**Session:** CS1-3  
**Title:** Pediatric Cochlear Implantation: Referral Patterns and Expanding Indications  
**Presenting Author:** Elizabeth Preston, AuD  
**Author Block:**  
Elizabeth Preston, AuD, Lisa Park, AuD, Hannah Eskridge, MSP, LSL CERT, AVT, Kevin Brown, MD, PHD; Otolaryngology, UNC, Durham, NC.

**Abstract:**

**Introduction:** Pediatric cochlear implantation continues to expand to children with residual hearing and with unilateral or asymmetric hearing losses who are not benefitting from well fit hearing aids. Centerwide guidelines were recently established using evidence-based audiometric criteria for referral to the cochlear implant (CI) team. We completed a retrospective study of children seen across our diagnostic clinics over the course of the last 5 years who met the newly established referral criteria to establish benchmarks and identify barriers to referrals for children with hearing loss who do not meet traditional criteria, but could potentially benefit from cochlear implantation.

**Methods:** The audiogram software database was queried to identify pediatric patients with sensorineural or permanent mixed hearing loss who were tested between January 1, 2014 and October 1, 2019 and had not yet received a CI. Subjects were included in the final analysis if they met the following criteria in at least one ear: Pure tone average (PTA) at 500, 1000, and 2000 Hz of > 65 dB HL, high frequency PTA at 2000, 4000, and 8000 Hz of > 70 dB HL, aided word recognition score of < 60%, or a PBMax score lower than the 4 frequency PTA minus 8 as established by Hoppe et al. (2015). There were 869 children included in the analysis. A binomial logistic regression was completed with referred vs not referred as the dependent variable.

**Results:** The overall model was significant (p < .001), and correctly classified 81.6% of cases. When controlling for all other factors, eight variables were statistically significant for predicting referral: race, insurance, PTA in either ear, age at the most recent visit, physician, inquiring about a CI, and the hearing loss category. Neither gender, county income, distance, audiologist, time between visits, speech and language co-treatment, year last seen by a physician, nor family reluctance to pursue a CI predicted referral. Children with severe-to-profound hearing loss in both ears were referred at high rates (91%), followed by children with severe-to-profound hearing loss in one ear who met non-traditional candidacy guidelines in the other (82%). Children with asymmetric loss, bilateral moderately-severe or severe loss, and single-sided-deafness were referred at lower rates (34%, 27%, and 26% respectively). As a whole, 48% of the children who met the current clinical candidacy guidelines were referred for a CI evaluation. Of those referred, 90% were seen and a CI was recommended for 97% of those children.

