening for hearing loss promoted use of hearing services/aids, or led to any positive improvements in quality of life.

Results / Discussion: In this paper we will report the baseline data including: a) the prevalence of dual sensory impairment among older clients attending low vision clinics; and b) the unmet need for hearing services among clients attending low vision clinics. Emerging data on participants' perceptions of the value of hearing screening and barriers to help-seeking will also be raised.

The epidemiology of childhood hearing loss in the Philippines

Mr John Newall¹, Associate Professor Norberto Martinez², Mr Hubert Ramos²

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Childhood hearing loss is a major cause of speech, language, social and cognitive delays. Previous research on the prevalence of childhood hearing impairment has typically shown a higher prevalence in the developing world than in the developed world. The current study reports on hearing and demographic data collected in the 2011 Prevalence Survey on Ear Disorders and Hearing Disability in the Philippines (a cross sectional, population based study). The study included 1306 children (0-18yrs of age) all of whom were assessed with a combination of; pure tone audiometry, Otoacoustic emission testing, otoscopy, tympanometry and questionnaire, as appropriate. Regression analysis suggested that hearing thresholds could best be predicted by variables including; rurality (those in urban areas having poorer thresholds than those in rural areas), number of occupants in the household (with higher numbers of housemates being associated with poorer thresholds) and having wax in the ear canal (associated with poorer thresholds). Looking only at those with audiometric data available, the prevalence of significant (moderate or worse) bilateral hearing impairment was 0.8%. If slight or mild hearing loss is included the prevalence rises to 17%. A further 13% of children had a unilateral hearing impairment. These figures are high, even when compared to prevalence rates in similar developing countries. The implications of the high prevalence of hearing loss in the Philippines and the contributing factors will be discussed in this paper.

The impact of universal newborn hearing screening on early hearing aid fitting – the Australian experience

Ms Alison King, Dr Laurie Upfold

Australian Hearing

Universal Newborn Hearing Screening (UNHS) aims to improve outcomes for congenitally hearing impaired children by facilitating early detection and intervention for the hearing loss. The provision of amplification is an important part of this process for the majority of children who have a moderate or greater bilateral hearing loss. In recent years, an increasing number of children who have mild or unilateral hearing loss have also been provided with amplification.

Australian Hearing has been providing amplification and ongoing hearing services to hearing impaired children up to 21 years of age since 1948, and has collected statistics about the age of first hearing aid fitting since 1955. This data provides a unique opportunity to investigate the impact of UNHS on early hearing aid fitting due to the longevity of the data base, the service's long-standing policy of promoting amplification at the earliest possible age and the fact that hearing aids are provided at no cost to families through Australian Government funding, thus removing a significant barrier to uptake of amplification.

This paper will examine the rate of early hearing aid fitting from 1955 to the present day, with particular emphasis on Australian Hearing's demographic data from 2000 – 2012. It will consider not only reductions in the age of first fitting, but also the changing profile of hearing loss within the aided child population. While early fitting rates have improved, the demographic data indicates that the majority of children receive their first hearing aid beyond the first year of life. The paper will discuss whether this data can be used to estimate rates of late onset hearing loss and whether it indicates a need for revision of the current expectations of incidence of congenital hearing loss.

The global burden of hearing loss

Professor Adrian Davis¹

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Background: The Global Burden of Disease project looks systematically at 291 diseases and injuries to quantify the **comparative** magnitude of **health loss** due to diseases, injuries by age, sex, geographies for specific points in time. Hearing loss has been one of the 292. I have tried to adapt a life course approach where hearing is important right from the start of life to assess not only the extent to which people have problems with their hearing but also the impact it has on them and those with whom they communicate.

Method: Studies from around the world were quality assessed and used to provide estimates for prevalence of hearing loss including data for the USA. The burden was assessed through a weighting exercise whereby several tens of thousands of people compared the different health states (several per 291 diseases) arising from each disease including hearing loss of different severities.

Results: Whilst the data on prevalence of hearing loss is sparse, it is something we can estimate relatively well and Australia could take a lead in some of this work in the future. However in order to estimate quality of life measures we need to know the burden of disease from hearing loss and that is something that is poorly understood and has been estimated as far lower than in previous attempts. Well outside the top ten!

Discussion: There is a considerable lack of understanding of the burden of hearing loss in children worldwide. There is also little country specific systematic, quality assessed data for prevalence of hearing loss and data to help global understanding of its burden, the impact that hearing healthcare has on it and the extent to which it mitigates the burden.

VicCHILD: establishment of the world's first population-based childhood hearing impairment longitudinal databank

Professor Melissa Wake^{1,2,3}, Ms Sherryn Tobin¹, Dr Zeffie Poulakis^{1,2,3}, Ms Laura McMillan¹, Ms Anne Hampton¹, Dr Katie Mueller¹, Dr Rachel Burt¹, Mr Luke Stevens¹, Professor Jane Halliday¹

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Aims: VicCHILD aims to: (1) establish the world's first population-based longitudinal databank for children with congenital hearing loss and (2) facilitate collaborative population-based research.

Methods: VicCHILD has prospectively recruited all children born in the state of Victoria since 2011 with bilateral or unilateral congenital hearing impairment, identified through the Victorian Infant Hearing Screening program (VIHSP), supplemented by one-off retrospective re-recruitment from two population-based studies and children born during VIHSP's roll-out (2005-10). VicCHILD follows participants indefinitely from soon after birth through adulthood, combining (1) questionnaire and assessment data collected approximately 5-yearly from VicCHILD families and children; (2) linkage to deafness-specific and generic population-based health and educational databases; and (3) salivary samples for genetic, epigenetic and viral studies. As of February 2013, 179 children had been recruited.

Results: The REDCap web-based server can be tailored to researcher access requirements. Data include: hearing diagnosis (type, degree, age at diagnosis); birth and family history data; demographics; child outcomes (eg language, academic achievement, mental health, HRQoL); parent outcomes (eg mental health, HRQoL); treatment; service utilisation, including lifetime Medicare data; buccal samples extracted and stored. These data will support a range of activities, including: (i) describing secular trends in outcomes; (ii) population-based quality improvement activities; (iii) learning what factors predict the best population outcomes; and (iv) randomised controlled trials of interventions.

Discussion: VicCHILD responds to a clearly-identified international need for new approaches to coordinated, collaborative, population-based research. As the VicCHILD repository grows, we hope it will stimulate and support novel local and international collaborations and capacity in congenital hearing impairment research.

SESSION 4 (HEARING CRC PHD STUDENTS – ORAL POSTERS)

(P1) Rapid electrophysiological assessment in infants: analysis of paired-stimuli sequences using deconvolved overlapping cortical auditory evoked responses

Mrs Lauren Turner¹, Mr Fabrice Bardy^{1,2,3}

1 Macquarie University, 2 Hearing CRC, 3 National Acoustic Laboratories

The objective of the current study is to investigate an alternative method of recording cortical auditory evoked potentials (CAEPs) in infants using pairs of rapidly presented stimuli and the Least Squares (LS) deconvolution technique to disentangle overlapped responses.

Participants were 10 normally hearing infants (6 female, 4 male) between the ages of 5 – 21 months. CAEP recordings were performed with a pair of complex tone stimuli presented through insert earphones at 65dB SPL adult equivalent in three inter-stimulus interval (ISI) ranges. Pairs of stimuli were presented with ISI jittered around 70, 140 and 210 ms and an inter-pair interval jittered around 1600 ms.

Deconvolved CAEP responses showed a characteristic morphological maturation from a largely broad infantile positivity, to a more biphasic response, with an increasing negative component in the older children. Maturation was also evident across latency and to some degree reflected in amplitude. Decreasing P1 latency was observed with an increase in age of the infant ($p=0.00664$). These findings confirm the LS deconvolution technique can disentangle the overlapping CAEP responses in an accurate and reliable way.

The ability to decode fast rate stimuli has been shown to be predictive of later language skill. Therefore CAEP responses to rapidly presented stimuli may assist future assessment methods, detection and early intervention for those children identified at risk of experiencing auditory processing or language delays.

(P2) Factors influencing target detectability in realistic listening scenarios

Mr Tobias Weller^{1,2,3}, Dr Virginia Best^{1,3}, Dr Jorg Buchholz^{1,2,3}

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In psychoacoustics there is an increasing demand for more realistic testing environments that better capture the real-world abilities of listeners and their hearing devices. However, there are significant challenges involved in controlling the detectability of relevant target signals in realistic environments. We conducted an extensive detection study in a simulated real-world environment to understand some of the important dimensions influencing detection.

A multi-talker cafeteria scene was generated using room simulation software and played back by means of a 3-D loudspeaker array. Detection thresholds for the target word "two" were measured adaptively for 8 different target directions in the horizontal plane. Performance was then measured for fixed signal-to-noise ratios around these thresholds to obtain a psychometric function for each direction. To examine the effect of target-location uncertainty, psychometric functions were also measured with randomized target directions.

Detection thresholds depended on the target direction, consistent with changes in signal-to-noise ratio caused by the head shadow. Target-location uncertainty increased thresholds globally by a small amount. These findings provide a framework for controlling the detectability of target sounds in future experiments aimed at measuring localization, identification, awareness etc. in realistic listening environments.

(P3) Objective analysis of higher-order ambisonics sound-field reproduction for hearing aid applications

Mr Christos Oreinos^{1,2,3}, Dr Jorh Buchholz^{1,2,3}

1 Department of Linguistics-Audiology, Faculty of Human Sciences, 2 National Acoustic Laboratories, 3 The HEARing Cooperative Research Centre

The evaluation of hearing aids (HAs) inside realistic sound environments is of increasing interest. Higher-order Ambisonics (HOA) has been used for loudspeaker-based sound field resynthesis and HOA recording microphone arrays are available. Although HOA has been evaluated perceptually, it is unclear how far the results can be transferred to evaluating HA technologies (particularly multi-microphone enhancement algorithms).

In order to determine the minimum HOA order required for HA testing, an HOA framework was developed, simulating the entire path from sound presented in a room, picked up by a microphone array, decoded and received at the ears of a HA-fitted dummy head. HA directivity patterns were compared between an ideal free-field and its HOA representation to evaluate the introduced error. In-room analysis was conducted to investigate the bandwidth and performance of a directional microphone in realistic situations.

For a bandwidth B , the required order M_{\min} was found to be $M_{\min} \approx \sqrt[3]{B/600\text{Hz}}$ for the anechoic (worst) case scenario. The presence of reverberation introduced natural room response variations across different source-receiver locations, suggesting that the acceptable HOA error can be increased. Hence, in reverberant environments the required HOA order is reduced and at least 2D HOA reproduction can be used for evaluation of HA technologies.

(P4) Effect of attention on the frequency following response to speech targets in competing spatially collocated and separated discourse

Mr Nematollah Rouhbakhsh^{1,2,3,4}, Dr Bram Van Dun^{2,3}, Professor Harvey Dillon³, Mr Jörg Buchholz^{2,3,3,5}, Ananthanarayan Krishnan⁶

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Aims: Spatial release from masking refers to the improvement in the detection threshold of a signal when spatially separated from competing sounds compared to when it is co-located. Here we examine whether the phase locked neural activity, reflected in the brainstem frequency following response (FFR), exhibits spatial release from masking for a signal presented with spatially separated competing sounds, and the effect of attention on this process. This technique could be used for detection of spatial processing disorders at an early age.

Method: Twelve normal-hearing adults were binaurally presented a synthetic steady-state vowel /u/ (F_0 , F_1 , and F_2 with frequencies 110, 310, and 870 Hz respectively) with duration of 250 ms and intensity of 60 dB SPL. It was convolved with a head-related transfer function corresponding to 0 degrees, masked by co-located (0 degrees), and separated (± 90 degrees) one-talker two-babble discourse in three SNR conditions (-5, 0, 5 dB). Both attention and no attention were directed towards the target.

Results: The results showed that the magnitude of brainstem response component at the fundamental frequency was significantly larger for the spatially separated condition compared to the co-located condition, but only at -5 dB SNR. A significant effect of attention was found at all SNRs. There was no interaction between attention and spatial separation.

Discussion: These results suggest that binaural processing relevant to spatial release from masking may be reflected in the phase locked neural activity in the brainstem. Spatial separation is most noticeable in relatively noisy environments.

(P5) Signal segregation in bilateral cochlear implant users

Mr Aswin Wijetillake, Dr Richard Van Hoesel, Associate Professor Robert Cowan

Advances in cochlear implant (CI) technology over the past few decades have meant that CI users are able to regain more and more of the hearing lost due to severe/profound sensorineural deafness. Today the majority of CI recipients are able to achieve reasonably good speech understanding in quiet listening conditions however performance in the presence of background noise often remains challenging. Everyday situations, such as conversing with a friend in a moderately busy café for example, can be difficult as the surrounding noise becomes muddled together with the speech.

Listeners with unimpaired hearing can generally untangle different sounds in a listening environment by utilizing specific features of each sound to distinguish them from one another. The location in space from which sounds originate provides one such (useful) feature, which can be detected more effectively by using two ears. This is especially true when the competing sounds are all speech. CI users, however, don't enjoy the same level of benefit from listening with both ears, which may be due to limitations CI and sound processing designs.

This project aims to explore the ability of bilateral CI users to separate concurrent sounds, and identify ways to improve that ability. The results from the study may lead to new sound processing strategies or implant designs that ultimately improve speech understanding and the ability to attend different sounds in noisy environments.

(P6) Abnormal processing of visual and auditory stimulus in noise in children with listening difficulties

Ms Pia Gyldenkaerne^{1,5}, Dr Phillip Gilley², Dr Mridula Sharma^{1,5}, Professor Suzanne C. Purdy³, Professor Harvey Dillon^{4,5}

1 Macquarie University, 2 University of Colorado at Boulder, 3 University of Auckland, 4 National Acoustic Laboratories, 5 HEARing CRC

Children with auditory processing disorders (APD) are characterized as having listening difficulties in background noise despite normal audiometric thresholds. The current study examined the effect of auditory background noise on the auditory and visual evoked potentials in children with auditory processing disorders as well as the audiovisual integration abilities in this population.

Two groups of children (aged 7-12) participated in this study (12 controls and 10 children diagnosed with APD). Electroencephalography (EEG) was recorded to the natural speech token /ba/ presented as auditory, visual or audiovisual stimulation imbedded in 8-talker babble at +10 and +3dB SNR.

