

Welcome to the 29th Biennial Symposium of the International Evoked Response Audiometry Study Group (IERASG)

June 14–18, 2025 | Boulder, Colorado, USA

University of Colorado – University Memorial Center | 1669 Euclid Ave, Boulder, CO
80309

We are delighted to welcome you to the 29th Biennial Symposium of the International Evoked Response Audiometry Study Group (IERASG), held in Boulder, Colorado, from June 14–18, 2025. This year’s meeting brings together researchers, clinicians, and technical experts from around the world to share innovations and foster collaboration in the field of auditory evoked responses.

IERASG continues to serve as a global forum for advancing research and clinical practices related to hearing and balance. We invite scientists, clinicians, and trainees whose work spans the development and application of evoked response techniques across diverse clinical populations—including individuals with hearing loss, brain injury, attention deficits, auditory processing disorders, tinnitus, hyperacusis, autism, and balance disorders. As a “study group,” our mission includes cultivating a welcoming, collegial environment that actively supports the next generation of researchers. Students, postdoctoral fellows, and residents are encouraged to engage fully with experienced leaders in the field.

IERASG 2025 aims to deepen our shared understanding of auditory system function, dysfunction, and rehabilitation, from the cochlea to the cortex. This year’s theme, *Forging Frontiers in Evoked Responses*, reflects our commitment to bridging research and clinical practice through inclusive dialogue and interdisciplinary collaboration.

Our exciting program includes pre-Symposium workshops, the Hallowell Davis Lecture, invited talks on key issues, oral and poster presentations, industry exhibits, and dedicated student sessions. We are particularly proud to highlight the contributions of early-career professionals, with top presentations recognized by the Susan Small Student Travel Award. A central goal of IERASG 2025 is to broaden participation and ensure voices are heard and valued from around the globe.

In addition to the scientific program, we invite you to enjoy a rich social experience that captures the spirit of Boulder and the Rocky Mountain region. Join us for an excursion to Chautauqua—a historic landmark offering scenic hiking trails, sweeping views of the Flatirons, and a deep connection to Colorado’s cultural and natural heritage. Explore Boulder’s vibrant arts scene, excellent restaurants, and access to nearby national and state parks. You may even spot local wildlife such as black bears, mountain lions, bobcats, coyotes, and elk.

We are thrilled to host this dynamic and inspiring meeting in Boulder and look forward to reconnecting with long-time colleagues and welcoming new members to our global IERASG community. Please join us in June 2025 for an unforgettable Symposium filled with rigorous science, meaningful mentorship, and lasting connections.

Warm regards,



Suzanne Purdy, Chair
IERASG



Kristin Uhler, Co-Chair
29th IERASG
conference



Christine Yoshinaga-Itano, Co-
Chair 29th IERASG conference

The IERASG 2025 Organizing Committee

XXIX IERASG 2025

Saturday 14 June -- Workshops

8:00 Registration, All day
09:00 – 11:00 Workshop 1
09:00 – 11:30 Workshop 2a
11:30 – 13:00 Workshop 2b
13:00 – 14:00 LUNCH
14:00 – 15:30 Workshop 3a
15:30 – 16:00 Coffee Break
16:00 – 17:30 Workshop 3b
18:00 – 20:00 Welcome Reception

Sunday 15 June

7:30 Registration, All day
08:30 Opening Ceremony
09:30 Hallowell Davis Lecture (Bob Burkard)
10:30 Session 1: AEPs in animal models
11:00 Coffee/Tea Break
11:30 Session 2: Late Auditory Evoked Responses, Evoked Potentials in Cochlear Implant Recipients
13:00 LUNCH
14:00 Guest Lecturer 1 (Rachael Taylor, New Zealand)
14:45 Round Table 1: VEMPs
16:00 Short break
16:15 A Tribute to Barbara Cone: Auditory Evoked Potentials Using Speech (Suzanne Purdy and Julia Wunderlich)
16:45 Industry Presentations
17:30 Student Session 1

Monday 16 June

8:00 Registration
09:00 Excursion (includes lunch)
14:00 Guest Lecture 2, Susan Small, Pediatric EP Lecture (Christie Yoshinaga-Itano, USA)
15:00 Session 3: From Old Dogs to Young Ears: Advancing Pediatric Hearing Science
16:00 Session 4: Auditory Brainstem Response
17:45 Posters, Wine, and Cheese

Tuesday 17 June

- 8:00 Registration
- 08:30 Guest Lecture 3: Tom Francart (Belgium)
- 09:15 Session 5: Novel Approaches to AEPs I
- 10:45 Coffee/Tea/Posters
- 11:00 Industry Presentations
- 12:00 Student Session 2
- 13:00 LUNCH/Posters
- 14:00 Guest Lecture 4 (Rebecca Millman, United Kingdom)
- 14:45 Round Table 2: Cognition, Listening Effort, and EEG
- 16:00 Session 6: Novel Approaches to AEPs II
- 18:00 Awards Dinner

Wednesday 18 June

- 08:30 Guest Lecture 5, Young Researcher: Chelsea Blankenship (USA)
- 09:15 Session 7: Acoustic Change Complex
- 10:45 Coffee/Tea Break
- 11:00 Session 8: Cortical Auditory Evoked Responses
- 13:00 Closing Ceremony

[Detailed Agenda on page 11](#)

Special Thanks to Our Sponsors:



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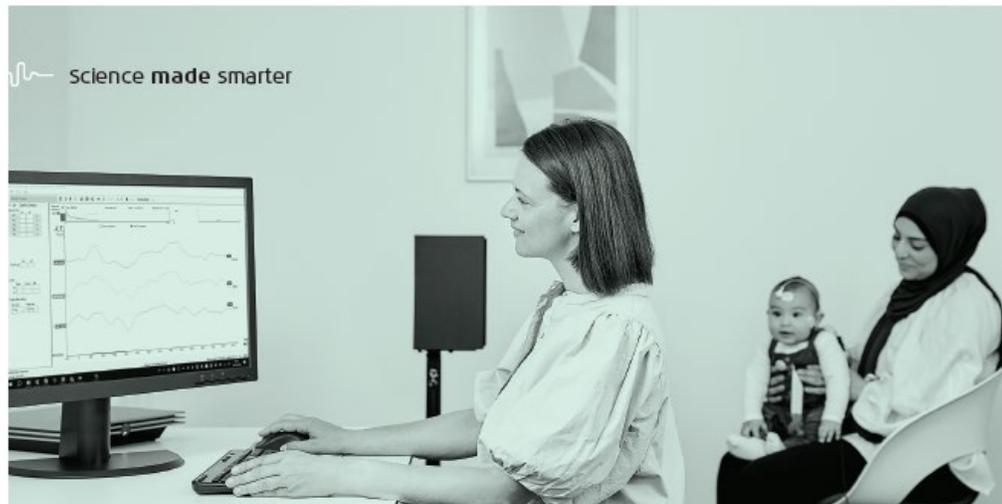


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 - Available test stimuli include:
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Detailed Schedule

Saturday 14 June – Workshops

Workshop 1: Advanced EEG Analysis

Presenters: Andrew Dimitrijevic (Canada) and Phillip Gilley (USA)

Workshop 2a: Collaborative discussion of infant ABR/ASSR assessment protocols and early hearing program outcomes

Presenters: Rebecca Awad and Megan Hedman (USA), Jenny Hatton and Heidi Schaefer (Canada)

Workshop 2b: Advances in middle ear analysis

Presenters: Lisa Hunter and Beth Prieve (USA)

Workshops 3a and 3b: Electrophysiology in clinical vestibular assessment

Presenters: Andy Beynon (NDL), Rachael Taylor (NZ), and Karen Hendrick and Andrea Gaitlin (USA)

[Read Saturday Abstracts on page 24](#)

Sunday 15 June

HALLOWELL DAVIS LECTURE: Robert Burkard

Title: Do what you love, and with hard work and a lot of luck it will
(hopefully) work out
Moderator: Suzanne Purdy

Session 1: AEPs in animal models

Moderator: Suzanne Purdy

1. Designing sparse EEG arrays to capture dolphin auditory evoked response (Abstract #116)
Presenter: Matt Schalles
2. Aging impairs temporal and binaural processing, and spatial hearing, while increasing synaptopathy, in the Mongolian Gerbil (Abstract #89)
Presenter: Matthew Sergison

Session 2: Late Auditory Evoked Responses, Evoked Potentials
in Cochlear Implant Recipients

Moderator: Matthew Sergison

1. N400 as a measure of cross-situational learning of spoken word to pseudosign pairs (Abstract #37)
Presenter: Mridula Sharma
2. Using linguistically complex listening tasks to evaluate higher-level informational masking effects in an AERP oddball paradigm (Abstract #69)
Presenter: Emily Smith
3. Comparative auditory late responses and neuropsychological abilities in Brazilian adults (Abstract #53)
Presenter: Luciana Macedo de Resende
4. Implanted cochlea sensitivity to electrical current and loudness percept (Abstract #119)
Presenter: Juan M Cornejo

Guest Lecturer 1: Rachael Taylor (New Zealand)

Beyond the labyrinth: The role of Vestibular Evoked Myogenic Potentials in
Neural Pathway Assessment

Moderator: Andy Beynon

Round Table 1: VEMPs

Moderators: Karen Hendrick and Andy Beynon

1. Pediatric VEMP Testing for the Cochlear Implant Population (15 minutes—Andrea Gatlin)
2. Pediatric VEMP Testing for the Congenital Cytomegalovirus Population (15 minutes—Karen Hendrick)
3. Cochlear Vestibular Implant (15 minutes—Andy Beynon)
4. Round Table Discussion/Questions (30 minutes—All presenters)

A Tribute to Barbara Cone: Auditory Evoked Potentials Using Speech

Suzanne Purdy and Julia Wunderlich

[More info...](#)

Industry Presentations 1

Moderator: Andrew Dimitrijevic

1. Advanced Bionics: Recording brain signals directly from the cochlear implant
Presenter: Chen Chen
2. Vivosonic: Improving signal-to-noise ratio with Vivosonic SOAP™-Kalman Weighted Averaging and other noise reducing technologies
Presenter: Angela Bottley

Student Session 1

Moderator: Rafael Delgado

1. Making eardrum electrocochleography simple, well-tolerated, and essential to assessing the human auditory periphery (Abstract #83)
Presenter: Sarah Haysley
2. The P300 auditory-evoked potential as a physiological measurement of listening effort: investigation in adults with and without hearing loss (Abstract #16)
Presenter: Louise Van Goylen
3. Cortical encoding of speech in noise in children and adults (Abstract #61)
Presenter: Madison Brown
4. Linking infant newborn ABR results to necessary medical investigations (Abstract #55)
Presenter: Gem Choi
5. Detection sensitivity and specificity of a mismatch response protocol (Abstract #35)
Presenter: Leith Towers

[Read Sunday abstracts on page 26](#)

Monday 16 June

Guest Lecture 2: Susan Small Pediatric EP Lecture

Christine Yoshinaga-Itano (USA)

From Bench to Bedside: Evoked potentials and Universal Newborn
hearing Screening

Moderator: Kristin Uhler

Session 3: From Old Dogs to Young Ears: Advancing Pediatric Hearing Science

Moderator: Steven Bell

1. Teaching old dogs new tricks: An OAE-based hearing screening test (Abstract #25)
Presenter: Sriram Boothalingam
2. Abnormal middle ear function and infant auditory evoked potentials (AEP) outcomes (Abstract #115)
Presenter: Rebecca Awad
3. Modeling fNIRS Responses to Speech Sound Discrimination in Sleeping Infants (Abstract #80)
Presenter: Julia Wunderlich

Session 4: Auditory Brainstem Response

Moderator: Dan Tollin

1. The parallel ABR (pABR) provides fast and accurate threshold estimates in adults with hearing loss (Abstract #111)
Presenter: Ross Maddox
2. Optimal parameters for evoking frequency-specific auditory brainstem responses using continuous speech (Abstract #88)
Presenter: Melissa Polonenko
3. Auditory brainstem response data preprocessing method for the automatic classification of hearing loss patients (Abstract #36)
Presenter: Moon Yun Park
4. The Fmpi: A generalized detector for evoked responses in the time and frequency domain (Abstract #41)
Presenter: Jaime Undurraga
5. Tired of peak-picking? An automated feature extraction technique for the auditory brainstem response (Abstract #99)
Presenter: Aryn Kamerer

6. Audiovisual enhancement of auditory and visual evoked potentials using flash/beep cross-modal stimulus paradigm (Abstract #63)
Presenter: Ozcan Ozdamar-emailed 5/7
7. The interaural time modulation following response: an objective measure of binaural unmasking in school-age children (Abstract #62)
Presenter: Lindsey Yper

Guest Lecture 3: Tom Francart (Belgium)

Neural tracking of speech features: applications in hearing research

Moderator: Mridula Sharma

[Read Monday abstracts on page 35](#)

Tuesday 17 June

Session 5: Novel Approaches to AEPs I

Moderator: Kerry Walker

1. Frequency specific objective AEP-based assessment of hearing perception in noise (Abstract #97)
Presenter: Angel De la Torre
2. Influence of noise exposure on stacked ABR and speech in noise measures (Abstract #44)
Presenter: Nilesh Washnik
3. Unraveling neural mechanisms underlying auditory brainstem response through computational simulation (Abstract #100)
Presenter: Ben-Zheng Li
4. The relationship between the Audible Contrast Threshold (ACT) test and the electrophysiological version of ACT (E-ACT) (Abstract #52)
Presenter: Lisbeth Birkelund Simonsen
5. Real-time implementation of a forward masking subtraction technique for recording electrically elicited auditory brainstem responses (Abstract #110)
Presenter: Rafael Delgado
6. Psychoacoustical and electrophysiological investigation of relative masking levels for narrowband chirps using a broadband noise masker (Abstract #70)
Presenter: Emmelie Knauth

Industry Presentations 2

Moderator: Martin Walger

1. Intelligent Hearing Systems: Title: The smart choice - Clinical and research advances on the IHS platforms
Presenter: Rafael E. Delgado

2. MedEI: Pulling Back the Mask: A closer look at artifact rejection strategies for ECAPs
Presenter: Jeffery Skidmore

Student Session 2

Moderator: Tammy Fredrickson

1. Effect of hearing aids on cognitive function in elderly patients with hearing loss: A functional near-infrared spectroscopy study (Abstract #30)
Presenter: JiWon Choi
2. Impacts of extended high-frequency hearing loss on neural encoding and perception of speech (Abstract #42)
Presenter: Sajana Aryal
3. Genetic predisposition to age-related hearing loss explains differences in otoacoustic emissions among healthy young adults (Abstract #117)
Presenter: Valerie Ingalls
4. Forward and backward masking in ABR and psychophysical measures: Assessing auditory temporal resolution (Abstract #74)
Presenter: Esmā Akis
5. Tracking rhythm in the brainstem: Temporal dynamics of envelope encoding and developmental differences with machine learning
Presenter: Pedro Andres Alba Diaz

Guest Lecture 4: Rebecca Millman (United Kingdom)

Cortical alpha oscillations as a measure of listening effort in adults with hearing loss

Moderator: Joaquin Valderama

Round Table 2: Cognition, Listening Effort, and EEG

Moderators: Andrew Dimitrijevic, Joaquin Valderama, Ramesh Kumar Muralimanohar

An interactive round-table discussion, conducted by invited experts, will explore the cognitive factors associated with auditory perception. The discussion will include appropriate behavioral and neurophysiological measures of cognition, such as listening effort, attention, and working memory. Additionally, we will also consider the effects of dementia on auditory cognitive processing, the impact of training on cognitive factors, and the combination of behavioral and neurophysiological measures to comprehend perception and enhance quality of life. The discussion will prioritize addressing audience inquiries and fostering open discussions on the current state of knowledge and the exchange of ideas.

Session 6: Novel Approaches to AEPs II

Moderator: Matt Sergison

1. Hidden hearing loss (synaptopathy) continues to hide in humans: Can evoked potentials rescue? (Abstract #112)
Presenter: Srikanta Mishra
2. Neural markers of emerging speech perception challenges in middle age: Insights from chirped speech-evoked responses (Abstract #109)
Presenter: Kelsey Mankel
3. Rhythmic priming of phonemic perception with the CE-chirp (Abstract #75)
Presenter: David Morris
4. Validation of the nested-TEMPEST stimulus for simultaneous measurement of parameterized syllabic and phonemic speech envelopes (Abstract #86)
Presenter: Ana Belen Carbajal Chavez
5. Effect of envelope enhancement on the cortical encoding of continuous speech (Abstract #124)
Presenter: Nike Gurindapalli
6. Auditory encoding of steady and dynamically changing virtual pitch in adults who stutter (Abstract #126)
Presenter: Dhatri Sadholalu Devaraju

[Read Tuesday abstracts on page 41](#)

Wednesday 18 June

Guest Lecture 5: Young Researcher: Chelsea Blankenship (USA):
Electrophysiological Assessment in Preterm Infants: Brainstem to Cortex

Moderator: Lisa Hunter

Session 7: Acoustic Change Complex

Moderator: Suzanne Purdy

1. A feasible strategy for eliciting the location-related Acoustic Change Complex
Presenter: Shuai Nie (Abstract #22)
2. Age-related differences in auditory spatial processing revealed by Acoustic Change Complex (Abstract #23)
Presenter: Xing (Jack) Wang
3. The Acoustic Change Complex as a gauge of spatial discrimination in the horizontal plane (Abstract #108)
Presenter: John Grose
4. Deep learning neural networks for individualized cortical auditory evoked potential classification: A trial averaging study (Abstract #103)
Presenter: Anthony Herdman-He will be hybrid

5. Acquisition of auditory frequency-following responses and cortical auditory evoked potentials at conventional and high stimulation rates using deconvolution in subjects with fetal alcohol spectrum disorders (Abstract #15)
Presenter: Sheila Templado

Session 8: Cortical Auditory Evoked Responses

Moderator: Mridula Sharma

1. Use of cortical auditory evoked potentials in cochlear-implanted children (Abstract #90)
Presenter: Sobrina Bouzaid
2. Bridging the gap: Implementing cortical auditory evoked potentials (CAEPs) in a busy clinical setting (Abstract #29)
Presenter: Tamar Gomes
3. Measurement of cortical auditory evoked potentials via bone conduction hearing device (Abstract #46)
Presenter: Mario Cebulla
4. Hearing aid audibility and acclimatization effects on measures of brain and behavior (Abstract #121)
Curtis Billings
5. Neurophysiological biomarkers for tracking auditory selective attention (Abstract #28)
Presenter: Joaquin T. Valderama
6. Cortical network disruptions in children with cochlear implants (Abstract #85)
Presenter: Karen Gordon

[Read Wednesday abstracts on page 52](#)

Posters

1. Application of P1 response threshold of cortical auditory evoked potential in rehabilitation evaluation of young children with cochlear implant (Abstract #38)
Liping Meng, Hui Ji, Weiluo Huang, Yaofeng Jiang
2. Applicability of an acoustic stimulus for evaluation of the Acoustic Change Complex in adults (Abstract #91)
Ana Claudia Figueiredo Frizzo, Yara Bagali Alcantara, Ana Luiza de Faria Luiz, Isabela Tiezi Rombola, John H Grose
3. Plasticity of the auditory cortex and brainstem in surgically induced unilaterally deaf adult humans with and without tinnitus (Abstract #14)
MinChul Park, Greg A. O'Beirne, Philip Bird, and Michael R. D. Maslin
4. Comparison of auditory brainstem evoked response (ABR) test results in infants screened for neonatal hearing loss (Abstract #27)
Joong Ho Ahn and So Hee Kang
5. Neural adaptations to new cochlear implants: A longitudinal electroencephalogram study (Abstract #11)
Shimin Mo, Claude Alain, and Andrew Dimitrijevic
6. A comprehensive evaluation of the newborn hearing screening system in Jordan (Abstract #93)
Faten Obeidat, Noura Alothman, Rania Alkahtani, Sameer Al-Najjar, Elham Ahmad, Mohammad Obeidat, Asia Ali, and Alia Alghwiri
7. Reduction of the power line interference in a single-channel AEP recording system based on low-cost consumer electronics: application for dissemination of audiology concepts in schools and at a science museum. (Abstract #94)
Angel de la Torre, Isaac M. Álvarez, Juan A. Muñoz-Orellana, Juan Martín-Lagos, Lourdes López-Pérez, and Juan A. Torres-Lara
8. Understanding early and late transient responses to speech: experiments using synthetic speech (Abstract #95)
Angel de la Torre, Isaac M. Álvarez, Nicolas Müller, Francisco A. Chiquero, Juan Martín-Lagos, and José L. Vargas
9. Stimulus duration effects on VEMP responses at 125 Hz and 500 Hz (Abstract #64)
Busra Kocak Erdem , Steven Lewis Bell, and Ying Ye
10. Interrelationships between auditory brainstem response threshold structure and spontaneous otoacoustic emissions (Abstract #57)
Rebecca E. Whiley and Christopher Bergevin
11. Phoneme-specific effects of contralateral noise on ipsilateral speech-evoked envelope following responses (Abstract #59)
Tan Ze Wang, Sriram Boothalingam, Vijayalakshmi Easwar and David Purcell

12. Total integration of SmartVS and Baby ISAO, a virtual and physical simulator experience, to enhance evoked potential education and training (Abstract #65)
Rafael Delgado and David Brown
13. Optimizing active middle ear implant coupling: intraoperative ABR and ASSR measurements (Abstract #49)
Carolina Köstler, David Herrmann, Kristen Rak, and Mario Cebulla
14. Electrophysiological changes in the auditory system associated with the progression of noise-induced hearing loss (Abstract #79)
Yoonchan Rah and Young-Soo Chang
15. Stimulating and recording cortical potentials via cochlear implant (Abstract #118)
Don Bell-Souder, Chen Chen, Anthony Spahr, and Anu Sharma
16. Speech-evoked envelope following responses to evaluate hearing aid benefit in infants with hearing loss (Abstract #45)
Viji Easwar, Michael Chesnaye, David Purcell, Susan Scollie, Genevieve Olencewicz, and Sanna Hou
17. The relationship between the number of newborn hearing screening (NHS) tests and the positive rate of ABR test in normal newborns (Abstract #76)
Chang Hyun Cho
18. Cortical evoked potentials in conductive and mixed hearing losses (Abstract #60)
Carly Schimmel, Kayla Cormier, and Anu Sharma
19. Neural markers of automatic and controlled attention in children with cochlear implants: An ERP study (Abstract #58)
Ola Badarni -Zahalka, Ornella Dakwar-Kaawar, Cahtia Adelman, and Josef Attias
20. Auditory evoked responses of the complete auditory pathway using structured stimulation sequences (Abstract #96)
Nicolas Müller, Angel de la Torre, Francisco A. Chiquero, Isaac M. Alvarez, Juan Martín-Lagos, and José L. Vargas
21. Can auditory steady-state potential detect hearing loss or normal hearing thresholds in infants, babies, and children?: Literature review (Abstract #31)
Mariana Ferreira Pires Martins, Milaine Dominici Sanfins, Caroline Donadon, Piotr Henryk Skarzynski, and Daniela Gil
22. CI adults' neural encoding of emotion and gender discrimination in speech (Abstract #26)
Xinyi Yao, Emily Graber, and Andrew Dimitrijevic
23. Genetic factors underlying age-related hearing loss affect suprathreshold ABR Wave morphology in healthy young adults (Abstract #120)
Valerie Ingalls, Srividya Grama Bhagavan, and Ishan Bhatt
24. Auditory brainstem responses to bone-conducted 4000-Hz brief tones in infants (Abstract #101)
Anthony Herdman, Jennifer Hatton, Anna VanMaanen, and David Stapells

25. Assessment of auditory reflexes using electrocochleography (Abstract #113)
Lydia White, Sarah Haysley, and Skyler Jennings
26. Auditory neuropathy/dys-synchrony (ANSD) evoked potentials assessment alignment (Abstract #43)
Megan Hedman
27. A large-sample simulation study evaluating the prevalence of underestimating steep-sloping hearing losses using auditory brainstem responses to brief tones and chirps (Abstract #102)
Anthony Herdman
28. Multichannel methods for rapid and high-quality frequency following responses (Abstract #122)
Nike Gnanateja Gurindapalli, Megan Hernandez, and Dhatri Sadholalu Devaraju
29. Auditory and language monitoring with objective and subjective measures: case report (Abstract #71)
Thais Augusto Souza, Milaine Dominici Sanfins, Leticia Inocência, and Daniela Gil
30. Urolithin A prevents age-related hearing loss in C57BL/6J mice by inducing mitophagy (Abstract #39)
Sung Il Cho, Eu-Ri Jo, and Hee Sun Jang
31. Neural representation of the coding process of language and speech aspects in children with congenital toxoplasmosis (Abstract #34)
Lais Ferreira, Milaine Dominici Sanfins, Marcia Keske-Soares, Piotr Henryk Skarzynski, and Eliara PV Biaggio
32. Light induced ABR responses after optogenetic microneedle for minimally invasive neuro-stimulation of inner ear (Abstract #82)
Min Young Lee, Subin Kim, So-Young Chang, and Dong-Kee Kim
33. Unilateral auditory neuropathy in a child with ipsilateral enlarged vestibular aqueduct: a case report (Abstract #93)
SungHee Km and Eun Jin Son
34. Frequency-specific hearing assessments using auditory evoked potentials to modified speech (Abstract #20)
Michael Chesnaye, Natasha Knezevic, David Purcell, and Viji Easwar
35. Cortical and cognitive encoding of noisy and reverberant speech (Abstract #123)
Ramesh Kumar Muralimanohar, Macy Knudsen, and Curtis Billings
36. Neurophysiological correlates of word learning in hearing-impaired preschool children (Abstract #72)
Marina Vasilyeva, Veronika Knyazeva, Ekaterina Garbaruk, Maria Boboshko, Elena Dmitrieva, and Aleksander Aleksandrov

37. Neural encoding of speech in Brazilian Portuguese-speaking school-aged children: An analysis using the frequency-following response (Abstract #48)
Caroline Donadon, Milaine Dominici Sanfins, Gabriele Libano, Aline Sanches, Piotr Henryk Skarzynski, and Maria Francisca Colella-Santos
38. Cochlear implantation outcomes in RRM2B-related deafness: A case report and literature review (Abstract #105)
Sabrina Bouzaid, Natalie Loundon, and Isabelle Rouillon
39. Correlation of electrically evoked stapedius reflex threshold (eSRT) and subjective measures in pediatric cochlear implant programming: Effects on speech discrimination (Abstract #106)
Sabrina Bouzaid, Natalie Loundon, and Isabelle Rouillon
40. Effects of intensity and hearing status on middle latency responses recorded with pABR stimuli (Abstract #98)
Isabel Herb, Ross Maddox, and Melissa Polonenko
41. Reflections on how to establish a reliable fNIRS protocol to study auditory cortical responses in children (Abstract #51)
Lucianar Macedo de Resende, Debora Marques de Miranda Rebecca Chrispim Silva, Ana Kelly Barbosa Oliveira, Silmara Abreu Melgaço, Suellen Rosa Oliveira, and Rickson Mesquita
42. Reducing artifacts in oVEMP Testing: A comparative analysis of ground electrode positions (Abstract #73)
Leila Moore
43. Impact of an interaural place of stimulation mismatch on the binaural interaction component in single sided deaf and bilateral CI users (Abstract #21)
Sebastian Roth, Franz-Ullrich Müller, Julian Angermeier, Antje Aschendorff, Thomas Wesarg, Werner Hemmert, and Stefan Zirn
44. Towards closed loop cochlear implant fitting based on intracochlear cortically auditory evoked potentials (Abstract #131)
Jonas Althoff and Waldo Nogueira
45. Investigating the link between speech-in-noise perception, hearing loss, and cognitive function in older adults (Abstract #127)
Sankalpa Mahadev, Hari Prakash Palaniswamy, and Bellur Rajashekar
46. Transient disappearance of otoacoustic emissions after conventional hearing aid use in OTOF-related auditory neuropathy: A literature review and case report (Abstract #107)
Sabrina Bouzaid, Isabelle Rouillon, and Natalie Loundon
47. Auditory Brainstem Response with NB CE-Chirp® LS in normal hearing infants (Abstract #67)
Diego Ormundo and Doris Ruthy Lewis
48. Impact of extended high-frequency hearing loss on neural and behavioral temporal processing and binaural hearing (Abstract #87)
Kerry Walker, Carol Sammeth, Nathaniel Greene, and Daniel Tollin

49. Identifying neurophysiological biomarkers of adaptation to noise (Abstract #56)
Joaquin T. Valderrama, Francisco Sánchez-Martínez, Miriam Marrufo-Pérez, and Enrique Alejandro Lopez-Poveda
50. Examining EEG correlates of tinnitus in mild to moderate hearing loss (Abstract #66)
Kayla Cormier, Carly Schimmel, Vinaya Manchaiah and Anu Sharma
51. Exploring amplitude growth functions of Auditory Steady-State Responses (ASSR) in adults with normal hearing. (Abstract #129)
Abdallah Alomiri, Steve Bell, and David Simpson
52. Cortical responses reveal effortful access to interaural level cues in children with bilateral cochlear implants (Abstract #84)
Karen Gordon, Lulia Snan, Angela Fung, Jaina Negandhi, Blake Papsin, and Sharon Cushing
53. Processing of binaural envelope and fine-structure interaural-time-difference cues along the auditory pathway in typical-hearing adults (Abstract #104)
Aditi Gargeshwari, Lulia Snan, G. Nike Gnanateja, Karen Gordon, Mohammad Maarefvand, and Ruth Y. Litovsky
54. Effect of noise and cognitive demands on neural processing of acoustic and phonological features (Abstract #125)
Dhatri Sadholalu Devaraju, Hannah Tenpas, Mary Scott, Advait Krishnan, and Nike Gnanateja Gurindapalli
55. Short-term neural adaptation is modulated by attention in younger adults but not older adults (Abstract #24)
Anoop Basavanahalli Jagadeesh and Ajith Kumar Uppunda
56. Psychoacoustical and electrophysiological assessment of relative masking level for a broadband chirp and a broadband masker (Abstract #78)
Jan Hots and Jesko Verhey
57. Evaluation of auditory evoked potential biomarkers of cochlear synaptopathy in listeners with self-reported hearing difficulties (Abstract #50)
Matthias Inghels, Sarah Verhulst, Attila Frater, Ingeborg Dhooge, and Iris Arweiler
58. Cochlear Implantation in the Elderly: Speech Performance, Associated Factor, Complication, and Surgical Safety
Lee, Kyu-yup - Primary Author

Abstracts

Saturday

Workshop 1: Advanced EEG Analysis

Presenters: Andrew Dimitrijevic (Canada) and Phillip Gilley (USA)

The Advanced EEG Analysis workshop will include: 1) EEG/ERP simulations using BESA simulator, 2) tutorials on using BrainStorm (free Matlab program) including Time-frequency analysis and Source analysis and 3) using Temporal Response Functions to examine cortical brain responses / neural tracking to continuous speech stimuli.