**Conclusion:** Pediatric patients were more likely to be referred for a cochlear implant evaluation if they were non-white, had private insurance, had more hearing loss in either ear, were younger, saw a current neurotologist, had a severe-to-profound hearing loss in at least one ear, or had parents who had asked about a CI. A large percentage of children meeting non-traditional clinical candidacy criteria were not being referred for a cochlear implant evaluation during the study period. The majority of those being referred meet traditional criteria of bilateral severe-to-profound hearing loss. Results of this study will be used to better serve our population of children with hearing loss.
Session: CS1-3
Session: Pediatric Cochlear Implantation
Title: Visual Processing of Static Facial Expressions by Adolescents with Cochlear Implants
Presenting Author: Delaney Evans, PhD
Author Block:
Delaney Evans, PhD, Andrea Warner-Czyz, PhD, Lyn Turkstra, PhD, Meredith Schepple, MSc, Julia Evans, PhD; The Univ. of Texas at Dallas, Richardson, TX.
Abstract:
Introduction: Adolescents with severe to profound hearing loss using a cochlear implant (CI) experience lower peer acceptance and higher rates of peer victimization than adolescents with typical hearing (TH). These peer problems may result from deficits in social dynamics including difficulty perceiving and processing linguistic cues, visual cues (e.g., facial expressions), or auditory cues (e.g., prosody of speech). Compensatory listening strategies such as lipreading assist CI users in word understanding; but inherent biases to visual affect cues in the lower half of the face may affect processing of emotions that require integration of cues from multiple regions of the face. This study uses eye-tracking methods to explore the visual attention patterns of adolescents with CIs and peers with TH when processing facial expressions on a static, visual emotion recognition task.
Methods: Participants included adolescents with CI (n = 34) and adolescents with TH (n = 24) ranging in age from 10 to 18 years. For the adolescent CI users, age at first CI ranged from 0.6 to 10 years and duration of CI use ranged from 1.9 to 16.6 years. All participants viewed static images of 4 individuals expressing 6 emotions (happiness, anger, sadness, fear, surprise, and disgust) and labeled the emotions displayed in each photograph from a closed-set list. During the visual emotion recognition task, participants’ fixation patterns were recorded via eye tracking to examine visual attention patterns to the eyes, mouth, and other regions of each facial expression.
Results: Both groups demonstrated similar visual attention to the eye regions of faces during the emotion recognition task. However, adolescent CI users attended significantly more to the primary emotion regions (i.e., eyes, mouth) when processing facial expressions of sadness, surprise, and disgust (p < .01). Time course data revealed qualitative differences between the CI and TH groups in fixation patterns to the eye, mouth, and other regions for each emotion type. A greater proportion of adolescents with CI fixated on the mouth beginning 500 milliseconds into the stimulus presentation - a pattern that differed from adolescents with TH.
Conclusion: Adolescents with CI are as effective as TH peers in identifying full-intensity static facial expressions but show different visual attention patterns. More CI users fixated on regions of the face frequently associated with expression and recognition of emotion (i.e., eyes, mouth) during real-time emotion processing than peers with TH. These results suggest that CI users rely on a visual processing strategy that emphasizes the mouth. Qualitative differences in looking pattern could detract from the CI user’s ability to perceive more complex social and emotional information in the timely and efficient manner necessary for successful interaction with peers. Knowledge of the effect of CI on emotion recognition could lead to more effective and efficient therapeutic intervention related to social deficits in adolescents with CI.
Session: CS1-3
Session: Pediatric Cochlear Implantation
Title: The Impact of Language and Demographic Factors on Speech Recognition of Children with Cochlear Implants
Presenting Author: Jace Wolfe, PhD
Author Block:
Jace Wolfe, Ph.D,1, Mickael Deroche, PhD2, Sara Neumann, AuD1, Vincent Gracco, PhD3, Lindsay Hanna, M.S.4, Will Towler, B.S.1, Alex Bien, M.D.5, Caleb Wilson, B.S.5;1Hearts for Hearing, Hearts for Hearing, OKLAHOMA CITY, OK, 2Concordia Univ., Montreal, Canada, 3Haskins Lab., New Haven, CT, 4Hearts for Hearing, Heart for Hearing, OKLAHOMA CITY, OK, 5Univ. of Oklahoma, OKLAHOMA CITY, OK.
Abstract:
Introduction: A high level of variability exists in the speech recognition outcomes of children with cochlear implants (CI). The primary objective of this study was to determine the impact of spoken language aptitude and demographic factors on the speech recognition of children with CIs. Word and sentence recognition in quiet and sentence recognition in noise were evaluated with the use of a contemporary battery of speech recognition measures (Pediatric Minimum Speech Test Battery - PMSTB - Uhler et al., 2017). A secondary objective of this study was to compare the speech recognition outcomes of children with CIs to age-matched children with typical hearing.
Methods: Fifty CI recipients, ages 7-17 years old, and 25 age-matched children with typical hearing were evaluated in this study. Twenty-five of the children with CIs had age-appropriate spoken language development (i.e., High Language Group, as indicated by a standard score of 100 or greater on the Core Language portion of Clinical Evaluation of Language Fundamentals [CELF] test), whereas twenty-five children of the children with CIs had delays in their spoken language development (i.e., Low Language Group, as indicated by a CELF score < 85). Speech recognition was evaluated with procedures recommended by the PMSTB. Word recognition in quiet was evaluated with the CNC monosyllabic words presented at 60 dBA. Sentence recognition in quiet and in noise were evaluated with AzBio sentences. Sentence recognition in noise was assessed at a +5 and +10 dB signal-to-noise ratio (SNR). Demographic variables were collected through retrospective chart review and included: chronological age at test, age at implantation, age at first hearing aid, percentage of auditory-verbal therapy appointments kept, percentage of audiology appointments kept, and daily data logging information. Prediction models examined relationships among demographic variables and speech recognition performance.
Results: Speech recognition in quiet and noise was significantly poorer in the Low Language compared to the High Language group. However, the difference in word recognition scores obtained by the two groups was not as large as the difference in sentence recognition scores in quiet, a finding that suggests that language may have a larger effect on sentence recognition scores than word recognition scores. Furthermore, even larger differences were observed in sentence recognition in noise scores between the Low and High Language groups, particularly at the +5 dB SNR. The poorer sentence recognition in noise scores of the children with poorer language outcomes may be attributed to language delays and/or deficits in auditory processing. The speech recognition scores in quiet and in noise of the High Language group were similar to that of age-matched peers with typical hearing. Greater hours of implant use were associated with higher speech recognition in quiet and noise. Better adherence to auditory-verbal therapy appointments was also associated better speech recognition outcomes.