Temporal analysis of the peak latencies and peak-to-peak amplitudes were performed. This analysis was followed by independent component analysis (ICA) performed through the EEGLAB toolbox (EEGLAB, San Diego, CA) under the public GNU license (Delorme and Makeig, 2004). Cortically constrained source estimations of the data was conducted using the sLORETA algorithm (implemented in Brainstorm v3.1; Tadel et al., 2011) assuming a generalized Boundary Element Model (BEM) (OpenMEEG; Gramfort et al, 2010; Kybic et al, 2005).

Children with APD showed an overall effect of background noise and presented no changes in the evoked potentials to changes in the signal-to-noise ratio. Addition of visual cues resulted in behavioral benefits, but did not affect the evoked potentials. Independent component analysis indicated group differences in visual and attentional networks. Results suggest that the APD group may have difficulties selectively attending to relevant stimulus in the presence of irrelevant background noise.

(P7) Human brain mapping of tinnitus

Mr Ankit Mathur¹, *Dr Catherine McMahon*¹,
*Mr Ronny Ibrahim*¹, *Dr Blake Johnson*¹

1 Macquarie University

Tinnitus is described as a phantom auditory perception in the absence of any external stimulus. Despite a long history of its known existence and availability of various subjective methods for measurement of tinnitus related distress (e.g. Tinnitus Reaction Questionnaire), surprisingly few objective methods exist to confirm its presence and better understand the cortical disruptions that are assumed to underpin its perception. However recent research by Weisz and colleagues (2005, 2007) suggests that an objective measure of tinnitus perception exists, using resting and sound-evoked cortical activity measured with magnetoencephalography (MEG).

The aim of the present study is to use a similar paradigm as Weisz and colleagues using MEG to measure spontaneous and sound-evoked cortical activity (generated by pure tones at octave frequencies between 500Hz-8kHz presented at 70dB SPL) in 10 participants with clinically significant tinnitus (TRQ>17) before and during a tinnitus remediation program (Neuromonics) to determine whether correlations between objective and subjective measures existed. Alpha (8-12Hz) and gamma (30-100Hz) band spontaneous activity and dynamic changes in the tonotopic map during remediation were used as markers of tinnitus measured before remediation and then at 5th and 10th week during the remediation process. We anticipate that these results will help improve the understanding of neural correlates of tinnitus and their correlation with subjective measures of tinnitus.

(P8) Prosody and auditory processing predicts reading ability in primary school aged children

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Dr Mridula Sharma^{2,3}, *Ms Pia Gyldenkaerne*^{2,3}

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This study investigated the predictors of reading ability in typically developing primary school aged children, with a particular emphasis on prosody and auditory processing. We used the same predictors with the same group of children to examine both word and nonword reading. Regression analyses showed that phonological awareness, prosody, auditory processing and rapid automatized naming were significant predictors of word reading. These variables, along with age, were also significant predictors of nonword reading. Overall, 81% and 73% of variability in word reading and nonword reading, respectively, was explained. These results suggest that prosody and auditory processing make independent (accounting for unique variance) and shared contributions (acting in conjunction with other variables) to reading development. We propose that sensitivity to prosody may be operating as a type of suprasegmental phonological awareness. Children's awareness of oral language, including its prosodic features, assists the mapping between orthography and phonology. The significant contribution of auditory processing confirms the importance of listening for children's reading development.

(P9) **A comparison of visual-gaze patterns during storybook comprehension tasks for school-aged children using cochlear implants from different early educational programs**

Mrs Christa Carey-Sargeant¹, **Dr Shani Dettman**², **Dr Bernice Mathisen**³

1 HEARing CRC, 2 The University of Melbourne, 3 La Trobe University

Maternal visual attention getting behaviors, language scaffolding and prosodic cueing have been shown to assist children with significant hearing loss (CSHL) and develop speech and language skills regardless of their communication mode (Carey-Sargeant & Brown, 2005; Tasker, et al, 2010). Within Australia there are three main types of early education programs for children with hearing impairment: (i) listening only (auditory-verbal), (ii) listening and lip reading (auditory-oral) or (iii) sign language (Auslan) with English (bilingual/bicultural). CSHL in Australia are receiving cochlear implantation during the 'critical period' prior to twelve months of age (Dettman and Dowell, 2010), avoiding neural re-organization of 'auditory language centres' for visual processing (MacSweeney, et al, 2004). The role of visual gaze in listening comprehension for CSHL after early implantation regardless of their early education experience is under-researched.

This paper will have three objectives:

1. to note the literature relating to visual gaze patterns of CSHL using a cochlear implant,
2. to present a research methodology to consider any possible correlations between the different types of early intervention programs utilised by children with a cochlear implant in Australia, their visual gaze patterns and their school age attainment of language, literacy and comprehension,
3. to report on preliminary research findings investigating the association between the various types of early intervention programs and particular patterns of visual attention (measured by visual gaze) in relation to story comprehension among school age children utilising a cochlear implant. Consideration of possible research outcomes for promoting language, literacy and comprehension for CSHL may also be discussed.

References:

Carey-Sargeant, C.L. and Brown, P.M. (2005) Reciprocal utterances during interactions between deaf toddlers and their hearing mothers, *Deafness and Education International*, 7(2), 77-97

Dettman, S, and Dowell, R. (2010) Language Acquisition and Critical Periods for Children Using Cochlear Implants. In M. Marschark and P.E. Spencer The Oxford Handbook of Deaf Studies, Language and Education, Vol. 2, New York, Oxford University Press, pp. 331-342.

MacSweeney, M., et al (2004) Dissociating linguistic and non-linguistic gestural communication in the brain. *Neuro Image* 22, 1605-1618.

Tasker, S., et al (2010) Joint Attention and Social Competence in Deaf Children with Cochlear Implants. *Journal of Developmental & Physical Disabilities*, 22(5), 509-532.

(P10) Examining the impact of early musical experience on the long-term speech and music perception outcomes of children with cochlear implants

Ms Michelle Moran

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Aims: This study aims to identify the factors that underlie better long-term music perception in children with cochlear implants (CIs). The project will seek to answer the question of whether early experiences with music in the home and pitch variation in mother's voice influence the music perception and level of musical engagement in implanted children. This study will also investigate whether there is a relationship between these early musical experiences, music perception and the abilities of children with CIs on a speech perception in noise task.

Method: Newly implanted children will be recruited from the cohort at the Cochlear Implant Clinic at the Royal Victorian Eye & Ear Hospital. Parents will be issued questionnaires at a number of intervals to determine both the child's and parent's level of engagement in music. Formal testing will be completed at 4-5 years of age to gather data on speech, language and music perception outcomes in this group and comparisons will be made between children with CIs and their normally-hearing siblings. This study will be completed over a number of years. The results of this project may lead to enhanced knowledge of the influence of music in early habilitation for children with CIs and may provide new guidelines to both clinicians and parents working with these children.

(P11) Speech characteristics of children with hearing loss in New Zealand

Areej Asad¹, Suzanne Purdy¹, Elaine Ballard¹, Liz Fairgray¹, Katherine Demuth², Caroline Bowen³, Mridula Sharma²

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International research have reported general speech characteristics of children with hearing loss (CWHL) but no such study has been undertaken to-date in New Zealand. This study aims to identify speech characteristics such as phonetic inventory, phonological processes and speech intelligibility prevalent in the speech of CWHL in New Zealand. Standardised picture-naming tasks such as Diagnostic Evaluation of Articulation and Phonology (DEAP), Goldman-Fristoe Test of Articulation-Second Edition (GFTA-2) and Hodson Assessment of Phonological Patterns-3 (HAPP-3) were used to elicit speech production. Speech intelligibility was assessed using a story retelling task. In this presentation the speech characteristics of eight children aged 5-7 years with moderate-profound hearing loss will be discussed. The results are compared to a control group matched for ethnicity, gender and age. Results show that CWHL (including those with early-identified hearing loss) had smaller phonetic inventories and poor speech intelligibility compared to children with normal hearing. Furthermore, these children have more developmental phonological processes (e.g., fronting, stopping, cluster reduction) as well as unusual processes such as backing. These findings will be the basis for the development of speech therapy programs for CWHL.

(P12) Patient-centred history taking in audiological rehabilitation? A peek inside

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The influence of the patient-practitioner relationship and communication in audiology is not well understood despite a well-founded link between patient-centredness and improved health outcomes in medicine. By conducting an effective initial interview, a practitioner facilitates development of a therapeutic patient relationship and gains insight into the patients' perspective; both essential elements of patient-centred care.

Aim: This first aim of this study is to describe the communication patterns of audiologists and their patients in the history taking phase of audiology appointments. The second aim is to explore the factors (e.g. gender, clinical experience, patient age, funding source) associated with patient-centred audiology interactions.

Method: Sixty initial audiology appointments between audiologist (n=30) and patient (n=60) were filmed in clinics across Australia. The opening and history taking segment of filmed appointments were analysed using the Roter Interaction Analysis System (RIAS).

Results: This oral presentation will present results on the variability of history taking in audiology appointments. The history taking phase in audiology appointments tended to be dominated by the audiologist, focused strongly on medical topics and lacked affective responsiveness.

Discussion: The results of this study suggest that initial interactions in audiology appointments do not align with patient-centred care principals and consequently patients may not be exposed to appropriate opportunities for rapport building and disclosure of their perspectives to the audiologist.

Conclusion: These findings have implications for the use of, and satisfaction with audiological rehabilitation where patient-centred care is advocated.

(P13) Bridging the gap: Translating outcomes research to clinical intervention

Miss Aleisha Davis^{1,2,3}

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Evidence based research has been instrumental in effecting significant practice changes to optimise outcomes and opportunities for children with hearing loss. This includes evidence for newborn screening of hearing across Australia, technological advancements for optimising sound through hearing aids and cochlear implants, and importance of early intervention through brain imaging studies. There now exists a growing body of outcome evidence for children with hearing loss who have benefited from these practice changes, which can be used to bridge the next gap to guide the advancement of clinical treatment techniques.

Aim: To identify clinical intervention treatment studies that optimise the development of spoken language in young children with hearing loss.

Method: A systematic search of the literature was conducted according to Cochrane systematic review protocols with set criteria for eligibility.

Results: Only a handful of studies exist in the literature that examines the effect of a specific clinical treatment approach for children with hearing loss designed from outcome based research.

Discussion: Although clinical intervention studies on treatment methods to optimise specific areas of spoken language development exist in other populations in the speech pathology literature, there is a lack of well described, defined and documented outcomes for children with hearing loss. This review demonstrates the need for current research to be translated to clinical intervention trials and current publications and presentations on outcomes should provide more specific information concerning the early intervention treatments employed.

Conclusion: The impact of translating research to clinical practice is discussed to optimise the potential of all children with hearing loss.

SESSION 5 (OBJECTIVE HEARING ASSESSMENT)

Estimation of hearing thresholds using ASSR, Chirp-ABR and Chirp-ASSR

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Background: The estimation of hearing thresholds in children is still very challenging, as it has to be done mainly by objective measurements. The high frequency threshold can be assessed reliably using *click evoked auditory brainstem response* (Click-ABR). Some methods estimate the low frequency threshold, but their reliability still remains to be proven.

Methods: In this investigation different electrophysiological tools for estimating hearing thresholds were used. The registrations were started with awake adults and compared to the behavioral thresholds. *Auditory steady state responses* (ASSR) were registered with 20 normal hearing and 16 hearing impaired ears, *Chirp-evoked ABR* (Chirp-ABR) with 9 normal hearing and 10 hearing impaired ears. A promising new approach is the registration of *Chirp-evoked ASSR* (Chirp-ASSR), which is done up to now with 8 normal hearing adult ears and just started with children.

Results: Exemplarily, at 500 Hz the registered ASSR-thresholds differed from the behavioral thresholds between 10 and 60 dB ($\bar{\Delta} 37 \pm 15$ dB). The differences yielded by the Chirp-ABR were clearly lower (0 - 30 dB, $\bar{\Delta} 18 \pm 10$ dB) when using a low frequency chirp (100-500 Hz). The Chirp-ASSR yielded differences between 0 and 25 dB ($\bar{\Delta} 15 \pm 10$ dB) at 500 Hz.

Conclusion: Audiological methods using chirp stimuli seem to yield more accurate threshold estimations, but ASSR registrations have got the advantage of full objectivity. Especially the Chirp-ASSR, which combines both advantages, seems to be a promising tool for objectively estimating hearing threshold in the low frequency range.

Diagnosis of hearing impairment in children

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For a qualified treatment of a hearing impairment which allows an appropriate language development of a child an early diagnosis of the hearing impairment is crucial. As a consequence of NHS (Newborn Hearing Screening) children are going to get diagnosed around the first two month of life. Therefore a complete objective diagnosis has to be done. Additional methods must be available to identify the plasticity of the neural hearing system.

Otoacoustic emissions (OAE), *Auditory brainstem responses* (ABR), *Electrocochleography* (ECoChG), *Auditory steady state responses* (ASSR) and *Impedance measurements* are the basis of our procedure. Additionally we perform a short *Rotatory intensity damping test* (RIDT) in all babies identified as hearing impaired to exclude an Usher Syndrome.

In case of confirmed profound hearing impairment and CT as well as MRI scan diagnostics a cochlear implantation can be performed. In all other cases conventional hearing aids or bone conducting hearing aids are fitted since confirmation diagnosis in the first two month.

Objective measurement of temporal auditory processing in young adults

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Abstract: Temporal processing of auditory cues is important in the perception of speech and, subsequently the development of language and reading ability in children. Certainly in auditory neuropathy spectrum disorder (ANSD), where neural firing is significantly disrupted, there seems to be a good correlation between the extent of disruption of temporal processing and speech perception abilities (Rance et al., 2004). As such, the development of an objective tool to estimate temporal processing ability may be useful in young infants diagnosed with ANSD to better understand their capacity to develop spoken language.

Aim: The aim of this study was to identify the role of cortical auditory evoked potentials (CAEPs) in the measurement of the perception of slow temporal cues.

Method: Cortical auditory evoked potentials were measured in 10 normally hearing young adults with normal temporal processing ability using a 32-channel Neuroscan Synamps 2 system. Broadband noise (BBN) was amplitude modulated using a 16Hz modulation frequency at 100%, 75%, 50%, 25% and 0% and was presented in 2 conditions: (i) alone and (ii) following an unmodulated BBN.

Results: An onset response and an acoustic change complex were measured in all adults for most conditions. Further, an auditory steady state response was present at the carrier frequency during the amplitude-modulated stimulus.

Discussion: CAEPs provide a robust objective measure of the perception of amplitude modulated stimuli alone as well as at the onset of a change in perception from a BBN to a modulated noise (where the acoustic change complex can be observed).