Learning Objectives:

- Students will be able to demonstrate how to use BrainStorm for time-frequency and source analysis.
- Students will be able to demonstrate the use of Temporal Response Functions to examine cortical brain responses/neural tracking of continuous speech stimuli.

PARTICIPANTS NEED THE FOLLOWING PREPARATION FOR THIS WORKSHOP:

Students should bring their own laptop computer with Matlab installed

Students are encouraged to view the YouTube tutorials (link provided during registration) to familiarize themselves with techniques that will be used

Workshop 2a: Collaborative discussion of infant ABR/ASSR assessment protocols and early hearing program outcomes

Presenters: Rebecca Awad and Megan Hedman (USA), Jenny Hatton and Heidi Schaefer (Canada)

The purpose of this workshop is to engage international early hearing programs in discussions about infant ABR/ASSR threshold protocols and program outcomes within a collaborative and respectful environment.

Learning objectives:

- To increase awareness of the differences and similarities between infant ABR/ASSR threshold protocols through discussion of selected protocol questions
- To support collaborative discussions on how practices can be adjusted in accordance with the majority of available evidence
- To learn from one another with the aim of improving infant ABR/ASSR threshold assessment protocols and patient outcomes
- To create opportunities for new collaborations

We recognize the diversity of research and training in the field. This workshop is about

working towards a common view based on the overall body of evidence. By attending this workshop, you agree to share ABR/ASSR protocols and data (if available), come with a growth mindset, and be respectful of each other. Open discussion is encouraged to ensure different perspectives are considered. Our goal is to have participation from a broad representation of international programs.

Workshop 2b: Advances in middle ear analysis

Presenters: Lisa Hunter and Beth Prieve (USA)

The Wideband Acoustic Immittance (WAI) Workshop will cover the following topics:

1. Fundamental Introduction to WAI & Terminology,
2. Hardware for Measurement of WAI with a demonstration of hardware,
3. Ambient and Pressurized WAI with demonstration in real ears,
4. Development of WAI in infants and children,
5. Analysis and Interpretation of WAI Results with example recordings,
6. Normal newborn and abnormal cases,
7. Cases of temporary, fluctuating conductive loss including Down syndrome, cleft palate, and other conditions,
8. Cases of permanent conductive loss

Learning Objectives:

- Participants will be able to list two main differences between wideband absorbance and standard tympanometry.
- Participants will be able to describe two anatomical differences between the newborn external and middle ear as compared to the adult external and middle ear.
- Participants will be able to describe how wideband absorbance changes with age from newborns to 1 year old children.
- Participants will be able to state at least two advantages and any disadvantages for the utilization of wideband absorbance and standard tympanometry.

Workshops 3a and 3b: Electrophysiology in clinical vestibular assessment

Presenters: Andy Beynon (NDL), Rachael Taylor (NZ), and Karen Hendrick and Andrea Gaitlin (USA)

This workshop will cover application of clinical VEMP recordings in adults and in children. The first part will start with an introduction of VEMP in the context of standard clinical vestibular assessment. Physiology and the evolution of VEMP testing, including practical tips & technical pitfalls, will be addressed, followed by a practical demonstration of VEMP recordings in adults.

After a short break, in the second part we will focus on VEMP testing in infants and children, requiring special considerations. The maturation of neural reflex pathways

responsible for VEMPs, the utility of bone conducted stimuli, and pediatric test modifications will be reviewed as well as application in children with high vestibular risk factors such as congenital cytomegalovirus (cCMV) and cochlear implant candidates/recipients. The clinical utility of VEMPs in these populations will be discussed and demonstrated.

Learning Objectives:

After this workshop, participants:

- will know the patho-physiological background of VEMPs
- will know the difference between cervical- and ocular-VEMPs
- will know which parameters are important to successfully perform VEMPs
- will know the clinical pitfalls during VEMP testing and are able to solve them
- will know differences between VEMP testing in adults vs. children
- can give examples of clinical VEMP applications in specific patient groups

Sunday

Hallowell Davis Lecture: Do what you love, and with hard work and a lot of luck it will (hopefully) work out

Bob Burkard (and way too many family, friends, teachers, mentors, mentees, and collaborators to list here)- I absolutely love doing research. There is something addictive about reading the literature, designing an experiment to address an interesting scientific problem, working through the challenges of getting the experiment to work, collecting and analyzing the data, and (for a hopefully brief period of time) being the only person (or one of a handful of people) who know(s) the results. I even enjoy writing, and find the review process at times helpful, often infuriating, both as an author, but also as a reviewer (or Associate Editor, or Editor). My career in the field of Audiology officially began when I enrolled in a Bachelor's Communication Disorders program at Buffalo State College in 1974. I was drawn to Audiology in part because of my interest in sound production and music, and in part because I would have rather poked needles in my eyes than spend my career being a speech pathologist. My first exposure to AEPs was during my Master's Audiology program at the University of Wisconsin-Madison: Bob Goldstein taught a course in AEPs. As I started my PhD program in Audiology/Hearing Science in Madison, I was exposed to a lot of auditory physiology, much of it from the Neuroscience faculty in the Medical School, and I had the great good luck to have Kurt Hecox (a pediatric neurologist) as my dissertation advisor. Kurt taught me a lot about AEPs, neurology, neuroscience and (by example) educated me about the scientific enterprise. This talk will be targeted at those starting their research careers. In this lecture, I plan on talking about my ~50 year academic research pilgrimage as a student of auditory (and vestibular) neuroscience. I will talk about my family, friends, teachers, mentors, mentees and collaborators influenced my research trajectory. I will highlight my research pedigree back to Hallowell Davis. I will interleave this discourse with experimental results, giving credit (in those instances where my memory still serves me well) about why a given experimental path was followed or a particular animal model was selected, and give a lot of credit to my collaborators and students who helped me along the way. I will note career choices that more or less went well, and

mistakes I made. You might think that research success is solely about how hard you can actively focus directly on the research enterprise, but this simply is not true. Your time spent in volunteer professional activities, your time in the classroom, and time spent in the clinic can shape your research career in often very unexpected ways. I will also talk about lessons I have learned during my career that will hopefully serve the audience as well as they have served me.

Session 1: AEPs in animal models

Designing sparse EEG arrays to capture dolphin auditory evoked response (Abstract #116)

Matt Schalles, John Buck, Jason Mulsow, Dorian Houser, James Finneran, Peter Tyack, Barbara Shinn-Cunningham

How does one best select electrode locations for sparse recording montages? In dolphins, a classic approach maximizes the signal to noise ratio of an auditory evoked potential (AEP). This yields a reliable solution for clinical audiology where a single EEG channel can assess the auditory health of stranded individuals. As multi-electrode systems mature for dolphin auditory research, how do we capture neural dynamics related to complex sounds in the dolphin's acoustic environment? Dolphins have lateralized control over production of echolocation clicks and communication whistles, yet previous studies report strongest AEPs along the dolphin midline. Like humans, there may be hemispheric specialization in the dolphin brain for communication. However, dolphins present a number of practical challenges to record noninvasive brain activity, from salt water to anatomy. When constrained by the number of channels on the recording equipment, can we select a sparse array of electrodes that represents information from across a large yet limited region of skin over the dolphin brain? More specifically, which 8 electrodes out of a 16 element array best represent the information in the full data set? We compare the results from three different montage selection strategies: 1. highest magnitude AEPs 2. highest signal-to-noise ratio 3. best linear reconstruction of the omitted 8 electrodes. Reconstruction indicates a role for frontal laterality, as well as electrodes clustered along the midline moving posterior from the blowhole. This could be useful in other species to estimate electrode placement for sparse montages due to recording equipment constraints.

Aging impairs temporal and binaural processing, and spatial hearing, while increasing synaptopathy, in the Mongolian Gerbil (Abstract #89)

Matthew Sergison, Nathaniel Greene, Achim Klug, Daniel Tollin

Background: Aging can lead to problems in spatial hearing abilities, often while sparing hearing thresholds. The mechanisms of this dysfunction are thought to involve binaural pathways in the auditory brainstem. Here, we combine auditory brainstem responses (ABRs), envelope following responses (EFRs), spatial hearing behavior, and cochlear histology in the Mongolian gerbil (*Meriones unguiculatus*) to investigate mechanisms of age-related dysfunction in binaural processing.

Methods: We performed ABRs and EFRs in cohorts of young (2-10 month) and aged (>30 month) gerbils. From ABRs, we calculated the binaural interaction component (BIC), a biomarker of spatial hearing abilities. We also performed spatial hearing behavior tasks utilizing prepulse inhibition of the acoustic startle response (PPI) on our gerbils. Lastly, we performed

immunohistochemistry stains on cochleae from our gerbils to assess age-related cochlear synaptopathy.

Results: We found that aged animals have reduced ABR wave amplitudes and reduced BIC amplitudes, indicating impairments of synchronous brainstem firing and binaural processing. However, aged animals do not have reduced hearing thresholds, indicating preserved peripheral hearing. Additionally, aged animals showed impaired synchrony to EFRs, further indicating temporal brainstem deficits. Aged gerbils also were impaired in behavior tasks measuring temporal processing of a gap in noise and minimum audible angle to broadband noise speaker swaps. Finally, aged gerbils had reduced synapses on inner hair cells compared to young gerbils.

Conclusion: This data shows aged gerbil have impaired auditory brainstem physiology, which impairs temporal and binaural processing and leads to dysfunction of spatial hearing behaviors, which is caused in part by increased synaptopathy.

Session 2: Late Auditory Evoked Responses, Evoked Potentials in Cochlear Implant Recipients

N400 as a measure of cross-situational learning of spoken word to pseudosign pairs

(Abstract #37)

Mridula Sharma, Arianna Colombaria, Varghese Peterb, Qian Yin Maia, Amanda Saksidac, Natalie Boll-Avetisyana, Outi Tuomainena

Background: This study applies a cross-situational learning paradigm to test the learning of unfamiliar sign language-like gestures or pseudosigns to spoken words.

Methods: Twenty-five children (8–11 years) and 19 adults (18–35 years) participated in the study and were familiarised with 8 spoken word and pseudosign pairs. A pseudosign was defined as an arbitrary hand movement, phonotactically legal in sign languages, with no previous cultural meaning, and no iconic relation to the referent it represented. N400 was used to measure their recognition and semantic categorisation skills to these word-gesture pairs.

Results: Both groups showed an N400 followed by an LPC response during the recognition task. During categorisation, adults demonstrated an N400 response whereas, in children, an N400 emerged only when the correctly identified trials were considered. Behaviourally, children and adults showed above-chance accuracy implying successful learning of pseudosigns and their meanings.

Conclusions: These results suggest that N400 may be used to evaluate the learning of new gestures to spoken word pairs.

Using linguistically complex listening tasks to evaluate higher-level informational masking effects in an AERP oddball paradigm (Abstract #69)

Emily Smith, Kathy Vander Werff

Behavioral studies show that speech babble disrupts performance more than energetic maskers, with two-talker babble producing the greatest informational masking due to the cognitive demands of separating competing voices. While auditory event-related potential (AERP) studies confirm that speech babble impacts neural responses more than energetic noise, they have not shown significant differences based on levels of informational masking,

such as varying talker number. This may be because previous paradigms lacked linguistic or semantic complexity to engage higher-level processing. This study examined neural correlates of informational masking from varying talker numbers during a linguistically demanding categorization oddball task.

AERPs were recorded from normal-hearing young adults during an oddball paradigm where participants linguistically categorized monosyllabic words as living or non-living while listening in three conditions: quiet, eight-talker, and two-talker babble. AERP responses were analyzed for P1, N1, P2, P300, N400, and P600 components.

In quiet, robust neural responses included obligatory sensory peaks and later cognitive responses (N400, P600). Speech maskers reduced amplitudes and prolonged latencies for N1, P2, and P300. Two-talker babble caused significantly greater reductions in N1 and P300 amplitudes and longer P300 and P600 latencies than eight-talker babble.

Results demonstrate that a linguistically demanding task elicited the expected informational masking pattern based on behavioral research. Speech-based maskers had a significant impact on neural response amplitude and latency, with two-talker babble producing greater change than eight-talker. The presence of N400 and P600, not elicited in previous informational masking studies, highlights engagement of higher-level semantic processing.

Comparative auditory late responses and neuropsychological abilities in Brazilian adults (Abstract #53)

Luciana Macedo de Resende, Bruna Stephanie Pereira, Luciana Mendonça Alves

Context: Auditory late responses (ALR), particularly the P300 wave, are indicators of cognitive processing and aging. Increased P3 latency and reduced amplitude are associated with cognitive slowing, but there is a lack of normative data for Brazilian adults, making it difficult to distinguish between healthy and pathological aging. This descriptive-comparative cross-sectional study aimed to observe healthy cognitive aging and establish regional normative data for P300.

Methods: The sample consisted of 60 individuals divided into two age groups: young adults (20–32 years) and middle-aged adults (40–55 years). The instruments used included an adapted auditory processing scale for Brazilian adults (EAPAC), ALR and P300 with a clinical protocol paradigm. A brief neuropsychological assessment (NEUPSILIN) was also applied. Statistical analysis included Student's t-test, Chi-square, Mann-Whitney, and Spearman correlation tests, along with the use of Matlab® software to calculate the grand average of ALR waves.

Results: Middle-aged adults showed worse memory performance (p-value 0,0022) and longer P300 latency (p-value 0,0001) compared to young adults. Correlation analysis revealed a negative association between P300 latency and memory task performance (p-value 0,005), as well as a positive correlation between P300 amplitude and language task performance (p-value 0,029).

Conclusion: The findings provide ALR and P300 normative data for two age groups and reinforce the relationship between aging and cognitive changes. This contributes to the early identification of possible cognitive deficits and supports the development of more precise clinical interventions.

Implanted cochlea sensitivity to electrical current and loudness percept (Abstract #119)

Juan M Cornejo, Lizette Carranco, Agar Quintana, Pilar Granados

Background: Previous works support the idea that, on average, implanted cochlea sensitivity to electrical current is better in apical than basal electrodes. Ideally, cochlear implant (CI) fitting final result is an iso-loudness perception across electrode array; under the assumption that once

patients achieve normal hearing thresholds loudness percept will have a similar growing function with incoming sound intensity.

The aim of this work is to know if patients with normal hearing levels, stimulation current level increment due to an incoming sound of progressive increasing sound intensity, leads to a similar loudness growing function across electrodes. We use Electrical Cochlear Response amplitude function in response to tone pips of variable intensity, while patient is using her/his cochlear implant in everyday mode.

Methods: 12 subjects, 6-20 y. o. grouped according to device brand -AB, Cochlear and Medel-. All of them with 40 dBHL average hearing levels. Stimuli: tone pips with frequency equal to fc of electrode band-pass filter and intensity from 10 to 70 dBHL.

Results: Results agree with previous works that found greater sensitivity for apical than basal electrodes. On average sensitivity goes from 3.1 uV/dBHL for apical, 2.0 uV/dBHL medial, and 1.4 uV/dBHL for basal electrodes, however, these figures mainly depend on electrode current dynamic range M/C level. Additionally, sensitivity may change among contiguous electrodes with same current dynamic range.

Conclusion: Nonsystematic current sensitivity changes along implanted cochlea involves an uneven loudness percept even though patient got normal hearing levels.

Guest Lecture 1 (Rachael Taylor, New Zealand)

Beyond the labyrinth: The role of Vestibular Evoked Myogenic Potentials in Neural Pathway Assessment

Vestibular evoked myogenic potentials (VEMPs) are short latency surface responses produced through activation of otolith receptors by sound or vibration. While commonly used to assess otolith organ function, VEMPs also provide valuable information regarding the function of the vestibular nerve and central reflex pathways. Reduced or absent VEMPs have been observed in conditions affecting the vestibular ganglion, vestibular nerve, brainstem, and even the neuromuscular junction. This presentation will review research findings and selected cases, highlighting typical VEMP outcomes in common VIIIth nerve disorders such as vestibular neuritis and vestibular schwannoma, as well as in rarer neurodegenerative conditions. When interpreted alongside auditory evoked potentials, such as auditory brainstem responses (ABRs), VEMPs contribute to more precise phenotypic profiling. This multimodality approach enhances diagnostic accuracy, particularly in complex cases where pathology involves auditory, vestibular and neurological processing. Early identification of auditory and/or vestibular involvement can support timely, targeted interventions aimed at maximising function, prolonging independence, and improving quality of life.

Round Table 1: VEMPs

Using bone conducted VEMP testing to monitor vestibular function in pediatric patients pre- and post- cochlear implantation (Abstract #32)

Karen Hendrick, Andrea Gatlin

VEMP testing can be a valuable evoked potential tool for monitoring the vestibular function in children pursuing cochlear implants (CI). With infants being implanted at as young as 9 months of age, the cVEMP is an effective test to obtain a pre-operative baseline starting at 6 months of age. This can be combined with a lateral head impulse test (HIT) to screen for canal dysfunction.

Mattingly and colleagues (2016) found that CI insertion resulted in a change in inner ear mechanics, rather than a change in eardrum or middle ear function, leading to a slight air-bone gap at lower frequencies for CI recipients. This led to a false perception of VEMP changes pre- and post-implantation if an air conducted stimulus was used for testing. Frohlich and colleagues (2022) evaluated the use of a B81 bone conduction oscillator in evoking VEMP responses in pediatric CI recipients and found it to be more effective for evoking VEMP responses in this population.

The audiology team at Children's Hospital Colorado has adopted a pre- and post-implantation vestibular monitoring guideline. Bone conducted VEMPs and lateral HIT are completed prior to implantation and a comprehensive vestibular test battery is completed around 3 months post-activation. Our protocols and early data will be shared during this presentation.

Cervical VEMP testing for infants with congenital cytomegalovirus (Abstract #33)

Karen Hendrick, Andrea Gatlin

Children with congenital Cytomegalovirus (cCMV) are at risk for both hearing loss and vestibular hypofunction that can progress throughout early childhood. The impacts of hearing loss on speech and language development are widely understood (Moeller et al., 2007). Early studies are finding vestibular hypofunction can lead to deficits in visuospatial tasks, executive functions, and spatial awareness, which can impact reading/academics, social skills, and memory (Hazen & Cushing, 2021). A systematic review of current literature found between 45-90% prevalence of vestibular hypofunction in children with cCMV, demonstrating the need for vestibular monitoring in addition to hearing monitoring in this population (Shears et al., 2021).

Evoked potential testing via ABR is a critical component for monitoring hearing in infants who are too young to complete traditional hearing testing. The cervical VEMP test operates similarly to an ABR in that it requires minimal patient participation and can be completed on young infants to assess part of the vestibular system. This presentation will focus on how cVEMP and head impulse testing (HIT) can help monitor vestibular function in the infant population using the evoked potential equipment that most audiology clinics will already have. Children's Hospital Colorado's hearing and vestibular monitoring recommendations for this population will be shared, as well as test modifications for this young population.

A Tribute to Barbara Cone: Auditory Evoked Potentials Using Speech



Presenters: Suzanne C Purdy and Julia Wunderlich

Professor Barbara Cone became an ASHA-certified audiologist in 1978 and was awarded her PhD in Communication Disorders from the University of Texas at Dallas in 1979. She published a seminal paper in the field with Kurt Hecox in 1978 based on her doctoral work entitled “The Brain Stem Auditory-Evoked Response in Neonates: A Normative Study.” Throughout her research career, Barbara was committed to exploring infant hearing through various electrophysiological responses. She was an active and enthusiastic IERASG Council Member, passionate about auditory electrophysiology and children. Barbara published an ASHA paper last year

titled “My Perspective: Auditory Evoked Potentials,” in which she “drew upon her scholarship in this area from over 4 decades of research and teaching to summarize the major findings when using speech stimuli to evoke auditory potentials that have been used in clinical contexts using Speech” (Cone, 2024, p.1). This presentation reviews Barbara’s research and other remarkable contributions to the field that have enhanced our understanding and clinical work involving auditory brainstem responses, steady-state responses, middle latency responses, mismatch negativity, P300, cortical onset responses, and the acoustic change complex. Barbara had special connections with New Zealand and Australia, having received an Erskine Fellowship to teach at the University of Canterbury in New Zealand in 2015, and from 1995 to 2001, she served as the Beth Smallwood Chair in Audiology and Speech Sciences at the University of Melbourne in Australia. Thus, it is fitting that a New Zealander and an Australian will discuss Barbara’s work. Julia Wunderlich was Barbara’s doctoral student in Melbourne and will reflect on this period when Barbara focused on auditory neuropathy and speech-evoked mismatch negativity in infants. Barbara planned to return to New Zealand in 2025 with research aspirations that included removing barriers to the implementation of cortical auditory evoked potentials in the clinic, automatic detection of cortical evoked potentials, and improving equity of access to electrophysiological testing for all children. In this presentation, we will reflect on a life well-lived, the remarkable contributions that Barbara made to pediatric audiology and electrophysiology, and her vision for future work.

Industry Presentations

Advanced Bionics

Recording Brain Signals Directly from the Cochlear Implant
(Direct CAEP measurements from the cochlear implants)

Presenter: Chen Chen

Vivosonic

Title: Improving Signal-To-Noise Ratio with Vivosonic SOAP™-Kalman Weighted Averaging and Other Noise Reducing Technologies

Presenter: Angela Bottley

Student Session 1

Making eardrum electrocochleography simple, well-tolerated, and essential to assessing the human auditory periphery (Abstract #83)

Sarah Haysley, Skyler Jennings

Electrocochleography (ECoChG) measured from a tympanic membrane electrode (TM-ECoChG) provides a robust and reliable measurement of human auditory nerve and hair cell responses. Unfortunately, this measurement is often avoided by clinicians and researchers due to concerns about safely placing the electrode on the eardrum and ensuring patient/participant comfort. Here we show that TM-ECoChG measured from a custom eardrum electrode is a simple and well-tolerated procedure that results in high-quality recordings. These recordings are associated with larger signal-to-noise ratios (SNRs) and improved reliability compared to recordings with ear canal electrodes (e.g., tiptrodes). Featured recordings include measurements of the compound action potential (CAP), cochlear microphonic (CM), and auditory nerve neurophonic (ANN) in response to clicks, tones, frequency-swept tones, and amplitude modulated carriers. These measurements, when obtained simultaneously with the auditory brainstem response (ABR) or envelope following response (EFR), provide a comprehensive electrophysiological assessment of the human auditory system. Such an assessment is expected to provide invaluable insight on human auditory physiology and clinical diagnostics in patients with normal and impaired hearing.

The P300 auditory-evoked potential as a physiological measurement of listening effort: investigation in adults with and without hearing loss (Abstract #16)

Louise Van Goylen, Katrien Kestens, Hannah Keppler, Lindsey Van Yper

Background: Individuals with hearing loss (HL) experience greater listening effort (LE) due to speech understanding difficulties. While the P300 auditory-evoked potential has been suggested as a physiological marker of LE, existing research has largely focused on normal-hearing (NH) individuals. Therefore, this study examines the effect of HL on the P300 as a measure of LE.

Methods: Fifty-two participants with NH and 52 with HL (mean age total group: 67.38 years, range: 45–80) were matched for age, sex, and education. The P300 was recorded at Fz, Cz, and Pz using an auditory oddball paradigm with digits "three" and "one" as standard and deviant

stimuli, respectively, in two quiet (65 and 69 dB SPL) and two noise conditions (0 and +4 dB SNR). N1 latency and amplitude measured detection ability. P300 latency, amplitude, and N1–P300 interpeak interval assessed LE. Linear mixed-effects models analyzed the effects of listening condition and hearing group on these measures for quiet and noise separately.

Results: In quiet, larger N1 amplitudes—but not P300 amplitudes—at 69 dB SPL were found, along with prolonged P300 latencies and N1-P300 interpeak intervals when having HL. In noise, smaller N1 amplitudes at 0 dB SNR were observed, with unaffected P300 amplitudes. N1 and P300 latencies were delayed at 0 dB SNR, with P300 latencies further prolonged when having HL. N1-P300 interpeak intervals were prolonged in HL, with no effect of listening condition.