Conclusion: Speech recognition in quiet and noise of children with CIs differs significantly between lower and higher language groups, a finding that indicates the importance of speech recognition in language development and also the impact of language aptitude on speech recognition. Demographic factors including percentage of attendance to auditory-verbal therapy sessions and hours of implant use contribute to speech recognition performance, especially in noise.
Session: CS1-3
Session: Pediatric Cochlear Implantation
Title: CI3s with Known Potential for Failure: Monitoring and Management in Children
Presenting Author: Ashleigh Lewkowitz, AuD
Author Block:
Ashleigh Lewkowitz, AuD, Jennifer Harris, AuD, Greg Licameli, MD; Boston Children's Hosp., Boston, MA.
Abstract:
Introduction: In late 2019 - early 2020, multiple large volume cochlear implant centers began to notice a trend of poor performance in a subset of patients with certain models of cochlear implants, the investigation of which prompted a voluntary field corrective action to be announced by the manufacturer in early 2020. The aim of this presentation is to discuss the unique clinical findings that audiologists should recognize as a potential indication of a failure in these particular devices. Additionally, our cochlear implant program has developed a monitoring algorithm for testing patients over time which is critical to support good speech and language outcomes, particularly in very young children.
Methods: Observation and monitoring of 3 key areas over time - impedances, evoked neural responses, and performance on measures of detection and/or discrimination - are critical to quickly identifying and managing failing devices. For very young children or children who are developmentally unable to reliably complete performance testing, monitoring of objective measures is weighted even more heavily. All patients implanted with devices with heightened potential for failure as outlined in the manufacturer's voluntary field corrective action are serially monitored for changes in any of the 3 key areas; should changes be observed, additional criteria have been developed to aid in determining subsequent management steps.
Results: By developing a serial monitoring plan of all patients implanted with devices included in the voluntary field corrective action, our center has been able to identify impacted recipients in a timely manner and plan next steps accordingly. While ultimately all children exhibiting signs of a failed device have been reimplanted, this algorithm provides a framework which has allowed for the possibility of temporary improvements in performance while revision is awaited. This proved especially helpful in the early days of the COVID-19 pandemic when revision surgeries had to be postponed.
Conclusion: Timely assessment and monitoring of device function and performance in children with cochlear implants with known potential for failure is imperative to limit and mitigate any potential developmental impacts of prolonged listening with a failed device. For children with these devices, clinicians should have a low threshold for requesting integrity testing and an even lower threshold for moving forward with revision should integrity testing reveal any abnormal electrode function. Depending on the developmental abilities of the child in question, consideration of soundfield detection thresholds and speech recognition testing performance and the ability to maintain that performance through mapping adjustments should also be strongly considered when discussing the timeline of revision. For children unable to participate in assessment of performance, any atypical findings on integrity testing should trigger prompt revision surgery.
Session: CS1-3
Session: Pediatric Cochlear Implantation
Title: The Impact of Cytomegalovirus Infection on Paediatric Cochlear Implantation Outcomes
Presenting Author: Eugene Omakobia, MA, MBChir, MRCS
Author Block:
Eugene Omakobia, MA, MB.BChir, MRCS, Helen Tan, MBBS FRCS, Han Cao, MBBS MRCS, Angela Cordingley, BA, David Strachan, MBBS FRCS, Simon Carr, MBBS MD FRCS;ENT, Yorkshire Auditory Implant Service, Bradford Royal Infirmary, Bradford, United Kingdom.
Abstract:
Introduction: With the recent change in UK cochlear implantation (CI) criteria, there has been renewed interest in the factors determining speech, listening and educational outcomes. We explored the impact of congenital cytomegalovirus (cCMV) infection on CI outcomes in children.
Methods: We retrospectively reviewed data for all children (<16 years) undergoing CI at our institution over a 13 year period. All patients with a history of cCMV infection were identified. An age- and gender-matched non-CMV control group was also identified. Patients with prior meningitis or syndromic hearing loss were excluded from the analyses. Specific outcome parameters including Meaningful Auditory Information Scale (MAIS), Meaningful Use of Speech Scale (MUSS), Listening Progress Score (LIP), Categories of Auditory Performance (CAP) and Speech Intelligibility Scale (SIR) were each assessed at baseline (before implantation), 1, 3 and 5 years after implantation. Results were then compared between the CMV and non-CMV groups to determine statistically significant differences.
Results: 26 children with prior CMV infection were identified. Mean age at implantation was 34.8 months, range = 13-89 months, male: female ratio = 14:12. A control group of 25 non-CMV patients was identified (Mean age at implantation = 34.4 months, range = 12-82 months, male: female ratio = 12:13. There were no statistically significant differences between the 2 groups at baseline. CAP at 5 years post implantation cCMV 5.56 vs non-cCMV 6.33 (p=0.0212) and LIP at 3 years post implantation cCMV 39.56 vs non-cCMV 42.00 (p=0.0228) all indicated poorer outcomes in the cCMV group. MAIS at 3 years post implantation cCMV 37.56 vs non-cCMV 39.60 (p=0.0936), MUSS at 5 years post implantation cCMV 33.75 vs non-cCMV 36.89 (p=0.0583) and CAP at 3 years post implantation cCMV 5.19 vs non-cCMV 5.89 (p=0.0828), demonstrated a trend towards a poorer outcome in the cCMV group, although not statistically significant.
Conclusion: This study is significantly larger than previous series and demonstrates more robust data regarding the outcomes of children with CMV. Children with congenital CMV and profound deafness, whilst benefiting from cochlear implantation have poorer outcomes than those children unaffected by CMV, particularly in terms of CAP and LIP and parents’ need to be counselled accordingly to manage expectations prior to implantation.
Title: Audiometric Outcomes In Children with Enlarged Vestibular Aqueduct  
Presenting Author: Kenan Alzouhayli, BA  
Author Block: Kenan Alzouhayli, BA, Prashant Malhotra, MD; Otolaryngology, Nationwide Children's Hosp., Columbus, OH.