Conclusion: This study provides support for the role of cortical potentials in objectively identifying temporal processing ability and may play an important role in its diagnosis for younger populations such as ANSD.

Reference:

Rance, G., McKay, C., Grayden, D. (2004). Perceptual characterization of children with Auditory Neuropathy. *Ear & Hearing*, 25, 34-46.

Measurement of brain function in cochlear implant recipients with a custom-engineered MEG system

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Cochlear implants offer unique scientific opportunities for basic and biomedical research into the plasticity of the central auditory system, and for investigation of the functioning of the central auditory system in the absence of peripheral features of the auditory system. To date, however, investigations in humans have been limited due to the incompatibility of cochlear implants with functional neuroimaging techniques. We describe a novel magnetoencephalography (MEG) neuroimaging system that has been designed to enable routine measurements of auditory cortical function in cochlear implant recipients, while coping with the electromagnetic artefacts of the implant. The cochlear implant MEG was designed to measure auditory cortical function in the hemisphere contralateral to the implant. The dewar is configured with a flat tail with an outer diameter of 20 cm. The gradiometers are configured in two stages: a sensing stage with 21 second-order axial gradiometers; and a reference stage consisting of 5 fluxgate magnetometers. This custom-engineered MEG system opens new avenues for research into the effects of deafness and restoration of hearing on brain development and brain function.

Deconvolution of magnetic Acoustic Change Complex (mACC) to rapid vowel-vowel transition in normal hearing adults

Fabrice Bardy¹, **Shu Hui Yau**², **Bram Van Dun**¹, **Harvey Dillon**¹, **Blake Johnson**²

1 HEARing CRC/NAL, 2 Macquarie University

Naturally spoken speech contains rapid temporal and spectral changes. The overall aim of the project is to find a robust neural biomarker of auditory discrimination for rapidly changing auditory stimuli.

In this study, we investigate the magnetic acoustic change complex (mACC), an obligatory auditory cortical response to vowel-vowel transitions. These transitions consist of a pitch change for a semi-synthetic /i/ vowel (F0 transition) and a second formant transition perceived as a change from /u/ to /i/. The mACC responses to these transitions were recorded using two different stimulus onset asynchronies (SOA). The long SOA of 1500 ms was compared to a short SOA, jittered between 100 and 172 ms.

Using MEG, brain activity was recorded in 17 normal hearing adults. In the short SOA condition, the time length of an mACC response is longer than the time between stimulus onsets. This results in multiple overlapping mACCs. Using a newly developed deconvolution technique, the aim is to disentangle the overlapped responses and compare these responses to the mACC in the long SOA condition.

For the short SOA condition, the results show that it is feasible to disentangle three sorts of overlapping cortical responses. The three different overlaps consist of: (1) overlap of onset response with an mACC, (2) overlap of two mACCs and finally (3) overlap of an mACC with an offset response. The difference of response morphology for short and long transition times will be discussed.

To date, no study has used a deconvolution technique to investigate ACCs evoked by rapidly presented acoustic changes. Discovering new neural biomarkers of rapid speech discrimination is of great interest in auditory processing research.

(P14) Mismatch negativity vs acoustic change complex: a comparison of two objective auditory discrimination paradigms using MEG

Miss Shu Hui Yau¹, **Mr Fabrice Bardy**², **Dr Jon Brock**¹, **Dr Blake Johnson**¹

1 Macquarie University, 2 National Acoustics Laboratories

Previous studies linking auditory processing disorders and language impairment have employed either Mismatch Negativity or Acoustic Change Complex paradigms, as tests of objective auditory discrimination, as both can be elicited without active participation of the subject. However, the Mismatch Negativity response may not be very reliable at the individual level. The aim of the study is to compare the efficiency of these two methods for future use in clinical populations and young children.

In this study, the magnetic Acoustic Change Complex (mACC) and mismatch field (MMF) responses from 15 normal hearing adults were recorded using Magnetoencephalography (MEG). Participants were played semi-synthesized speech sounds consisting of pitch (F0 shift) and vowel changes (F2, F3 shifts) while they watched a silent DVD, in both mACC and MMF paradigms. After MEG recording, they completed psycho-acoustic tasks that tap into auditory discrimination skills. The mACC response is an obligatory response obtained with each sound transition, while the MMF response is obtained after subtraction of the brain's response to standard sounds from its response to deviant sounds within an oddball paradigm. To compare efficiency of mACC against MMF, root mean square responses for the two paradigms are extracted. A source reconstruction model was also applied to compare the neural generators for mACC and MMF. Results will be discussed in terms of efficiency of mACC and MMF as objective measures of auditory discrimination.

SESSION 6 (INTERVENTION)**When paper & excel aren't enough: tracking every child's development in the interface of research and clinical practice***Miss Aleisha Davis, Miss Alyshia Hansen, Mr Jim Hungerford*

The Shepherd Centre

The current challenge in pediatric hearing loss research is in identifying atypical areas of development in listening speech and language to correctly guide clinical intervention studies. Conversely, the challenge of early intervention providers is to ensure all children and families receive the most appropriate and timely services so optimal progress is made in the critical 'early' years.

This paper will examine how both these challenges have been addressed in a not-for-profit early intervention setting using the Child Development Information System 4 (CDIS 4). This innovative system supports the collection of information in a clinical setting on the acquisition of children's skills in the four domains;

1. Audition (phoneme, syllable, word and discourse level),
2. Language (vocabulary, mean length of utterance, morpheme, grammatical marker and question development),
3. Speech (infant vocal development, vowel and consonant acquisition, intelligibility at word and sentence levels and phonological processing skills), and
4. Cognition (pragmatics and theory of mind, play, concept and preliteracy skills, phonemic and phonological awareness).

Information will be presented on the first 6 months of use of this tool by clinicians for over 150 children in an early intervention program aged 0 to 6 years. Snapshot and longitudinal rate of progress data provide comparisons to normal development. The inbuilt flagging system indicates areas of concern to guide individual family intervention and key research areas. As the interface between research and clinical practice, this tool can assist in optimising outcomes for all children with hearing loss and become a critical piece in guiding prospective research directions.

How mothers speak to hearing impaired children: implications for rehabilitation*Dr Christa Lam-Cassettari¹, Dr Christine Kitamura¹*

1 UWS, MARCS Institute

Aims: Delays in language acquisition for hearing impaired (HI) infants persist despite early identification and access to hearing prostheses. We examined potential constraints in the speech environment that could adversely influence language development by examining the acoustic properties of mothers' speech to HI and normal hearing (NH) infants.

Method: Firstly, a mother was recorded interacting with her HI and NH twin, and secondly, mother-infant interaction was recorded under conditions of simulated HI using a double-video set-up. Here, we manipulated (i) mothers' knowledge of whether they believed their infants could hear them or not, and (ii) the audibility of the speech signal available to the infant (full, partial, inaudible). A sheep, shoe and shark were used to elicit the corner vowels /i/, /u/ and /a/. Vowels were acoustically analysed for mean fundamental frequency (F0), F0 range, duration and formant frequencies (F1, F2), the latter to provide a measure of vowel hyperarticulation and typically exaggerated in speech to infants.

Results: There were no differences in F0 or duration in speech to NH or HI infants. Vowel hyperarticulation, however, was significantly less or completely absent in speech to HI infants (compared to speech to an adult). Moreover, under simulated HI conditions, there was no effect of whether mothers were aware or unaware of their infants being able to hear them.

Discussion: While vowel hyperarticulation is related to language development, it is sacrificed in speech to HI infants.

Conclusion: Our results raise implications for intervention strategies whereby parents may benefit from instruction to increase vowel hyperarticulation.

Bright start: transition to school program

Ms Rachael Ward, Ms Loretta Sassi

Cora Barclay Centre

The Bright Start transition to school program was developed at the Cora Barclay Centre, SA, to enhance the transition to school for children who are deaf or hearing impaired.

Transition from pre-school to school can be a challenging time for all children and families. The early years of school can present challenges for all children; including new curriculum concepts, literacy and socialisation. For any child with a disability the challenges are potentially greater; a noisy classroom can be exhausting and can decrease access to learning for children with hearing loss. Starting school with confidence can help set the foundations for future school learning.

The Bright Start Transition to school program aims to develop children's:

1. school related vocabulary to build their confidence for following discussions and instructions at school
2. Theory of Mind and social-emotional skills
3. self help and self advocacy skills- particularly in relation to equipment management
4. ability to participate in small group learning environments
5. pre-reading skills and introduce some phonic sounds

The program is augmented by a Bright Start Transition to School document that helps families navigate their way towards schooling. In addition a Family Counsellor provides opportunities for families to gather with other parents to explore their feelings and experiences around their child's transition to school.

An evaluation of a communicative intervention programme for hearing caregivers and their deaf children in a developing context

Dr Sharon Hurt, Isabelle Boisvert

Sydney Cochlear Implant Centre

This study was conducted in Cape Town, South Africa and constituted a PhD thesis in Speech and Language Pathology.

Aim: The study evaluates the effectiveness of a 12-week group intervention programme in a developing context that involves hearing primary caregivers of young deaf signing children. The programme was designed to enhance dyadic communicative interaction and empower caregivers as effective change agents.

Method: The programme was developed specifically for caregiver-child dyads from low socio-economic backgrounds. Professionals from a range of disciplines, Deaf signing adults, and an English-isiXhosa interpreter were involved in programme development, implementation and evaluation. The sixteen caregiver-child dyads who participated in this study were referred to a diagnostic and habilitation centre (in a tertiary hospital) for children with a hearing loss. The subject group was its own control, constituting a quasi-experimental design. Comparisons of videotaped dyadic interactions during play and storytelling were analysed pre- and post- intervention. Analyses of post-intervention questionnaires and focus group interviews with the caregivers were also performed. A coding system was compiled to investigate communication and sign language parameters.

Results: Results indicated a positive change in the style of caregiver-child interaction post-intervention and it is believed that the programme resulted in empowerment of the caregivers.

Conclusion: The findings have numerous clinical and theoretical implications. In particular, within the developed context of Australia where the primary language is English, this study supports the need to consider tailoring intervention services for families of hearing-impaired children from socio-economically disadvantaged and non-English speaking backgrounds. The need to consider caregiver education level is also highlighted.

Harm minimization in approaches to language acquisition for deaf children: are we doing enough?

Professor Trevor Johnston

Macquarie University

Most children born deaf in Australia today have cochlear implants at an early age and this allows many of them to access sound and develop speech. We know that success with cochlear implants is variable and that we are still unable to reliably identify those factors that predict the best candidates and likely outcomes. We also know that children exposed to an accessible language in meaningful interactions acquire it effortlessly. It is, therefore, problematic that many families are still advised not to expose their implanted child to Auslan (Australian Sign Language) in the first instance. If, during the critical period for first language learning, these children do not acquire English, it is then also too late for Auslan. This deprives them of a linguistic safety-net and is thus unethical because it *is certain* to lead to linguistic deprivation in some children—a violation of the principle of harm minimization in any medically-based intervention. I argue that the speech-only-first advice should be unambiguously abandoned by cochlear implant teams. However, I concede that without a dedicated program scientific documentation and description of Auslan a policy clarification of this kind would be tokenistic. Linguistically robust resources for teachers and learners (including parents) are simply not yet available to underpin Auslan as a safety-net in any effective way and will not be until dedicated linguistic research is supported and undertaken. I conclude that on both these fronts—implant habilitation advice and practice, and sign language research—we are simply not doing enough, and in a balanced way, to ensure the best outcomes for implanted children. It is surely time to do so.

Reading the early warnings: lessons from tracking development in early intervention

**Miss Tracy Hopkins, Miss Aleisha Davis,
Miss Yetta Abrahams, Ms Donna Sperandio**
The Shepherd Centre

Although outcomes are continuing to show that children with all levels of hearing loss can develop speech and language skills equivalent to hearing peers with early diagnosis, optimal technology and early intervention, we know this is not possible for all children yet minimal evidence exists as to why.

Aim: To examine the speech and language development paths of children with hearing loss in an early intervention program to identify early flags and indicators for later outcomes.

Method: A retrospective review was conducted of the speech and language results of all the 91 children who graduated from The Shepherd Centre program from 2009 – 2012. Results at 6, 12 and 24 months post device fitting and chronological ages 3, 4 and 5 years, in association with demographic, audiological and therapy data were reviewed and progress tracked.

Results: Early indication of outcomes at 5 years were found to typically show by 3 years of age and development paths at this stage continued to follow established trajectories.

Discussion: Red flags for poor outcomes include drops in standard scores out of the average range, not keeping up with 12 months progress in 12 months, ongoing concerns for device use and management and ongoing middle ear involvement. Interdisciplinary teams within services need to address these early flags with families.

Conclusion: Research into children's progress through the early years of intervention will provide clinicians and families with valuable evidence and information to guide informed early choices about appropriate communication mode and services for every child.

THURSDAY 18 APRIL 2013

SESSION 8 (COGNITION/SOCIAL)

I thought you knew that! Theory of mind in children with hearing loss at 5 years

Miss Aleisha Davis, Ms Donna Sperandio, Ms Kristin Bayley, Mrs Tracy Hopkins

The Shepherd Centre

As the Listening and Spoken language outcomes rise for children with hearing loss, more children are leaving early intervention programs with age appropriate speech, language and vocabulary as measured on standardised assessments. However, there is growing thought that a number of these children leave with underlying social and emotional difficulties which are not captured adequately by such assessments, which have a profound impact on their ongoing peer interactions.

Aim: To assess the Theory of Mind Skills for children with hearing loss at 5 years of age and compare these to their listening, speech and language skills.

Method: All children graduating from The Shepherd Centre's early intervention program in 2012 were assessed extensively to establish their development in Theory of Mind (n= 33). Both established milestone tasks and a behavioural checklist were used.

Results: 10 of the 33 children were unable to complete the assessments due to under developed language and attention skills. More than 80% of the remaining children were unable to complete the assessment to the level expected of a typical hearing child.

Discussion: Implications of poor development of Theory of Mind needs to be explored with specific reference to children with hearing loss and possible mechanisms which may contribute to delayed development such as overhearing, lack of sufficient tonal access, and impact of diagnosis and intervention styles.

Conclusion: Evidence of delayed development of theory of mind in children with hearing loss provides valuable information for clinicians and guides future research in looking beyond traditional outcome measures.

Language outcomes great! But what about social competency?