Conclusion: The findings suggest that HL affects both early cortical detection and higher-order processing, highlighting the utility of the P300—particularly its latency and N1-P300 interpeak interval—as physiological markers of LE.

Cortical encoding of speech in noise in children and adults (Abstract #61)

Madison Brown, Varghese Peter, Sriram Boothalingam, Mridula Sharma

Background: The brain's ability to encode speech at different time scales is important for speech comprehension. Recent research suggests that low levels of background noise improve the cortical tracking of the acoustic envelope of speech. Using conversational speech, the current research aims to measure the cortical encoding of speech in noise in children and adults.

Methods: Thirty-three children (8-17 years) and forty-four adults (18-29 years) listened to conversational speech in quiet, +15dB, and +5dB SNR (background babble noise) while undergoing an EEG recording. Neural entrainment to speech in each condition was assessed via Temporal Response Function models (TRF) and their predictive accuracy.

Results: In adults, the TRF N1-P2 amplitude increased with decreasing SNR $F(2,86)=7.30$, $p<.05$, but in children peak amplitudes remained the same for all conditions $F(2,64)=1.86$, $p>.05$. TRF predictive accuracy in adults at 15 dB SNR ($M=0.021$, $SE=0.002$) and 5 dB SNR ($M=0.021$, $SE=0.002$) was higher than the quiet condition ($M=0.015$, $SE=0.002$) $F(2,86)=6.31$, $p<0.05$. In children, the TRF predictive accuracy at 5 dB SNR ($M=0.015$, $SE=0.002$) was lower than the quiet ($M=0.021$, $SE=0.002$) and 15 dB SNR ($M=0.18$, $SE=.002$) conditions $F(2,64)=4.1$, $p<.05$.

Conclusion: While a slight increase in the level of background noise improves neural entrainment to speech in adults, in children it is detrimental to speech in noise understanding. Further research aims to investigate cortical encoding of speech in noise in specific age groups to determine maturational effects on neural entrainment.

Linking infant newborn ABR results to necessary medical investigations (Abstract #55)

Gem Choi, Holly Teagle, Suzanne Purdy, Andrew Wood

Background: Variation exists in the medical work-up for infants diagnosed with permanent hearing loss via ABR, observed across specialist groups, healthcare systems, and even within regions or centres. Despite multiple guidelines, adherence is often poor. New Zealand (NZ) has had a structured approach to Early Hearing Detection and Intervention for over a decade, with a nationally unified approach to diagnostic ABR testing, enabling investigation into the next steps in the infant's diagnostic journey.

Methods: A mixed-methods study was conducted, including a retrospective chart review over five years. Nine of 17 services were purposively sampled to capture variation. Semi-structured interviews were held with clinical staff, including audiologists, paediatricians, otorhinolaryngologists, a virologist, and a geneticist.

Results: Variation in medical work-up was measured, with influencing factors including timing of specialist interaction, centre resources, and the health needs of the population. An example was

MRI which can be attempted under natural sleep when performed under 3 months of age but requires sedation at older ages. Natural sleep MRI is less expensive and carries fewer risks than sedation MRI. This study found that the need for sedation influenced specialists' decisions regarding MRI.

Conclusion: The influence of timing suggests that task-shifting could improve the patient journey. Audiologists could initiate MRI for infants with severe or profound SNHL and bilateral ANSD (to assess cochlear nerve deficiency) or unilateral ANSD (to check for CNS abnormalities). In well-resourced centres, this could extend to moderate SNHL (to check for EVA).

Detection sensitivity and specificity of a mismatch response protocol (Abstract #35)

Leith Towers, Dean Sutherland, Mike Maslin

Background: Validation procedures following the fitting of hearing devices are essential for assessing their effectiveness and ensuring they meet users' auditory needs. Recent research has explored the Mismatch Response (MMR) as an objective biomarker for auditory discrimination, offering a non-behavioural measure of neural responses to sound changes that might be suitable amongst infants. However, transitioning MMR-based protocols from research to clinical settings presents challenges, particularly in analysing and interpreting MMR data at the individual level. This study evaluates the detection sensitivity and specificity of an MMR protocol using Hotelling's T₂, a statistical method for determining electrophysiological response presence or absence in individuals.

Methods: Electrophysiological data were collected from three cohorts. MMR detection sensitivity was estimated using data from 16 normally hearing infants (3–13 months) and 17 normally hearing adults exposed to stimuli designed to elicit an MMR. Detection specificity was assessed using no-sound trial data from 76 normally hearing adults.

Results: The Hotelling's T₂ detection algorithm demonstrated acceptable specificity, with false detection rates of 6.6%, reducing to 4% when applying upper-confidence interval exclusionary criteria with 10,000 bootstrap samples. Sensitivity analysis of the MMR data yielded a 93% detection rate, indicating strong overall performance of the detection algorithm.

Conclusion: MMR testing demonstrates high specificity and strong potential as a reliable tool for early hearing device validation. While further research and refinement are necessary, these findings support the feasibility of MMR-based clinical applications in audiology.

Monday

***Susan Small Lecture:* From Bench to Bedside: Evoked potentials and Universal Newborn hearing Screening. Christie Yoshinaga-Itano, USA**

The need to identify newborns referred from universal newborn hearing screening propelled ABR into clinical acceptance in pediatric audiology, but not until about 2000. Although research on auditory evoked potentials had been ongoing for 20 years and clinical equipment was available, when UNHS was introduced in the United States in 1992, auditory brain stem testing was not standard in the clinical practice of pediatric audiology. Audiologists were skeptical of using these technologies in audiological evaluations and the gold standard was behavioral.

Many diagnoses were not occurring until 12 months after the newborn hearing screening. This is the story of the long and winding road about what was required to move from bench to bedside. The necessity of the clinical use of ABR testing in pediatrics could only be proven if behavioral testing was not possible and therefore, required the referral of newborns. But, newborns were only referred if universal newborn hearing screening (UNHS) was established. UNHS could only be established if there were research findings to respond to key public health questions and there was no funded research to respond to these questions. This presentation will address the challenges of pivoting research to address a public health agenda, the speed of the clinical focus from behavioral to evoked potentials, the rewards and consequences in research funding for responding to the national need.

Session 3: From Old Dogs to Young Ears: Advancing Pediatric Hearing Science

Teaching old dogs new tricks: An OAE-based hearing screening test (Abstract #25)

Sriram Boothalingam, Sanna Hou, Matthew Croteau, François Deloche, Vijayalakshmi Easwar

Background: Newborn Hearing screening programs commonly use auditory brainstem responses (ABR) or otoacoustic emissions (OAEs) to detect hearing loss. ABR is preferred despite higher costs, as OAEs cannot detect neural deficits like auditory neuropathy spectrum disorders (ANSD). We have developed a technique that repurposes the click stimulus and evoked emissions to monitor brainstem reflexes, potentially detecting and aiding in the differential diagnosis of ANSD with just OAEs.

Objectives: To generate proof-of-concept data using clicks and click-evoked (CE) OAEs to infer cochlear and auditory nerve health.

Methods: CEOAEs and OAE-evoking clicks (~80 dB ppSPL) were monitored over 1s to activate and estimate medial olivocochlear (MOCR) and middle ear muscle (MEMR) reflexes as proxies for auditory neural health, in addition to cochlear health (OAEs). Data were collected from 100+ young normal-hearing adults (18–35 years) and 60+ children (0–17 years) with normal hearing (n=25), sensorineural (n=23), conductive (n=10) loss, and ANSD (n=5).

Results: Data from young normal-hearing adults demonstrate the feasibility of our approach, with test-retest reliability comparable to conventional tests. Children with hearing loss showed no responses, while those with confirmed ANSD showed present OAEs but absent reflexes.

Conclusion: Clicks and OAEs can effectively screen for cochlear and neural deficits. Our approach, requiring only conventional OAE recording hardware and fewer operational resources, offers a cost-effective alternative for newborn and post-newborn hearing screening and diagnostics.

Abnormal middle ear function and infant auditory evoked potentials (AEP) outcomes (Abstract #115)

Rebecca Awad

Early identification of hearing loss and provision of early intervention is known to improve outcomes for infants who are deaf or hard-of-hearing (Moeller, 2000; Yoshinaga-Itano, Coulter, & Thomson, 2000; Yoshinaga-Itano et al., 1998). Identifying hearing loss by 3 months of age is a well-established goal for all programs who provide diagnostic hearing services to infants (JCIH, 2019). Various factors can cause delays in the timeliness of hearing diagnosis and

intervention (Holte et al., 2012; MacNeil, Liu, Stone, & Farrell, 2007). The presence of middle ear fluid at the time of diagnostic testing is one such factor (Findlen et al, 2023).

This study aims to expand understanding of abnormal middle ear function's scope and impact on infant testing outcomes. In-depth chart reviews were completed for infants who received an Auditory Evoked Potentials evaluation at Children's Hospital Colorado. Charts were reviewed for hearing diagnosis and immittance results, as well as number of appointments to final diagnosis, age at final diagnosis, and lost-to-follow-up rates. This study looks at how immittance results interface with the other variables investigated, with the aim of discussing how to best support testing and manage infants with abnormal immittance results.

Modeling fNIRS Responses to Speech Sound Discrimination in Sleeping Infants

Background

(Abstract #80)

Julia Wunderlich

Functional near-infrared spectroscopy (fNIRS) is a promising tool for measuring how infants detect and differentiate speech sounds. To advance its clinical use, we need to understand how fNIRS responses change over time, across brain regions, and with different sounds. Building on our previous work modelling oxy-haemoglobin (HbO) responses to sound detection, we extended our approach to model speech discrimination.

Methods

We recorded fNIRS responses from 16 sleeping, normal-hearing infants (3–13 months old) using 18 channels over both temporal and prefrontal cortices. Sounds were presented monaurally (left or right ear) at 65 dB SPL via a tubephone.

For discrimination testing, we used a non-silence baseline paradigm. First, infants heard a repeating "Ba" sound for ~5 minutes. Then, we introduced 20 presentations of three different novel contrasts ("Tea/Ba," "Bee/Ba," "Ga/Ba"), each lasting 5.4 seconds, interspersed with jittered intervals of the repeating "Ba" baseline sound (22–32 s). The novel contrasts were presented in a pseudorandomized order.

Results

Using the independent components (one positive, one negative) identified in our prior detection study, we modelled discrimination responses with a median goodness-of-fit of 81%. Responses peaked later with left-ear stimulation ($p < .05$), and the negative component was smallest for the most subtle contrast ("Ga/Ba," $p = .003$).

Conclusion

Our findings suggest that speech detection and discrimination responses in infants arise from two independent mechanisms. The positive response likely reflects an obligatory brain response to sound, while the negative response may indicate brain arousal during sleep.

Session 4: Auditory Brainstem Response

The parallel ABR (pABR) provides fast and accurate threshold estimates in adults with hearing loss (Abstract #111)

Ross Maddox, Isabel Herb, Melissa Polonenko

Background: The parallel auditory brainstem response (pABR) is a stimulus presentation paradigm that provides diagnostic frequency-specific ABR measurements faster than traditional methods by presenting tonebursts at all test frequencies in both ears all at once, rather than one at a time. Here we tested the pABR's accuracy and speed in adults with hearing loss.

Methods: We recruited 70 adults with widely varying hearing loss configurations. For all subjects we determined estimated thresholds using the pABR and measured pure-tone thresholds behaviorally. We determined the pABR's accuracy by comparing the two. To determine the pABR's speed advantage we also estimated thresholds using a standard clinical serial ABR system.

Results: The correlation between pABR and behavioral thresholds was high, with $r = 0.90$. Absolute error was low, with 79% of errors within the 10 dB step size, and 90% of all errors under 14 dB. The pABR was also fast. In the ten subjects where we compared the speed of the ABR paradigms, the mean recording time for the pABR was 28 minutes versus 70 for serial ABR, with the pABR faster for every subject.

Conclusion: The pABR provides highly accurate threshold estimates in adults with hearing loss. It is substantially faster in clinical use than the current standard of care. It is therefore a viable method for objective threshold estimation in adults and holds great promise for accurately diagnosing infant hearing loss while addressing the primary drawback of current methods: speed.

Optimal parameters for evoking frequency-specific auditory brainstem responses using continuous speech (Abstract #88)

Melissa Polonenko

Background: Auditory brainstem responses (ABRs) are used to identify hearing loss across multiple frequencies. We recently created a multiband peaky speech method that evokes ABRs for audiometric octave-bands using continuous speech from narrated stories. But our previous work showed that testing can take over 30 minutes for some folks. This study evaluated the optimal stimulus parameters to evoke robust ABR responses in the fastest recording time.

Methods: Several experiments were conducted in adults with normal hearing using multiband speech (10 bands: 5 bands centered at 0.5–8 kHz in 2 ears simultaneously) presented at 65 dB SPL: 1) phase-profile (zero versus chirp-phase profiles that corrected for cochlear delays, $n=16$ and for different chirps, $n=34$); 2) mean fundamental frequency, f_0 (original and lowered to ~ 100 Hz, $n=28$); and 3) combining the lowest two bands (8-band versus 10-band, $n=18$). ABRs were compared across parameters using wave V amplitude and the recording time to reach a 0 dB signal-to-noise ratio (SNR).

Results: ABRs were larger for chirp- than zero-phase profiles, but similar for the CE- and speech-based chirps; and 2) original f_0 s < 180 Hz shifted down to ~ 100 Hz. These parameters evoked 10 robust ABRs within 30 minutes for 70% of participants, but 8-band stimuli most effectively reduced testing time to within 25 minutes for most participants.

Conclusions: Multiband ABRs to optimized parameters are recordable in 25 minutes for adults with normal hearing. Reasonable recording times will facilitate applications for hearing screening and evaluation of amplified speech in young children.

Auditory brainstem response data preprocessing method for the automatic classification of hearing loss patients (Abstract #36)

Moon Yun Park, Kyoung Ho Park

Auditory brainstem response (ABR) is the response of the brain stem through the auditory nerve. The ABR test is a method of testing for loss of hearing through electrical signals. Basically, the test is conducted on patients such as the elderly, the disabled, and infants who have difficulty in communication. This test has the advantage of being able to determine the presence or absence of objective hearing loss by brain stem reactions only, without any communication. This paper proposes the image preprocessing process required to construct an

efficient graph image data set for deep learning models using auditory brainstem response data. To improve the performance of the deep learning model, we standardized the ABR image data measured on various devices with different forms. In addition, we applied the VGG16 model, a CNN-based deep learning network model developed by a research team at the University of Oxford, using preprocessed ABR data to classify the presence or absence of hearing loss and analyzed the accuracy of the proposed method. This experimental test was performed using 10,000 preprocessed data, and the model was tested with various weights to verify classification learning. Based on the learning results, we believe it is possible to help set the criteria for preprocessing and the learning process in medical graph data, including ABR graph data.

The Fmpi: A generalized detector for evoked responses in the time and frequency domain (Abstract #41)

Jaime Undurraga, Søren Laugesen

Detecting evoked potentials (EPs)—such as peripheral, midbrain, and cortical responses—can be challenging due to physiological background noise. It often requires averaging responses to several hundred to thousands of stimulus presentations to objectively determine the presence of an EP using statistical methods. However, many of these methods rely on assumptions that are not always met. To address this issue, we developed the Fmpi, a powerful detection method that accurately estimates the parameters of the underlying parametric F distribution at the individual level and in real-time, based on the temporal dynamics and spectral color of the ongoing noise.

Until now, we have employed the Fmpi exclusively for time-domain analysis. In this study, we extended the Fmpi to frequency-domain analyses. Using simulations and real auditory steady-state response (ASSR) recordings, we demonstrate that the Fmpi achieves the correct sensitivity while significantly reducing testing time, both in the presence and absence of an EP, through a novel utility detection approach which allows early stopping recordings that are very unlikely to lead to a detected response. Comparisons with state-of-the-art methods, including a computationally intensive bootstrapping method, show that the Fmpi can be applied for both time- and frequency-domain analysis, resulting in better or similar performance compared to the other methods.

Tired of peak-picking? An automated feature extraction technique for the auditory brainstem response (Abstract #99)

Aryn Kameroner, Jarrod Mau

Background: The morphology of the auditory brainstem response (ABR) contains diagnostic information on the health of the auditory sensory and neural system. ABR morphology is often analyzed by visual inspection of the time domain waveform and manually placing markers on peaks and troughs, requiring significant time, training, and expertise. We recently developed a model-based automated technique for extracting morphological features that is easy to implement, more accurate in noisy data, and provides more data than can accurately be measured by visual inspection or peak-picking algorithms.

Methods: A Gaussian Mixture Model-based Feature Extraction Technique (GMM-FET) was implemented on ~5,000 human ABRs collected for several different studies from people with normal hearing and audiometric hearing loss, different electrode montages (vertical and horizontal), stimuli (click, chirp, tone burst, and speech), and levels (100-30 dB pe SPL). Fit of the model to each response waveform was measured by root-mean-squared error (RMSE) normalized to maximum response amplitude.

Results: Fit of the GMM-FET to the response waveforms was excellent with mean RMSE by stimuli $\leq 8\%$ of maximum response amplitude. Six features are extracted by the technique for

each wave (I-VI) and the summing potential: peak latency, amplitude, semi-width, onset latency (or initial spike latency), area, and curvature, resulting in 42 extracted features per ABR. Conclusions: The GMM-FET is a viable alternative to visual inspection or peak-peaking algorithms for analysis of ABR morphology.

Audiovisual enhancement of auditory and visual evoked potentials using flash/beep cross-modal stimulus paradigm (Abstract #63)

Ozcan Ozdamar, Rafael Delgado, Jonathon Toft-Nielsen

Background: Understanding how the brain represents external events through auditory and visual senses is a key question in neuroscience, with significant implications for how humans process combined stimuli. There is extensive evidence that auditory and visual pathways, along with their respective cortices, are interconnected. This study investigates audiovisual (AV) interactions using transient acoustic stimuli (beeps) and visual stimuli (flashes), examining auditory and visual evoked potentials (AEPs and VEPs).

Methods: AEPs and VEPs were recorded using scalp electrodes (Cz-mastoids, Oz-Fz) at a high EEG sampling rate of 10 kHz with a two-channel system. Eight stimulus combinations were used, consisting of beeps and flashes. Auditory stimuli included one or two binaural beeps (15 ms each), designated as B1 and B2. Visual stimuli involved one or two LED-generated flashes (15 ms each), designated as F1 and F2, separated by 35 ms. Stimuli were presented individually or combined, following the Sound-Induced Flash Illusion (SIFI) method.

Results: Unimodal stimuli (B1 and F1) produced expected AEP and VEP waveforms. Double unimodal presentations (B1 & B2 or F1 & F2) resulted in more complex waveforms. Bimodal AV stimulation (F1B1) primarily elicited super-additive effects, especially in the P1, N1, P2 (AEP) and N75, P100, N175 (VEP) components, leading to larger amplitudes. Missing corresponding stimuli in beep or flash sequences led to illusory percepts and even more complex waveforms.

Conclusion: Understanding complex audiovisual interactions can inform models of multimodal stimulus processing, improving diagnostics and rehabilitation strategies.

The interaural time modulation following response: an objective measure of binaural unmasking in school-age children (Abstract #62)

Lindsey Yper, Julie Kjær Jacobsen, Tobias Neher, Jaime Undurraga, Laura Stausholm Hansen

Binaural hearing enables sound localization and speech perception in everyday listening environments. Many studies have investigated the benefit of binaural hearing on signal detection and identification using binaural unmasking paradigms. Despite these paradigms being relatively simple, they require attention and motivation — two factors that influence performance, particularly in difficult-to-test populations, such as young children. An objective measure of binaural unmasking would enable researchers and clinicians to evaluate binaural benefit without requiring listeners to participate actively. Here, we investigate if auditory evoked responses can be used to evaluate binaural unmasking in school-age children. To date, 27 normal-hearing children aged 6-14 have been tested. The stimulus was a 81-Hz amplitude-modulated bandpass-filtered noise (900-Hz bandwidth, centered at 550 Hz) with an interaural time difference (ITD) alternating periodically between zero and a fixed ITD (200, 400, or 800 μ s) at a rate of 6.8 Hz, eliciting a steady-state response known as the interaural time modulation following response (ITM-FR). First analyses show that ITM-FRs can be elicited in school-age children, and that the responses grow with ITD as expected from the binaural unmasking literature. Work is currently underway to investigate whether the response magnitude correlates with performance on a related binaural unmasking task.

Tuesday

Guest Lecture 3: Tom Francart (Belgium)

Neural tracking of speech features: applications in hearing research

Authors: Tom Francart, Jonas Vanthornhout

Modern signal processing techniques allow to measure to what extent features of natural continuous speech signals are present in the brain. These features include purely acoustical ones such as the temporal envelope, but also higher-level ones such as semantic or linguistic representations. Relating stimulus features with brain signals (EEG) allows to study how the brain processes speech and has a plethora of applications. We will review the research in our lab regarding speech features, applications in hearing diagnostics, smart hearing aids (auditory attention decoding), coma diagnostics and aphasia, and advanced signal processing and deep learning to relate brain signals and stimulus features.

Session 5: Novel Approaches to AEPs I

Frequency specific objective AEP-based assessment of hearing perception in noise

(Abstract #97)

Angel De la Torre, Francisco A. Chiquero, Isaac M. Alvarez, Nicolas Müller, Juan Martín-Lagos, José L. Vargas

Background: The electrophysiological objective evaluation of hearing perception under noise conditions could be very useful as an early indicator of auditory damage, usually causing a reduction of the hearing quality (and a reduction of speech intelligibility) and not necessarily associated with an increase of the hearing thresholds (for this reason, known as hidden hearing loss, HHL).

Methods: We propose a protocol for recording ABR and MLR responses to frequency specific stimuli (tone bursts) with and without background noise. The responses elicited by tone bursts of different intensity and frequency, in the presence and absence of background noise, are estimated with appropriate deconvolution methods and are compared.

Results: In this pilot study including 8 subjects (with no reported hearing impairment), the changes in the ABR and MLR waves associated with the presence of noise are evaluated and analyzed taking into account factors like the age and exposition to noise. The presence of noise causes significant changes in the amplitudes and latencies of the responses depending on the stimuli and noise levels.

Conclusions: The experimental results suggest that the electrophysiological assessment of the hearing perception in noise could be valuable for early detection of HHL. An optimization of the protocol (to obtain reliable information with minimum duration of the exploration) is necessary. The promising results of this study invite to design a more extensive study involving a larger population (including normal hearing- and hearing-impaired subjects) in order to identify appropriate parameters for evaluating HHL.

Influence of noise exposure on stacked ABR and speech in noise measures (Abstract #44)

Nilesh Washnik, Ishan Bhatt, Chandan Suresh, Kelsey Mankel, Alexander Sergeev, Rafael Delgado, Li Xu

Introduction: Studies investigating hidden hearing loss (HHL) in individuals with high noise exposure background (NEB) have yielded inconclusive results. One possible explanation for the lack of consensus in human studies on HHL is that the test protocols and paradigms used thus far may not have been sufficiently sensitive to detect its consequences. Therefore, there is a need to develop more sensitive testing protocols and techniques that can reliably identify HHL in humans.

Methods: The study aimed to determine the effects of NEB on auditory nerve function using the Stacked Auditory Brainstem Response (SABR) test and speech-in-noise performance. The study included 34 college students with varying NEB. Derived-band auditory brainstem responses (ABRs) were recorded from the left ear using ichirp and notch noise at frequencies of 0.5, 1, 2, 4, and 8 kHz at 80 dBnHL. The derived-band ABRs were temporally aligned by time-shifting each response according to its observed peak V latency and summed to generate SABR. The amplitude and latency of waves I and V were measured from the SABR. Speech recognition in noise was evaluated using the CNC test at signal-to-noise ratios (SNRs) of -9, -6, -3, 0, and +3 dB.

Results: A negative association was observed between NEB and the amplitude of stacked ABR wave I. Additionally, NEB was negatively correlated with the CNC scores.

Conclusion: The SABR wave I amplitude may serve as a valuable tool for detecting HHL in humans. Future research should evaluate its efficacy across different age groups using a larger dataset.

Unraveling neural mechanisms underlying auditory brainstem response through computational simulation (Abstract #100)

Ben-Zheng Li, Shani Poleg, Tim Lei, Achim Klug

Background: Understanding the contributions of various auditory centers to the auditory brainstem response (ABR) has become increasingly significant across various research fields.

Methods: To address this, we propose a computational model capable of synthesizing ABR waves from large-scale neuronal simulations using a spiking neuronal network model. This approach enables investigation of ABR morphology and wave alterations in different medical conditions. Our model bio-plausibly replicates ABR morphology of the healthy auditory system from the spiking output of populations of neurons in the auditory brainstem. It also effectively demonstrates that myelin deficits and degraded contralateral inhibition in the superior olivary complex contribute to aberrant ABR in aging gerbils and autistic mice.

Results: In aging, the model successfully replicates ABR abnormalities linked to demyelination in the medial nucleus of the trapezoid body (MNTB) pathway, findings supported by histological evidence from electron microscopy. In autism, the model identifies myelin deficits and hyperexcitability as critical factors responsible for prolonged wave III-V intervals and reduced wave III amplitudes, aligning with experimental observations. Lastly, the model has been extended to study ABR alterations during recovery from sepsis as well as the effects of various types of anesthesia, providing valuable insights into their underlying neural mechanisms.

Conclusion: By advancing computational modeling approaches, this framework serves as a powerful tool for predicting ABR morphology changes under various conditions, improving the interpretation of clinical data, and identifying potential abnormalities in the afferent auditory pathway. These capabilities underscore its potential for enhancing both research and clinical applications in auditory neuroscience.

The relationship between the Audible Contrast Threshold (ACT) test and the electrophysiological version of ACT (E-ACT) (Abstract #52)

Lisbeth Birkelund Simonsen, Jaime Undurraga, Abigail Kressner, Torsten Dau, Søren Laugesen

The non-language dependent Audible Contrast Threshold (ACT) test estimates aided speech-in-noise performance by assessing a patients' ability to discriminate spectro-temporally modulated target sounds from non-modulated references. Since ACT requires active participation, an objective version is needed for testing infants and young children. This study introduces an electrophysiological version of the ACT test (E-ACT), which utilizes an auditory change complex (ACC) paradigm. The primary objectives are to explore the relationship between ACT and E-ACT and to evaluate the test-retest reliability of E-ACT. The stimuli used with ACT are based on a noise carrier, whereas E-ACT employs a tone-complex carrier, since tonal stimuli have been shown to elicit stronger ACC responses. Hence, this study also investigates behavioral differences between ACT and a tonal-carrier based test ("tonal-ACT"). Data from two experiments, involving 18 and 47 adults, were included. ACC responses were analyzed using the objective Fmpi detector to determine the presence of a detected response. Results revealed a significant relationship between ACT and tonal-ACT, while E-ACT exhibited moderate test-retest reliability. E-ACT correlated significantly with ACT ($R^2=0.22$, $P<0.001$), though ACT values were, on average, 4 dB lower (indicating better performance). Interestingly, 12 participants obtained lower thresholds on E-ACT than on ACT, a finding that will be further discussed.

The E-ACT provides an objective alternative to the behavioural ACT test. However, as this study was conducted in an adult population, future research should focus on infants and young children.