Abstract:  
Introduction: Enlarged vestibular aqueduct (EVA) is an inner ear malformation that has been linked to congenital and progressive hearing loss in children. A strong correlation has not been established between vestibular aqueduct morphology and severity of hearing loss. Given speculations that this is a pressure-related phenomenon, we are creating a computational model of pressure from the intracranial compartment to labyrinth. We look for potential audiologic patterns of progression of hearing loss in children with EVA in order to correlate with EVA morphology using advanced 2D and 3D imaging biomarkers, or functional modeling.

Methods: A retrospective chart review of 175 pediatric patients who were confirmed to have an EVA diagnosis based on CT or MRI as per neuroradiology reports. Data pertaining to audiologic timeline (Universal Newborn Hearing Screening, Data of fitting hearing aid, date of cochlear implantation and last visit date) were obtained from the EMR. Audiometric data was obtained from multiple audiograms for each patient. Baseline audiogram, last audiogram, and one audiogram per year (for patients with multiple audiograms) were evaluated in order to capture possible annual trends. Frequency data (250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz) were collected and used to calculate Pure Tone Average data. Air and bone conduction data are collected. Masked bone data is used for the bone conduction data. Tympanometry data is collected and limited to Type (A, B, or C) and Volume. Finally, a Word Recognition Score is collected for each audiogram. Statistical analysis will be performed to capture significant audiometric trends associated with the progression of EVA.

Results: One hundred and six children with EVA are included in the analysis, with 25 (23.6%) having had Cochlear Implant (CI). The median ages at the first and last audiograms are 6.7 and 11.9 years, respectively. The number of audiograms per child ranged between 2 and 11. The mean change in the left ear unaided air Pure Tone Average-4 (PTA4) is 8.5 dB in bilateral EVA and 8.3 dB in left-sided EVA. The mean change in the left ear masked bone PTA4 is 3.2 dB in bilateral EVA and 4.5 dB in left-sided EVA. The mean change in the right ear unaided air PTA4 is 2.2 dB in bilateral EVA and 7 dB in right-sided EVA. The mean change in the right ear masked bone PTA4 is -4.2 dB in bilateral EVA and 15.4 dB in right-sided EVA. Individual results are described.