Mrs Jackie Brown, Ms Jessica Balfour-Ogilvy, Ms Emma Rushbrooke

Hear and Say

Hear and Say strives to stay relevant to the needs of the ever changing, growing and maturing demographics of the children and young adults under its care. Age-appropriate speech and language outcomes and exceptional use of hearing technology are not the only outcomes desired for a young person with hearing loss in order to achieve their full potential in today's world. Social competency and a feeling of self-worth are highly desirable and present challenges for many young people.

In response to a perceived need, Hear and Say has developed a comprehensive Social Skills Program for children/young adults with a hearing loss, from birth through to adolescence. In this presentation we will outline the six defined programs (LEAP, LAUNCH PAD, ROCKET, COMET, STAR and CICS) that aim to provide a safe environment for young people with hearing loss to explore and share feelings and emotions, increase peer support, develop clear and effective communication skills, venture to challenge themselves and develop teamwork and trust.

Examples of sessions and video footage will demonstrate aspects of the programs. Surveys, both oral and written, were administered pre and post participation in the programs. Data from these surveys will be presented to validate the need for, and demonstrate the benefit of, dedicated social skills programs across a range of age groups.

The impact of speech and language on social inclusion for young children with hearing loss: a model for evaluation

Dr Gabriella Constantinescu^{1,2}, *Ms Aleisha Davis*^{1,3}, *Associate Professor Dimity Dornan*^{1,2}, *Dr Rebecca Taylor*⁴, *Dr Anthony Hogan*⁴

1 First Voice, 2 Hear and Say, 3 The Shepherd Centre, 4 Australian National University

Social inclusion refers to the child's connectedness in their social setting which goes beyond their physical presence in the environment. The area of social inclusion continues to be of interest to professionals and parents of children with hearing loss as it is seen as an important outcome of early intervention. Recent studies have suggested that for children with hearing loss, inclusion may be influenced by the child's communication mode and speech and language skills, where greater exposure to spoken language and good communication skills have been associated with better social inclusion. To date however, the limited studies conducted in this area have included varying definitions and measures of social inclusion. Consequently, it is difficult to generalise findings, and at a clinical level, to look at the impact of early intervention on social inclusion for children with hearing loss. This presentation will describe a new model for defining and evaluating social inclusion in relation to speech and language outcomes for this population and in comparison to outcomes for children with normal hearing. The model uses five faces to conceptualise social inclusion. Preliminary findings from the First Voice national research project utilising this model will also be discussed, as well as the use of a comprehensive questionnaire to capture this information. The research currently includes 180 children with hearing loss aged 4-6 years. It is anticipated that this new model will further contribute to the provision of evidence-based service delivery for children with hearing loss in Australia and internationally.

Reducing the cognitive load for cochlear implant children by reducing listening effort in complex noisy environments

Dr Karyn Galvin, *Ms Kathryn Hughes*, *Ms Jennifer Holland*

The University of Melbourne

Background: An individual's cognitive resources are finite. When more effort is expended on speech understanding, fewer resources remain for other tasks. Investigating listening effort is important to maximizing classroom learning and participation.

Aims: To develop an objective test of listening effort in a complex noisy environment, and to determine if listening effort was reduced with bilateral versus unilateral cochlear implants.

Study 1

Method: A dual-task paradigm was used, with performance on an easier secondary task indicative of effort expended on a primary task. The primary task was CNC words presented via an 8-loudspeaker array. The presenting loudspeaker was randomly selected; noise was presented from the remaining loudspeakers. The secondary task was closed-set shape matching. Eight bilaterally implanted adolescents participated.

Results: The change in response time on shape matching when CNC words were also presented was significantly less in the bilateral condition for the group and three individuals.

Study 2

Method: To increase the sensitivity of the test, a language-based secondary task was developed in which pictures were matched to categories. The revised test was trialed with 42 normal-hearing children, adolescents and adults.

Results: The change in response time on the picture-categorization task when CNC words were also presented was similar for adults and adolescents, but significantly greater for children. CNC scores were similar across the single-task and dual-task conditions for all ages.

Conclusions: Bilateral implants reduce listening effort for some individuals. The revised test is suitable down to 9 years. Children demonstrated greater listening effort than adolescents or adults.

Using video-feedback interventions to enhance psychosocial outcomes in pre-lingual hearing impaired children

Dr Christa Lam-Cassettari, Dr Meghana Wadnerkar, Dr Deborah James

NIHR Nottingham Hearing Biomedical Research Unit

Aims: Hearing loss has been shown to adversely affect psychosocial outcomes in childhood. However, an evidence base for early intervention strategies that enhance psychosocial outcomes in contemporary populations of children with pre-lingual hearing loss is lacking. We tested the effect of a family centred video-feedback intervention in optimising child outcomes in hearing families with a pre-lingual hearing-impaired child.

Method: Parent-child dyads were recorded in spontaneous free play interactions at multiple pre- and post-intervention baselines. All families received three sessions of an accredited video-feedback intervention in their own home by an accredited guider. The psychosocial outcomes of parent and child were assessed using the Emotional Availability scales.

Results: Post-intervention assessment showed an increase in four dimensions of the Emotional Availability scales, namely parental sensitivity and structuring, and child responsiveness and involvement.

Discussion: Our results raise implications regarding the type of intervention strategies used with hearing-impaired children and support the use of family centred video-feedback interventions to promote optimal development.

Conclusion: Early parent-child communication can be enhanced with a video-feedback intervention. Future studies should place greater emphasis on the evaluation of psychosocial outcomes in the pre-lingual period.

SESSION 9 (HEARING AND HEARING AIDS)

Effect of frequency compression on speech perception of hearing impaired children

Dr Vicky Zhang^{1,2}, D. Teresa Ching^{1,2}, Ms Sanna Hou^{1,2}, Ms Patricia Van Buynder^{1,2}, Ms Lauren Burns^{1,2}, Mr Chris Flynn¹, Ms Karen McGhie¹, Ms Angela Wong^{1,2}

1 National Acoustic Laboratories, 2 HEARing CRC

The aim of this study is to evaluate whether frequency compression (FC) hearing aids increased the speech perception performance in noise for hearing impaired children. Seventy-two children (37 fitted with FC hearing aids, 35 fitted with conventional hearing aids) were assessed at 5yrs of age (SD 0.75yrs). The average air conduction hearing threshold across four frequencies (4FA, 0.5, 1, 2, and 4 kHz) in the better ear was 56 ± 23 dB HL for FC group and 56 ± 21 dB HL for conventional amplification (CA) group. Speech reception thresholds (SRTs) for 50% correct identification were measured with speech presented from 0 degrees azimuth, and competing babble from either 0 degrees or +/-90 degrees azimuth. Spatial release from masking (SRM) was defined as the difference between SRTs measured with co-located speech and babble and SRTs measured with spatially separated speech and babble. When speech and babble originated from the frontal source (S_0N_0 condition), children who used FC were slightly better than those who used conventional amplification. The signal-to-noise ratio (SNR) for 50% correct was 4.7 dB for the FC group and 5.3 dB for the CA group. When babble was spatially separated from target speech (S_0N_{90} condition), the SNR of the FC group was 3.0 dB and that of the CA group was 2.6 dB. In both listening conditions, the difference between groups was not significant ($p > 0.05$). There were no significant differences in spatial masking release between groups ($p > 0.05$).

One size does not fit all. Expanding the application of implantable hearing technologies

*Mrs Jackie Brown, Mrs Jane McGovern,
Ms Emma Rushbrooke*

Hear and Say

Finding the best possible amplification to meet the individual needs of young children with hearing loss is a complex process. The technological solutions now available, such as middle ear implants, hybrid implants and a wide variety of cochlear implants, combined with changes in candidacy criteria, have facilitated rapid growth in amplification options. At Hear and Say, ear decisions regarding the fitting of optimal hearing devices require a multi-disciplinary team effort, primarily involving the highly skilled Audiology and Auditory-Verbal Therapy teams.

In this presentation, these two specialised disciplines will discuss their roles in achieving best possible outcomes for the children under their care. A number of cases will be presented, including those with Auditory Neuropathy Spectrum Disorder, steeply sloping hearing loss, moderately severe hearing loss and conductive hearing loss. The presentation's content will look at each available technology, candidacy and outcomes in a broad manner which presents the most current and applicable research. Cases will also be used to reinforce the application of the information to daily practice.

Video footage will provide some examples of both Audiology and Auditory-Verbal Therapy practice at Hear and Say. Information regarding results from pre-implant audiological and speech and language assessments will then lead to discussion of possible implantable hearing technologies that could be offered and indications for candidacy. Each case will present the final decision re candidacy and device fitting and conclude with post-operative and on-going audiological and Auditory-Verbal Therapy management, highlighting the importance of this team approach, both pre and post implantation, on maximising outcomes.

Evaluation of speech recognition of hearing impaired users using a personal digital adaptive radio frequency system

*Mrs Angela Pelosi¹, Mr Jace Wolfe², Dr Linda
M. Thibodeau³*

1 Phonak AG, 2 Hearts for Hearing Foundation, Oklahoma City, OK, 3 University of Texas at Dallas, Callier Center for Communication Disorders

Permission has not been granted to publish this abstract.

Wireless technology – improving signal-to-noise ratio for children in challenging situations

MA Astrid Haastrup¹, MA Charlotte Thunberg Jespersen¹

GN ReSound AS

Children learning language require better SNR than adults who are language proficient, and hearing-impaired children require significantly higher SNRs than their normal-hearing aged peers for equivalent speech recognition performance (Bradley & Sato, 2008; Neuman & Hochberg, 2010).

Hearing Instruments alone cannot provide optimum SNRs for speech understanding in all difficult listening situations.

Wireless transmission of audio is a technology that can be used to overcome the negative effect of distance, reverberation and noise. This technology is almost universally recommended for use with school-aged and older children, but is less commonly used with younger children and infants. Though, the benefit of wireless transmission of sound to children's hearing instruments gives them the most favorable signal possible (Mulla, 2011; Thibodeau, 2008), which is desirable regardless of age.

This presentation will describe a proprietary 2.4 GHz digital wireless technology and how it is used to send a signal e.g. speech (mothers voice, teachers instructions) and music directly from an external microphone into the hearing instruments without transmitters or intermediary devices. It will also describe how the audio plug in can be used in educational settings to send signals from iPods/TVs or other audio signals directly to the hearing instrument.

It is important to verify that the device is functioning according to pre-determined targets especially when fitting wireless technology to children who may not be able to provide subjective feedback. The presentation will also focus on fitting of hearing instruments and external microphone together with verification towards standard verification guidelines (ASHA, 2002; AAA, 2011).

(P15) All the advantages of FM without the FM – verifying integrated 2.4GHz technology using aurical hit

MA Astrid Haastrup¹, MA Charlotte Thunberg Jespersen¹

1 GN ReSound

To ensure proper functional status of hearing assistive technology, verification guidelines for FM systems have been published (ASHA, 2002; AAA, 2011). These guide lines include a protocol for measuring transparency, SNR advantage and maximum output of the FM system. The verification process is especially important when fitting hearing assistive technology for pediatric patients, as children may not be able to give any subjective feedback regarding the performance and SNR benefits provided by the wireless system. These procedures can also be applied to hearing instruments with integrated wireless 2.4GHz technology combined with an external mini microphone. In this case the hearing instruments themselves act as the FM receivers.

The Mini Microphone is a 2.4 GHz wireless accessory which combined with wireless hearing instruments provide signal-to-noise ratio (SNR) advantages comparable with traditional FM systems without the need for additional hardware worn at ear level, as the receiver is integrated in the hearing instrument.

This presentation will describe the Mini Microphone, its usability and the benefits it provide. Hearing instrument and Mini Microphone fitting with focus on verification using the guide lines used with FM systems will also be described.

(P16) **Modelling the cochlear amplifier**

Professor Jonathan Tapson¹, **Professor Andre van Schaik**¹, **Dr Tara Julia Hamilton**¹

¹ The MARCS Institute, University of Western Sydney

The cochlear amplifier appears to play a critical role in the dynamic response of the mammalian auditory system. Current hypotheses suggest that it operates by electromechanical transduction at the outer hair cells. We have modelled the hypothesised OHC action and dynamics in software, in electroacoustic amplifiers, and in aVLSI silicon cochleae. These models suggest that dynamics approximating a Hopf bifurcation are possible, and are perhaps critical in explaining the high dynamic range and compressive nonlinearities observed in mammalian cochleae.

(P17) **A hybrid computational model of the auditory periphery**

Mr James Wright, **Mr Ram Kuber Singh**, **Professor Andre van Schaik**

The MARCS Institute, University of Western Sydney

The HybridMAP is an implementation of the Meddis computational model of the auditory periphery. Based on the MATLAB Auditory Periphery (MAP1_14) and the Real-time Auditory Periphery (RTAP) – a C/C++ implementation of MAP1_14 for the Windows OS, the HybridMAP implements the components of the auditory periphery from the outer ear through to the auditory nerve as compiled C++ code, in a modular cascade of filters architecture. The external interfaces to the modules are instrumented with the MATLAB MEX framework, which allows compiled code to be dynamically loaded by MATLAB during the execution of a script. This affords a substantial improvement in the speed of execution, while retaining the flexible environment of MATLAB for extension and experimentation. A modified MATLAB implementation of the MAP1_14 model allows the experimenter to select which components of the auditory periphery to execute using precompiled modules, and offers the opportunity for modular execution of a hybrid of compiled code and MATLAB scripting. The compiled code modules can also be executed in a purely C++ harness enabling the execution of the model in real time.

(P18) Modelling outer hair cells and understanding their role in hearing

*Dr Tara Hamilton*¹, *Professor Jonathan Tapson*¹, *Professor Andre van Schaik*¹

¹ The MARCS Institute, University of Western Sydney

In this presentation we present a model and hypothesis of the role of the outer hair cells (OHCs) in the cochlea. The OHCs have long been thought of as being responsible for the active behaviour of the cochlea and in this paper we hypothesise the mechanism by which this may be achieved. The model was developed with the assistance of a hardware cochlea model that includes the cochlea's nonlinear and active characteristics. The hardware cochlea model allows us to change the parameters of the model in real time, giving us the ability to understand how individual parameter changes can affect the performance of the entire cochlea. The cochlea model we used discretises the basilar membrane (BM) into individual resonators where each resonator has a best frequency that decreases logarithmically from the base to the apex. Our results show that the tuning of each of these resonators affects the selectivity and gain of adjacent resonators. By studying the innervation of afferent and efferent nerve fibres that connect from the OHCs in the cochlea to the brain and vice versa, we can see that the nerve fibre innervation matches the pattern of tuning required to change the gain and selectivity of individual sections of the BM, and hence conclude that the OHCs must be involved with tuning the BM response.