Real-time implementation of a forward masking subtraction technique for recording electrically elicited auditory brainstem responses (Abstract #110)

Rafael Delgado, Suhrud Rajguru, Carlos Curet, Carlos Lopez, Guillermo Savio, Jonathon Toft-Nielsen, Fred Telischi

Background: Around one million people globally have received cochlear implants (CIs), but performance varies depending on anatomical and pathological factors. Accurate assessment of cochlear nerve viability is crucial for CI surgery, especially in cases like pediatric temporal bone malformations, prolonged adult deafness, acoustic neuroma or neurofibromatosis type 2 patients, and those unable to participate in behavioral audiograms.

Electrically evoked auditory brainstem responses (eeABR) reflect the peripheral auditory system but are typically obscured by a significant artifact from electrical stimulation. A subtractive forward masking technique can reduce this artifact, making eeABR more reliable for clinical populations.

Methods: In this study, a subtractive forward masking technique was applied in real-time using the IHS Duet system. Electrical stimuli were presented via a transtympanic needle electrode. Stimuli alternated between a standard biphasic pulse alone and a pairing of the pulse with a forward masker biphasic pulse. The responses from the two stimuli were subtracted to eliminate the electrical stimulus artifact. This subtraction method, based on de Sauvage et al. (1983), exploits the auditory nerve's refractory properties. Norwegian brown rats were used for optimization, and recordings were made before and after deafening to confirm the response source.

Results: The forward masking technique successfully eliminated most electrical stimulus artifacts, enabling the detection of early components previously obscured by the electrical artifact.

Conclusion: Advanced processing techniques for eeABR recording will improve objective evaluations for CI candidacy.

Psychoacoustical and electrophysiological investigation of relative masking levels for narrowband chirps using a broadband noise masker (Abstract #70)

Emmelie Knauth, Torsten Rahne, Jesko Verhey, Jan Hots

Background: To prevent cross hearing, a masker has to be presented contralaterally. The minimum level of the masker relative to the signal level that is necessary to mask the signal in this ear is referred to as the relative masking level (RML). RML were already determined for a few frequency-specific short-time stimuli that were used to elicit auditory steady-state responses (ASSR), e.g. tone pips. It is, however, not known which RML are required for narrowband (NB) chirps.

Methods: In a first experiment, RML for NB chirps were determined psychoacoustically for a normal-hearing group. In an air-conduction (AC) condition, chirps were presented via insert phones, and in a bone-conduction (BC) condition via a bone conductor. Broadband noise was presented ipsilaterally with insert phones in both conditions. In a second experiment, RML were determined using ASSR for a group of single-sided deaf participants. Chirps and noise were presented in a similar way to the psychoacoustic experiment. RML were studied with a repetition rate of 40 Hz.

Results: RML depend on chirp center-frequency and conditions but showed good agreement for the two experimental approaches. Average psychoacoustic RML (masker level in dB SPL – signal level in dB nHL) range from 27 to 36 dB for the AC condition and from 29 to 53 dB for the BC condition.

Conclusion: The RML required for NB chirps highly depends on the audiological examination. Presenting the four NB chirps simultaneously, the highest RML value should be applied to ensure masking is effective for all NB chirps.

Industry Presentations

Intelligent Hearing Systems

Title: The Smart Choice - Clinical and Research Advances on the IHS platforms

Presenter: Rafael E. Delgado

MedEI

Title: Pulling Back the Mask: A Closer Look at Artifact Rejection Strategies for ECAPs

Presenter: Jeffery Skidmore

Student Session 2

Effect of hearing aids on cognitive function in elderly patients with hearing loss: A functional near-infrared spectroscopy study (Abstract #30)

JiWon Choi, Jeong-Sug Kyong, Hyun Bok Song, Sang Yeon Lee, Myeong Sin Kang, Jae-Jin Song, Jun Ho Lee

Introduction: A growing body of research indicates a strong association between dementia and hearing loss. Recent studies have identified age-related hearing loss as a modifiable risk factor that can delay cognitive deterioration. However, the underlying neural mechanisms of these two conditions are not yet fully understood. This study investigates the impact of hearing aids (HA) on cognitive function over 12 months.

Method: 94 patients participated in our study, 59 in the HA group and 35 in the Control group. Neuroimaging was performed during five cognition tasks using functional near-infrared spectroscopy (NIRS) covering the frontal lobe.

Results: HA group showed a significant increase, and the Control group showed a significant decrease in HbO₂ after one year. In particular, in cognitive task J4, the 'Word list memory (immediate recall) task' showed significant differences in the HA and non-HA groups after a year. Similarly, the HA group showed statistically significant improvement in the behavioral cognitive task (J4), unlike the Control group. With the non-parametric Mann-Whitney test, the two groups' baseline difference (pre) was not observed ($U=853$, $Z=-1.30$, $p=0.19$, two-tailed).

Conclusion: Biologically, the hearing loss of elderly people resulted in a significant overall hemodynamic increase in the frontal lobe after a year of wearing hearing aids. The hemodynamic changes of HbO₂ in the frontal lobe may reflect the cognitive enhancement in the HA group. Further longitudinal observation will provide a clear view of the causal relationship between hearing loss and cognitive impairment.

Impacts of extended high-frequency hearing loss on neural encoding and perception of speech (Abstract #42)

Sajana Aryal, Fanyin Cheng, Spencer Smith

Introduction: Extended high frequency (EHF) hearing may support real-world listening. However, little is understood about how the auditory nervous system uses information from the EHF region. Here, we examine if the auditory nervous system can extract speech information from the EHF range known to be important for listening in noise (i.e., fundamental frequency (f_0) and slow syllabic-rate modulations) and if this ability predicts speech-in-noise performance in listeners with and without EHF loss.

Method: Neural and perceptual measures were collected from 41 participants, including: audiometry (250 Hz–16 kHz); middle ear muscle reflex thresholds and growth functions; frequency following responses (FFRs) to broadband and high-pass (> 4 kHz and > 8 kHz) speech stimuli; and Digits in Noise SRTs for different noise maskers (BB, < 2 kHz, < 4 kHz, and < 8 kHz).

Results: 14 out of 41 participants had EHF loss. Group comparisons revealed shallower MEMR growth functions, reduced FFR f_0 amplitudes for BB ($p < 0.05$) and > 4 kHz ($p < 0.01$) speech stimuli, and poorer overall DIN SRTs ($p < 0.01$) for listeners with EHF loss. EHF thresholds predicted FFR f_0 amplitudes in the BB and > 4 kHz conditions as well as DIN SRTs ($p < 0.01$).

Conclusion: The auditory nervous system can extract fast (f_0) and slow (f_0 modulation) information from the EHF region. Shallower MEMR growth, weaker BB and > 4 kHz FFRs, as well as poorer DIN SRTs in EHF loss, suggest that EHF thresholds represent systemic cochlear damage impacting suprathreshold hearing in the standard frequency range.

Genetic predisposition to age-related hearing loss explains differences in otoacoustic emissions among healthy young adults (Abstract #117)

Valerie Ingalls, Srividya Grama Bhagavan, Ishan Bhatt

Background: Age-related hearing loss (ARHL) is a highly prevalent health condition associated with numerous health comorbidities, including dementia, cognitive decline, and social isolation.

One known mechanism of ARHL is degeneration of outer hair cells, observed by measuring distortion product otoacoustic emissions (DPOAEs). We hypothesized that genetic variations associated with ARHL also explain differences in DPOAEs among young adults with normal hearing. Early identification of high-risk individuals before the clinical onset of ARHL is critical to providing timely preventative intervention.

Methods: We selected 7218 single-nucleotide polymorphisms (SNPs) associated with ARHL in a previous genome-wide association study meta-analysis (meta-GWAS). We performed regression analysis to determine whether these variations explained differences in DPOAEs among 357 healthy young adults with self-reported normal hearing. We evaluated SNP effects on DPOAEs using linear mixed models, then mapped SNPs to genes using functional annotation to quantify gene-specific effects.

Results: 1336 SNPs were significantly associated with DPOAE amplitudes. Of these, 442 SNPs demonstrated consistent direction of effect on auditory function as in meta-GWAS. 78 mapped genes were significantly associated with DPOAEs and demonstrated consistent direction of effect on DPOAEs compared to the meta-GWAS.

Conclusion: Individuals with genetic predisposition to ARHL exhibit significantly lower DPOAE amplitudes, well before clinical onset of ARHL. Genes influencing DPOAEs likely have effects on the cochlea itself, and especially outer hair cells. We emphasize the need for early intervention for high-risk individuals, who may be experiencing decline in cochlear function well before their peers.

Forward and backward masking in ABR and psychophysical measures: Assessing auditory temporal resolution (Abstract #74)

Esma Akis, Steven Bell, David Simpson

Background: Understanding speech in noisy environments is challenging for many individuals and can be particularly difficult for older listeners due to a decline in the auditory system's temporal resolution. Traditional hearing tests do not evaluate temporal resolution, and behavioural tests of temporal resolution are impractical for some populations. This study aims to develop objective methods to measure auditory temporal resolution using Auditory Brainstem Responses (ABR).

Method: The experimental design focused on forward and backward masking techniques in ABR by introducing silent gaps between noise and a click. Behavioural evaluation included measuring forward and backward masking thresholds and standard Gaps in Noise (GIN) test. Data were collected from 20 participants with normal hearing and ABR presence was analysed using statistical detection methods.

Results: Average behavioural thresholds were 7.25 ± 1.68 ms with the GIN test, 6.92 ± 3.57 ms with forward masking, and 11.15 ± 5.51 ms for backward masking. Average ABR temporal resolution thresholds were 3.30 ± 1.80 ms for forward masking paradigm, consistent with previously reported values but not correlated with behavioural thresholds in this sample. The backward masking paradigm showed high detection rates regardless of gap duration, suggesting the ABR is not sensitive to backward masking.

Conclusion: The forward masking paradigm, combined with objective detection methods, holds promise for estimating auditory temporal resolution. While backward masking is seen during behavioural temporal perception, our findings suggest that it does not occur at the brainstem level.

Tracking rhythm in the brainstem: Temporal dynamics of envelope encoding and developmental differences with machine learning (Abstract #114)

Pedro Andres Alba Diaz, Anu Nair, Srikanta Mishra

Envelope following responses (EFRs) assess neural encoding of amplitude-modulated (AM) sounds, but their stability over time within a session remains underexplored. The temporal evolution of EFRs provides insights into neural adaptation and synchrony. Animal models suggest subcortical EFRs are sensitive to suprathreshold neural adaptation. Traditional EFR analysis, like fast Fourier transformation, offers limited temporal insight, while time-frequency representations preserve both spectral and temporal information, making them better suited for examining neural dynamics. This study examined the temporal dynamics of EFRs to suprathreshold modulation using continuous wavelet transform. Behavioral studies indicate prolonged maturation of AM sensitivity, though the neural sources remain unclear. While brainstem processing is considered mature in children, studies suggest brainstem circuits exhibit developmental plasticity. A secondary aim was to compare temporal dynamics between adults and children.

EFRs were recorded (modulation frequency= 101 Hz; sinusoidal AM carrier= 4 kHz) from normal-hearing adults (N = 20) and children (N = 25; 7-12 years) at modulation depths of 40%, 60%, and 100%. In addition to group statistics, machine learning classifiers were applied to examine fine-grained differences in envelope encoding, using spectral and temporal features from wavelet-transformed data to distinguish modulation depth and group effects.

Analyses focused on amplitude and phase-locking value (PLV), examining changes over time as a function of modulation depth, group, and their interaction. Preliminary results suggest that PLV is sensitive to modulation depth and temporal variations across groups. Detailed results will be discussed in the context of neural adaptation mechanisms and subcortical encoding of envelope periodicity.

Guest Lecture 4: Rebecca Millman (United Kingdom)

Cortical alpha oscillations as a measure of listening effort in adults with hearing loss

Background: Understanding speech presented against a background of noise can be effortful, especially for older adults with hearing loss (Pichora-Fuller et al., 2016; Alhanbali et al., 2017). Cortical electroencephalography (EEG) is one of the many different objective measures used to index listening effort (Pichora-Fuller et al., 2016; Alhanbali et al., 2019). Changes in the power of EEG oscillations in the alpha frequency band (8-13 Hz) may indicate increased listening effort (Obleser et al., 2012; Petersen et al., 2015; Dimitrijevic et al., 2019; Fiedler et al., 2021), or suppression of irrelevant background noise during effortful listening tasks (McMahon et al., 2016). Methods: Our research focuses on using EEG alpha power to measure listening effort during speech-in-noise listening tasks for older adults who have a hearing loss. We use the Nexus-10 with the BioTrace software (Mind Media B.V. neuro and biofeedback system) to acquire EEG data. We use EEGLab (Delorme & Makeig, 2004) to analyse the EEG data during discrete time periods of interest during a listening task. Results: For older adults with hearing loss, changes in EEG alpha power during listening to, and remembering, speech captures aspects of listening effort that are distinct from those captured by other objective measures of listening effort (Alhanbali et al., 2019). Baseline alpha power can predict performance accuracy on a digits-in-noise task (Alhanbali et al., 2022). The degree of hearing loss modulates EEG alpha power prior to the presentation of a speech stimulus (Alhanbali et al., 2022) and during listening to, and remembering, a speech stimulus (Petersen et al., 2015). Preliminary work from our group suggests that EEG alpha power may be used as an objective marker of when (i.e., at different time periods in a listening task) participants with varying degrees of hearing loss use listening effort to achieve listening success. Conclusion: Changes in EEG alpha power have the

potential to provide insight into the temporal dynamics of listening effort throughout the course of a listening task. These temporal changes in EEG alpha power may help to explain individual differences in the experience of listening effort.

Session 6: Novel Approaches to AEPs II

Hidden hearing loss (synaptopathy) continues to hide in humans: Can evoked potentials rescue? (Abstract #112)

Srikanta Mishra

Science is facing an all-time high replication crisis. In recent history, no topic has contributed more to this crisis in auditory sciences than cochlear synaptopathy in humans. The near-impossible mission to diagnose synaptopathy has received over a decade of attention, with a variety of evoked potentials—such as electrocochleography, auditory brainstem responses (ABRs), and envelope following responses (EFRs)—attempted in vain. Each technique has its limitations; e.g., the widely cited ABR wave I faces substantial test-retest reliability issues, calling into question its ability to detect even group differences reliably. EFRs have been touted as a robust measure based on the premise that fibers with high thresholds and low spontaneous rates show strong phase locking to temporal envelopes. While some studies show promising findings, the evidence remains tenuous. A critical issue often overlooked is the role of cochlear mechanisms in interpreting weaker EFRs. Although otoacoustic emissions (OAEs) are applied to rule out cochlear contributions in synaptopathy studies, cochlear function is dynamic and depends on the operating point of the cochlear amplifier. In this talk, we present data examining the effect of cochlear compressive nonlinearity on suprathreshold EFRs. Cochlear nonlinearity was characterized by compression threshold, linear, and compressive slopes using distortion product input/output functions in young adults with normal audiograms (n=35). Preliminary analysis suggests links between compression parameters and phase locking in EFRs. Results will confirm whether suprathreshold encoding of amplitude modulations is sensitive to individual variations in cochlear amplifier function, with direct implications for assessing the utility of EFRs in synaptopathy.

Neural markers of emerging speech perception challenges in middle age: Insights from chirped speech-evoked responses (Abstract #109)

Kelsey Mankel, Jillian Dodson, Lauren Arnold

Background: Age-related changes in the central auditory system contribute to declines in speech-in-noise (SiN) perception, yet little is known about transitional neural changes in middle age that may signal current—or future—perceptual difficulties. This study explored chirped speech (Cheech) to assess the relationship between neural responses across the auditory pathway and speech recognition in young and middle-aged adults.

Methods: 20 young adults (18-24 years old) and 17 middle-aged adults (35-60 years old) participated in this study. Hearing was screened via pure-tone audiometry, distortion product otoacoustic emissions (DPOAEs), and the QuickSIN. Cheech, which embeds short frequency sweeps (chirps) into continuous speech, was used to evoke auditory brainstem (ABR), middle latency (MLR), and auditory late latency (ALR) responses while participants completed a speech recognition task using Cheech-modified AzBio sentences in quiet, +3 dB, and -3 dB SNR conditions.

Results: Middle-aged adults showed a greater decline in SiN abilities compared to younger adults, despite having normal hearing thresholds. They also exhibited smaller DPOAE amplitudes and slightly higher pure-tone average thresholds. Additionally, the relationship between neural responses and SiN recognition performance differed between age groups. In younger adults, both MLR and ALR measures were associated with SiN recognition, whereas this relationship was absent in middle-aged participants.

Conclusion: Findings suggest that early age-related changes at thalamo-cortical levels contribute to a decoupling between neural responses and SiN perception, potentially serving as a marker for emerging speech processing difficulties. These results underscore the need for clinically viable tools to detect subtle auditory processing deficits before they affect perception.

Rhythmic priming of phonemic perception with the CE-chirp (Abstract #75)

David Morris

Background: Frequency-dependant transmission delay in the cochlear, can be counteracted with chirps which have an adjuvant effect on ABR amplitudes. As the upper auditory brainstem is also implicated in the precise transfer of afferent timing information, this study explores whether chirps could prime speech perception. Specifically, trains of CE-chirps were used as primes, and a condition was included in which the durational difference of the discrimination stimuli was equal to the SOA of the prime.

Methods: Primes were: 1) Regular, where chirps were presented at an isochronous SOA of 45 ms, which was also the discriminable difference in the task stimuli; 2) Random, where chirps were randomly distributed in the priming window; and 3) pink noise only. 64-channel EEG data was acquired from participants (N=14) and behavioural, sensor level (electrode) and source level (auditory alpha clustering based on Equivalent Current Dipoles) measures were derived.

Results: Neither behavioural nor sensor-level analyses revealed priming effects. Auditory alpha clusters during the maintenance period, localized to Brodmann Area 21 (left Medial Temporal Gyrus) showed significant event-related desynchronization in both chirp conditions, and synchronization in the the noise only, which was temporally broadest at 12 Hz.

Conclusion: The divergence in alpha activity indicates that the chirp trains influenced speech perception regardless of temporal regularities in presentation. This may be due to upregulation of subcortical instances of the auditory pathway which subsequently conditions cortical regions.

Validation of the nested-TEMPEST stimulus for simultaneous measurement of parameterized syllabic and phonemic speech envelopes (Abstract #86)

Ana Belen Carbajal Chavez, Marlies Gillis, Maaïke Smit, Pol Ghesquière, Maaïke Vandermosten, Jan Wouters

The fidelity of neural phase-locking (i.e., neural synchronization) to the speech envelope provides insight into the underlying mechanisms of speech processing. This synchronization can be measured through neurophysiological recordings of the auditory steady-state response (ASSR), elicited by low-, single-frequency amplitude-modulated (AM) sounds. However, due to high interindividual variability in neural synchronization—especially below 20 Hz—single-frequency modulations provide limited insight into phase-locking across an entire frequency band.

Recently, Gransier and Wouters (2021) developed the Temporal Envelope Speech Tracking (TEMPEST) framework, which utilizes speech-like stimuli to assess a distribution of modulation frequencies rather than a single discrete frequency. Previous findings demonstrated a strong correspondence between neural activity evoked by TEMPEST stimuli and that elicited by AM sounds at syllabic (~4 Hz) and phonemic (~20 Hz) rates, suggesting that TEMPEST provides a more comprehensive measure of speech temporal processing. Leveraging on the TEMPEST

framework, we developed nested-TEMPEST, a novel stimulus that integrates nested distributions of phonemic and syllabic modulation frequencies, enabling simultaneous assessment of both frequency bands.

This study aims to (1) assess intra-subject correspondence of neural activity elicited by AM sounds, single distribution and nested-TEMPEST stimuli, (2) evaluate the test-retest reliability of the nested-TEMPEST across two sessions, and (3) investigate to which extent neural activity elicited by nested-TEMPEST is related to neural tracking to continuous speech in silence (N = 20). Our goal is to validate the nested-TEMPEST as a time-efficient, reliable, and standardized framework for measuring speech processing. Data collection is ongoing, and first results will be presented at the conference.

Effect of envelope enhancement on the cortical encoding of continuous speech (Abstract #124)

Nike Gurindapalli, Megan Hernandez, Janani Sampath, Dhatri Sadholalu Devaraju

Background: Envelope enhancement is a signal processing strategy designed to improve the perception of speech. Behavioral studies have shown that envelope enhancement improves speech in noise perception for normal hearing listeners, and those with sensorineural hearing loss. While behavioral studies are important, they do not provide a complete picture of the differences in neurophysiological computational processes underlying speech processing and related top-down processing. In this study, we used ecologically-valid continuous speech stimuli that are ideally suited to evaluate the benefits of envelope enhancement on speech perception. We applied novel system-identification approaches to study the neurophysiological benefit from envelope enhancement.

Methods: We obtained multichannel EEG data in 15 neurotypical participants who listened to different speech stimuli (IEEE sentences and audiobook) in quiet and in the presence of speech-shaped noise. The listeners either repeated the sentences heard or answered questions about the audiobook. Multivariate regression approaches and deep-learning algorithms were used to analyse the encoding of acoustic and linguistic features in the cortex.

Results: Results showed a significant improvement in the encoding of acoustic and linguistic features in speech with envelope enhancement in both quiet and noise conditions. Some indications of alleviation in listening effort with envelope enhancement were seen in the alpha range of EEG.

Conclusions: Envelope enhancement results in improved neurophysiological encoding of speech in typical listeners. Use of novel stimulation and analysis approaches have made it possible to evaluate the efficacy of signal processing strategies in enhancing processing of ecologically valid speech stimuli.

Auditory encoding of steady and dynamically changing virtual pitch in adults who stutter (Abstract #126)

Dhatri Sadholalu Devaraju, Santosh Maruthy, Ajith Kumar Uppunda, Nike Gnanateja Gurindapalli

Background: Although stuttering is a speech production deficit, it may be a result of underlying deficits in auditory monitoring of the acoustic feedback signal as posited by internal models of sensory motor processing. Studies on auditory processing in individuals who stutter show deficits in temporal processing and it is important to discern the level at which it is compromised as they persist to stutter into their adulthood. We aim to investigate how these temporal processing deficits would manifest in encoding of fine-grained temporal cue using frequency following responses (FFRs).

Methods: We examined FFRs in fifteen each individuals who stutter and fluent adults using a complex signal in which pitch was systematically varied from 100 to 200Hz, another with flat F0 of 100 Hz. The first complex tone consisted of 1-15th harmonic while the complex tone with missing fundamental consisted of 6-15th harmonic. The FFRs were recorded from the vertex (Cz) (linked mastoid reference, high forehead ground) and analyzed using Brainstem Toolbox.

Results: The spectral amplitudes of FFRs (F0, H2 & H3) did not differ between individuals who stutter when compared to their peers. Analysis of FFRs to complex tones with changing F0 showed that both the groups were able to encode pitch in the absence of fundamental, but the pitch tracking errors were higher in individuals who stutter when compared to individuals who do not stutter.

Conclusion: The results highlight that individuals who stutter exhibit deficits in encoding of missing F0 when the pitch varies rapidly. In conclusion, this study provides preliminary evidence for impaired neural processing of fine-grained temporal cues in individuals who stutter.

Hearing aid audibility and acclimatization effects on measures of brain and behavior

(Abstract #121)

Curtis Billings

Background: Hearing aid acclimatization, or changes in brain and behavioral measures over time, has been reported by patients and clinicians; however, the scientific literature is mixed with some studies demonstrating acclimatization in some individuals but not in others. Differences across studies and individuals may be due in part to differences in outcome measures, sensitivity of measures, and/or groups tested. The goal of this study was to use measures of neural encoding, behavior, and self-report to demonstrate effects of test-retest, immediate audibility, and long-term acclimatization among hearing aid users.

Methods: Veterans in the VA Portland Healthcare System (n=30+) were fit with hearing aids and followed longitudinally. Participants were tested twice pre-fitting to approximate test-retest effects, within a week of the fitting to determine audibility effects, and around 2 and 6 months post-fitting to determine acclimatization effects. Three categories of outcome measures were used (brain, behavior, self-report) to extract possible objective and subjective changes in audibility and acclimatization. Outcome measures included cortical N1-P2 and cognitive P3 auditory evoked potentials, speech-in-noise testing, and self-report questionnaires (hearing aid benefit, effort, and tinnitus).

Results & Conclusions: Preliminary results suggest good test-retest effects, and audibility/acclimatization effects that vary depending on the specific outcome measure. The best measure to demonstrate effects depends on the specific effect of interest and whether the underlying cause is primarily a bottom-up or top-down phenomenon. This study may lead to better rehabilitation and treatment strategies to improve hearing aid benefit in new hearing aid users. (Study supported by VA-RR&D 5I01RX003702).

Wednesday

Guest Lecture 5: Young Researcher: Chelsea Blankenship (USA)

Electrophysiological Assessment in Preterm Infants: Brainstem to Cortex

Over 400,000 infants are born preterm every year in the United States which places the infant in a particularly vulnerable state for hearing, visual, motor, cognitive, speech-language, and literacy deficits. Approximately 10% of preterm infants have permanent hearing loss or are at risk for delayed or progressive hearing loss. Many infants receive aminoglycoside antibiotics, increasing their risk for high-frequency, progressive hearing loss. About 40% of very and extremely preterm infants (≤ 32 weeks gestational age [GA]) develop speech-language disorders by school entry. However, currently it is not possible to identify which infants will develop speech-language disorders, resulting in delayed diagnosis and intervention. This presentation will review results from an ongoing longitudinal study that aims to improve early prediction of speech, language, and pre-literacy deficits in infants born very and extremely preterm. The study includes 150 infants assessed from birth to 3 years with resting-state functional MRI, spontaneous and speech-evoked EEG, and comprehensive hearing and speech-language measures. The focus of the presentation will be on electrophysiological assessments at 3 months of age including: 1) chirp-evoked Auditory Brainstem Response to detect slight and high-frequency hearing loss, 2) spontaneous EEG to assess neural activity and functional connectivity between brain regions in quiet, and 3) speech-evoked EEG to index the infant brain's sensitivity to speech sounds. Analysis will include comparisons to a cohort of full-term healthy infants, evaluate the impact of sub-cortical auditory function on cortical measures, and explore relationships with medical factors from the NICU, socio-demographic variables, MRI brain abnormality scores, and language outcomes at 2 and 3 years corrected age.

Session 7: Acoustic Change Complex

A feasible strategy for eliciting the location-related Acoustic Change Complex (Abstract #22)

Shuai Nie, Juan Zhang, Xing Wang, Jinsheng Dai

Background: Sound localization relies on binaural cues, yet objective assessment, particularly in children, remains challenging. The purpose of this study was to introduce a novel strategy for eliciting the acoustic change complex (ACC) using continuous location-alternating stimulus, aiming to establish a reliable tool for clinically assessing spatial hearing.

Methods: Forty normal-hearing participants were recruited for the study, including 20 children aged 5-6 years and 20 young adults. The ACC elicited by location-change stimuli ($\pm 15^\circ, \pm 10^\circ, \pm 5^\circ, \pm 2^\circ$) continuous pink noise were recorded. Latencies and amplitudes as a function of azimuths were analyzed using the analysis of variance and multiple linear regression model.