Conclusion: A pattern of hearing loss is seen in children with EVA. Our further analysis specifies this pattern in more details in order to correlate it with EVA morphology. Children who are not typical CI candidates but are believed to progress to hearing loss based on EVA morphology can benefit from a CI in earlier stages.
Session: CS2-1
Session: Telehealth Part I, Innovations and Developments in Audiology
Title: Evaluating the Accuracy of Speech to Text Applications for Cochlear Implant Candidates
Presenting Author: Prithwijit Roychowdhury, BS
Author Block:
Prithwijit Roychowdhury, BS, Melissa Castillo-Bustamente, MD, Dhrumi Gandhi, MS, Renata M. Knoll, MD, Matthew J. Wu, BS, Elliott D. Kozin, MD, Aaron K. Remenschneider, MD, MPH; Otolaryngology, Mass Eye & Ear, Boston, MA.
Abstract:
Evaluating the Accuracy of Speech to Text Applications for Cochlear Implant Candidates
Introduction:
The COVID-19 pandemic has had drastic impacts on communication for patients with hearing difficulties. Universal masking has become a public health priority to prevent the disease transmission; unfortunately, masks, especially N95s in the healthcare setting, may obscure facial features, muffle speech, and disrupt speech perception. This can present a major barrier to effective communication between healthcare providers and hard of hearing patients. In the hospital setting, Communications Access Real Time (CART) service is the gold-standard in assistive technologies. CART allows providers to access real-time transcription with a stenographer. However, CART is not readily accessible in all healthcare settings. Mobile speech to text (STT) applications are available to help provide captioning for patients in the absence of real-time transcription with a stenographer. There is little information about the accuracy of mobile STT applications for medical transcription purposes and no information on their accuracy when masking is utilized. Herein, we seek to investigate the accuracy of two popular STT applications (Ava 24/7 and Live Transcribe) for iOS and compare their performance to the CART service at our institution.
Methods: Six researchers tested the two STT applications. Three researchers were native English speakers and three were non-native English speakers. One of two passages (either the Rainbow Passage to assess normal speech patterns or a Cochlear Implant (CI) surgery consent to assess medical terminology) were read with and without an N95 mask. Researchers read the passage three times for each condition. The microphone for the device with the STT app was kept six feet apart from the speaker for all tests to simulate social distancing guidelines. CART testing was completed by one native English speaker and one non-native English speaker. The Levenshtein distance was used to produce an error rate from the comparison of the transcripts from each test to the original passages.
Results: The CART service had the lowest error rate of all testing conditions (1.2 – 11.1%). Ava 24/7 was found to have a significantly lower average error rate (17.9 ± 9.19%) than Live Transcribe (38.9 ± 20.1%) in all testing conditions (p < 0.05). There were no differences in the average error rate between the Rainbow passage and the CI surgery consent. While the average error rate was greater with the N95 (+ 4.93%) in all of the testing conditions, this was not statistically significant (p = 0.15). The average error rate for the STT apps was greater in the non-native English-speaking group (+ 9.24%) when compared to the native English-speaking group (p < 0.05).
Conclusion: When in the hospital setting, real-time stenography is the ideal solution to augment communication with patients who are hard of hearing. If CART is not available, a STT application such as Ava 24/7 may be considered and appear capable of medical terminology transcription.
Session: CS2-1
Session: Telehealth Part I, Innovations and Developments in Audiology
Title: Telehealth with Cochlear Implants: A Variety of Options
Presenting Author: Melissa Anderson, AuD
Author Block:
Melissa Anderson, Au.D., Hannah Eskridge, MSP; Children’s Cochlear Implant Ctr. UNC, Chapel Hill, NC.
Abstract:
Introduction: Telehealth is becoming a major part of healthcare, especially during the COVID19 pandemic. In the past, telehealth programs were designed to provide care to patients who were not able to come to the clinic due to remote locations or other reasons. However, the COVID19 pandemic has forced audiologists and other healthcare providers to adopt telehealth programs in order to maintain services and ensure patient safety. This presentation highlights the creation of a virtual clinic to increase our ability to serve pediatric patients with CI implants remotely.
Methods: A variety of telehealth programs within our Virtual Clinic were implemented and continuously reviewed over the course of a two-year period. The last year of this period took place during the COVID19 pandemic. The first program consists of a partnership program between pediatric diagnostic audiologists and our CI program. Testing was completed by the pediatric audiologist at a remote clinic and mapping was completed via telehealth by the CI audiologist at the CI Clinic. Surveys were completed by patients’ families as well as participating clinicians to measure success of this program. The COVID 19 pandemic created barriers to our first program and we designed new telehealth options for our patients. We provided virtual counseling and troubleshooting via a secure web chat. Counseling appointments included both pre and post implant counseling. Our Virtual Clinic also consisted of a two-pronged approach of virtual booth testing and a mailed tablet for programming. First, lists of CNC words were presented through a secure web chat program and scored by an audiologist. A plan was made with the patient’s family regarding follow-up. The patient could either come into the clinic to participate in a “in clinic virtual visit” or be mailed a remote programming tablet. The “in clinic virtual visit” consisted of the patient being in the clinic, but in a separate room from the clinician. The clinician would complete remote programming with the help of the family. This allowed for contactless care during the pandemic.
Results: A total of 12 patients were able to be seen in our first program prior to pausing due to COVID19. Surveys completed by families indicated 100% of satisfaction with 75% reporting it was as beneficial as coming to the clinic. The majority of families noted benefit from the reduction in travel time. When asked if they would like to continue the program 25% said yes, 50% said they would prefer a mix of telehealth and in clinic, and 25% preferred to be seen in person. The audiologists who participated in the program indicated satisfaction with the overall experience. Communication between audiologists was found to be the biggest obstacle with 50% reporting it as an issue and was refined over the course of the program. A total of 151 patients were seen in our Virtual Clinic during the pandemic. Families indicated high satisfaction with a safer way to receive care. Clinicians were able to restore their visit volume to pandemic and provide appropriate care to patients.
Conclusion: There are a variety of ways to provide telehealth for CI users. A multi-pronged approach to telehealth and remote care will help audiologists provide appropriate care to their patients. Remote programming and testing is feasible through secure web chat programs. Partnership between diagnostic audiologists and CI audiologists can help increase access to care while maintaining the overall quality of service.
Session: CS2-1  
Session: Telehealth Part I, Innovations and Developments in Audiology  
Title: Remote Cochlear Implant MAPPing: Lessons Learned During COVID-19  
Presenting Author: Kristin Dilaj, AuD, PhD