SESSION 10 (LITERACY)

Family reading habits, language and reading development in school-aged children with early cochlear implants

*Dr Julia Sarant*¹, *Ms Sharyn Bant*¹, *Ms Jennifer Holland*¹, *Ms Lisa Bennet*¹, *Ms Philippa Garrard*¹, *Dr Peter Busby*²

¹ The University of Melbourne, ² Cochlear Ltd

Aims: This study examined the family reading environments and language and reading development of school-aged children with early cochlear implants (CIs) in order to document outcomes and identify predictive factors of success.

Method: 35 eight-year-old children implanted by age 3.5 years participated. Reading ability was assessed using the Wechsler Individual Academic Achievement Test, and language development was assessed using both this test and the Clinical Evaluation of Language Fundamentals. Relationships between language and reading outcomes, family reading habits and other factors affecting outcomes were examined using Pearson correlation coefficients and multiple linear regression analysis.

Results: 63% of children had age-appropriate or better overall reading ability, and 63-65% of children had age-appropriate or better spoken language outcomes on the CELF and WIAT-II respectively. The degree of parental involvement in children's education, child IQ, family history of reading difficulties, children's average weekly screen time, and the amount of time children spent reading each week were significantly correlated with reading outcomes. Language outcomes were also correlated with these factors, and also with the age at which children started reading and with family history of speech/language difficulties.

Discussion: Language and reading outcomes for this group of children are similar to those reported for other children with reasonably early implantation over the last decade. Parental input continues to be the prime factor affecting language and reading outcomes.

Conclusion: These children are part of an ongoing larger study of broader outcomes for children with CIs. We will continue to examine these outcomes in the future.

Children with hearing impairment in the classroom: what are the implications for self-regulation of learning and academic participation?

Ms Karen Gregory, Dr Anne McMaugh
Macquarie University

This paper discusses the social and academic participation experienced by children with cochlear implants and hearing impairment. With improvements in cochlear technology and national newborn hearing screening, there is a focus on the delivery of appropriate support for children with hearing impairment in mainstream classrooms. There is a growing interest in factors that enhance academic participation for children with cochlear implants, and the effects these have on their engagement in classroom activities. The research reviewed highlights the difficulties experienced by some children and adolescents in group interactions and noisy learning environments. This has implications for classroom learning and the self-regulatory abilities of students in group-based learning pedagogies which are widely used in Australian classrooms. This paper suggests that the ability to employ self-regulatory strategies, such as the ability to monitor one's listening, are important skills for all children in classrooms where oral communication and social learning in language-rich environments is emphasised. For example, research indicates that although it is good practice to encourage students to ask for clarification when their listening is compromised, this skill may not be developed in all students and may not always occur. There is a need for classroom teachers and other teaching para-professionals to be aware of their teaching practices and communication styles, which may disadvantage students with cochlear implants and hearing impairment in their classrooms. The benefits of self-monitoring techniques to enhance the listening skills of children with cochlear implants and hearing impairment in mainstream classrooms will be discussed.

Seeds of literacy: towards auditory profiles for normal and at-risk infants

Professor Denis Burnham¹, Professor Usha Goswami²

1 MARCS Institute, University of Western Sydney,
2 University of Cambridge

In this study we are investigating individual differences in the quality of young infant's auditory analysis and how that might determine later language development and reading ability. There are already indications that infant perceptual ability relates to language development: auditory discrimination is related to mothers' degree of vowel hyperticulation in infant-directed speech, which in turn is related to the child's later vocabulary level; and infants' attunement to the sounds of their native language is related to measures of cognitive maturity, and is possibly delayed in infants at-risk for dyslexia. Here 120 5-month-old infant (60 Control and 60 at-risk for dyslexia, ARD) are being tested monthly and then later 3-6 monthly up until the age of 5 years on (a) threshold tests of auditory ability (b) attunement to native language sounds. Later, Vocabulary, Phonological Awareness, Non-Word Repetition, Articulation, Rapid Automatized Naming, and yet later measures of Reading Knowledge, Experience and Ability will be incorporated. Results so far indicate a tendency for lower discrimination limens in Control than ARD infants especially around 9-10 months. Analyses of IDS are progressing and ERP MMN tests will soon be added. By means of this longitudinal study over a wide age range (5 months to 5 years) using a battery of subtle tests of auditory processing we will profile infants' perceptual ability, evaluate how early differences in auditory profiles might predict later language and reading development, and thus provide early norms against which hearing-impaired infants' perceptual ability (and later language and literacy correlates) may be compared.

SESSION 11 (LANGUAGE)**The terminological challenge: divergent terms and concepts in clinical research on child language development****Emeritus Professor Pam Peters, Dr Elisabeth Harrison, Mr Adam Smith**

Macquarie University

The terminology of research relating to language development in children is highly variable, at the crossroads of clinical and linguistic disciplines (Walsh 2008). Variation can be seen immediately in high-level terminology such as *language development/language acquisition/language learning* (Marschark 2001), where the alternatives may or may not reflect different paradigms associated with first and second language learning, and/or formal and informal learning of a language. The underlying model is crucial to interpreting the research findings, and comparing them from one experiment to another. Most fundamentally, this affects the translation of research findings into fruitful clinical and pedagogical practice (Rose et al. 2005).

In previous research on the terminology of clinical audiology and speech pathology, Harrison, Peters, Smith (2011) found substantial divergence in the terms relating to clinical language assessments. Coreferential pairs drawn from medical and linguistic contexts, e.g. *autism v. semantic—pragmatic disorder*, raise the question of whether the terms represent the same language learning issues, or two different sets. International differences such as British *stammering v. American stuttering* exemplify another parameter of divergence.

This paper does not argue for attempting to standardize the interdisciplinary terminology used in child language learning research, but rather to map the divergences in an accessible online resource, and make it available to researchers, clinicians, and public stakeholders. An online platform (TermFinder), designed to deal with divergences among disciplinary and professional terms (Smith, Peters 2011) will be introduced, to show how this terminological challenge for the clinical sciences can be met.

References:

Harrison E, Peters P & Smith A 2011 Development of an online termbank for clinical sciences. Paper presented at 8th Pacific Conference on Speech, Language and Hearing, held in Christchurch, NZ

Marschark, M 2001 *Language Development in Children Who Are Deaf: A Research Synthesis Project FORUM* at NASDSE

Rose M, Best D, & Higgs J (eds) 2005 *Transforming Clinical Practice through Clinical Education*. Elsevier

Smith A & Peters P 2011 An online termbank in Family Law: decoding legal terminology for the general public. Paper presented at Australex conference, ANU

Walsh, Regina 2008 *Criteria for the analysis of Speech Pathology Terms*. Melbourne, Speech Pathology Association

Auditory-oral progress of infant-CI, infant-HA and infant-CODA in deaf family environments**Dr Robyn Cantle Moore**^{1,2}

1 RIDBC Renwick Centre, Royal Institute for Deaf and Blind Children, 2 University of Newcastle

Early intervention supporting the auditory-oral habilitation of infants diagnosed with hearing loss places emphasis on the parents' role in promoting listening and speech through everyday routines and care-giving. This presentation reports the preliminary findings of 4 parallel case studies monitoring the early verbal development of sibling infants with different hearing status (CI, HA and normal hearing/CODA) who are growing up in Deaf family environments. Subject data was collected at 6 / 9 / 12 and 18 months of age using established assessment protocols (IMP, Rossetti, PLS-4, MacArthur-Bates, LENA) and regular video documentation. Patterns of similarity and difference in auditory-oral progress are described, HI : normal hearing. The unique nature and circumstance of each family and individual is acknowledged and no case-to-case comparisons are made.

Adaptive assessment of speech-perception in school-aged children with hearing impairment

Ms Rebecca Bull^{1,2}, Professor Greg Leigh^{1,2},
Dr Mridula Sharma³

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In Australia, the vast majority of children with hearing impairment attend regular schools and are in regular classes (Hyde, Ohna, & Hjulstadt, 2005/2006; Power & Hyde, 2002; Punch & Hyde, 2010). The level of specialist educational support provided to each student is partly determined based upon audiological criteria including auditory thresholds and speech-perception scores.

Speech-perception is typically assessed using lists of phonemes, words or sentences which yield a percent-correct score. Although there are numerous tests available for this purpose, there is not yet a standard technique or test of hearing for speech in children (Northern & Downs, 2002). Such evaluations provide verification of fitting strategies and are aimed at demonstrating benefits of amplification, however they do not sufficiently reflect children's functional auditory communication skills or capabilities (Jamieson, Kranjc, Yu, & Hodgetts, 2004). Despite this, the results are used to infer management strategies for improving communication.

Following work by Erber and Bull (2011b; 2011a), we have further modified standard approaches to speech-perception testing to provide information to educators about the perceptual capabilities and limitations (auditory) of a child with hearing impairment. In addition to a percent-correct score, the results indicate the auditory, visual and environmental conditions under which a child with hearing impairment might successfully access oral information in the classroom.

A single case study will be presented to demonstrate the development of the procedure and a current project to validate the process will be discussed. This research has the potential to provide a meaningful link between audiological assessment and real-life communication practices for hearing impaired children and their educators.

References:

- Bull, R., & Erber, N. P. (2011b). *Listening to learn: Measuring speech perception in the classroom*. Paper presented at the Itinerant Teachers of the Deaf Conference (ITOD).
- Erber, N. P., & Bull, R. (2011a). *Adaptive hearing assessment (AHA!) for school-aged children with hearing impairment*. Paper presented at the 26th Australian and New Zealand Conference for Educators of the Deaf (ANZCED).
- Hyde, M., Ohna, S. E., & Hjulstadt, O. (2005/2006). Education of the Deaf in Australia and Norway: A comparative study of the interpretations and applications of inclusion. [Article]. *American Annals of the Deaf*, 150(5), 415-426.

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Power, D., & Hyde, M. (2002). The characteristics and extent of participation of Deaf and Hard-of-Hearing students in regular classes in Australian schools. [Empirical article]. *Journal of Deaf Studies and Deaf Education*, 7(4), 302-311.

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The perception of auditory and auditory-visual lombard speech for younger and older adults

Mr Michael Fitzpatrick, Associate Professor
Jeesun Kim, Professor Chris Davis

MARCS Institute

Talkers adapt their speech production in noise (known as 'Lombard' speech). Younger adults can take advantage of the acoustic changes to the speech signal (e.g. an increased intensity, and flatter spectral-tilt) as well as the visual speech of the talker to substantially improve their speech perception in noise. For older adults, however, it is unclear how effective Lombard speech modifications will be in facilitating their speech perception in noise. For instance, older adults have to overcome difficulties related to hearing impairment, central auditory processing problems, as well as a general cognitive decline in the processing of speech. Furthermore, there is also evidence that older adults receive relatively less benefit from visual speech information than younger adults. As such, older adults may not be able to utilize the acoustic and visual Lombard speech modifications in noise to the same extent as younger adults. It is the aim of the current study therefore to examine older and younger adults' perception of auditory and auditory-visual Lombard speech. A set of vCv and cVc tokens were presented to younger and older participants in a speech identification task. To examine the effect of Lombard speech, the stimuli were either recorded in quiet (i.e. normal speech) or in noisy (i.e. Lombard speech) conditions. To examine the role of visual speech, the stimuli were also presented in auditory-only, visual-only and auditory-visual conditions. Results will be analysed and discussed in relation to theories of speech production strategies for younger and older adults in noise.

Microtia and atresia program at Hear and Say

Mrs Jackie Brown, Ms Emma Rushbrooke, Mrs Simone Cheadle

Hear and Say

Microtia and Atresia are low incidence congenital disorders with, in 90% of cases, the condition being unilateral; therefore support services have been loosely structured and perhaps not seen as a priority.

Universal Newborn Hearing Screening has resulted in an increased number of families who have children with either unilateral or bilateral Microtia and/or Atresia enrolling at Hear and Say for early intervention services, highlighting to Hear and Say the special and complex needs of these children and their families. In 2008, the Microtia and Atresia Parent Support Group was formed, with annual conferences, relevant to both parents and professionals, commencing in 2009. The launch of the Hear and Say Australian Microtia and Atresia Support Centre, in 2012, has provided a forum for sharing of knowledge and expertise from medical, surgical, audiological and educational disciplines, formalising a coordinated service for these children and their families.

The objectives of this presentation are to:

- provide an overview of the program at the Hear and Say Microtia and Atresia Support Centre.
- highlight the importance of early intervention for children with Microtia and Atresia, regardless of whether the condition is unilateral or bilateral.
- discuss treatment options for these children, including surgical opportunities and the use of a range of hearing devices.
- demonstrate the importance of a coordinated multidisciplinary team approach.

Feedback from both parents and professionals, along with individual case studies, will highlight the impact of Microtia and/or Atresia and the importance of targeted early intervention to assist these children to achieve their full potential.

Developing the spoken language of children with hearing loss remotely: a telemedicine approach

Dr Gabriella Constantinescu¹, Ms Michelle Ryan¹, Associate Professor Dimity Dornan¹, Ms Emma Rusbrooke¹, Ms Jackie Brown¹, Ms Jane McGovern¹, Dr Monique Waite¹, Dr Anne Hill²

1 Hear and Say, a First Voice Centre, 2 The University of Queensland

Auditory-Verbal Therapy (AVT) is an effective method for developing spoken language for children with hearing loss. However, access to traditional face-to-face services is often impossible in rural areas due to the lack of trained professionals and the regular travel, distance and costs of travel faced by families. As such, there is a need for additional service delivery options for this population to ensure equal access.

This presentation will outline Hear and Say's Outreach AVT Telemedicine program, currently supporting 40 Queensland children with hearing loss. It will also discuss a pilot project investigating the feasibility of the program in developing spoken language for a group of children with hearing loss. This is the first comparison study of its kind worldwide.

The language outcomes at 2 years post optimal aiding were compared between a group of children with bilateral hearing loss in the telemedicine and face-to-face programs. Seven children in each group (M = 2.4 years) were matched on age at fitting of hearing aids, optimal aiding, enrolment in the program, and pre-amplification pure tone average for the better hearing ear.

Non-significant differences in language scores were found between the two groups on the Preschool Language Scale-4 assessment. Furthermore, language scores for the children in the telemedicine program were within the average range for children with normal hearing. Practical aspects relating to the delivery of sessions via telemedicine will also be discussed.

The findings provide an indication of the feasibility of telemedicine as a service delivery option for developing spoken language for children with hearing loss.