Results: Location-change continuous stimulation reliably elicited stable ACC. In children, the angle shifts significantly modulated the amplitudes of P1 ($F=24.16, p<0.0001$), N2 ($F=8.061, p<0.001$) and P1-N2 ($F=82.34, p<0.0001$), and also influenced the latencies of P1 ($F=31.92, p<0.0001$) and N2 ($F=4.735, p<0.05$). In adults, the sound sources significantly affected the amplitudes of N1 ($F=6.099, p<0.01$), P2 ($F=21.95, p<0.0001$) and N1-P2 ($F=64.88, p<0.0001$), as well as the latencies of P1 ($F=159.7, p<0.0001$), N1 ($F=131.2, p<0.0001$) and P2 ($F=130.7,$

$p < 0.0001$). Multiple regression analysis showed N1 latency, P2 latency and N1-P2 amplitude as the three strongest predictors in adults, while in children, the key predictors included P1-N2 amplitude and P1 latency.

Conclusions: Continuous location-alternating stimulus presentation is a feasible and efficient strategy in eliciting the ACC, at least in young adults and children as young as 5 years old. Given its time efficiency and convenience, this method could be considered for further clinical application.

Age-related differences in auditory spatial processing revealed by Acoustic Change Complex (Abstract #23)

Xing (Jack) Wang, Juan Zhang

Background: The auditory spatial processing abilities mature throughout childhood and degenerate in older adults. We aimed to compare the differences in onset CAEPs and location-evoked acoustic change complex (ACC) responses among children, adults, and the elderly.

Methods: One hundred and seventeen people were recruited in the study, including 57 typically-developed children, 30 adults, and 30 elderlies. The onset-CAEP evoked by white noise and ACC by sequential changes in azimuths were recorded. Latencies and amplitudes as a function of azimuths were analyzed using the analysis of variance, Pearson correlation analysis, and multiple linear regression model.

Results: The ACC N1'-P2' amplitudes and latencies in adults, P1'-N1' amplitudes in children, and N1' amplitudes and latencies in the elderly were correlated with angles of shifts. In the elderly, decreased P2' amplitudes lead to reduced sensitivities among angles. The onset-CAEP amplitudes slightly decreased with angles in adults and children, while not in the elderly. Children's ACC responses gradually differentiated into the P1'-N1'-P2' complex. Multiple regression analysis showed that N1'-P2' amplitudes ($R^2=0.33$) and P2' latencies ($R^2=0.18$) were the two most variable predictors in adults, while in the elderly, N1' latencies ($R^2=0.26$) explained most variances.

Conclusion: The changes in auditory spatial processing ability at different ages can be assessed by location-evoked ACC responses as an objective measurement. The N1'-P2' amplitudes and P2' latencies in adults, and N1' latencies in the elderly explained most variances. The differentiation of N1' responses in children indicates the maturation of spatial processing abilities.

Applicability of an acoustic stimulus for evaluation of the Acoustic Change Complex in adults (Abstract #91)

Ana Claudia Figueiredo Frizzo, Yara Bagali Alcantara, Ana Luiza de Faria Luiz, Isabela Tiezi Rombola, John H Grose

Background: This study sought to develop an acoustic stimulus compatible with the Bio-logic Evoked Potential (EP) System that enabled objective evaluation of pitch discrimination in adults with normal hearing. The stimulus included transitions in the fundamental frequency (F_0) of a harmonic complex, an important cue for speech perception in noise and speaker identification, allowing differentiation between target and competing sounds [1].

Methods: Two custom stimuli were created, each lasting 500 ms for EP system compatibility. The experimental stimulus consisted of harmonics 1-12 of $F_0 = 150$ Hz for the first 300 ms, followed by a 10-ms transition to a harmonic complex with $F_0 = 180$ Hz (20% shift) for the remaining 190 ms. The reference stimulus maintained a constant F_0 of 150 Hz throughout. It was hypothesized that the experimental stimulus would evoke an acoustic change complex

(ACC), while the reference would not. Cortical auditory evoked potentials were recorded in 20 normal-hearing adults, with stimuli presented via insert phones at 80 dB SPL.

Results: Grand mean waveforms revealed robust onset P1-N1-P2 responses to both stimuli, with only the experimental stimulus eliciting an ACC. Individual variability in ACC responses was noted. Despite the smaller ACC amplitude compared to the onset response, its presence confirmed the effectiveness of the experimental stimulus in evoking the ACC in normal-hearing adults, indicating the neural capacity for F0 discrimination.

Conclusion: The study successfully developed an acoustic stimulus that evoked a pitch-shift ACC in normal-hearing adults using the available EP system.

The Acoustic Change Complex as a gauge of spatial discrimination in the horizontal plane (Abstract #108)

John Grose, Monica Folkerts, Emily Buss

This study aimed to compare an objective measure of spatial discrimination using the Acoustic Change Complex (ACC) to the behavioral measure of minimum audible angle (MAA). Stimuli were 200-Hz wide noise bands centered at 500 Hz to facilitate interaural time difference cue utilization. MAA was measured for standard angles of 0, 18, 36, 54, and 72 degrees relative to midline. The ACC was measured for fixed angular shifts of 4.5, 9, 13.5, 18, and 36 degrees relative to a 0-degree reference, with the shift occurring 400 ms after the onset of the diotic reference. All testing occurred under ER2 insert phones, with angular shifts implemented using generic head-related transfer functions. Presentation level was 65 dB SPL. Participants were 60 adults with normal/near-normal audiograms equally divided into three age groups of young, middle-aged, and older participants. MAA results displayed the expected pattern of poorer discrimination as the reference angle increased. The ACC, quantified using the Inter-Trial Phase Coherence (ITPC) metric, showed a robust response for the largest angular shift which declined as the angular shift decreased. No reliable responses were observed for the two smallest angular shifts. Comparing the MAA for a 0-degree reference to the ACC showed that behavioral spatial discrimination was more acute than could be measured objectively. Age-related effects were evident, with performance generally declining with increasing age. This pattern of results demonstrates that, although parallels exist between behavioral and electrophysiological measures of spatial discrimination, the ACC does not appear to be as sensitive as the MAA.

Deep learning neural networks for individualized cortical auditory evoked potential classification: A trial averaging study (Abstract #103)

Anthony Herdman

Objective: This study investigated the use of deep-learning neural networks (DLNNs) to classify cortical auditory evoked potentials (CAEPs) as response-present or response-absent in individual participants.

Methods: CAEPs were recorded from 36 participants, with responses averaged over 6, 10, 20, 30, 40, and 60 trials. A DLNN was trained separately for each participant using an individualized approach, with 20% of trials left out for validation. The goal was to determine the accuracy of DLNN classification as a function of the number of trials per averaged waveform.

Results: The classification accuracy of the DLNN improved as the number of trials per average increased. Across participants, mean accuracy values were 59%, 64%, 74%, 75%, 85%, and 91% for 6, 10, 20, 30, 40, and 60 trials per average, respectively. These results indicate that the DLNN could reliably help discriminate CAEP presence or absence, with performance improving as more trials were included in the average.

Conclusion: The findings demonstrate that DLNNs can effectively classify CAEP responses on an individual basis, with accuracy increasing as a function of trial averaging. This participant-

specific training approach highlights the potential of deep learning in enhancing CAEP detection, which could have implications for clinical and research applications.

Acquisition of auditory frequency-following responses and cortical auditory evoked potentials at conventional and high stimulation rates using deconvolution in subjects with fetal alcohol spectrum disorders (Abstract #15)

Sheila Templado, Rafael Delgado, Guillermo Savio, Francisco García-Purriños

Background: Fetal Alcohol Spectrum Disorder (FASD) is an affliction caused by prenatal exposure to alcohol due to maternal consumption during pregnancy, and the leading cause of avoidable acquired intellectual disability. Several morbidities have been described; including learning difficulties, attention deficits, memory impairments, language deficits and listening difficulties in noisy environments.

Methods: A total of 25 normal-hearing subjects have participated in the study; including 11 individuals with FASD. We recorded Frequency-Following Responses and Cortical Auditory Evoked Potentials (CAEPs) with a /Da/ stimulus with a duration of 160ms at 80 dBnHL, at 4.35/s for FFR; and at 1.1/s for CAEPs; and, with simultaneous acquisition with CLAD at 3.9/s Rate.

Results: The Frequency Following Responses (FFR) results showed significant latency delays, weaker cross correlation, lower pitch tracking, and smaller Signal-to-Noise Ratio, in the FASD group compared to the control group. The LLR results showed significant latency and amplitude changes within (rate associated) and between groups. In addition, morphological changes were observed in FASD group at the higher stimulation rate.

Conclusion: The results of this study suggest that, FFR and CAEP may be used as a neurobiological marker of auditory processing disorders, in children and young adults with prenatal alcohol exposure. The use of higher stimulation rates appears to sensitizes the CAEP measures. It is important understanding the impact of alcohol consumption during pregnancy on neurodevelopment, and the need to incorporate auditory electrophysiological test in the evaluation of these patients and to understand how these measurements can contribute to their diagnosis.

Session 8: Cortical Auditory Evoked Responses

Use of cortical auditory evoked potentials in cochlear-implanted children (Abstract #90)

Sobrina Bouzaid, Natalie Loundon, Isabelle Rouillon

Introduction: Early cochlear implantation (CI) in children with severe-to-profound hearing loss requires objective methods to validate device programming. Cortical auditory evoked potentials (CAEPs) provide an objective measure of auditory perception, complementing behavioral tests.

Objective: To assess the feasibility of CAEP recordings in pediatric CI recipients during follow-up (three to six months post-activation), identify clinical implementation challenges, and evaluate their role in optimizing implant function and programming.

Methods: This retrospective study included children implanted before 25 months of age between 2021 and 2023. CAEP recordings were performed using HearLab™ or Duet® (IHS) with stimuli at 65 dB SPL. Cortical responses were analyzed based on objective criteria ($p < 0.05$ or cross-correlation > 0.7) and visual waveform analysis.

Results: Among 39 children (mean age: 18 months), 24 completed testing, and 19 showed at least one identifiable cortical response. Challenges included poor cooperation (movement, distraction) and electrical artifacts from CI stimulation. Interpreting absent CAEP responses was

complex, especially with progressive mapping protocols. While 70–80% of early-implanted children develop language comparable to hearing peers, 20–30% face persistent difficulties. **Conclusion:** Integrating CAEPs into routine follow-up is feasible and helps identify children at risk for delayed language development. CAEP-based protocols reassure families about device function and assist audiologists in fine-tuning CI settings, optimizing rehabilitation strategies and improving language outcomes.

Bridging the gap: Implementing cortical auditory evoked potentials (CAEPs) in a busy clinical setting (Abstract #29)

Tamar Gomes

At Boston Children's Hospital, our audiology team has been exploring the integration of cortical auditory evoked potentials (CAEPs) into our clinical services to support cochlear implant (CI) and hearing aid (HA) guidance and counseling. While CAEPs are well-documented in research, real-world implementation presents unique challenges, particularly for experienced audiologists learning a new technique without the structure of graduate courses, dedicated labs, or direct clinical training.

This presentation shares our journey of adopting CAEP testing within a high-volume clinic, highlighting the barriers encountered and strategies used to bridge the gap between published research and practical application. We will discuss the learning process, logistical hurdles, and the role of professional collaboration in overcoming these challenges. Additionally, we will present a case study of a child with bilateral auditory neuropathy spectrum disorder (ANSD) who provided a timely opportunity to evaluate pre- and post-CI CAEP responses. By examining waveforms across multiple sessions, we explored changes over time and the impact of clinical experience on data interpretation.

This session will provide insight into the real-world implementation of CAEPs, offering valuable lessons for audiologists, researchers, and professionals interested in expanding objective measures in clinical practice. Our experience underscores the importance of continuous learning, adaptation, and collaboration in translating research into meaningful patient care.

Direct recording of cortical auditory evoked potentials using only the cochlear implant: Methodology, clinical correlates, and performance outcomes (Abstract #40)

Joseph Attias, Suhail HabibAllah, Chen Chen

Background: Traditionally, brain activity recordings in cochlear implant (CI) recipients have relied on scalp electrodes and external EEG equipment. While informative, this method has limitations, particularly for young children. This study introduces an innovative technique using the intracochlear electrode array and built-in telemetry of CIs to record directly auditory brain activity without additional external equipment. The current study aimed to demonstrate the feasibility of directly recording electrically evoked cortical auditory evoked potential (eCAEPs).

Methods: Thirty children and 10 adults with bilateral Advanced Bionics CIs participated. A brief electrical stimulus was delivered to one CI, triggering the contralateral CI to record. The recording montage utilized a basal electrode referenced to the case. After software and hardware adjustments, each recording included a sweep with stimulus and a sweep without stimulus. Averaging in a 600-millisecond time window demonstrated a typical eCAEP pattern in all participants.

Results: A typical eCAEP pattern in all participants with a test duration of less than 5 minutes and good repeatability was demonstrated. Compared to scalp recordings, the intracochlear montage yielded significantly larger potential amplitudes, though component

latencies were similar. Importantly, the eCAEP correlated with implantation timing and participants' linguistic and auditory performance.

Conclusion: This groundbreaking approach establishes intracochlear stimulation and recording as a powerful tool for monitoring CI recipients, especially children. The method offers significant advantages, potentially revolutionizing objective monitoring and intervention strategies post-implantation. By eliminating external equipment and providing robust signals, this technique could enhance clinical management of CI patients, particularly in challenging populations like very young children.

Measurement of cortical auditory evoked potentials via bone conduction hearing device (Abstract #46)

Mario Cebulla, Karin Bauer, Søren Laugesen, Anja Kurz

Background: Fitting of bone-conduction hearing devices can be difficult when patients are unable to cooperate, such as in young children, so an objective method for assessing hearing performance would be desirable. Analysis of Cortical Auditory-Evoked Potentials (CAEP) can be a helpful method for estimating the efficiency of such devices.

Methods: CAEP measurements were carried out with the bone conduction device Ponto 5 (Oticon Medical). Speech-like narrowband stimuli were used described by Stone et al. [1]. Stimuli were presented in free sound field at two different stimulation levels (65 and 45 dB SpRefL) to fifteen normally hearing participants with simulated hearing loss.

Results: In a total of 45 measurements, 95.5% and 75.5% CAEP were identified at stimulation levels of 65 and 45 dBSpRefL, respectively. Typical CAEP Amplitudes (P1, N1, P2) were slightly, but not significantly, larger unaided compared to aided condition. The latencies also did not differ significantly.

Conclusion: The measurement method presented shows that CAEP can be reliably recorded via a bone conduction device. This allows an objective verification of the fitting when subjective test procedures cannot be performed.

Hearing aid audibility and acclimatization effects on measures of brain and behavior (Abstract #121)

Curtis Billings, Chantal van Ginkel, Michele Hutter, Jacob Chesler, David Van Wagenen

Background: Hearing aid acclimatization, or changes in brain and behavioral measures over time, has been reported by patients and clinicians; however, the scientific literature is mixed with some studies demonstrating acclimatization in some individuals but not in others. Differences across studies and individuals may be due in part to differences in outcome measures, sensitivity of measures, and/or groups tested. The goal of this study was to use measures of neural encoding, behavior, and self-report to demonstrate effects of test-retest, immediate audibility, and long-term acclimatization among hearing aid users.

Methods: Veterans in the VA Portland Healthcare System (n=30+) were fit with hearing aids and followed longitudinally. Participants were tested twice pre-fitting to approximate test-retest effects, within a week of the fitting to determine audibility effects, and around 2- and 6-months post-fitting to determine acclimatization effects. Three categories of outcome measures were used (brain, behavior, self-report) to extract possible objective and subjective changes in audibility and acclimatization. Outcome measures included cortical N1-P2 and cognitive P3 auditory evoked potentials, speech-in-noise testing, and self-report questionnaires (hearing aid benefit, effort, and tinnitus).

Results & Conclusions: Preliminary results suggest good test-retest effects, and audibility/acclimatization effects that vary depending on the specific outcome measure. The best measure to demonstrate effects depends on the specific effect of interest and whether the

underlying cause is primarily a bottom-up or top-down phenomenon. This study may lead to better rehabilitation and treatment strategies to improve hearing aid benefit in new hearing aid users. (Study supported by VA-RR&D 5I01RX003702).

Neurophysiological biomarkers for tracking auditory selective attention (Abstract #28)

Presenter: Joaquin Valderama

Background: Selective attention enables speech comprehension in noisy environments by enhancing relevant sounds while suppressing distractions. Traditional auditory evoked potential (AEP) tests use artificial stimuli, limiting ecological validity. This study explores the feasibility of using natural speech stimuli to objectively assess selective attention.

Methods: EEG recordings were collected from 10 normal-hearing adults (4 females, 21–42 years) while they listened to an audiobook, either alone or competing with another audiobook at 0 dB SNR. Neural responses were analysed to compare *attended* versus *unattended* speech conditions. Cortical responses to words onset were obtained using deconvolution, and amplitude differences in the P1-N1-P2 complex were evaluated to identify objective markers of selective attention.

Results: The study successfully recorded cortical responses to natural speech at both group and individual levels, even under competing speech conditions. A key finding was the significant reduction in N1-P2 amplitude for unattended speech compared to attended speech, while P1-N1 amplitudes remained similar. This suggests that N1-P2 amplitude reflects speech comprehension rather than mere detection, as indicated by the stable P1-N1 component, making it a strong candidate for an objective biomarker of selective attention.

Conclusion: This novel AEP-based approach demonstrates the feasibility of an objective measure for selective attention using natural speech. Future research may explore brainstem-level responses, investigate the association of this biomarker with standardised cognitive tests of selective attention, and evaluate its sensitivity to hearing-in-noise problems reported by individuals with or without hearing loss.

Cortical network disruptions in children with cochlear implants (Abstract #85)

Karen Gordon

Background: Unilateral deprivation in development creates an aural preference and disrupts binaural processing in auditory cortices. The present aim was to identify whole-brain effects in children with long term unilateral cochlear implant (CI) use.

Methods: Multi-channel electroencephalography measured cortical responses evoked by CI pulse-trains in 34 adolescents (15.4 ± 1.9 years of age) with long term right unilateral CI use; 21 received a second left CI after 11.5 ± 1.7 years of deprivation on this side. Acoustic click-trains or tone-bursts evoked responses in a control group ($n=16$, 15.9 ± 6.4 years of age). Surface potentials and dipole moments identified using the TRACS beamformer were assessed by frequency over time. Phase-locking values between 4 and 60Hz were calculated for 171 pairs of 19-cephalic recording electrodes and, in a subset of the CI cohort ($n=13$), imaginary coherence of theta band (5-8 Hz) activity was calculated between time-varying dipole moments in 90 cortical regions. Unique brain networks were identified using the Network-Based Statistical toolbox and Graph theory analysis including community detection.

Results: Activity from the experienced CI showed phase synchronization in theta and beta frequencies with bursts of gamma activity between frontal, temporal and parietal cortical regions in both hemispheres. Atypical responses from the new CI showed abnormally strong ipsilateral responses in a unique network between a temporal-occipital module and a temporal-frontal module with left Heschl's gyrus and left lingual gyrus central to information flow between the two.

Conclusions Unique brain networks suggest increased attention and higher-order processes potentially to support listening through one CI.

Posters:

1. Application of P1 response threshold of cortical auditory evoked potential in rehabilitation evaluation of young children with cochlear implant (Abstract #38)
Liping Meng, Hui Ji, Weiluo Huang, Yaofeng Jiang

Objective: To explore the application value of P1 response threshold of cortical auditory evoked potential (CAEP) in evaluating the rehabilitation effect of cochlear implant in young children.

Methods: Thirty-three young children after cochlear implantation were divided into groups according to hearing age: Group A (hearing age 1~<2 years old) 10 people; Group B (hearing age 2~<3 years old) 13 people; Group C (hearing age 3~<4 years old) 10 people. The subjective assessment was carried out using the assessment tool for hearing-impaired children ---- "Criteria and Methods for assessing Auditory and language ability of hearing-impaired children" and objective electrophysiological examination was carried out using CAEP to evaluate the rehabilitation effect. SPSS 25.0 software was used for statistical analysis.

Results: The results of subjective assessment of auditory ability and language ability in each group showed an increasing trend with the increase of auditory age. In this study, the P1 response threshold of CAEP in CI implanted children had a significant positive correlation with the 2k Hz hearing threshold after intervention, and the P1 response threshold of CAEP was negatively correlated with many items in subjective auditory ability and language ability assessment.

Conclusion: The P1 response threshold of CAEP has a stable correlation with the results of speech audiometry, which can effectively and objectively evaluate the postoperative rehabilitation effect of young children with cochlear implantation.

2. Applicability of an acoustic stimulus for evaluation of the Acoustic Change Complex in adults (Abstract #91)
Ana Claudia Figueiredo Frizzo, Yara Bagali Alcantara, Ana Luiza de Faria Luiz, Isabela Tiezi Rombola, John H Grose

Background: This study sought to develop an acoustic stimulus compatible with the Bio-logic Evoked Potential (EP) System that enabled objective evaluation of pitch discrimination in adults with normal hearing. The stimulus included transitions in the fundamental frequency (F0) of a harmonic complex, an important cue for speech perception in noise and speaker identification, allowing differentiation between target and competing sounds.

Methods: Two custom stimuli were created, each lasting 500 ms for EP system compatibility. The experimental stimulus consisted of harmonics 1-12 of $F_0 = 150$ Hz for the first 300 ms, followed by a 10-ms transition to a harmonic complex with $F_0 = 180$ Hz (20% shift) for the remaining 190 ms. The reference stimulus maintained a constant F_0 of 150 Hz throughout. It was hypothesized that the experimental stimulus would evoke an acoustic change complex (ACC), while the reference would not. Cortical auditory evoked potentials were recorded in 20 normal-hearing adults, with stimuli presented via insert phones at 80 dB SPL.

Results: Grand mean waveforms revealed robust onset P1-N1-P2 responses to both stimuli, with only the experimental stimulus eliciting an ACC. Individual variability in ACC responses was noted. Despite the smaller ACC amplitude compared to the onset response, its presence confirmed the effectiveness of the experimental stimulus in evoking the ACC in normal-hearing adults, indicating the neural capacity for F_0 discrimination.

Conclusion: The study successfully developed an acoustic stimulus that evoked a pitch-shift ACC in normal-hearing adults using the available EP system.

3. Plasticity of the auditory cortex and brainstem in surgically induced unilaterally deaf adult humans with and without tinnitus (Abstract #14)
MinChul Park, Greg A. O'Beirne, Philip Bird, and Michael R. D. Maslin

Objective: Cortical auditory evoked potentials (CAEPs) and auditory brainstem responses (ABRs) were compared between surgically induced unilaterally deaf (UD) adult humans with tinnitus (UD+T), without tinnitus (UD-T), and with binaurally hearing controls (CO). We hypothesized increased CAEP amplitudes from UD+T individuals, and increased ABR amplitudes from all UD individuals.

Methods: Data were gathered from 34 individuals (8 UD-T, 13 UD+T, 13 CO) using a 64-channel BioSemi device. Stimuli were delivered monaurally at 60 dB nHL. Evoked potential amplitudes and scalp topographies were compared between groups.

Results: Only UD+T individuals showed higher N1 amplitude compared to the controls (1.48 versus 1.04 μ V) over the ipsilateral hemisphere (relative to intact ear). Higher ABR wave III/V ratios were revealed in both UD groups (UD-T 0.426 and UD+T 0.317) compared with the CO group (0.213), regardless of channel.

Conclusions: Tinnitus is thought to be a perceptual correlate of deafferentation-induced activity increase within the central auditory system (CAS) and the present findings support this. However, increased CAEP amplitude was observed amongst UD+T individuals, while altered ABR amplitude was observed in all UD listeners, suggesting deafferentation alone is insufficient for tinnitus.

Significance: Deafferentation and associated increased brainstem activity may be necessary but insufficient for triggering tinnitus.

4. Comparison of auditory brainstem evoked response (ABR) test results in infants screened for neonatal hearing loss (Abstract #27)
Joong Ho Ahn and So Hee Kang

Objective: This study aimed to evaluate the outcomes of Auditory Brainstem Evoked Response (ABR) tests in infants who received "refer" results from Automated Auditory Brainstem Response (AABR) screenings, focusing on false positive rates and the necessity of follow-up testing.

Materials and Methods: The study retrospectively analyzed 71 infants under 1 year of age who underwent AABR screening and follow-up ABR testing from January to December 2021. Infants were divided into unilateral (n=49) and bilateral (n=22) refer groups. ABR thresholds were categorized as normal (<30 dBnHL), mild-to-moderate (30-70 dBnHL), and severe-to-profound (≥ 70 dBnHL).

Results: Among the 71 cases, 38 (54%) showed ABR abnormalities. In the unilateral group, 24 infants (49%) had ABR thresholds ≥ 30 dBnHL, while in the bilateral group, 14 infants (64%) showed abnormal thresholds. Transient conditions like otitis media with effusion accounted for most mild-to-moderate cases, which improved with intervention.

Conclusion: Although AABR is an effective screening tool, it may not be necessary to conduct numerous tests before confirming hearing impairment, considering the relatively low probability of meaningful improvement. When a unilateral ear exhibits abnormal results, this tendency becomes even more accentuated.

5. Neural adaptations to new cochlear implants: A longitudinal electroencephalogram study (Abstract #11)
Shimin Mo, Claude Alain, and Andrew Dimitrijevic

Background: Cochlear implants (CIs) can restore auditory function, but post-implantation outcomes vary widely and often do not correlate well with each other. Standard clinical tests (e.g., AzBio) assess speech perception in controlled environments but overlook cognitive demands (e.g., selective attention) that are critical for real-world speech-in-noise listening. Consequently, these tests do not effectively predict Patient-Reported Outcome Measures (PROMs), which reflect CI users' daily listening challenges. To address this gap, this study aims to examine long-term changes in post-CI naturalistic speech perception using ecologically valid tests and electroencephalogram (EEG).

Method: Twenty-two newly implanted CI users will participate in four sessions (0-, 3-, 6-, and 12-months post-activation), completing behavioral digits-in-noise (DiN) and EEG audiobook listening tasks. In both tasks, participants will focus on a target speaker while ignoring distractors varying in speaker identity and location (DiN) or identity only (EEG). Better speech-distractor identification and greater Temporal Response Function (TRF) weights will indicate better objective speech perception outcomes.

Results: Analyses included 19 participants who were 3 months post-activation. PROMs, behavioral speech perception, and speech-distractor identification improved significantly over time. Speech neural tracking using TRF modeling revealed a significant session effect, suggesting neural adaptations in cognitively demanding speech tracking after 3 months of CI use. Interestingly, a greater gain was observed in the condition with more difficult target-distractor segregation.

Conclusion: Preliminary findings suggest neural adaptations to continuous speech tracking

improve post-CI, and that CI users report more positive real-life hearing experiences. These ecologically valid measures may guide the development of personalized, long-term interventions to enhance CI outcomes.

6. A comprehensive evaluation of the newborn hearing screening system in Jordan (Abstract #93)

Faten Obeidat, Noura Alothman, Rania Alkahtani, Sameer Al-Najjar, Elham Ahmad, Mohammad Obeidat, Asia Ali, and Alia Alghwiri

The Newborn Hearing Screening (NHS) program was officially launched in Jordan in 2021. Since its inception, no studies have examined the effectiveness of the program. This study seeks to assess the effectiveness and outcomes of the NHS program in Jordan. A retrospective cross-sectional study was conducted to investigate the program coverage rate, referral rate, loss to follow-up rate and the hearing status of newborns who successfully completed the necessary diagnostic assessment. Live births in all hospitals administered by the Ministry of Health (MoH) in Jordan from July 2021 to November 2023 were included. Out of 25,825 newborns delivered, 99.4% (25,682) were screened. A referral rate of 0.7% (189) was recorded. Approximately 61.9% of those referred (n=117) had normal hearing, while 31.7% (60 infants) were diagnosed with hearing loss. The prevalence of congenital hearing loss was 0.14%, and the mean age for identifying hearing loss was 11 months. The current status of the NHS program in Jordan is promising. The program has achieved most benchmarks recommended by the Joint Committee on Infant Hearing (JCIH), demonstrating encouraging outcomes. There is a need to investigate and address the factors causing delays in the identification of hearing loss in Jordan.