Author Block:  
Kristin Dilaj, AuD/PhD, Jennifer Cox, AuD, Alison Marinelli, AuD/PhD, Julia Garrick, AuD; New England Ctr. for Hearing Rehabilitation, Hampton, CT.

Abstract:

Introduction: Remote programming has been demonstrated to be an effective way to provide cochlear implant service. Due to our clinic reducing patient contact during COVID-19 and the continued needs of our patient population (newly implanted patients, patients working as essential workers, and equipment breakdown) our clinic put together a remote programming trial where we could continue to deliver service with audiologists programming remotely. This presentation will focus on what we learned about providing remote programming options to patients and their families.

Methods: Our clinic provided remote programming to patients in two ways: 1) Patients picked up a laptop with programming cords/equipment to program in their own home 2) Patients came to the clinic and a facilitator would set up the room for an audiologist to remote in. For both programming methods, HIPAA compliant zoom was utilized to allow an audiologist to remote onto the programming computer. Programming was completed with adult and pediatric patients utilizing Med-El, Advanced Bionics and Cochlear implants. Equipment was cleaned prior to being provided to patients and following delivery back to the clinic. E-mails with instructions on how to connect were sent to all patients prior to their appointments. During remote programming sessions, audiologists would utilize the same strategies for programming as during in-person visits including threshold and comfort level measurements, sweeping of C/M levels, bilateral balancing, word recognition verification, and sound quality verification.

Results: Remote programming was successfully conducted with patients at home and at the clinic. In order to verify the programming was successful, word recognition tasks were completed over the computer and/or family members would work with the patient during the session. Some patients had little difficulty with connecting to the laptop in their home while for others multiple sessions were required. There was one instance where a programming session could not be completed due to issues with technology. A few patients needed multiple visits to complete the programming session due to age, fatigue, poor map quality, and/or uncertainty about map quality. Issues that arose included poor WiFi connections, patients seeing the programming screen, sound quality of the speakers, and distractibility being in the home for the patient and the audiologist. Benefits of remote programming included continuity of care, programming in a comfortable environment which allowed for verification in a more typical listening environment, collaboration with aural (re)habilitation therapists during the sessions, and the ability to program over multiple days to ensure a successful programming. Surveys about patient satisfaction with this type of programming are currently being sent to patients to determine their subjective ratings of success during their remote visits.