SESSION 12 (FAMILIES)

Third-party disability in children with hearing impairment: a qualitative exploration of the experience of siblings

Dr Nerina Scarinci^{1,2}, Ms Taylor Funk¹, Ms Ennur Yanbay^{1,2}, Professor Louise Hickson^{1,2}

1 School of Health and Rehabilitation Sciences, The University of Queensland, 2 HEARing Cooperative Research Centre

Family-centred care is acknowledged as the best way to meet the needs of children with hearing impairment and their families. In family-centred care, the interrelated nature of family relationships is acknowledged, and therefore, the impact of the hearing impairment on the entire family is considered. This impact is a "third-party disability", where family members may experience activity limitations and participation restrictions as a result of the child's hearing impairment (WHO, 2001). Despite the importance of family-centred care in the provision of services for children with hearing impairment and their families, there is limited research examining the impact of hearing impairment on families and the habilitation needs of family members, especially siblings.

This study aimed to investigate the impact of communication disability on siblings of children with hearing impairment and to explore their habilitation needs. Semi-structured in-depth interviews were conducted with five siblings of children with prelingual hearing impairment, ranging in age from 4 to 20 years. The qualitative draw and talk technique was utilized to facilitate discussion with younger participants. Thematic analysis revealed five main themes relating to the impact on siblings: (1) awareness of hearing impairment and hearing devices; (2) communication impacts; (3) daily impacts; (4) relationships; and (5) emotional impacts. Results indicate that siblings of children with hearing impairment value being included in the habilitation process, where their needs and goals are also addressed by the service. This study highlights the importance of taking a family-centred care approach to addressing the needs of other family members, including siblings.

Improving paediatric outcomes through a parent-focused approach

Associate Professor Dimity Dornan^{1,2}, Professor Robert Cowan³, Graeme Clark³

1 Hear and Say, 2 First Voice, 3 University of Melbourne

Background: Recent reviews of research and productivity have confirmed the need for multicentre, multidisciplinary collaborations to provide the best opportunities for professionals for tipping public opinion, creating major breakthroughs for children with hearing loss. Australia has benefitted from a history of collaboration - National Acoustic Laboratory, HEARing CRC, First Voice and now Australian Hearing Hub, creating a perfect scenario for nurturing future clinicians, scientists and professional trainers, creating a new force for better child outcomes. Tempting as it is to innovate far ahead of conventional thinking, focussing only on technology and improved habilitation, we must not overlook the power of the original "innovators", parents guarding their young. Outcomes of a recent population-based Australian study on children early and later identified with hearing loss have indicated the importance of maternal education as a significant predictive factor for outcomes.

Aim: This presentation aims to review the current and new research evidence for listening and spoken language outcomes for parent-based education programs for children with hearing loss.

Results/Discussion: Neurobiological correlates of listening, spoken language and literacy will be discussed with reference to parents learning to establish the neural foundations critical for listening, spoken language, cognition and literacy for their child. The presentation will outline a model for parents and professionals relating to the frequency, intensity and quality of auditory input that is needed to maximise listening, speaking and reading outcomes for a child with hearing loss.

Implications: This review provides a blueprint for best practices and framework for future research.

Parent/caregiver engagement in early intervention for children with hearing loss at 3 years of age: participation in early education and reading activities at home

Ms Vivienne Marnane, Dr Teresa Ching, Mrs Julia Day, Ms Kathryn Crowe, Ms Miriam Gunnourie, Ms Jessica Thomson, Ms Louise Martin, Ms Laura Street

National Acoustic Laboratories

Previous studies have indicated that family involvement in early education is a positive predictor of language development in young children with hearing loss (eg Moeller 2002). Likewise, other aspects of family "engagement" activities have also been found to assist with child language and literacy development (eg Westerlund & Lagerberg 2008).

As part of the Longitudinal Outcomes for Children with Hearing Impairment (LOCHI) study, we collected information on two aspects of caregiver engagement: a) participation in their child's early education and b) frequency of shared reading activities at home. Data were gathered through parent report, with ratings of involvement in education also obtained from teacher/habilitationist report independently.

Data from about 300 families were collected when the children were 3 and 5 years of age. Analysis of the data indicated that ratings of family involvement in the child's early intervention did not differ significantly between parent/caregiver and teacher reports. Overall, approximately 70% of families were rated at the highest level of involvement. Parental involvement in early education was not a significant factor affecting child outcomes at 3 years of age. This finding differs from those reported in previous studies. In those studies, retrospective ratings of teachers were used, which were likely to be biased by the performance level of the children at the time. In relation to home reading activity, more than 70% of families reported that it occurred on a daily basis. The potential impact of shared book reading on reading and language development of children at 3 and 5 years of age will be discussed.

(P19) **Parental involvement in early intervention for children with hearing impairment: a sub-study of the Longitudinal Outcomes of Children with Hearing Impairment (LOCHI) study**

Ms Louise Martin, Ms Laura Street, Dr Teresa Ching, Ms Jessica Thomson, Ms Julia Day, Ms Ennur Yanbay

National Acoustic Laboratories

This poster reports on the methodology and preliminary findings of a study investigating parental involvement in early intervention for children with hearing impairment.

The LOCHI study has shown that maternal education level is a significant factor influencing child outcomes at 3 years of age. However the nature in which maternal education impacts on outcomes is not clear. Previous literature has suggested an association between education level of parents and their involvement in their children's education and literacy development (Bornstein & Bradley, 2003; Bracken & Fischel, 2008). This sub-study aims to explore the ways in which parental education and parental involvement in early intervention may influence language outcomes of children with hearing loss.

Participants will be recruited from families of LOCHI children who were above the 80th percentile and those who were below the 40th percentile on language measures at three years of age. Semi-structured in-depth interviews will be conducted with parents/caregivers. The interview will be recorded, transcribed verbatim, and will be analysed using qualitative content analysis.

Preliminary findings will be discussed in relation to implications for improving outcomes of children with hearing loss.

Are language scores all that matter? Family perceptions of early cochlear implantation at 6mths compared to 12mths of age

Miss Yetta Abrahams, Miss Aleisha Davis, Mrs Tracy Hopkins, Miss Katie Neal

The Shepherd Centre

The benefit of cochlear implantation for children with profound hearing loss under 12 months of age is well established and clinics have been performing these surgeries in Australia for some time. Professionals and parents alike are now seeking evidence for short and long term benefit in implanting younger than this.

Aim: To identify if benefit exists in early implantation (close to 6mths) versus later implantation (close to 12 months) through spoken language development, parent engagement levels and impact on attachment and relationships as perceived by the family.

Method: 30 children who received at least one cochlear implant prior to 12 months of age were assessed using formal auditory, language and speech tools. Children were assessed at 6, 12 and 24 months post switch on, and chronological ages 3, 4 and 5 years. Family engagement levels and qualitative analyses of family feedback on the impact of attachment and relationships were examined.

Results: At 6 months post switch on, the highest scores were achieved by those children implanted earlier with a decline in scores as their age of 1st CI implantation increases to 12 months. There is a wider spread of results at 3 years chronological age, with the highest performers those children who received implants earlier.

Discussion: Although evidence suggests children implanted closer to 6 months initially do better in their spoken language development, qualitative feedback from families indicates benefits beyond language scores that need to be considered when evaluating the long term impact of implanting at a very early age.

Parent stress and child language development in Australian families of children with cochlear implants

Dr Julia Sarant¹, Ms Philippa Garrard¹,
Ms Sharyn Bant¹, Ms Jennifer Holland¹,
Ms Lisa Bennet¹

1 The University of Melbourne

Aims: The relationship between parent stress and child language development has not previously been examined for school-aged children with cochlear implants (CIs). This study examined parent stress levels, factors contributing to parent stress, child language outcomes and the relationships between parent stress and child language in 70 families of children with CIs.

Method: Parent stress was measured using the Parenting Stress Index, and child vocabulary and language was assessed using the Peabody Picture Vocabulary Test (PPVT-4), the Preschool Language Scales (PLS-4), the Clinical Evaluation of Language Fundamentals (CELF-4) when children were aged either five or eight years.

Results: Parents in this study overall did not show a higher incidence of stress than do parents of children without disabilities, but parents of children with delayed language were significantly more stressed. Child behaviour and a lack of spousal and social support were the prime causes of parent stress. Higher parent stress levels were negatively correlated with vocabulary and language outcomes for the younger children in the group, but not for the older children.

Discussion: Parent stress outcomes, and the factors that were correlated with higher parent stress, are discussed. The relationship between parent stress and child language development is also discussed. These results suggest a link between child language abilities and the incidence of child behaviour problems.

Conclusion: Better child language outcomes were associated with lower parent stress. This study offers further insight into the stress experience of parents and also into language outcomes of children with CIs.

AUDITORY VALLEY PRESENTATION

Hearing research made in Germany: the Auditory Valley congratulates the Australian Hearing Hub

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Although the institutions belonging to the Australian Hearing Hub have histories of their own, the Hearing Hub is a new global player when it comes to hearing research. The Auditory Valley has been playing a similar role in Germany and Europe for several years now. Emerging from the research networks of the University of Oldenburg and the Hannover Medical School, the Auditory Valley brings together the leading institutions of hearing research and hearing industry in Europe. Within the Auditory Valley, hearing research is conducted in various disciplines (physics, biology, medicine, engineering, etc), various institutions (universities, polytechnic institutes, Fraunhofer groups, public-private partnerships, private businesses, etc.) and various scopes (basic research, applied research, medical product development, industry projects, etc.).

Recent years were very successful for the Auditory Valley. Alone in 2012, institutions in the Auditory Valley were awarded with outstanding research grants. The most important event was the start of the German Cluster of Excellence "Hearing4all". Another highlight was the award of the Deutscher Zukunftspreis (German President's Award for Technology and Innovation) by the President of the Federal Republic of Germany to Birger Kollmeier and Volker Hohmann, two of the leading scientists of the Auditory Valley, together with Torsten Niederdränk from Siemens AG.

The current contribution will give an overview of the research performed in the Auditory Valley. It will highlight the major ongoing and completed projects and summarize the most interesting results. A central aim of this contribution is to encourage future collaborations between the Auditory Valley and the Australian Hearing Hub.

FRIDAY 19 APRIL 2013

SESSION 14 (INTERVENTION/ATTENTION)

The next chapter: advancing early intervention practices for young children with hearing loss

Miss Aleisha Davis, Dr Elisabeth Harrison, Associate Professor Robert Cowan

1 Macquarie University, 2 HEARing CRC, 3 The Shepherd Centre

Over the last ten years outcomes from early diagnosis, early fitting of devices and advances in technology have been the drivers for policy change and development of services for young children and their families. The opportunity now exists for similar advances in intervention practices by integrating the results of recent evidence based research into clinical intervention practices. Viewed through the lens of a systematic review, the research in this area provides future directions and drivers for advances in early intervention techniques.

Aim: To assess the efficacy of a range of early intervention treatments for optimising the development of spoken language in young children with hearing loss.

Method: A systematic search of the literature was conducted. Titles and abstracts were independently reviewed and screened for inclusion against criteria for study types, participants and interventions. Eligible articles were examined in full-text format and assessed for methodological quality and design.

Results: 1008 studies were identified for screening of which 245 met criteria for study types and participants. Only 12 studies examined specific treatments within a spoken language program and were eligible for analysis.

Discussion: Lacking adequate research-based evidence, clinicians must rely on reason-based practice and clinical experience until more information becomes available on specific methods of optimising outcomes. In addition, publications and presentations on outcomes should provide more specific information concerning the early intervention treatments employed.

Conclusion: Recommendations on research areas to guide clinical practice are made and integrating these findings into practice can further advance the potential of all children with hearing loss.

The First Voice national research project: a preliminary glimpse. Listening, speech and language development of children with hearing loss

Miss Aleisha Davis, Dr Gabriella Constantinescu, Dr Dimity Dornan

1 The Shepherd Centre, 2 Hear and Say, 3 First Voice

Aim: To examine the listening, speech and language outcomes of children with hearing loss enrolled in First Voice spoken language early intervention programs across Australia and New Zealand, to identify patterns and trends in the development of their spoken communication skills, and explore the impact of demographic factors for a group of children receiving comparable early intervention services.

Method: Formal assessment and data recording protocols were aligned across 6 spoken language early intervention centres using recognized tools. Standards were defined for the collection of demographic, hearing and device information. Data is collected prospectively for all children at 6 month intervals aged between 6 months and 6 years, between July 2011 and July 2013.

Results: The project is now in the 2nd year of data collection. An exploratory analysis of the data collected in year 1 on the 530 children in the project provides information on age, gender, cultural heritage, primary language, primary care giver's level of education, newborn screening results, aetiological information, additional disabilities, type, stability and symmetry of hearing loss, age of device fitting and type of device, cochlear implantation age if applicable and type, location and frequency of intervention received, and spoken language skills.

Conclusions: Preliminary data indicates demographic patterns and begins to track listening, speech and language development for this group of children through early intervention. Further analysis of demographic and aetiological factors is needed to examine their effect. Initial observations point to some variance across states and may provide further evidence for the additional requirement of early childhood hearing of screening.

Differences in selective attention networks during listening in noise – a MEG study of children with listening difficulties

Ms Pia Gyldenkaerne^{1,5}, *Dr Phillip Gilley*²,
Dr Mridula Sharma^{1,5}, *Professor Suzanne C. Purdy*³,
Professor Harvey Dillon^{4,5}

1 Macquarie University, 2 University of Colorado at Boulder,
3 University of Auckland, 4 National Acoustic Laboratories,
5 HEARing CRC

Difficulties listening in background noise are one of the most common complaints amongst people with hearing and listening difficulties; however, very little is known about the underlying cortical processes involved in listening in noise. This study aims to identify a cortical model for listening in noise in children with auditory processing disorders compared to a control group as well as the processes involved when additional visual cues are added.

Two groups of children (aged 7-12) participated in this study (10 controls, 10 children diagnosed with APD). Magnetoencephalography was recorded to the natural speech token /ba/ presented as auditory, visual or audiovisual stimulation imbedded in 8-talker babble at +10 and +3dB SNR.

MEG data was pre-processed and exported using BESA v.5.3. Cortically constrained source estimates of the MEG activity were then conducted using the sLORETA algorithm (implemented in Brainstorm v3.1; Tadel et al., 2011) assuming a generalized Boundary Element Model (BEM) (OpenMEEG; Gramfort et al, 2010; Kybic et al, 2005).

A model for listening in noise is suggested. The poorer signal-to-noise ratio resulted in significant differences in the activity of a selective attention network (including the middle frontal gyrus). Intra-group differences were found in the audiovisual condition, but no significant group differences in the auditory evoked fields were found. Results in this study suggest differences in the activity of a selective attention network during listening in noise for children with auditory processing disorders.