7. Reduction of the power line interference in a single-channel AEP recording system based on low-cost consumer electronics: application for dissemination of audiology concepts in schools and at a science museum. (Abstract #94)

Angel de la Torre, Isaac M. Álvarez, Juan A. Muñoz-Orellana, Juan Martín-Lagos, Lourdes López-Pérez, and Juan A. Torres-Lara

Background: In IERASG-2023 we presented an AEP recording system mostly based on consumer electronics. It was based on a PLI reduction procedure, requiring the simultaneous acquisition of the differential and common-mode signals and applying appropriate signal processing in a statistical framework. It presents the inconvenience of requiring specific hardware for extracting the common-mode signal and a recording system with at least two input channels.

Methods: We present an advanced procedure for PLI reduction using only the differential signal. The procedure analyzes the recorded signal and implements an efficient subtraction of the PLI without the need of any specific hardware. With this procedure, the recording system is even simpler (and cheaper) than the previous approach, making it appropriate for education purposes. Based on this new conception, we have designed a dissemination workshop with demo activities, oriented to primary and high schools, to introduce basic concepts of audiology and AEPs. This workshop will be carried out in the spring-2025 in several schools and at Granada science museum (Parque de las Ciencias).

Results: The performance of the proposed procedure is evaluated in terms of the reduction of the PLI and quality improvement in AEPs, including ABR/MLR/ALR, recorded in different out-of-laboratory scenarios. The activities carried out in the workshop (including ECG

analysis, EMG description and AEPs recordings using different stimulation patterns) are presented.

Conclusions: We describe a robust, flexible, low-cost and open AEP recording system appropriate for research, education and dissemination purposes, with an example of a workshop for dissemination of audiology concepts.

8. Understanding early and late transient responses to speech: experiments using synthetic speech (Abstract #95)

Angel de la Torre, Isaac M. Álvarez, Nicolas Müller, Francisco A. Chiquero, Juan Martín-Lagos, and José L. Vargas

Background: Recording auditory responses evoked with natural speech is challenging, due to the inherent variability and typical parameters of normal speech, with fundamental frequency between 90-260 Hz (glottal pulses separated between 3.8 and 11 ms) and articulation rates around 10-12 phonemes/s (phoneme duration between 40 and 150 ms). Due to this difficulty, conventional methods for obtaining evoked responses to speech include transient responses using short and isolated vowels or syllables, frequency following response to fundamental frequency in stationary phonemes, or speech-evoked envelope following responses.

Methods: Based on the multi-response deconvolution method developed by our team, and using synthetic phonemes, we propose a simultaneous deconvolution of events corresponding to phonemes and to events corresponding to glottal pulses. In the proposed protocol, the stimulation pattern includes several phonemes (/a/, /i/ and /s/) and click bursts. We deconvolve separately the responses to the short-term events (glottal pulses in vowels and individual clicks in click bursts), and to the long-term events (phonemes or click bursts).

Results: Responses recorded from 6 subjects, reveals consistent early responses (with clear ABR/MLR components) to the short-term events and late responses (with clear MLR/ALR components) to the long-term events. Results with different configurations of the stimulation pattern also illustrate which configurations are more appropriate to obtain consistent responses within exploration times around 10 minutes.

Conclusions: This preliminary study with synthetic speech provides valuable information for a better understanding of the perception of the speech, and for the development of protocols based on speech signals to assess the auditory function.

9. Stimulus duration effects on VEMP responses at 125 Hz and 500 Hz (Abstract #64)

Busra Kocak Erdem , Steven Lewis Bell, and Ying Ye

Background: VEMPs assess otolith function, and stimulus duration could be a significant factor influencing VEMP responses, potentially causing differences in amplitude and latency. The current study explored the effect of stimulus duration on VEMP for different test frequencies and different transducer types.

Methods: The study included eighteen healthy adults (aged 23-41). VEMP responses were recorded using four transducers (AC, B81, BEST, mini-shaker) at three stimulus durations (1:2:1, 1:4:1, 1:8:1) for 125 Hz and 500 Hz. Response quality was assessed using Fsp and Bootstrap methods, and latency and peak-to-peak amplitudes were measured.

Results: At 500 Hz, c-oVEMP responses remained stable across durations, with no significant latency changes, while amplitude decreased with higher cycle counts, resembling behaviour seen in acoustic reflex responses. At 125 Hz, mini-shaker and BEST transducer oVEMP responses were significantly duration-dependent, with longer stimuli producing higher mean Fsp values and increased peak-to-peak amplitudes (Friedman, $p < .05$).

Conclusion: Stimulus duration significantly affected oVEMP responses at 125 Hz, with larger and longer duration responses observed at longer durations, supporting Parker-George et al. (2016)'s hypothesis of oscillatory compensatory eye muscle movement at low frequencies. At 500 Hz, latencies remained stable across durations, suggesting a frequency-specific response pattern. Optimising stimulus duration according to frequency and transducer type may increase the clinical efficiency of the VEMP test in diagnosing vestibular disorders.

10. Interrelationships between auditory brainstem response threshold structure and spontaneous otoacoustic emissions (Abstract #57)
Rebecca E. Whiley and Christopher Bergevin

Background: Quasiperiodic fluctuations with frequency, called microstructure, are unique to an ear and observed in various audiometric responses. There are connections between microstructures in behavioural hearing thresholds and otoacoustic emissions (OAEs), faint sounds generated by healthy ears, in mammals (Dewey 2025). For example, threshold microstructure minima often coincide with spectral peaks of spontaneous emissions (SOAEs). Few studies have evaluated microstructure in electrophysiological data, and it is unknown whether threshold variations around SOAE peaks occur in the auditory brainstem response (ABR). To explore such, we consider a non-mammalian species that exhibits robust SOAE activity.

Methods: We recorded SOAEs and ABRs from adult green anole lizards (*Anolis carolinensis*). ABRs were measured across levels between 0.8-7 kHz and at fine-frequency intervals (20-50 Hz) about selected SOAE peaks in each subject. We extracted ABR amplitudes and latencies, and computed thresholds (after Suthakar & Liberman 2019).

Results: Each subject had a unique SOAE spectrum with peaks typically between 1-4.5 kHz. The gross morphology of ABR audiograms was conserved across subjects, with minimum thresholds of ~45 dB SPL around 2.5 kHz. Individual-specific threshold variations of up to 10 dB occurred near SOAE peaks. ABR amplitudes and latencies increased and decreased, respectively, with stimulus level, but exhibited frequency-dependent variations near SOAE peaks.

Conclusion: We demonstrate that threshold fluctuations related to SOAE peaks occur in electrophysiological data from green anoles. Ongoing analyses seek to ascertain whether these ABR variations derive from similar processes that give rise to microstructures observed in evoked OAEs from anoles and mammalian behavioural responses.

11. Phoneme-specific effects of contralateral noise on ipsilateral speech-evoked envelope following responses (Abstract #59)
Tan Ze Wang, Sriram Boothalingam, Vijayalakshmi Easwar and David Purcell

Background: A speech-based objective validation paradigm is required to evaluate hearing aid fittings for infants. A previously designed speech stimulus /susafi/ was used to elicit envelope-following responses (EFRs) from 2 consonants and 6 vowel formant bands so auditory brainstem phase-locking can be quantified. However, the precise effect of contralateral acoustic stimulation on speech-evoked EFRs remains unclear, which would have implications on binaural EFRs elicited in sound field. The present study aimed to characterize the effect of contralateral noise (CN) presentation on EFR bands elicited by our /susafi/ stimulus.

Methods: The stimulus /susafi/ was presented to normal-hearing young adults through an insert earphone while they lie relaxed in an electromagnetically-shielded sound booth. Speech-shaped noise was presented to the contralateral ear at various levels and durations. EEG was recorded from the vertex to the nape of the neck, with the left collarbone as ground. EFR amplitudes were isolated from the grand average EEG sweep with Fourier analysis.

Results: Continuous CN presentation at 80 dB SPL increased EFR amplitudes for two EFR bands and decreased EFR amplitudes for five. Continuous and interleaved CN presentation at 60 dB SPL altered a subset of those EFR bands.

Conclusion: Results suggest that speech-evoked EFR amplitudes are affected by CN presentation, and these effects differ across phonemes, CN level, and CN duration. These effects are likely due to a complex mechanism that includes many efferent pathways and feedback loops.

12. Total integration of SmartVS and Baby ISAO, a virtual and physical simulator experience, to enhance evoked potential education and training (Abstract #65)
Rafael Delgado and David Brown

Background: Simulation has become a vital tool in various professions for training and skill assessment, including medical fields like audiology. Simulators enable students to learn, practice, and master techniques in a controlled environment, without risking patient safety. This is particularly important in recording of auditory evoked potentials (AEPs), where students need to practice critical skills and often lack access to patients with diverse conditions. Rather than practicing on peers, simulators offer a range of clinical disorders under specific conditions, expanding and standardizing training experiences.

Methods: The SmartVS virtual simulator, used for audiology training in otoscopy, tympanometry, behavioral audiometry, otoacoustic emissions, and AEPs, was integrated with ISAO, a physical simulator mannequin. SmartVS offers a realistic clinical setting where students learn to use various instruments and connect transducers to virtual patients, allowing them to acquire and interpret results. Meanwhile, ISAO enables students to connect actual clinical equipment to the mannequin. With over sixty virtual patients representing a range of hearing loss conditions, students gain a broad clinical exposure. The integration of these patient profiles across both simulation platforms allows students to first practice in SmartVS before transitioning to actual data collection on ISAO, reinforcing their skills with consistent, realistic patient cases.

Results: Student performance evaluations indicate that students using these integrated simulation tools have a better understanding of evoked potentials and are more confident in using clinical systems.

Conclusion: Integrated simulation tools are proving to be essential for effective evoked potential testing training, offering significant improvements in student learning outcomes.

13. Optimizing active middle ear implant coupling: intraoperative ABR and ASSR measurements (Abstract #49)

Carolina Köstler, David Herrmann, Kristen Rak, and Mario Cebulla

Background: The Vibrant Soundbridge (VSB; MED-EL, Innsbruck, Austria) is an active middle ear implant used for the treatment of sensorineural, conductive, and mixed hearing loss. The coupling of the electromagnetic actuator to various middle ear structures is critical for ensuring optimal hearing outcomes and depends on the type of hearing loss and individual middle ear anatomy. Currently, auditory brainstem response (ABR) and frequency-specific auditory steady-state response (ASSR) methods are available for intraoperative evaluation of coupling efficiency. This study investigates the intraoperative measurement of aided ABR and ASSR thresholds to verify and optimize VSB coupling.

Methods: Intraoperative measurements were performed in over 50 patients using a standard AEP system (Eclipse Interacoustics) and a specialized adapter (AcoustiAP, MED-EL). ABR thresholds were determined using broadband stimuli and wave V identification. ASSR thresholds were measured at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. Preoperative bone conduction thresholds and postoperative vibrogram thresholds were used for correlation analyses.

Results: Both ABR and ASSR thresholds were reliably measured intraoperatively in all patients. ABR measurements showed a strong correlation with ASSR threshold, preoperative bone conduction thresholds and postoperative vibrogram thresholds. ASSR measurements demonstrated a high correlation with bone conduction thresholds for frequencies of 1000 Hz, 2000 Hz and 4000 Hz, with a weaker correlation at 500 Hz.

Conclusion: The combined use of intraoperative ABR and frequency-specific ASSR measurements provides a reliable and efficient method for evaluating and optimizing VSB coupling. These methods enable precise intraoperative assessment, allowing immediate adjustments to improve postoperative hearing outcomes.

14. Electrophysiological changes in the auditory system associated with the progression of noise-induced hearing loss (Abstract #79)

Yoonchan Rah and Young-Soo Chang

Objectives: To evaluate and compare the clinical characteristics and electrophysiological changes in patients with different degrees of noise-induced hearing loss (NIHL) with normal controls to elucidate the progression of auditory damage attributed to noise exposure.

Methods: A retrospective cohort study was conducted through a chart review of all patients who presented to a tertiary referral center. Sixty-nine participants were included in the study: 29 had NIHL, and 40 were healthy controls. All the participants underwent electrophysiological tests and pure-tone audiometry.

Results: Nine patients showed mild hearing loss (mild HL group), while the others showed worse than moderate HL on pure-tone audiometry (severe HL group). In addition, the

average pure tone threshold and auditory brainstem response (ABR) values in the three groups were compared. Significantly reduced ABR wave I and V amplitudes were present in both the mild and severe HL groups compared to the control group ($p < 0.001$ and $p = 0.002$, respectively), without significant differences between the mild and severe HL groups. In the multivariate analysis, ABR wave V amplitude was negatively associated with ABR wave I–V inter-peak latency delay ($B = -0.48$, $p = 0.02$).

Conclusion: The results of the present study confirm the similarity in the electrophysiological characteristics between the mild and severe HL groups. Thus, widespread disruption in the auditory neural conduction could have been established in the early period when the patient developed mild HL following noise exposure.

15. Stimulating and recording cortical potentials via cochlear implant (Abstract #118)
Don Bell-Souder, Chen Chen, Anthony Spahr, and Anu Sharma

Introduction: The use of subjective feedback makes the process of cochlear implant (CI) programming challenging when users are unable to actively or accurately report their experience (e.g. pediatrics). Therefore, objective measurements that reflect the accuracy or effectiveness of CI stimulation would be useful. The cortical auditory evoked potential (CAEP) is a feasible method to objectively measure auditory cortex maturation in response to sound.

Methods: We recorded the electrically-stimulated cortical auditory evoked potentials (eCAEP) in seven adult participants. Stimulation was provided using research software which presented a simulated speech sound to participants using the participants' Advanced Bionics CI's. The research software was then able to record the eCAEP directly using the participant's contralateral CI. The eCAEP was also recorded using a commercial EEG system, and the waveforms recorded by the two systems were compared using cross-correlation.

Results: An eCAEP response was observed in all participants, and the CI recorded eCAEPs were comparable to scalp recorded eCAEPs. The eCAEP responses were highly correlated between the scalp and CI recordings (cross-correlation $r=0.83$ for the grand averages, individual mean cross-correlations ranged from 0.13 to 0.70). Obligatory CAEP peaks showed no significant latency difference based on recording method. In addition, CI recorded eCAEP waveforms converge in a distinct waveform by as early as 130 sweeps.

Conclusion: This study shows the feasibility of recording the eCAEP directly through a participant's CI. This type of recording could potentially be used in the future to guide CI fitting and track auditory cortex development in response to CI use.

16. Speech-evoked envelope following responses to evaluate hearing aid benefit in infants with hearing loss (Abstract #45)

Viji Easwar, Michael Chesnaye, David Purcell, Susan Scollie, Genevieve Olenciewicz, and Sanna Hou

With infants being fit with hearing aids as early as 2–3 months of age, it is essential to use objective measures to ensure that hearing aids are providing the intended access to speech. This ongoing study aims to evaluate the accuracy of speech-evoked envelope following responses (EFRs) in predicting speech audibility and developmental outcomes in infants with hearing loss under 2 years of age. In a total of 12 infants with normal hearing (NH) and

12 infants with mild to profound hearing loss (HL), we recorded single-channel EFRs between the high forehead and the nape. A modified stimulus token, “sashi”, was used to elicit frequency-band-specific EFRs at the fundamental frequency of voice (~90 Hz; f0 EFRs) and the syllabic rate of speech (<8 Hz; slow rate EFRs). The stimulus was presented through a loudspeaker at 65 dB SPL. Preliminary results show that frequency-specific f0 EFRs were detectable in at least 80% of NH infants. In infants with HL, f0 EFR detectability varied with the estimated speech intelligibility index and improved with the use of hearing aids. Slow rate EFRs were detectable in 90% of NH infants. In infants with HL, detectability increased from 50% without hearing aids to 80% with hearing aids. The higher number of f0 EFRs detected, which is an indicator of better access to speech, was also associated with better functional listening and speech production scores. Together, these data support the promising utility of EFRs to measure hearing aid benefit and optimize hearing in infants.

17. The relationship between the number of newborn hearing screening (NHS) tests and the positive rate of ABR test in normal newborns (Abstract #76)
Chang Hyun Cho

Objective: The newborn hearing screening (NHS) test protocol for normal newborns recommended in Korea is to be tested once more if the result of first AABR or AOA test is refer. However, in many obstetrics and gynecology hospitals only do NHS once, unlike protocol, and there is a practical problem in that they send the baby to ENT clinic immediately for confirmation tests. This creates a problem of increasing time and cost by unnecessarily performing confirmation tests.

Methods: The positive rates of confirmation tests using ABR, DPOAE and tympanogram were compared between newborns who came to Gachon University Gil Hospital's ENT department after being examined once by the NHS at Incheon Regional Obstetrics (group A) and newborns who were examined twice as protocol (group B).

Results: A total of 518 normal newborns were confirmed from 2017 to 2024, of which 459 were group A and 59 were group B. In the confirmed test, the positive rate was 27 of 459 (6.3%) in group A and 9 of 59 (15.3%) in group B.

Conclusion: As recommended protocol, two consecutive NHS tests are effective for accurate and efficient hearing loss confirmation tests, and are more desirable for both parents and hospitals in terms of time and cost efficiency.

18. Cortical evoked potentials in conductive and mixed hearing losses (Abstract #60)
Carly Schimmel, Kayla Cormier, and Anu Sharma

Background: Cortical auditory evoked potentials (CAEP) are a biomarker of auditory cortex development that has been measured extensively in adults and children with sensorineural hearing loss. Additionally, cortical visual evoked potentials (CVEP) provide further information regarding crossmodal reorganization of the brain due to hearing loss. However, there is less research on cortical potentials in individuals with conductive/mixed losses, including those with microtia/atresia. The goal of this research is to examine crossmodal reorganization in conductive/mixed hearing losses, including before and after amplification.

Methods: Participants include two case studies of adults with congenital unilateral microtia/atresia. Case #1 has a unilateral conductive hearing loss and not pursuing amplification. Case #2 has a mixed hearing loss in one ear and a high-frequency

sensorineural hearing loss in the contralateral ear, tested before and after osseointegrated device use. Participants underwent electroencephalography (EEG) testing, including CAEPs in response to a speech stimulus and CVEPs in response to a visual motion stimulus to investigate crossmodal reorganization. EEG was measured in a soundbooth using a high-density EEG cap. Source localization was performed to estimate areas of cortical activation.

Results: When analyzing source localization from the CAEP and CVEP, case #1 had expected activations, while case #2 showed evidence of auditory activation during the visual stimulus, indicative of crossmodal reorganization. After eight months of consistent OID use, this reorganization reverses.

Conclusions: Results from this research indicate various outcomes of crossmodal reorganization in two cases of adults with congenital microtia/atresia with different configurations of hearing loss. Future steps include testing more participants, including children with conductive/mixed losses.

19. Neural markers of automatic and controlled attention in children with cochlear implants: An ERP study (Abstract #58)
Ola Badarni -Zahalka, Ornella Dakwar-Kaawar, Cahtia Adelman, and Josef Attias

Background: This systematic event-related potentials (ERPs) study examined automatic attention (measured via frontocentral Novelty P3) and controlled attention mechanisms (measured via parietal Target P3) in pediatric cochlear implant (CI) users with early bilateral implantation. Understanding these distinct neural processes may explain the variable auditory outcomes observed in CI users compared to normal-hearing (NH) peers and inform targeted rehabilitation strategies.

Methods: Twenty-five prelingually deaf children with early bilateral CIs and 28 normal-hearing (NH) controls, matched for age (7-13 years) and gender, completed a novel oddball task during ERP recording (standard tones 70%, target tones 15%, novel sounds 15%) and performed speech-in-noise and memory tasks.

Results: CI users showed reduced Novelty P3 ($p < 0.001$) but preserved Target P3 compared to NH peers. Speech-in-noise recognition and short-term memory were poorer in CI users ($p < 0.001$). Both P3 components correlated with speech-in-noise performance: Novelty P3 ($r = 0.368$, $p = 0.025$) and Target P3 at Pz ($r = 0.400$, $p = 0.0125$). In CI users, short-term memory correlated with Target P3 ($r = 0.58$, $p < 0.05$).

Conclusions: This study reveals impaired automatic attention but preserved controlled attention in pediatric CI users. The reduced Novelty P3 suggests a higher threshold for involuntary attention switching, requiring more cognitive resources for detecting acoustic changes. These findings indicate the need for rehabilitation protocols targeting automatic attention mechanisms while leveraging intact controlled attention. The correlations between neural markers and behavioral outcomes provide valuable biomarkers for monitoring intervention effectiveness.

20. Auditory evoked responses of the complete auditory pathway using structured stimulation sequences (Abstract #96)
Nicolas Müller, Angel de la Torre, Francisco A. Chiquero, Isaac M. Alvarez, Juan Martín-Lagos, and José L. Vargas

Background: Based on advanced deconvolution methods, we have demonstrated the viability of simultaneous recording of transient responses of the complete auditory pathway (including ABR, MLR and ALR). However, the simultaneous deconvolution of early and late responses is limited by the small amplitude of the ALR components when they are elicited at high stimulation rates, and also by statistical constraints related to the properties of the matrix involved in the deconvolution.

Methods: In order to overcome the previous limitations and with the aim of obtaining simultaneously good quality early and late transient responses, we propose the use of structured stimulation sequences, involving different time-scale events. In particular, the stimulation pattern consists in click bursts, with configurable stimulation amplitude, inter-stimulus interval, burst duration and inter-burst interval. The stimulation sequence is deconvolved under a multi-response paradigm, using independent response models for the click events and for the burst events for the different stimulation levels.

Results: This study includes responses from 8 subjects. Consistent responses are obtained for both clicks and bursts events, with a clear predominance of peripheral response to clicks and central response to bursts. The amplitude of the MLR/ALR responses to bursts is substantially larger than that elicited by clicks, and a strong dependence with the subject attention is also observed.

Conclusions: The experimental results provide a better understanding of the difficulty associated to the simultaneous recording of the early and late responses, as well as a better understanding of the auditory processing at different levels of the auditory pathway.

21. Can auditory steady-state potential detect hearing loss or normal hearing thresholds in infants, babies, and children?: Literature review (Abstract #31)
Mariana Ferreira Pires Martins, Milaine Dominici Sanfins, Caroline Donadon, Piotr Henryk Skarzynski, and Daniela Gil

Background: The Auditory Steady-State Response (ASSR) uses statistical tests to examine auditory thresholds, reducing examination time and evaluator bias. However, its use in individuals with normal or mild hearing loss remains a concern. This review examines ASSR in neonates and young children with normal and mild hearing abnormalities.

Methods: A systematic literature review was conducted in August-September 2024 using PubMed, Web of Science, and Scopus. MeSH descriptors, including "auditory steady state response," "objective audiometry," and "frequency-specific hearing threshold," were combined to retrieve relevant articles and abstracts. Exclusion criteria included adult/elderly studies, animal trials, grey literature, non-English publications, and bone conduction only ASSR research.

Results: 1266 studies were initially selected. After applying inclusion/exclusion criteria, 16 publications were included. ASSR research as a diagnostic instrument has yielded inconclusive results. 56.25% of studies endorsed its diagnostic application, 18.75% rejected it, and 18.75% were inconclusive. This disagreement highlights the need for further investigation, particularly in pediatric populations, using rigorous methodologies. Technical advancements and improved sound stimuli have shown promise in improving the equivalence of auditory thresholds compared to other diagnostic procedures.

Conclusion: These findings support ASSR's usefulness as a diagnostic tool for newborns, babies, and children. However, technical developments and second-generation stimuli are more beneficial in cases of minor hearing loss or normal hearing, necessitating methodological standardization.

22. CI adults' neural encoding of emotion and gender discrimination in speech (Abstract #26)
Xinyi Yao, Emily Graber, and Andrew Dimitrijevic

Objective: This study is aimed to investigate how CI listeners use prosodic features to discriminate speech emotion and voice gender, and how prosodic features are encoded in their brain.

Method: Twenty-two CI adults were recruited and completed emotion and gender discrimination tasks with a 64-channel electroencephalogram (EEG) recording the neural response. The stimulus were 400 semantically neutral sentences, with emotional articulation (happy/angry) and gender (male/female) of the speaker varied across trials. Participants were required to discriminate the emotion or gender of the speaker based on a visual cue presented prior to each sentence.

Result: Behaviorally, CI listeners recognized anger faster than happiness, and the recognition accuracy for female voices was higher than for male voices. Differentiating speech emotion was much more challenging than telling voice gender. As for EEG data, temporal response function (TRF) mapping of envelope, pitch, and timbre features revealed similar patterns. CI participants displayed significantly greater N1 amplitude and longer P2 latency when detecting angry stimuli compared to happy stimuli, and showed shorter P2 latency in male voices than female voices and in emotional discrimination than voice-gender differentiation. Δ accuracy was calculated by subtracting the r-value of one single TRF model from the full model, finding that in two tasks CI listeners relied most on timbre, and then on envelope and pitch.

Conclusion: CI users exhibited better performance in discriminating happy emotions and female voices. For both emotion and voice-gender discrimination, timbre is the most important feature followed by envelope and pitch, though emotion discrimination proved more challenging.

23. Genetic factors underlying age-related hearing loss affect suprathreshold ABR Wave morphology in healthy young adults (Abstract #120)
Valerie Ingalls, Srividya Grama Bhagavan, and Ishan Bhatt

Background: Age-related hearing loss (ARHL) is a highly prevalent health condition associated with numerous comorbidities, including dementia, cognitive decline, and social isolation. ARHL is associated with neural dysfunction such as cochlear synaptopathy. Suprathreshold auditory brainstem response (ABR) is one possible method to assess auditory neural function. We hypothesized that genetic variations associated with ARHL would also explain differences in ABR among young adults with normal hearing. Early identification of high-risk individuals before the onset of ARHL is critical to providing timely preventative intervention.

Methods: We selected 7218 single-nucleotide polymorphisms (SNPs) associated with ARHL in a previous genome-wide association study meta-analysis (meta-GWAS). We performed regression analysis to determine whether these variations explained differences in ABR

amplitudes among 357 healthy young adults with self-reported normal hearing. We evaluated SNP effects on ABR using linear mixed models, then mapped SNPs to genes using functional annotation and quantified gene-specific effects.

Results: 148 SNPs and 49 mapped genes were significantly associated with ABR wave I amplitude; 56 SNPs and 29 mapped genes were significantly associated with wave III; 126 SNPs and 67 mapped genes were significantly associated with wave V.

Conclusion: Individuals with genetic predisposition to ARHL exhibit significantly lower ABR amplitudes, well before clinical onset of ARHL. This highlights the need for early intervention for high-risk individuals, who may be experiencing decline in auditory function well before their peers. Comparing effects of genes across ABR waves represents a potential method for localizing effects of genes on auditory neurophysiology.