Conclusion: Remote programming can be successful for patients of all ages with support at home or at the clinic. Technology limitations will impact programming sessions. Having an effective way to verify your programming is critical to success and will be patient dependent. In addition, protocols must be in place for cleaning and monitoring equipment, distribution of equipment and use of an online platform for programming. Information regarding patient satisfaction will also be presented.
Session: CS2-1  
Session: Telehealth Part I, Innovations and Developments in Audiology  
Title: Using Remote Technology for Intraoperative Monitoring During Cochlear Implantation  
Presenting Author: Keri Colio, AuD  
Author Block:  
Keri Colio, AuD, Julie Purdy, PhD, Kristen Baisley, AuD, Erin Levy, Aud, Michelle Hu-Lapid, Aud, Megan Butcher, AuD, Kristina Bevill, (Extern); Audiology, Rady Children’s Hosp., San Diego, CA.

Abstract:  
Introduction Intraoperative testing of cochlear implant device impedances and evoked compound action potential measurements are extremely important to assess the device integrity and response of the auditory nerve. At our center we have been using intraoperative cochlear implant testing for all surgeries for the past five years. The objective of this study was to assess the effectiveness, feasibility and financial impact of remote NRT/NRI/ART in a pediatric cochlear implant program. Methods Remote intraoperative testing was performed either via a remote desktop control program called DesktopCentral or via Zoom into the operating room main computer, with the audiologist remaining in their office while this testing was performed. The time for set up and completion of the cochlear implant intraoperative test, as well as any technical issues, effectiveness of the test and cost related to the audiologist’s time and productivity were assessed for all patients in the past 10 years. Results Our center has performed over 200 pediatric cochlear implant surgeries in the past 10 years. We have done remote NRT/NRI/ART for the past five years. Before remote NRT/NRI the average time spent by the audiologist to travel to the operating room and perform the testing was between 180-240 minutes. With remote NRT/NRI/ART this time was reduced to 20 minutes, also allowing the audiologist to have more flexibility in their schedule, as they remained in their office. This translates to a time and cost savings as it allows us an additional 160-220 minutes of billable patient contact time. There were no significant technical difficulties with NRT/NRI/ART and the testing was reliable for all cases. Conclusion Intraoperative cochlear implant monitoring is extremely important and remote testing is easily implemented using readily available commercial software such as Zoom. We believe that this should be a standard recommendation for all cochlear implant centers that do not have an audiologist on site to perform intraoperative device monitoring.
Session: CS2-1
Session: Telehealth Part I, Innovations and Developments in Audiology
Title: Complete Cochlear Implant Care (CCIC) Requiring a Single On-site Visit: Patient-centered Care Using Telehealth
Presenting Author: Ashley Nassiri, MD, MBA
Author Block:
Abstract:
Introduction: The healthcare pathway for patients undergoing cochlear implantation (CI) is complex. Challenges around access to relatively scarce high-volume CI centers and a growing population of eligible CI candidates additionally stress the need for coordinated, convenient care that minimizes travel burden and expedites care. With the use of telehealth and remote programming technology, the Complete Cochlear Implant Care (CCIC) model reduces barriers to receiving CI care.
Methods: Preliminary studies of the traditional CI healthcare delivery model identified two major barriers to care: travel burden and preoperative patient education and engagement. The CCIC model was designed to address these patient concerns. Electronic educational materials are transmitted to patients through the institution’s patient-provider communication platform, and communication with the patient is largely conducted through video telehealth appointments. To minimize travel burden and trips to the institution, CCIC leverages local resources for the patient including imaging centers, audiologists, and otolaryngologists. Postoperatively, hardware with preinstalled testing and programming software is shipped to patients prior to their remote programming appointments.
Results: The CCIC model emphasizes early patient engagement through the use of electronic educational materials including videos, CI device materials, and information about the care process. The surgeon, audiologist, and anesthesiologist conduct initial patient visits through video telehealth appointments. To minimize travel burden, preoperative audiometric testing and imaging are obtained locally and screened by providers prior to an on-site visit. If a patient is deemed a likely CI candidate and is interested in proceeding with surgery, he or she is scheduled for an on-site visit. The on-site coordinated visit seeks to minimize the patient travel burden and complete all in-person aspects of CI care in one trip to the institution. The two-day on-site visit includes CI candidacy testing, CI surgery, and CI activation on the first day and a follow-up programming session on the second day. The CCIC model incorporates remote audiologic testing and programming at 1, 3, 6, 12 months postoperatively, with the option for additional appointments as needed. The postoperative surgical follow up appointment (incisional examination) occurs locally with the patient’s local provider, and patients complete a short survey that screens for postoperative complications.
Conclusion: The use of telehealth and remote programming technology is critical in developing a CI care model that reduces the travel burden and potentially increases access to care for CI patients.
Session: CS2-1
Session: Telehealth Part I, Innovations and Developments in Audiology
Title: CI Telehealth During a Global Pandemic
Presenting Author: Allison Biever, AuD
Author Block:
N/A
Abstract:
Invited Presentation
Session: CS2-2
Session: Surgical Techniques & Technologies, Part II
Title: Can Machine Learning be Used to Predict Cochlear Implant Performance?
Presenting Author: Matthew Shew, MD