Auditory attention switching important for listening in noise

*Mr Imran Dhamani*¹, *Dr Mridula Sharma*²,
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*Dr Suzanne Purdy*⁵

1 Department of Linguistics, Macquarie University; The HEARing CRC, 2 Department of Linguistics, Macquarie University; The HEARing CRC, 3 Department of Physiology, University of Sydney, 4 Department of Physiology, University of Sydney, 5 University of Auckland; The HEARing CRC

Difficulty understanding speech in background noise is one of the most commonly reported complaints in children who have listening difficulties (Moore et al, 2012). Previous studies have attributed such listening difficulties to deficits in hearing sensitivity or auditory processing abilities, but recently, another line of research suggests a possible role of attention and memory deficits (Moore, 2012). Although research has suggested that selective attention and attention switching are important abilities influencing speech understanding in noise, there is a dearth of research to assess these abilities in children with listening difficulties. There have also been suggestions that listening difficulties in noise are most often observed in children who have a history of recurrent middle ear infections (Moore et al, 2003) and maybe associated with poor attention abilities (Asbjornsen, et al, 2005). Thus the aim of this research was to examine selective attention and attention switching abilities in a group of school aged children (10-15 years) with complaints of difficulty listening in noisy backgrounds and a history of recurrent middle ear infections who otherwise have clinically normal hearing sensitivity and auditory processing skills. We developed a novel task based on a modification of the multi-probe signal method (Dai et al, 1991) to assess selective attention and attention switching abilities. The results show markedly slower attention switching ability in children reported with listening difficulties in contrast to their age matched controls. The results suggest a top-down information processing (cognitive) deficit. The results provide an important insight into the underlying cause of listening difficulties.

Age-related changes in perceptual attention: an electrophysiological investigation

Dr Yatin Mahajan, Professor Chris Davis,
Associate Professor Jeusun Kim

The MARCS Institute, University of Western Sydney

Research on age-related changes in attention has typically examined the processes involved in the maintenance, retrieval, and manipulation of representations in working memory (executive attention). Less work has been carried out on changes in those processes involved with filtering, orienting and the maintenance of the bottom-up processing of stimuli (perceptual attention). In the present study we investigated changes in perceptual attention by examining whether there were differences in how three age groups (young adult, 20-40 yrs, middle-aged, 40-60 yrs and elderly, > 60 years) attended to rapidly changing auditory and visual stimuli. The effects of attention on the processing of auditory, visual and auditory-visual stimuli were determined by using electrophysiological auditory steady state responses (ASSR) and steady state visual evoked potentials (SSVEP) with a novel technique called 'frequency tagging'. ASSR and SSVEP were elicited using tones and visual flicker respectively that were modulated at different frequencies while participants selectively attended to minor stimulus changes. The preliminary results of the experiment will be discussed with respect to auditory and visual responses across the life-span. The results of the present study will be used as a point of comparison for the effects of intra and intermodal attentional load on perceptual abilities of persons with hearing impairment.

(P20) Sound intervention practices: developing PA teaching strategies for children with hearing loss

Dr Megan Gilliver^{1,2}, Professor Linda Cupples³,
Dr Teresa Ching^{1,2}, Professor Greg Leigh⁴,
Ms Julia Day^{1,2}

1 Hearing CRC, 2 National Acoustic Laboratories, 3 Macquarie University, 4 Royal Institute for Deaf and Blind Children

Children with hearing loss consistently show poorer average reading development than their peers with normal-hearing, with the gap between the groups continuing to increase as children age. Poor Phonological Awareness has been suggested as one reason for some of the reading difficulties experienced by children with hearing loss.

The development of PA skills has historically been linked with both reading disability, and "normal" variations in reading ability in hearing children. However, for children with hearing loss the role for PA in reading development is less well established and its dominant importance has been contested. Recent findings suggest that PA may play a stronger role in reading development for children who have already acquired some level of spoken language, with children receiving amplification earlier showing better PA than later-fitted peers.

PA teaching interventions for children with normal hearing have been well researched and show encouraging outcomes for development of key literacy skills. However, to date there is a dearth of studies examining the effectiveness of PA interventions for children with hearing loss.

This paper will describe the development of a PA intervention study currently being conducted as a joint project between NAL, Macquarie University, & RIDBC. Aimed at preschool-aged children, materials have been designed specifically to investigate the efficacy of a PA intervention on developing PA and reading skills in comparison to a vocabulary-based intervention. An overview of the study and design will be presented along with any preliminary findings.

SESSION 15 (COCHLEAR IMPLANTS)**Developmental and demographic characteristics of children using cochlear implants who acquire language successfully over the first 10 years of life**

Dr Shani Dettman^{1,2,3}, Professor Richard Dowell^{1,2,3}

1 The University of Melbourne, 2 HEARing CRC, 3 Royal Victorian Eye and Ear Hospital

Language outcomes for children using cochlear implants range from almost no spoken language acquisition to receptive and expressive language milestones that are not significantly different to hearing peers with typical development. This study examined a number of child/family variables and covariates, which suggest that early age at implant, on its own, is insufficient for normal language development to occur. Results were analysed for 90 children who completed age appropriate measures of language acquisition (Rossetti Infant-Toddler Language Scales [RI-TLS], Peabody Picture Vocabulary Test [PPVT], Preschool Language Scales (PLS-4), Clinical Evaluation of Language Fundamentals [CELF-4] at 4 years of age (range 3.1 to 5.9 years; SD 0.6 years) and again at 8 years of age (range 7.3 to 9.9 years; SD 0.6 years). Completed test scores were converted to standard score equivalents where relevant. The percentage of children scoring within the average range (standard score 85 to 115) at 4 years of age, and again at 8 years was examined. Child variables such as age at diagnosis, hearing aid fitting and implant surgery, and family characteristics such as parental participation and socio-economic factors were analysed. Furthermore, characteristics of children who were able to demonstrate accelerated language acquisition over this time period were considered.

Getting in early: defining the importance of cochlear implantation in the second ear in language acquisition

Ms Toni Isaacson, Ms Kylie Chisholm

SCIC

Aim: This paper aims to identify the impact of receiving one or two cochlear implants, and if two, the impact of simultaneous or sequential surgeries. Impact will be explored through analysing the speech and language outcomes of 3 cohorts of children and will evaluate the role of parental engagement.

Method: Data analysed for 3 cohorts of 15 children (45 children in total) .

1. bilateral simultaneous CI's
2. bilateral sequential CI's (second CI before 18 months)
3. unilateral CI (bimodal)

Outcome on speech, language, perceptual and functional measures at 6, 12 and 24 months post cochlear implantation and then at 5 years of age were measured for the first cohort.

Results: There was no significant difference between groups within the first cohort for the first 2 years following cochlear implantation. However some variability became evident at the 5 year of age interval. This data provided evidence for trajectory of the critical period for implantation of the second ear when this was appropriate.

A trend in the data demonstrated how parental support can influence outcome.

Conclusion: These findings demonstrate speech and language within the 1SD of age appropriate levels can be attained if the child is implanted within the first 12 months of life, albeit bilateral or unilateral. The impact of age when receiving the second cochlear implant is variable, however performance at 5 years of age indicated that a second cochlear implant led to better outcomes with speech, language, audition and functional listening.

Optimizing auditory perceptual and language outcomes for children using cochlear implants

Professor Richard Dowell^{1,2,3}, **Dr Shani Dettman**^{1,2,3}

1 The University of Melbourne, 2 HEARing CRC, 3 Royal Victorian Eye and Ear Hospital

Research in Melbourne has studied the long term auditory perception and language development outcomes for children with cochlear implants for over 25 years. A useful conceptual framework has been developed to help understand the multitude of factors that contribute to long term benefits. Most individual factors can be treated in terms of their effect on the provision of useful auditory information to the child. In addition, factors can be divided into those that affect the delivery of information to the child's auditory system, and those that affect the child's ability to use this information. The latter group can be divided further into characteristics of the child and their environment. This paper will summarize key studies that demonstrate factors that play a significant role in outcomes. Improved implant technology, decrease in age of implantation, the communication environment of the child, the quality and consistency of audiological care, cognitive deficits, and bilateral implantation have all been identified as potential major influences. Additional family and child characteristics also play significant roles in children reaching their full potential. The average perceptual improvement for children with profound congenital hearing loss in terms of speech perception is from 10% to 80% phoneme score on standard open set monosyllable tests. Recent data suggest that language development for children implanted under 2 years averages 90% of the progress observed for normal hearing children. Prior to the inception of cochlear implants, studies of language development in profoundly deaf children showed language progress between 40% and 60% of normal.

Challenges influencing paediatric cochlear implant outcomes in emerging populations

Dr Derrick Wagenfeld, **Mrs Lida Muller**

Outcomes from paediatric cochlear implantation have improved greatly over recent years, because of newborn hearing screening programs, early cochlear implantation, early intervention therapy, and technological advances. Profoundly deaf children implanted before one years of age, can be expected to develop normal spoken language competence; to understand and express human communication at a level commensurate with his or her age and / or cognitive ability (McConkey Robbins, 2000).

Even with the improved auditory signal provided by the CI, these children will need systematic and intensive training to reach their full auditory potential.

Implanting children has to take place within the framework of the available educational and rehabilitative facilities and in the SA context services are seriously inadequate. This often influences whether a child can be implanted or not.

Diversity in South Africa is a way of life for us, rather than a challenge.

The challenges in South Africa are:

- Late identification of hearing loss.
- Lack of suitable schooling
- Lack of skilled intervention.
- Extending expertise into the rest of Africa.

In our presentation we will expand on these challenges and propose strategies involving health, education and industry authorities to constructively address them.

Barriers to early cochlear implantation: what are we waiting for?

Dr Shani Dettman^{1,2,3}, *Ms Jing Chen*¹, *Professor Richard Dowell*^{1,2,3}

1 The University of Melbourne, 2 HEARing CRC,
3 Royal Victorian Eye and Ear Hospital

Early identification of significant hearing loss via neonatal screening should lead to early intervention, including hearing aid (HA) fitting and cochlear implantation (CI) where warranted. There are many factors, however, that may influence parents proceeding with these interventions earlier versus later. To examine trends in age at device use, all 640 paediatric records at the Melbourne Cochlear Implant Clinic were divided into 8 equal cohorts of 80 subjects based on date of CI (Cohort 1=1985 to Cohort 8=2012). The mean age at HA fitting and CI surgery for Cohort 1 was 1.62 years and 6.47 years respectively. By Cohort 8, the mean age at HA fitting was 0.70 years and age at CI surgery was 3.74 years. The percentage of children who received a CI under 4 years of age was unchanged from 49% in Cohort 1 to 46% in Cohort 8, but the percentage who received a CI under 12 months of age increased from 0% in Cohort 1 to 15% in Cohort 8. This study sought to determine underlying reasons why some children proceeded earlier with devices. Child demographic information (gender, additional disability, hearing loss [onset, duration, course and severity), and family characteristics (language other than English and socio-economic status) were analysed for all 364 children who received a cochlear implant under 4 years of age. Earlier hearing aid fitting and higher SES were correlated with earlier cochlear implantation. Progressive hearing loss or premature birth history were significantly associated with later cochlear implantation.

SESSION 16 (OUTCOMES)

When does auditory processing become a disorder?

*Associate Professor Robert Cowan*¹, *Ms Dani Tomlin*^{1,2}, *Professor Harvey Dillon*^{1,3}, *Dr Mridula Sharma*^{1,4}, *Associate Professor Gary Rance*^{1,2}

1 Hearing CRC, 2 Melbourne University, 3 NAL,
4 Macquarie University

Aim: This study examines the relationship between listening ability, academic progress and auditory processing (AP) test scores, in order to measure the real life impact of reduced AP ability.

Method: 155 children with varying degrees of listening concern, including a normative group, were assessed using a traditional AP test battery. A measure of self reported listening ability was developed using questionnaires from 3 separate sources.

Results:

1. Children with reduced listening ability score also showed poorer academic outcomes.
2. AP scores of Dichotic Digits and Frequency Pattern Tests as well as LiSN S show significant correlation with listening ability and academic outcomes. However Masking Level Differences and Gaps in Noise scores showed no correlation with these real life measures.
3. The results of these correlations show that performance ranges on correlating AP tasks between two and three standard deviations below the mean are consistent with a listening ability reduced by half a standard deviation. These results are also consistent with reduced academic outcomes of the same amount. Similar results are also seen on composite measures of AP performance.

Conclusions: The results allows for the individual and collective components of the traditional AP test battery to be evaluated for their ability to assess the impact of poor AP skills in children. Evidence of AP skill levels associated with significant real life impact can be determined. The relevance of including tasks that show no correlation with real life impact must also be considered. These results influence clinical practice guidelines.

Population outcomes of universal, risk factor and opportunistic screening for congenital hearing loss

Professor Melissa Wake^{1,2,3}, Dr Teresa Ching^{4,5}, Dr Karen Wirth¹, Dr Zeffie Poulakis^{1,2,3}, Dr Fiona Mensah^{1,2,3}, Dr Lisa Gold⁶, Ms Alison King⁷, **Ms Sherryn Tobin¹**, Professor Sheena Reilly^{1,2,3}, Professor Field Rickards³

1 Murdoch Childrens Research Institute, 2 Royal Children's Hospital, 3 The University of Melbourne, 4 National Acoustic Laboratories, Australian Hearing, 5 The HEARing Cooperative Research Centre, The University of Melbourne, 6 Deakin Health Economics, Deakin University, 7 Australian Hearing

Aims: To compare population outcomes of three methods of detecting congenital hearing impairment: universal newborn screening (UNHS), risk factor screening and opportunistic detection.

Methods: Population-based follow-up of (1) 5-6 year olds born 2003-5 in New South Wales (NSW; n=69) and Victoria (VIC; n=65), when NSW offered UNHS and VIC risk factor screening (neonatal intensive care screening + universal risk factor referral) and (2) 7-8 year olds born 1991-3 (n=86), when detection was largely opportunistic. Participants had bilateral congenital HL >25 dB HL in the better ear, aided by 4 years; the 1991-3 cohort excluded children with intellectual disability (ID). Main outcomes were age of diagnosis; directly-assessed language; and parent-reported behaviour and health-related quality of life (HRQoL).