24. Auditory brainstem responses to bone-conducted 4000-Hz brief tones in infants (Abstract #101)

Anthony Herdman, Jennifer Hatton, Anna VanMaanen, and David Stapells

Objective: This study aimed to determine (i) the maximum intensity for normal hearing (MINH) for auditory brainstem responses (ABR) to 4000-Hz bone-conducted (BC) 5-cycle tones in infants, (ii) correction factors for 4000-Hz estimated hearing thresholds (dBeHL), and (iii) prevalence of ipsilateral-contralateral asymmetries in wave V amplitudes and latencies for BC stimuli (500-4000Hz).

Methods: A retrospective review of 118 infants (median age=1.4 months) was conducted. The intensity (dBnHL) at which 95% of normal-hearing infants had a response was defined as the MINH for BC 4000-Hz. Correction factors were estimated from ABR and behavioural thresholds from infants with normal hearing (N=6) and mild-moderate sensorineural hearing loss (n=8). Wave V ipsi/contra asymmetries were examined for 500-, 2000-, and 4000-Hz BC stimuli.

Results: The MINH for BC 4000-Hz was 30 dBnHL because 98% of normal-hearing infants showed ABRs at this level and 86% at 25 dBnHL. The correction factor for BC 4000-Hz stimuli was estimated to be -10 dB. For infants with normal hearing, ipsilateral recordings consistently showed shorter latencies and larger amplitudes than contralateral recordings, confirming cochlear dominance effects.

Conclusions: Findings indicate 30 dBnHL as the level to determine presence of normal cochlear sensitivity when using BC 4000-Hz brief tones in infants. The preliminary -10-dB correction factor should be used until larger studies verify its validity. Ipsilateral-contralateral asymmetries provide insights into cochlear dominance, reinforcing the need to record from both channels for accurate BC-ABR interpretation. Further research is ongoing to optimize clinical protocols.

25. Assessment of auditory reflexes using electrocochleography (Abstract #113)

Lydia White, Sarah Haysley, and Skyler Jennings

Background: The middle ear muscle (MEM) and medial olivocochlear (MOC) reflexes adjust the response of the auditory periphery in real-time, which is expected to improve the neural

coding of sound. Accurate characterization of this coding is essential for understanding human auditory physiology and informing auditory models. The MEM reflex stiffens the middle ear, attenuating sound before reaching the cochlea. The MOC reflex reduces outer hair cell motility, decreasing cochlear amplifier gain. This work quantifies the effects of the MEM and MOC reflexes using the cochlear microphonic (CM), a far-field potential sensitive to outer hair cell currents.

Methods: The CM was measured from a custom eardrum electrode. Participants listened to an upward- or downward-frequency sweep (probe, 90 dB SPL, 100-6000 Hz). The MOC or MEM reflexes were elicited by contralateral acoustic stimulation (CAS; broadband noise) at 50 dB SPL or 90 dB SPL, respectively. CAS-mediated changes in magnitude and phase were quantified.

Results and Conclusions: Low-level CAS resulted in an increase in CM amplitude and a lag in CM phase, consistent with MOC reflex activity. High-level CAS resulted in a decrease in CM amplitude and a lead in CM phase, consistent with increased MEM activity. These results support the utility of the CM to investigate the MOC and MEM reflexes, which is expected to lead to improved understanding of how these reflexes influence the neural coding of sound. Further, this work provides crucial information for implementing these reflexes in humanized computational models of the auditory system.

26. Auditory neuropathy/dys-synchrony (ANSD) evoked potentials assessment alignment (Abstract #43)
Megan Hedman

Background: The prevalence of permanent, congenital hearing loss is 1-2 in every 1000 babies. The incidence of auditory neuropathy spectrum disorder (ANSD) is estimated between 5 and 10% of patients with permanent hearing loss. Although clinicians may be comfortable with the diagnostic test battery to identify ANSD, what is included in the test battery, follow-up recommendations, and intervention is variable among practices and clinicians for this unique population.

Methods: 28 centers were contacted to complete a survey regarding ANSD practices. The results of this survey raised concern that perhaps patients with an ANSD diagnosis are receiving inconsistent assessment and management. In response to the survey results, and to advance best practices and patient outcomes, a national task force to identify factors that affect the assessment and management was established.

Results: The goal of the task force is to provide a protocol to promote evidence-based practice and aid in research data collection to best inform the field of audiology and other disciplines. Elements of the assessment have been established.

Conclusion: The task force has drafted an initial position statement regarding the key components of an auditory evoked potentials evaluation to rule in or out the diagnosis of ANSD. Ultimately, even amongst the task force it is evident that some components are crucial to the diagnosis while others are dependent on the resources and multidisciplinary services offered within the region. Nevertheless, with a framework of best practices, audiologists will be better supported and unified in their test battery, allowing for greater consistency across the country.

27. A large-sample simulation study evaluating the prevalence of underestimating steep-sloping hearing losses using auditory brainstem responses to brief tones and chirps (Abstract #102)
Anthony Herdman

Narrow-band (NB) chirp stimuli are commonly used in auditory brainstem response (ABR) testing due to their proposed amplitude advantage over brief 2-1-2 tones. However, NB-chirps may have a frequency-specificity disadvantage because they typically have one-octave wide bands that could activate a broader cochlear region than 2-1-2 tones. This could lead to underestimating hearing thresholds in infants with steep-sloping (>30 dB/octave) hearing losses due to off-frequency activations.

This study used simulations to estimate how many thresholds may be underestimated in a large population of infants (n=1350) with hearing losses commonly found in early hearing programs. Infants (n=135/year over 10years) were simulated to have mid-to-high frequency sloping losses either evenly distributed (0-60 dB/oct) or clinically distributed (85% between 0-15 dB/oct, 15% between 15-60 dB/oct) across the population. ABR audiograms were modeled using auditory-filter outputs based on Glasberg & Moore (2000). Stimuli were 2-1-2 tones, NB-shChirps with ½-octave and 1-octave bandwidths (SimHERA), NB-CE-Chirps (Interacoustics), and NB-iChirps (I.H.S.).

Results for evenly distributed slopes showed cases with slopes >30dB/octave (n=672) had >15dB threshold underestimations for 98(4%), 69(3%), 256(9%), 201(7%), and 14(1%) thresholds, respectively, for 2-1-2 tones, ½-octave NB-shChirps, 1-octave NB-shChirps, NB-CE-Chirps, and NB-iChirps. Similarly, clinically distributed cases (n=124) showed >15dB threshold underestimations for 29(6%), 14(3%), 57(11%), 47(9%), and 7(1%) thresholds, respectively.

These simulations suggest that 1-octave chirp stimuli (NB-shChirps and NB-CE-Chirps) may underestimate thresholds in a larger number of infants with steep-sloping losses (>30dB/octave) than would 2-1-2 tones, ½-octave NB-shChirps, or NB-iChirps. A large-sample, real-world study is recommended to confirm these findings.

28. Multichannel methods for rapid and high-quality frequency following responses (Abstract #122)

Nike Gnanateja Gurindapalli, Megan Hernandez, and Dhatri Sadholalu Devaraju

Background: The frequency following responses (FFRs) are highly precise neural responses that mirror the periodicity of sound stimuli, offering invaluable insights into the intricate encoding of speech sounds in the human auditory system. Originating throughout the central auditory pathway, with prominent contributions from the brainstem and the cortex, FFRs play a crucial role in dissecting the representation of speech features across the auditory hierarchy. Despite their informative nature, measurement of FFRs is time-consuming due to small amplitudes and low signal-to-noise ratios. This limitation not only prolongs experimental durations but also hinders the exploration of task-relevant or real-time training effects on FFRs within reasonable time. Although certain methodologies have employed multichannel recordings to expedite FFR measurements, they predominantly focus on frequency domain analyses and fail to adequately capture the temporal dynamics of stimulus frequency information.

Methods: We introduce a novel approach to enhance the signal-to-noise ratio of FFR waveforms through denoising source separation techniques. By designing spatial filters biased towards amplifying phase-locked neural components while suppressing non-phase-locked elements. The denoising approach was applied across multichannel FFRs to four

Mandarin pitch trajectories obtained in 15 individuals with typical hearing.

Results: We achieved a four-fold increase in signal-to-noise ratio when applied to multichannel FFRs elicited by dynamic Mandarin pitch trajectories. Furthermore, our methodology facilitated enhanced single-trial decoding by machine learning models for classifying stimulus pitch trajectories.

Conclusions: Our method represents a significant advancement in FFR research methodology, offering expedited data acquisition, enhanced signal fidelity, and broader applicability across diverse experimental scenarios.

29. Auditory and language monitoring with objective and subjective measures: case report (Abstract #71)

Thais Augusto Souza, Milaine Dominici Sanfins, Leticia Inocêncio, and Daniela Gil

Background: Pre-lingual hearing loss impacts on communication, interferes with the development of speech, language and social skills, impacting the child's way of life as a whole. Auditory rehabilitation in early childhood promotes neural plasticity by exposing the child to auditory situations, stimulating all stages of auditory and speech development. This study aimed to measure, through objective and subjective evaluations, the development of the auditory and language skills of a child with profound sensorineural hearing loss over twelve months after cochlear implantation.

Method: Longitudinal case study, of a qualitative and quantitative nature, of a two-year and six-month-old child using a Cochlear Implant, treated at the Educational Audiology outpatient clinic of a public hospital. Four monitoring evaluations of auditory cortical maturation were carried out using the cortical auditory evoked potential and the application of scales to measure auditory development, integration and memory and also global development.

Results: Decreased latency and improvement in P1 component wave morphology were observed after six months of device use and auditory rehabilitation. The Auditory Integration and Projection Scales for auditory and linguistic performance showed increased auditory integration throughout the follow-up.

Conclusion: There was an evolution in auditory, motor and language skills, although below the development milestones expected for the age. The development analysis could be measured qualitatively through clinical markers and quantitatively by the emergence of P1 with adequate latency for the auditory stimulation time.

30. Urolithin A prevents age-related hearing loss in C57BL/6J mice by inducing mitophagy (Abstract #39)

Sung Il Cho, Eu-Ri Jo, and Hee Sun Jang

Mitochondrial dysfunction with aging is associated with the development of age-related hearing loss. Mitophagy is a cardinal mechanism to maintain a healthy mitochondrial population through the turnover of damaged mitochondria. Declining mitophagy with age causes a buildup of damaged mitochondria, leading to sensory organ dysfunction. The effect of Urolithin A (UA), a mitophagy inducer, was investigated on age-related hearing loss in a mouse model. C57BL/6J mice were treated with UA from 6 to 10 months of age. UA

attenuated an auditory brainstem responses (ABR) threshold shift at 8, 16, and 32 kHz frequencies, and improved mitochondrial DNA integrity and ATP production in the cochlea and auditory cortex. The mRNA levels of mitophagy-related genes and protein levels of PINK1, Parkin, BNIP3, and LC3B increased in the cochlea and auditory cortex. The expression of mitophagosomes and mitophagolysosomes in the cochlea, spiral ganglion, auditory cortex, and inferior colliculus increased, together with the expression of Parkin and BNIP3 in the cochlea, spiral ganglion, auditory cortex, and inferior colliculus. These results indicate that UA counteracted mitophagy decline in the auditory system and prevented age-related hearing loss. UA can be used as a potential agent to prevent age-related hearing loss.

31. Neural representation of the coding process of language and speech aspects in children with congenital toxoplasmosis (Abstract #34)
Lais Ferreira, Milaine Dominici Sanfins, Marcia Keske-Soares, Piotr Henryk Skarzynski, and Eliara PV Biaggio

Background: Children with congenital toxoplasmosis (CT) are at increased risk for central auditory nervous system dysfunction, potentially affecting hearing and language development. This study explored neural speech sound encoding and language aspects in children with CT.

Method: An observational, analytical case-control study was conducted with seven children diagnosed with CT and six typically developing children aged four to six. Participants underwent frequency-following response (FFR) and language/speech development assessments.

Results: Latencies were higher in all FFR components for the CT group. The slope measure was also higher. No control group children showed receptive or expressive language changes. In the experimental group, two of seven children had language disorders with reduced vocabulary and severe speech sound disorder (SSD). One had altered expressive language and mild-to-moderate SSD, and four others had mild to severe SSD. All experimental group children showed altered language and/or speech. A significant correlation was found between three INFONO results and the FFR A-D intervals ($p < 0.05$).

Conclusion: Our findings align with studies demonstrating significant neural speech sound coding impairments in children with CT [1], persisting into early childhood. This population exhibits a prolonged speech sound coding process compared to healthy peers, impacting speech acquisition and development.

32. Light induced ABR responses after optogenetic microneedle for minimally invasive neurostimulation of inner ear (Abstract #82)
Min Young Lee, Subin Kim, So-Young Chang, and Dong-Kee Kim

Background: The auditory sensory deprivation can cause degeneration of related nervous structures and further lead to decrease of other brain functions such as cognition and emotion. The specific parameter of light energy can be delivered to inner ear with minimal trauma to trigger stimulation using optogenetic engineering technique.

Methods: The biodegradable hyaluronic acid-based microneedle which releases AAV viral vector is designed for trans round window delivery to cochlear scala tympani. As for in vivo experiments, transfection efficiency using AAV-GFP to compare conventional viral delivery

and microneedle delivery was analysed. Light (continuous, 532 nm, 0.38 mW) induced ABR response were measured in optogenetically engineered rat using microneedle.

Results: Conventional AAV viral vector delivery using microcatheter and microneedle AAV viral vector were compared (same virus copy no.). The microneedle AAV-GFP delivery showed significantly increased GFP amount measured by western blot analysis compared to conventional method. For comparison of two methods AAV-GFP was used initially. In epifluorescence analysis, both methods showed good transfection in inner hair cells. But in microneedle AAV-GFP group, vivid transfection of spiral ganglion neuron was observed, which was observed rarely in conventional AAV delivery. With the light stimulus these structures showed robust phase-locked-electrical activities. These microneedle with AAV-mCherry-Halorhodopsin were transplanted into round window of rat and ABR response without sound was measured with the laser irradiation. With the laser stimulation, waveforms of irregular but increased amplitudes were observed.

Conclusions: This study observed the auditory-neural-signals by the light-stimuli in microneedle-groups.

33. Unilateral auditory neuropathy in a child with ipsilateral enlarged vestibular aqueduct: a case report (Abstract #93)
SungHee Km and Eun Jin Son

Auditory neuropathy (AN) is a distinct type of sensorineural hearing loss that is characterized by the presence of otoacoustic emissions and/or cochlear microphonics, and present mostly bilaterally. Unilateral AN is consequently only seldom described, and most frequently as isolated cases. The etiology of unilateral AN remains poorly understood in children.

We experienced a case of congenital unilateral hearing loss detected by newborn hearing screening, diagnosed unilateral AN on the right side at 3 months of age and figured out unilateral profound hearing loss on the right side and ipsilateral enlarged vestibular aqueduct (EVA) by temporal bone CT at 7 years of age. Until now, there is no report of coexisted AN and EVA in the same ear. The present case suggested that unilateral AN could be accompanied by and/or caused by ipsilateral EVA.

34. Frequency-specific hearing assessments using auditory evoked potentials to modified speech (Abstract #20)
Michael Chesnaye, Natasha Knezevic, David Purcell, and Viji Easwar

There is growing interest in using neural responses to speech to assess hearing, driven largely by speech's high ecological validity. To support this, methods like the Temporal Response Function (TRF) approach were developed, which allow overlapping neural responses to be estimated for a wide range of speech features. The goal for this study was to use the TRF approach with Bayesian estimation to infer low- and high-frequency (LF and HF, respectively) speech audibility from overlapping neural responses to slow-rate (<8 Hz) phoneme transitions.

To test if neural responses to LF and HF phonemes can be used for frequency-specific speech audibility assessments, randomised phoneme sequences (/s/, /a/, /sh/, /i/) were presented to 22 normal-hearing adults while recording single channel EEG. To assess frequency-specificity, responses was also recorded with either all vowels (LF phonemes) or all fricatives (HF phonemes) set to zero. Since the TRF approach does not cleanly separate

overlapping responses, a bootstrap approach combined with Bayesian estimation was used to approximate the posterior distribution for statistical inference. The approach achieved LF and HF detection rates (respectively) of 0.95 and 0.33 (all phonemes audible), 0.95 and 0.05 (vowels audible), and 0.05 and 0.67 (fricatives audible).

Results show that frequency-specific speech audibility assessments using overlapping neural responses are feasible. However, the approach requires further testing in other populations (e.g. infants) using a wider range of speech stimuli. Frequency-specific speech audibility assessments using overlapping neural responses is a challenging problem, and more work is needed to optimize detection methods for this task.

35. Cortical and cognitive encoding of noisy and reverberant speech (Abstract #123)
Ramesh Kumar Muralimanohar, Macy Knudsen, and Curtis Billings

Background: Physiological measurements could help clarify the underlying processes driving individual perceptual experiences in everyday complex listening environments. The purpose of this study was to systematically analyze the differential encoding of speech affected by reverberation, noise masking, and the combination of the two in an active listening paradigm. The stimuli were picked to mimic the spectral variability of natural listening situations.

Methods: A complex oddball paradigm consisting of multiple consonant-vowel (CV) stimuli was used to record cortical N1 and cognitive P3 auditory evoked potentials. Normally-hearing young adults (n=24) completed the task. Sixteen CV tokens spoken by eight talkers were used for testing. These test tokens were presented in four conditions: (1) anechoic, (2) background babble, (3) reverberation, and (4) background babble + reverberation. Four runs in each condition were completed. Participants were instructed to press a button whenever they heard the target consonant. Additional data on accuracy of consonant identification and reaction times were also recorded.

Results: Preliminary analyses showed that the complexity of environmental interferences resulted generally in weaker auditory evoked potentials. The effect of the reverberation (reverberation time=900 ms) used in this study was not equivalent to the background noise (10 dB signal-to-noise ratio). Increasing levels of environmental interference also resulted in greater consonant confusions.

Conclusion: Preliminary results show that background noise affected these evoked potentials more than the reverberant conditions. The impact of neural encoding on behavioral results will also be discussed.

36. Neurophysiological correlates of word learning in hearing-impaired preschool children (Abstract #72)

Marina Vasilyeva, Veronika Knyazeva, Ekaterina Garbaruk, Maria Boboshko, Elena Dmitrieva, and Aleksander Aleksandrov

Background: A child's brain has a unique capacity for the rapid acquisition of large amounts of new vocabulary. A specific neurocognitive mechanism, dubbed «fast mapping» (FM), is assumed to be a key instrument in the rapid formation of new word representations after even a single exposure to novel language items. In the case of hearing loss, these abilities become challenging, and neurophysiological bases of the FM mechanism remain obscure. To address this question, we used event-related potentials (ERPs) to define brain dynamics

elicited by novel words following a single-shot semantic learning task in a group of hearing-impaired children.

Methods: 23 children (5-8 y.o.) with bilateral permanent sensorineural hearing loss (SNHL) fitted with hearing aids and 24 healthy counterparts underwent an FM paradigm: a counterbalanced set of familiar and novel words presented acoustically in conjunction with visually familiar and novel objects. A single mapping trial was administered to derive the meaning of a novel item from the semantic context. Acoustic stimuli were: familiar native (Russian) words; novel native and non-native word forms. Passive auditory ERPs were recorded immediately after the training.

Results: In the healthy group, a single-shot learning task resulted in an early N400 effect for novel native trained word forms, with no similar changes for non-native ones. Conversely, in the SNHL group, a significant learning effect was found for novel non-native stimuli only.

Conclusion: The current study reveals, for the first time, significant differences in lexical-semantic processing during rapid native and non-native word acquisition in healthy and hearing-impaired children.

37. Neural encoding of speech in Brazilian Portuguese-speaking school-aged children: An analysis using the frequency-following response (Abstract #48)
Caroline Donadon, Milaine Dominici Sanfins, Gabriele Libano, Aline Sanches, Piotr Henryk Skarzynski, and Maria Francisca Colella-Santos

Background: The frequency-following response (FFR) is an electrophysiological measure that reflects the brainstem's encoding of speech sounds. It preserves important temporal and spectral sound features, aiding language processing. FFR is used in pediatric populations to assess neural encoding efficiency and detect auditory processing deficits. However, data specific to Brazilian Portuguese-speaking children are scarce. This study aimed to examine FFR responses in this population and investigate the effects of age, gender, and ear laterality on speech encoding.

Methods: The study included 37 children aged 8 to 10 years with typical development and good academic performance. FFR recordings were obtained using the consonant-vowel syllable /da/ (170 ms). Latencies of the V, A, D, E, F, and O waves were analyzed. The influence of age, gender, ear laterality, and central auditory processing performance and school performance was examined.

Results: Significant ear differences were found for waves D and E, with longer latencies in the left ear. No significant effects of age or gender were observed. A relevant size effect was found between central auditory processing, school performance and wave latencies.

Conclusion: The study identified lateralization differences in speech sound encoding, with no age or gender effects. These findings contribute to understanding auditory processing in Brazilian Portuguese-speaking children and provide a reference for clinical assessments.

38. Cochlear implantation outcomes in RRM2B-related deafness: A case report and literature review (Abstract #105)
Sabrina Bouzaid, Natalie Loundon, and Isabelle Rouillon

Introduction: Mitochondrial DNA (mtDNA) depletion syndromes linked to RRM2B mutations are rare disorders affecting multiple organ systems, including muscles, peripheral nerves, kidneys, and the auditory system. The resulting sensorineural hearing loss (SNHL) is often progressive and profound, but data on cochlear implantation (CI) outcomes in these patients remain scarce.

Methods: A systematic literature review was conducted using PubMed to identify reports on RRM2B-related SNHL and cochlear implantation outcomes. Additionally, we present a clinical case of a child with RRM2B-related deafness, detailing pre- and post-implant auditory function.

Results: Published reports indicate that SNHL in RRM2B-related syndromes is typically severe-to-profound, progressive, and associated with multisystemic involvement. Few studies have examined CI outcomes, but existing data suggest that some implanted patients achieve auditory benefit, although variability in speech and language development is observed.

In our case, a 2-year-10-month-old girl with profound bilateral SNHL and a confirmed homozygous RRM2B mutation underwent cochlear implantation (CI622, N8 processor) at 28 months. Pre-implantation, auditory brainstem responses (ABR) and otoacoustic emissions (OAE) were absent, and auditory steady-state responses (ASSR) showed no detectable thresholds. Post-implantation, cortical auditory evoked potentials (CAEPs) were robust at 65–75 dB, and the child demonstrated progressive auditory awareness (7.5h/day CI use) and improved speech perception with speech therapy (2x/week). Given these promising results, a second CI is planned to optimize binaural auditory processing.

Conclusion: While CI outcomes in mitochondrial SNHL remain poorly documented, this case, along with the available literature, suggests that cochlear implantation can provide meaningful auditory benefit, even in children with complex neurodevelopmental challenges.

39. Correlation of electrically evoked stapedius reflex threshold (eSRT) and subjective measures in pediatric cochlear implant programming: Effects on speech discrimination (Abstract #106)

Sabrina Bouzaid, Natalie Loundon, and Isabelle Rouillon

Introduction: This study evaluates the correlation between subjective comfort levels and electrically evoked stapedius reflex threshold (eSRT) in cochlear implant (CI) programming. While eSRT may enhance programming accuracy, its relationship with subjective measures and speech perception remains underexplored. This study also compares speech discrimination in quiet and noise using eSRT-based vs. subjective-based programs.

Methods: Thirty pediatric CI users (8–18 years, implanted ≥ 1 year) participated. At Visit 1 (V1), eSRT was measured, and CIs were programmed using two settings: Csubj (subjective-based) and CeSRT (eSRT-based). Speech performance was assessed with monosyllabic words in quiet and FRASIMAT sentences in noise. Assessments were repeated at Visit 2 (one month later). Correlations between eSRT and Csubj were analyzed, and audiometric outcomes were compared.

Results: A strong correlation was found between CeSRT and Csubj ($r = 0.97$, $p < 0.05$). Speech performance at V2 was significantly better with CeSRT in both quiet and noisy conditions ($p < 0.05$), demonstrating the effectiveness of eSRT-based programming.

Conclusion: eSRT is a valuable tool for optimizing CI programming in pediatric users. Its strong correlation with subjective measures and improvements in speech perception support its integration into clinical protocols.

40. Effects of intensity and hearing status on middle latency responses recorded with pABR stimuli (Abstract #98)

Isabel Herb, Ross Maddox, and Melissa Polonenko

Background: Auditory function is often assessed with auditory brainstem responses (ABR) to frequency-specific tonebursts. The parallel ABR (pABR) paradigm allows simultaneous ABR and middle latency response (MLR) recording, providing a more comprehensive auditory assessment. Our recent work has shown that MLR visualization improves threshold estimation accuracy when wave V is small. However, intensity-related MLR changes in individuals with normal hearing and hearing loss remain largely uncharacterized. Thus, this study evaluated how MLR amplitude and latency vary with intensity across frequencies in these two groups.

Methods: Two-channel ABRs were recorded from 70 adults with varying audiometric thresholds and 20 adults with normal hearing using pABR stimuli (0.5–8 kHz tonebursts) at 40 stimuli/s across an intensity series (between ~0–80 dB nHL). ABR wave V and MLR waves Na-Pa and Nb-Pb were analyzed for peak amplitude and latency using linear mixed-effects modeling to assess intensity-related changes by hearing status.

Results: Preliminary analysis reveals that MLR amplitude and latency change at similar rates across intensity and frequency for both hearing groups. In contrast, Wave V showed frequency- and intensity- dependent effects, with hearing loss reducing amplitude, especially at low frequencies. In contrast, MLR amplitude remained consistent across groups and frequencies.

Conclusion: MLR responses collected simultaneously with ABR recordings show similar changes in amplitude and latency across frequency, intensity and hearing loss. This robustness near threshold supports the MLR's use in hearing assessments, while its resilience to hearing loss suggests potential value for suprathreshold testing.

41. Reflections on how to establish a reliable fNIRS protocol to study auditory cortical responses in children (Abstract #51)

Lucianar Macedo de Resende, Debora Marques de Miranda Rebecca Chrispim Silva, Ana Kelly Barbosa Oliveira, Silmara Abreu Melgaço, Suellen Rosa Oliveira, and Rickson Mesquita

Background: Research regarding fNIRS and auditory stimulation need standardized strategies to ensure that data are interpretable and comparable. This study discuss suggestions to improve fNIRS collection and interpretation based on preliminary research findings.

Methods: 19 fNIRS recordings from normal hearing children aged 1 to 4 years were analyzed. A combination of 32 sources and 32 detectors was positioned bilaterally on the

head to yield 92 source-detector combinations. The acquisition was recorded through NIRScout Tandem 1616 (NIRx, Germany). Three sound stimuli were presented at 65dB SPL: pure tone, International Speech Test Signal, infant storytelling, with durations varying from 5 to 20 seconds, alternating with random durations of silence. Data analysis consisted of pruning the low signal-to-noise ratio channels, correcting motion artifacts of the remaining channels, and identifying the activated channels for each task using a general linear model framework.

Results: Preliminary analysis showed an unsystematic activation within the channels and children across the stimuli, which evidenced a lack of a clear activation pattern. Out of all stimuli, storytelling led to a more pronounced activation in the temporal and parietal areas, whereas the pure tone was the least informative.

Conclusion: Auditory activation patterns in children may be quite variable. To establish a reliable protocol one should consider acquisition parameters, such as type of stimuli, and defining regions of interest when working with fNIRS may offer a comprehensive interpretation of neural response to sound. Focusing on deoxyhemoglobin (HbR) may enhance the accuracy of fNIRS data interpretation and reduce the impact of confounding systemic variables.

42. Reducing artifacts in oVEMP Testing: A comparative analysis of ground electrode positions (Abstract #73)
Leila Moore

Enhanced amplitude of oVEMP responses has been seen with use of a reference electrode on the medial canthus (MC). Past researchers have found that the contralateral MC, relative to stimulus presentation, is not electrically indifferent and have proposed that amplitudes are enhanced due to the presence of inverted responses recorded from the MC. However, if the ipsilateral MC is also electrically indifferent is unknown. We tested 20 healthy female participants (ages 19–36) using an 8-channel evoked potential system. Each participant completed oVEMP testing with the active electrode placed at the infraorbital midline and three different reference positions: 1) ipsilateral MC, 2) contralateral MC and 3) high forehead (Fz). Configurations were also assessed using these three locations as the active recording site. Overall, responses were present in 28% of contralateral MC and 37.5% of ipsilateral MC recordings, which was not statistically significant ($\chi^2(1)=0.643$, $p=0.424$). Additionally, responses were present on 18% of recordings from Fz. Notably, only 60% of waveforms recorded from the MC were inverted. These results suggest that reference contamination may exist when using a reference electrode placed on the ipsilateral or contralateral MC and polarity of response may impact response amplitude.

43. Impact of an interaural place of stimulation mismatch on the binaural interaction component in single sided deaf and bilateral CI users (Abstract #21)
Sebastian Roth, Franz-Ullrich Müller, Julian Angermeier, Antje Aschendorff, Thomas Wesarg, Werner Hemmert, and Stefan Zirn

Background: The DN1 amplitude of the binaural interaction component (BIC) is known to alternate with different interaural mismatches like interaural time difference and level difference. As Sammeth et al. (2023) have shown, it is also sensitive to interaural frequency mismatch in normal hearing listeners. Therefore, the relatively large interaural place of stimulation mismatch between electrical and acoustic stimulation in single sided deaf cochlear implant (SSD CI) users (Bernstein et al., 2021) could have a comparable effect on

the DN1 amplitude.

At IERASG 2023, we showed that increasing interaural place of stimulation mismatch reduces DN1 amplitude in a subgroup of SSD CI users. In addition to the ongoing measurements with SSD CI users, we also included BiCI users as a reference group with bilateral electrical stimulation (Hu and Dietz, 2015).

Methods: For the SSD-CI users we adjusted our stimulation signal to a NB-Chirp to get a greater and more reliable auditory brainstem response. Furthermore, we automated our pretests and control the acoustic and electrical stimulation for both groups now with the Nucleus Implant Communicator (NIC) software.

Results: Preliminary data show a reproducible DN1 amplitude in two BiCI users over a broad range of electrodes. One SSD-CI users measured with the adjusted method also showed a comparable DN1 amplitude over a broad range of electrodes.

Conclusion: BIC measurements are possible for a subgroup of SSD-CI and BiCI users. The results indicate that BIC tuning appears to be spectrally broad in both groups of listeners.

44. Towards closed loop cochlear implant fitting based on intracochlear cortically auditory evoked potentials (Abstract #131)
Jonas Althoff and Waldo Nogueira

For individuals with profound hearing loss, cochlear implants (CIs) improve access to sounds that support speech perception. CI effectiveness depends on fitting stimulation parameters, particularly audibility thresholds and the loudest comfortable sound. These parameters are typically based on subjective patient feedback, highlighting the need for objective loudness measures.

Previous studies have examined electrically evoked compound action potentials (eCAPs) to estimate stimulation thresholds. eCAPs are easily measured using CI electrodes without extra hardware. However, their correlation with perceived loudness remains uncertain. More recently, cortical auditory evoked potentials (CAEPs) have shown a strong correlation with behavioral hearing thresholds (Mao et al., 2018). CAEPs, typically recorded via EEG, require additional hardware, making routine clinical use challenging. Recent studies suggest intracochlear EEG (iEEG) can record cortical responses from contralateral CI electrodes (Aldag et al., 2022; Bell-Souder et al., 2024).

This study measured eCAPs and CAEPs in five Advanced Bionics CI users at eight behaviorally determined loudness levels, ranging from threshold to uncomfortably loud. Neural responses were recorded via EEG and iEEG. A loudness growth function was derived to assess correlations between loudness levels and neural responses.

Similar to Mao et al. (2018), our results suggest CAEPs could serve as a reliable clinical threshold estimate. Pilot iEEG-CAEP recordings indicate feasibility but are affected by CI artifacts. Further research is needed to refine iEEG recording systems for clinical application.

45. Investigating the link between speech-in-noise perception, hearing loss, and cognitive function in older adults (Abstract #127)
Sankalpa Mahadev, Hari Prakash Palaniswamy, and Bellur Rajashekar

Background: Older adults with hearing loss often struggle with Speech-in-noise (SiN) perception, which may affect cognitive functions. However, the mechanisms connecting these are not well understood. This study aimed to explore these relationships using behavioral and electrophysiological measures, along with advanced statistical techniques

Method: Forty older adults participated in the study: 20 with mild to moderate sensorineural hearing loss and 20 age- and education-matched normal-hearing controls. All participants underwent comprehensive audiological assessments and cognitive evaluations. SiN perception was assessed through a speech-in-noise task, while cognitive abilities were measured using working memory tasks (n-back) and attention networks (ANT). Event-related potentials (ERPs) were recorded using a 32-channel EEG system during this process.

Results: Correlation analysis showed significant links between SiN and cognitive performance, indicating that poorer SiN perception is associated with longer reaction-times and decreased ERP amplitudes. A regression model with electrophysiological predictors explained 63.8% of the variance in SiN perception, outperforming a behavioral-only model. The 1-Back test amplitude was the strongest indicator. Mediation analysis showed SiN perception significantly mediated the impact of peripheral hearing thresholds on the 1-Back amplitude, accounting for 83.1% of the total effect. However, the reverse mediation model was not significant. This highlights the role of central auditory deficits in cognitive decline, with SiN perception as a key intermediary between peripheral hearing loss and cognitive function.

Conclusion: The study provides strong evidence that hearing loss, particularly deficits in SiN perception, independently contributes to cognitive decline, while controlling for age and education.

46. Transient disappearance of otoacoustic emissions after conventional hearing aid use in OTOF-related auditory neuropathy: A literature review and case report (Abstract #107)
Sabrina Bouzaid, Isabelle Rouillon, and Natalie Loundon

Introduction: Auditory neuropathy spectrum disorders (ANSD) due to OTOF mutations are characterized by prelingual hearing loss, absent auditory brainstem responses (ABR), but preserved otoacoustic emissions (OAE). This pattern reflects synaptic dysfunction between inner hair cells and the auditory nerve, while outer hair cells (OHCs) remain functional. However, the long-term stability of OAEs in OTOF-related ANSD remains unclear.

Methods: A literature review on OAE stability in OTOF-related ANSD was conducted. Additionally, we report two clinical cases where patients with initially robust OAEs experienced a progressive disappearance of emissions after prolonged use of conventional hearing aids. OAE monitoring was performed after hearing aid discontinuation to assess reversibility.

Results: In both cases, OAEs disappeared progressively with hearing aid use but reappeared several weeks after discontinuation. This suggests a possible impact of amplified sound on OHC function, potentially via cochlear impairment, basilar membrane regulation, or middle ear effects.

Conclusion: The transient loss and recovery of OAEs after hearing aid use raises questions

about their role as biomarkers for OHC integrity and suggests possible modulation of peripheral auditory responses by amplification. Close audiological monitoring is needed to optimize management in OTOF-related ANSD.

47. Auditory Brainstem Response with NB CE-Chirp® LS in normal hearing infants (Abstract #67)

Diego Ormundo and Doris Ruthy Lewis

Background: NB CE-Chirp® LS was developed to synchronize the triggering of inner hair cells when a specific region of the basilar membrane is stimulated. Clinically, this mechanism evokes a robust wave V in the ABR, which improves the detectability of the electrophysiological response, especially at low levels. Therefore, this study aimed to investigate ABR thresholds with NB CE-Chirp® LS, and its amplitude and absolute latency in normal hearing infants.

Methods: ABR was performed with Eclipse EP25 system. NB CE-Chirp® LS of 500, 1000, 2000 and 4000 Hz was delivered using ER-3A insert earphone. ABR threshold was defined as the lowest intensity with a recordable wave V, accompanied by an absent response 5 dB below.

Results: Eighteen normal hearing infants were evaluated. ABR threshold (dB nHL) mean and Standard Deviation were: 23.8 (\pm 4.2); 14.4 (\pm 5.7); 6.0 (\pm 5.0); and 7.0 (\pm 5.9). Absolute latency (ms) mean and Standard Deviation were: 8.86 (\pm 1.12); 9.21 (\pm 0.95); 9.44 (\pm 0.78); and 9.64 (\pm 0.52). Amplitude (nV) mean and Standard Deviation were: 0.123 (\pm 0.035); 0.127 (\pm 0.039); 0.141 (\pm 0.052); and 0.105 (\pm 0.028) respectively for 500, 1000, 2000 e 4000 Hz.

Conclusion: ABR threshold with NB CE-Chirp® LS reaches low levels, in special for high frequencies. It provides absolute latencies similar between frequencies and robust amplitude. These results give to examiner more confidence in the peak-picking wave V, improving the demarcation of the ABR threshold, as well as the audiogram estimation.

48. Impact of extended high-frequency hearing loss on neural and behavioral temporal processing and binaural hearing (Abstract #87)

Kerry Walker, Carol Sammeth, Nathaniel Greene, and Daniel Tollin

Background: Successful binaural hearing, including speech understanding in noise, requires a precise encoding of ear-specific auditory cues, such as interaural level and timing differences. Reduced access to these cues can result in a variety of listening difficulties even in individuals with clinically normal hearing thresholds. Increasing reports highlight the impacts of peripheral deficits, including elevated extended high-frequency (EHF) thresholds, on suprathreshold listening tasks in noise and temporal processing. This preliminary study investigates the impacts of EHF hearing on temporal processing and binaural hearing tasks and several neural markers representing encoding across the auditory pathway.

Methods: As an extension of a larger study examining the impact of aging on binaural hearing, subjects completed behavioral assessments of temporal processing and spatial speech-in-noise. Subjects also completed several electrophysiological measures including the auditory brainstem response/Binaural Interaction Component (ABR/BIC), speech-evoked frequency following response (sFFR), and the Interaural Phase Modulation Following Response (IPM-FR). All subjects had normal hearing thresholds from 250-4000

Hz bilaterally.

Results: Preliminary analysis reveal that subjects (n=9) with EHF loss performed significantly worse on spatial speech in noise and temporal fine structure sensitivity tasks. Spectral analysis of evoked responses also reveals that subjects with EHF loss exhibit poorer sub-cortical phase locking (sFFR) and cortical representations of binaural cues (IPM-FR) despite normal hearing thresholds for the frequencies comprising these measurements.

Conclusion: Impacts of EHF loss were observed on both behavioral and electrophysiological measures of temporal processing and binaural hearing thus highlighting the importance of EHF assessments as a potential marker of sub-clinical listening difficulties.

49. Identifying neurophysiological biomarkers of adaptation to noise (Abstract #56)

Joaquin T. Valderrama, Francisco Sánchez-Martínez, Miriam Marrufo-Pérez, and Enrique Alejandro Lopez-Poveda

Background: '*Adaptation to noise*' refers to the auditory system's ability to adjust its settings to optimise the neural encoding of sounds in noisy environments, thereby enhancing speech comprehension in challenging acoustic venues such as cafés and shopping centres. Non-invasive biomarkers could provide insight into the neural mechanisms underlying this process, potentially improving the diagnosis of speech-in-noise hearing difficulties. The aim of this study was to investigate behavioural and neurophysiological markers of adaptation to noise, exploring its time course and potential neural origins.

Methods: Speech intelligibility thresholds (50% recognition) were measured in 15 normal-hearing adults (8 males; 19–46 years) for words presented at three time points after the onset of speech-shaped noise: 50 ms (early), 800 ms (middle), and 1600 ms (late). Auditory brainstem responses elicited by 50 ms click-trains were compared for trains presented 50 ms and 800 ms after the noise onset at +5 dB SNR.

Results: Speech intelligibility thresholds improved by 2.4 dB and 2.9 dB in the middle and late conditions, respectively, compared to the early condition, indicating behavioural adaptation to noise. Neurophysiological data collection is ongoing (2 participants tested, with >10 participants expected by June 2025).

Conclusion: The observed improvements in speech intelligibility suggest a significant adaptation effect, and help characterise its activation time constant. Preliminary neurophysiological results support the feasibility of the study design and may provide insights into whether adaptation to noise occurs at the midbrain level or in auditory processing centres.

50. Examining EEG correlates of tinnitus in mild to moderate hearing loss (Abstract #66)

Kayla Cormier, Carly Schimmel, Vinaya Manchaiah and Anu Sharma

Background: This study aimed to identify EEG differences in individuals with mild to moderate hearing loss with and without tinnitus, focusing on the P300 event-related potential (ERP). The P300 reflects cognitive processes such as attention. Prior research indicates auditory P300 responses may be reduced in amplitude and delayed in latency with tinnitus, and similar trends have been observed with hearing loss. However, visual P300 measures are less studied, and findings have been mixed regarding their sensitivity to

tinnitus. Our goal was to better understand neurocognitive differences in the hearing loss and tinnitus population.

Methods: Participants included older adults with mild to moderate hearing loss (9 with tinnitus, 6 without). EEG was recorded using a 128-channel cap. Auditory stimuli included a frequent 500 Hz tone and a rare 1000 Hz tone, while visual stimuli included a frequent “O” and a rare “X.”

Results: Preliminary results show visual P300 amplitudes were significantly reduced in the tinnitus group. N2 amplitudes in both auditory and visual oddball paradigms were larger in individuals with tinnitus. Furthermore, auditory P300s demonstrated amplitude changes over the first year of hearing aid use only in participants without tinnitus.

Conclusions: In this small dataset, tinnitus was associated with distinct ERP differences, including reduced visual P300 and enhanced auditory and visual N2 amplitudes. Larger N2 amplitudes may reflect heightened auditory attention. Furthermore, a lack of change in auditory P300 amplitudes following hearing aid use in the tinnitus population suggests future studies should consider tinnitus in evaluating ERP changes due to amplification.

51. Exploring amplitude growth functions of Auditory Steady-State Responses (ASSR) in adults with normal hearing. (Abstract #129)
Abdallah Alomiri, Steve Bell, and David Simpson

Background: The Auditory Steady-State Response (ASSR) is an electrophysiological measure used to objectively estimate hearing thresholds by recording periodic neural responses to modulated auditory stimuli. ASSR enables simultaneous assessment at multiple frequencies, significantly reducing testing duration, particularly beneficial for populations with limited cooperation, such as infants or sedated patients. Cortical-generated responses at approximately 40 Hz modulation frequency diminish during sleep or sedation, whereas subcortical-generated responses at around 80 Hz remain relatively stable.

Objective: This study aimed to compare amplitude growth functions of ASSRs at both modulation frequencies in adults with normal hearing to examine differences between cortical and subcortical auditory processing.

Methods: Twenty-two adults (aged 18–37 years) with normal hearing thresholds participated. ASSRs were elicited using amplitude-modulated stimuli at modulation rates of 40 Hz and 80 Hz, delivered through ER-2 insert earphones. EEG recordings were acquired using an Interacoustics Eclipse system integrated with Cambridge Electronic Design hardware. Data analysis was conducted offline in MATLAB.

Results: Signal amplitudes at both modulation frequencies systematically increased with stimulus intensity, indicating enhanced neural synchrony. The amplitude growth exhibited frequency-dependent characteristics, with higher frequencies demonstrating steeper amplitude increases than lower frequencies. Significantly, the 40 Hz modulation consistently yielded larger amplitudes across frequencies, particularly at higher intensities. Conversely, the 80 Hz modulation produced lower yet stable amplitude growth.

Conclusions: The preliminary results highlight distinct amplitude growth characteristics for cortical and subcortical ASSR responses. Further comparative analyses with Pure Tone

Audiometry are required to validate these findings and enhance the clinical applicability and accuracy of ASSR in adult populations.

52. Cortical responses reveal effortful access to interaural level cues in children with bilateral cochlear implants (Abstract #84)

Karen Gordon, Lulia Snan, Angela Fung, Jaina Negandhi, Blake Papsin, and Sharon Cushing

Background and Rationale: Children using bilateral cochlear implants (BCIs) perform ILD lateralization tasks despite abnormal cortical processing of Interaural level differences (ILDs). Present aims were to identify cortical detection and attentive discrimination of ILDs underlying the behavioral results in these children.

Methods: Multi-channel electroencephalography measured cortical responses evoked by 40 Hz amplitude modulated tones (1 kHz) delivered to BCIs through a research system. Study 1: 2s presentations in which ILD was switched from 0 dB at 1s to 4, 10, or 20 dB in 24 children using BCIs (13.8 ± 3.0 years of age) and peers with typical hearing (TD) ($n=8$, 14.0 ± 2.6 years of age). Study 2: shorter durations (50 ms) delivered in an oddball paradigm (ILD=0 in 70%, ILD=16 dB in 30%). Twelve children with BCIs (14.51 ± 2.21 years of age) and TD peers (15.33 ± 1.18 years of age) were asked to press a button upon each deviant presentation.

Results: Study 1: Cortical ILD sensitivity was measured by increasing amplitude areas with increasing ILD and behavioral lateralization of ILDs. Asymmetric BCI levels reduced both cortical and behavioral sensitivity to ILDs ($p < 0.05$). Study 2: Expected P300 peaks occurred later in the BCI than TDs; amplitude areas increased with response accuracy ($p = 0.04$) and tended to decrease with response time ($p = 0.07$) in the BCI group.

Conclusions: Despite abnormal binaural processing in children with BCIs, their brains remain adept at detecting and discriminating changes in ILDs with effort. These measures have potential for use in clinical programming of BCIs.

53. Processing of binaural envelope and fine-structure interaural-time-difference cues along the auditory pathway in typical-hearing adults (Abstract #104)

Aditi Gargeshwari, Lulia Snan, G. Nike Gnanateja, Karen Gordon, Mohammad Maarefvand, and Ruth Y. Litovsky

Objectives: This study investigates cortical processing of interaural timing differences (ITDs) in typically hearing (TH) listeners as a foundation to determine neural mechanisms underlying ITD processing in individuals with bilateral cochlear implants. Of interest are neural signatures of ITDs in temporal fine structure (TFS) versus envelope (ENV) ITDs as these cues are accessed differently through cochlear implants.

Methods: TH participants [mean age (SD): 21.8years (1.64)] heard 50ms TFS (100pulses/sec) and ENV (4000pulses/sec modulated at 125Hz) stimuli. Electroencephalography (EEG) responses were recorded at 64-cephalic electrodes during passive or active listening. A deviant stimulus (ITD=750 μ s) occurred on 25% of trials in random order amidst standard stimuli (ITD=0). Accuracy and reaction-times to the deviant ITDs and behavioral just-noticeable-differences (JNDs) were compared with cortical responses.

Results: Attention-related enhancement was observed in early cortical sensory processing (P1 and N1 amplitudes) for the TFS-ITD cues ($p < 0.05$). Later cortical processing (P2), associated with attentional processing and object formation, showed enhancement for ENV-ITD cues ($p < 0.05$). The active attentional response associated with auditory discrimination (P300) was larger for TFS than ENV cues ($p < 0.001$). P300 amplitudes correlated with smaller JNDs ($p < 0.01$), faster reaction times ($p < 0.05$), and greater accuracy ($p < 0.01$) for TFS-ITDs than the ENV-ITDs.

Conclusions: Findings suggest increased attentional demands for ENV-ITD processing. This highlights differential processing of binaural spatial-mapping cues in the time domain in TH listeners. This study offers insights beyond outcomes of behavioral methods, laying foundation for future investigations of binaural processing in cochlear implant users.

54. Effect of noise and cognitive demands on neural processing of acoustic and phonological features (Abstract #125)

Dhatri Sadholalu Devaraju, Hannah Tenpas, Mary Scott, Advait Krishnan, and Nike Gnanateja Gurindapalli

Background: Speech and language processing in presence of noise exerts additional effort on cognitive processes (attention and working memory) based on Ease of Language Understanding model. Most of the studies evaluating effects of top-down factors on phonological processing have used dual-task paradigms involving both auditory and visual modalities. We adapted an auditory n-back task where the cognitive demands are manipulated in auditory modality and the responses do not require overt speech production, which is compromised in individuals with communication disorders. Electroencephalography (EEG) along with modern machine-learning approaches provides an excellent opportunity to assess the temporal dynamics of cognitive effects on phonological processing, especially in the presence of noise.

Methods: We recorded EEG in ten participants from 64 electrodes placed on the scalp while the participants listened to words and nonwords in quiet and noise conditions. Participants performed a passive listening task, a no-back task, and a 2-back task, which required different levels of sustained attention and working memory demands. All the participants were 18-30 years old, had normal hearing thresholds and normal cognitive functioning.

Results: The results show suppression of amplitude at around 200 ms for non-words compared to words. The neural encoding of speech is enhanced during sustained attention and working memory demands. However, the neural encoding of speech is reduced in presence of noise.

Conclusion: Understanding these mechanisms is beneficial in disentangling the role of cognitive factors in speech and language processing in noise, which is critical to develop evidence-based intervention strategies in individuals with speech and language disorders.

55. Short-term neural adaptation is modulated by attention in younger adults but not older adults (Abstract #24)

Anoop Basavanahalli Jagadeesh and Ajith Kumar Uppunda

Background: Neural adaptation, the reduction of neural response to repeated stimuli, plays an important role in auditory perception. Despite reports of older adults exhibiting less efficient adaptation to repetitive sounds, the impact of attention on auditory aging remains understudied. This study examines age-related differences in neural adaptation driven by attention.

Method: A total of 58 participants with clinically normal hearing in both ears (4-frequency PTA < 15 dB HL) were recruited and categorized into two age groups: the Young Normal Hearing (YNH) group (18–35 years, n = 28) and the Older Normal Hearing (ONH) group (50–75 years, n = 30). CAEPs were recorded from each participant in response to disyllabic speech sounds presented using a 256-channel EEG equipment under two attention conditions – active attention (button press) and passive attention (watching muted video). After pre-processing the raw EEG data, mean N1 amplitudes of the first 30 and last 30 sweeps were calculated separately for each attention condition for both groups.

Results: RM-ANOVA revealed significant main effects of Attention and Sweeps, with no significant group effects or interactions. Post-hoc comparisons (Bonferroni-corrected) showed that N1 amplitudes were larger in the first 30 sweeps than the last 30 sweeps under active attention. Additionally, N1 amplitudes were greater in the active than passive condition during the first 30 sweeps. No other comparisons reached significance.

Conclusion: Active attention likely leads to a stronger modulation of cortical neural adaptation in YNH that is not observed in the ONH group. This shows that aging negatively alters neuro-cortical modulation

56. Psychoacoustical and electrophysiological assessment of relative masking level for a broadband chirp and a broadband masker (Abstract #78)
Jan Hots and Jesko Verhey

Background: For an estimate of an average hearing threshold across frequency, broadband (BB) chirps are nowadays often used in brainstem evoked response audiometry (BERA), since larger responses are evoked compared to, e.g., clicks. The minimum masker level relative to the signal level necessary to prevent cross hearing, i.e. the relative masking level (RML), was previously estimated for clicks, but data for chirp are still lacking. The aim of the present study is to fill this gap and provide RML for broadband chirps in broadband masking noise.

Methods: RML of a BB chirp was measured in normal-hearing listeners using a psychoacoustical paradigm and a clinical BERA-system. The chirp was presented via a bone-conductor, the noise was presented using insert phones. To mimic an asymmetric hearing loss, a noise with a high-enough level was presented ipsilaterally, so that the chirp was inaudible in that ear. The RML was estimated for a masking noise in the contralateral ear. In the psychoacoustical task, the monaural RML was additionally measured where masker and signal were presented via insert phones.

Results: Monaural RML were independent of signal level and interindividual differences were small. Larger interindividual differences were found in the bone-conduction condition. The RML using BERA are comparable to those found in the psychoacoustical task.

Conclusion: The RML determined in the study may be used in the clinical routine in whenever cross hearing is likely to occur.

57. Evaluation of auditory evoked potential biomarkers of cochlear synaptopathy in listeners with self-reported hearing difficulties (Abstract #50)

Matthias Inghels, Sarah Verhulst, Attila Frater, Ingeborg Dhooge, and Iris Arweiler

Background: Cochlear synaptopathy (CS), the loss of auditory nerve synapses due to aging, noise damage or ototoxicity, is expected to be prevalent in a large part of the population. Recent advancements make it possible to assess the degree of CS with an EFR measurement.

Methods: To assess CS, we used an EFR to a rectangularly amplitude modulated (RAM, 110 Hz) 4 kHz pure presented at 70 dB SPL intensity. The EFR marker of CS, an ABR, speech-in-noise intelligibility thresholds (SRT), and a self-reported hearing difficulty score (HHIE-s questionnaire) are collected from 86 patients aged 18-87. The control group has normal audiograms and an HHIE-s score ≤ 4 , the test group had an HHIE-s score > 4 .

Results: EFRs recorded at 70 dB SPL were significantly smaller in participants with self-reported hearing issues and correlated with their HHIE-s scores. Across all participants, EFR strength declined with age, indicating reduced temporal envelope coding regardless of hearing complaints. In the control group, EFR strength showed no relation to audiometric thresholds or SRTs, suggesting that their stronger EFRs were not tied to hearing ability. In contrast, among those with hearing deficits, weaker EFRs were significantly linked to reduced audibility and poorer SRTs. Overall, EFR markers proved more sensitive than ABR wave-I and -V amplitudes.

Conclusion: Our results show that EFR stimuli are promising markers to assess the degree of synaptopathy in clinical practice. Using this as a diagnostic tool, hearing aids can be developed to take into account the CS related hearing difficulties.

58. Cochlear Implantation in the Elderly: Speech Performance, Associated Factor, Complication, and Surgical Safety

Lee, Kyu-yup - Primary Author

The number of CI procedures performed on the elderly is increasing. The purpose of this study was to analyze the results and safety of cochlear implantation in the elderly, as well as to evaluate the predictive factors on CI outcomes.

The study included 56 patients aged ≥ 40 years, who received CIs between 2009 and 2020. They were divided into two groups: 27 younger adults (40-64 years) and 29 elderly (> 64 years). The study compared their pre- and postoperative speech perception and category of auditory performance (CAP) scores, surgical complications, and hospitalization periods. It also evaluated associated factors in the elderly group by examining categorical and continuous variables and postoperative CAP score.

There was a significant improvement in speech recognition tests (both word and sentence) and CAP scores in both groups compared to the pre-implantation scores ($p < 0.001$). No significant associated factors were found on postoperative CAP scores, except for etiology. Postoperative CAP significantly improved in the sudden hearing loss group compared to the groups with other etiologies ($p = 0.045$). The elderly group had more comorbidities than the

younger adult group ($p=0.026$), but there were no significant differences in postoperative complications and hospitalization periods.

While speech recognition and CAP scores were relatively lower in the elderly group compared to the younger adults, the elderly group showed significant improvements in audiological results after CI. Moreover, CI was safe and well tolerated in elderly patients.