Results: Among children without ID, outcomes improved incrementally from opportunistic to risk factor to UNHS for age of diagnosis (22.5 vs. 16.2 vs. 8.1 months, $p<0.001$), receptive language (81.8 vs. 83.0 vs. 88.9, $p=0.05$), expressive language (74.9 vs. 80.7 vs. 89.3, $p<0.001$) and receptive vocabulary (79.4 vs. 83.8 vs. 91.5, $p<0.001$); nonetheless, all remained well below population means. Similar though weaker trends were evident for the whole cohort, including children with ID. Benefits of UNHS were maximal in the mild-moderate range for letter knowledge, severe range for receptive vocabulary, and profound range for receptive language. Behaviour and HRQoL were largely independent of severity and screening program.

Conclusions: UNHS improves outcomes, but realising its full benefit will require rigorous optimization of early pathways, plus research to advance the science of intervention, amplification and hearing restoration.

The phonological abilities of hearing impaired children: interim results from the LOCHI study

Ms Julia Day^{1,2}, Dr Teresa YC Ching^{1,2}, Ms Laura Street^{1,2}, Ms Jessica Thomson^{1,2}, Ms Kathryn Crowe^{1,2}, Ms Vivienne Marnane^{1,2}, Ms Louise Martin^{1,2}, Ms Miriam Gunnourie

1 National Acoustic Laboratories, 2 Hearing CRC

Permission has not been granted to publish this abstract.

SESSION 17 (SPEECH PRODUCTION)**Intelligibility of speech produced by children with hearing loss by naive listeners****Ms Gretel Macdonald**¹, **Dr Nan Xu**², **Dr Teresa Ching**³, **Professor Katherine Demuth**²

1 Sydney University, 2 Department of Linguistics, CCD, Macquarie University, 3 National Acoustics Laboratory, Australian Hearing, HEARing CRC

The evaluation of speech intelligibility of hearing aided children has traditionally been made by trained speech pathologists. Results from this kind of assessment provide important normative data and indications for clinical interventions. However, these clinical assessments cannot inform our understanding on how well the general population understands speech produced by hearing aided children. In this study assessment of hearing aided children was first made by the National Acoustic Laboratory as part of their "Effects of frequency compression on outcomes of hearing-impaired children" study using the Beginner's Intelligibility Test (BIT). In this study we investigated the intelligibility of speech of these same children producing BIT sentences by naive participants. First year students enrolled in Introductory Psychology at Macquarie University, Sydney Australia were recruited in return for course credit. All speakers were screened for normal hearing with no history of hearing impairment, are native speakers of Australian-English and have no experience listening to speech by hearing aided children. Each listener heard sentences played from a computer via headphones with the presentation of sentences and speakers randomised across listeners. Each listener provided ratings on two speakers with each speaker rated by at least two listeners. After each sentence listeners will be asked to type the sentence heard then rate on a six point scale how well they have understood the sentence. We predict that the results will correlate with clinical scores and provide valuable information on how well the general public understands hearing aided children.

The realisation of narrow focus by adolescent cochlear implant users**Ms Colleen Holt**¹, **Associate Professor Janet Fletcher**²

1 Audiology and Speech Pathology, The University of Melbourne, 2 Linguistics and Applied Linguistics, The University of Melbourne

Background: For English speakers, marking a word as being in narrow focus generally involves the use of finely-controlled fundamental frequency (F0) movements (pitch accents). It is well-known that cochlear implant (CI) users have difficulty perceiving F0 variations, but more accurately perceive duration-based aspects of speech. This study investigates the production of narrow focus by a group of adolescent CI users and a group of their normally-hearing (NH) peers. It was hypothesised that the CI group would use variations to phrasing and pausing more often (or instead of) pitch accentuation.

Method: 21 adolescent CI users and 20 NH adolescents were recorded reading dialogues designed to elicit narrow focus on target items.

Results: Independent samples t-tests were used to compare the proportion of pitch accentuation and phrasing strategies used by the two groups. Both groups most frequently used pitch accentuation to place the target word in narrow focus. The CI group used significantly more phrasing strategies, and significantly less pitch accentuation, than the NH group.

Conclusion: The hypothesis that the CI group would most frequently use phrasing strategies to realise narrow focus on target items was not supported. For this group of CI users, difficulties in hearing variations in F0 did not preclude the use of pitch accents on narrowly-focused target words.

Variations in speech development in preschoolers as a function of age at cochlear implantation

Dr Nils Kristian Prenzler, Doris Adams, Dr Angelika Illg, Professor/Dr Thomas Lenarz, Professor/Dr Anke Lesinski-Schiedat

ENT Department, Hannover Medical School

Because of early cochlear implantation, children with profound hearing loss are now able to obtain oral speech acquisition. This speech development is of paramount importance for social development and the ability to attend a mainstreamed school.

Since 2010 all children implanted at Hanover Medical University are tested with the Marburg Speech Comprehension Test (MSVK) before beginning school. Based on these results, the families receive details about school attendance. 60 children, aged 60 to 95 months, have been examined with the MSVK test battery in the field of semantics, syntax and pragmatics.

The results were compared to a normal-hearing control group and divided into 4 groups based on the age at implantation: Group 1 (n=9) was implanted during the first year of life; Group 2 (n=25) during the second year of life; Group 3 (n=19) during the third year of life, Group 4 (n=7) during the fourth year of life. Each of the groups contained children who matched the average results in the control group, either in all or in specific areas of the MSVK.

The comparison between the groups revealed that children in group 1 and 2 displayed significantly better performance in passive vocabulary and sentence comprehension than the children in Groups 3 and 4. Interestingly, no significant differences were observed between Group 1 and 2 in any of the tested conditions.

These data underline the importance of an early implantation for speech development in children with severe hearing loss.

SESSION 18 (APD)

Is APD just attention disorder?

Ms Pia Gyldenkaerne^{1,4}, Dr Mridula Sharma^{1,4}, Professor Suzanne C. Purdy², Professor Harvey Dillon^{3,4}

1 Macquarie University, 2 University of Auckland, 3 National Acoustic Laboratories, 4 HEARing CRC

Children clinically diagnosed with auditory processing disorders (APD) are often described as easily distracted and inattentive, leading some researchers to propose that APD might be a consequence of underlying attention difficulties or a subtype of attention disorders. The aim of this study was to investigate the link between auditory processing and attention by determining the relationship between performance on an auditory and visual sustained attention task and performance on a common APD test battery.

This study was a cross-sectional observational study of school-aged children with suspected auditory processing difficulties and a smaller group of control children with no listening concerns. Participants were 119 children including 18 control children with no listening or educational concerns. All children passed a standard audiological assessment and were assessed with a standard APD test battery, two psychoeducational tests and an integrated visual and auditory continuous performance test was used to assess the children's sustained attention.

Results showed significant but moderate intercorrelations between APD test battery scores, reading accuracy, and non-verbal intelligence, however, weak correlations were found between performance on APD tests and the measures of auditory and visual sustained attention. This indicates that performance on APD tests depends on some processes of sustained attention, supporting the view that, although auditory processing and attention deficits may co-occur in some children and have similar symptoms, they are not in general manifestations of a singular disorder.

Frequency importance functions for Mandarin Chinese talkers

Miss Ming-Wen Kuo¹, Christine Kitamura¹,
Teresa Ching², Gary Walker¹, Harvey Dillon²

1 MARCS Institute & School of Social Sciences and Psychology, University of Western Australia, 2 National Acoustics Laboratory

Aim: A frequency importance function (FIF) describes how each frequency band contributes to speech intelligibility in hearing devices. This study aims to develop Mandarin FIFs for tones, words and sentences in order to evaluate how each influences intelligibility at different frequency bands.

Method: Speech stimuli were recorded by a male broadcaster using monosyllabic words from Mandarin Speech Test Materials (MSTMs) and ten-word sentences from the Chinese Mandarin Hearing in Noise Test (CHINT). The speech was passed through a broadband digital filter to separate the speech signal into high- and low-pass conditions for discrete frequency bands (141, 224, 355, 562, 891, 1413, 2239, 3548, 5623, and 8913 Hz) and speech noise added to create 9 signal-to-noise ratios (SNRs: 15, 12, 9, 6, 3, 0, -3, -6, -9 dB). In the speech recognition test, normal hearing Mandarin speaking participants were asked to orally repeat words and sentences; and in the word session, to indicate the tone used on the screen.

Results: The results show that (1) with increasing contextual information, the FIF tends to shift toward a higher frequency region - the reverse of English findings and (2) both word and sentence FIFs indicate more importance centred at 112 Hz (compared to English).

Discussion: The results indicate that the inclusion of tonal information in speech contributes more importance in the low frequency region (<250Hz).

Conclusions: Our findings suggest that hearing impaired Mandarin Chinese listeners will benefit from different strategies for amplification formulas and speech intelligibility estimation.

The listening and learning self-perceptions of children with CAPD

Dr Chyrisse Heine, Associate Professor Michelle Slone

Monash University

CAPD in children is strongly associated with listening and learning difficulties in a variety of domains. Although this correlation has been documented, few studies have explored children's self-perceptions of their experience of difficulties. Children's self-perceptions of disability can affect emotional status and can exert a profound influence on both short and long-term development across diverse areas.

This study examined the self-perceptions of 100 children aged 7-11 years, who were diagnosed with CAPD prior to their participation in any intervention. All children completed a questionnaire in which they rated their difficulties on a 3 point Likert scale in the domains of listening, language, literacy, attention, work habits and general learning. In addition, participants answered open ended questions in relation to their school subject preferences and areas of difficulty and the strategies they use for enhancing their listening and learning.

Results were analyzed descriptively and suggested that in general children with CAPD are aware of difficulties affecting their learning but utilized limited strategies to overcome their listening difficulties and lack of understanding of information within a classroom setting.

This study has implications for suggesting strategies for enabling children with CAPD to clarify information and improve their listening and learning in the classroom.

Classroom behaviour and academic skills of children with CAPD: teacher's perceptions

Dr Chyrisse Heine, Professor Michelle Slone

CAPD is a multidimensional disorder that transcends language and literacy and other academic domains and a close association exists between (C)APD and literacy and academic problems and (C)APD and speech and language disorders. However, possibly due to the salience of language and literacy difficulties in the classroom and unfamiliarity with CAPD as a distinct disorder, it is frequently overlooked by teachers as a reason for referral. School staff are primary referral sources for investigating CAPD in children, yet few studies have explored teacher's perceptions of children's difficulties in a wide range of listening, academic and behavioural domains.

This study examines the perceptions of 100 teachers of children aged 7-11 years, who were eventually diagnosed with CAPD. All teachers completed a questionnaire in which they rated the child's difficulty on a 5 point Likert scale in the domains of listening, language, literacy, numeracy and classroom behaviour. In addition, teachers identified the major concern that required remediation.

Results were analyzed descriptively and suggested that over half the teachers perceived that the children with CAPD had moderate or greater difficulty with classroom listening, language, literacy and classroom behaviour. Numeracy was perceived as an area of difficulty in just under half of the teachers.

These findings suggest the need for a wholistic approach to assessment and remediation of listening, language and literacy difficulties that includes CAPD which could impact on all these skills. This study has implications for suggesting ongoing liaison between audiologists and teachers, particularly in providing up to date information regarding the relationship between CAPD and classroom performance and behaviors. Further research investigating the correlation between teachers' perceptions and test results is required to identify classroom referral concerns that would necessitate a child's referral for CAPD evaluation.

POSTER ONLY

(P21) Attentional control and distractibility in children using a cochlear implant

Dr Marc Kamke¹, Ms Jeanette Van Luyn², Dr Gabriella Constantinescu³, Dr Jill Harris⁴

1 The Queensland Brain Institute, 2 School of Psychology, 3 Hear and Say, 4 Minerals Industry Safety and Health Centre, Sustainable Minerals Institute

It is well established that early auditory deprivation induces changes in visual perception, cognition and attention. Under some conditions these changes in visual perception can compensate for a hearing loss, but such changes may also negatively impact auditory perception. For example, speech perception performance in non-proficient cochlear implant users is degraded in the presence of highly salient, attention-capturing visual stimuli. In this study, we investigated whether task demands influence attentional capture by salient visual stimuli in children who use a cochlear implant. Thirteen implant users (aged 8 – 16 years) and age-matched normally hearing children were presented with a rapid sequence of visual and auditory events. The participants' task was to search for and identify numbers presented in a specified target colour, or to identify a change in the tonal frequency. Prior to each target a visual distractor was presented. Significant decrements in visual performance were found when the distractor was presented in the same colour as the target, compared to trials in which the distractor was in a different colour or rotated on its axis. These 'contingent capture' effects did not differ between the groups. There was no difference across the visual distractor types or groups in performance on the auditory task. These results show that attentional capture by salient visual stimuli in proficient cochlear implant users depends on top-down attentional control settings, as it does in normally-hearing children. The results therefore suggest that successful use of a cochlear implant is associated with normal visual attentional control and distractibility.

(P22) Lexical access in 4 year-olds: a magnetoencephalographic study

Dr Graciela Tesan, **Associate Professor Blake Johnson**, Professor Stephen Crain

Centre of Excellence for Cognition and its Disorders,
Macquarie University

Using a picture-word matching task, magnetoencephalography (MEG) was used to identify the source of the magnetic N400 in preschool children. Previous ERP studies have found that an N400 response is elicited in children as young as 19 months old in children, by presenting pictures that are incongruent with the linguistic input (1). This effect is clearest in centro-parietal sites in children, as in adults. However, ERP studies are not very informative about the anatomical sources of the cognitive processes that underlie the N400 reflects. Using a paediatric MEG system (2), we investigate the temporal and spatial distribution of the brain structures that are activated in the child brain in response to spoken words.

MEG signals from preschool children (N= 19, Mean= 53 , SD= 6 months) were recorded using a 64-channel whole-head paediatric MEG system. The task was picture-word matching; children saw the picture of a common object, followed by a matching or non-matching word. Children were instructed to press one button for correct trials, and another one for incorrect trials. An eyetracker was used to ensure fixation on the pictures. Incongruent words elicited significantly larger responses over the left middle temporal gyrus.

Activity in bilateral temporal lobes was observed from the onset of the spoken word, with a stronger and larger source over the left hemisphere between 350 and 550 ms. The stronger bilateral activation for the mismatch condition was evident over the middle and superior temporal lobes. Statistical comparison between conditions showed a cluster of significantly larger activity for the mismatch condition on the middle temporal gyrus.

We successfully localized the source of the magnetic N400 effect in 4 year-olds, elicited by spoken words that did not match the preceding visual context. The activation of the posterior middle temporal sources of the N400m in preschool children can be observed using a paediatric MEG. The temporal and spatial distribution of this source is consistent with those reported in adults in intra-cortical EEG studies and MEG studies.