Author Block:
Matthew Shew, MD, Otolaryngology Head & Neck Surgery, Washington Univ. Sch. of Med., St. Louis, MO.

Abstract:
Introduction: Machine learning (ML) is a subdiscipline of artificial intelligence (AI) that is focused on complex pattern matching and creating prediction models based on data at a speed and scale that exceeds human capabilities. ML can be used as a real-time clinical prediction tool to help improve patient counseling and decision making, however it’s not meant to replace it as an autonomous decision-making system. Cochlear implants (CI) work extremely well however, despite significant advances and research efforts, we still cannot accurately predict speech perception performance outcomes between patients. The objective of this study was to evaluate if ML can be used to predict speech perception performance among CI recipients at 6 months post implantation using a prospectively collected dataset.

Methods: ML was performed using the dataset collected from the CI532 clinical trial, a prospective study which enrolled 96 patients across 13 CI centers. Pre-operative clinical data including age, etiology of hearing loss and audiogram results were used as model features in an attempt to predict speech perception scores defined as a consonant nucleus consonant score (CNC) ≤ 50%, CNC delta ≤40%, and CNC delta ≤30% at 6 months post implantation. This data was then fed into a ML pipeline that evaluated the performance of multiple different algorithms using 3-fold cross validation (CV) and a standard test:train split of 75%:25%. The algorithms with the highest potential were then optimized and validated on the held out test set (n=24 patients).

Results: Total of 12 candidate models were used to screen performance of CNC ≤50% using area under the receiver operator curve (AUROC) as target performance metric. Optimized Support Vector Machine (SVM[RBF]) performed with median AUROC and area under precision-recall curve (AUPRC) of 0.665 (IQR, 0.579-0.737) and 0.456 (IQR, 0.361-0.563), respectively. Setting an optimized threshold, ML models were able to predict CNC ≤50% with 66.7% sensitivity, 88.3% specificity, and 57.1% precision. For CNC delta ≤40% optimized SVM(RBF) achieved AUROC 0.604 and AUPRC 0.5. Setting optimized threshold, ML predicted CNC delta ≤40% with sensitivity of 60%, specificity 78.6%, and precision 66.7%. For CNC delta ≤30% optimized SVM(RBF) performed worse with AUROC 0.568 and AUPRC 0.407. Optimized threshold ML predicted CNC delta ≤30% with sensitivity 100%, specificity 21.1%, and precision 25.0%.

Conclusion: Current methods are poor at predicting patients who will have suboptimal CI performance. Using ML, we are able to significantly increase our ability to predict potential poor performers based on preoperative biographical factors alone. Given the small dataset, definitive conclusion are still limited and larger studies with better pre-operative variables are needed before widespread implementation is possible.
Session: CS2-2  
Session: Surgical Techniques & Technologies, Part II  
Title: Prediction of Children's Language Outcome Using Diffusion Tensor Imaging and Machine Learning  
Presenting Author: Nancy Young, MD  
Author Block:  
Nancy M. Young, MD1, Xiujuan Geng, PhD2, Gangyi Feng, PhD2, Maura Ryan, MD3, Patrick C. M. Wong, PhD2; 1Otology, Northwestern Univ. Feinberg Sch. of Med., Chicago, IL, 2Linguistics, Chinese Univ. of Hong Kong, Shatin, Hong Kong, 3Medical Imaging, Northwestern Univ. Feinberg Sch. of Med., Chicago, IL  
Abstract:  
Introduction: Our research group has created predictive models of language outcome after cochlear implantation (CI) of young children based upon neuroanatomy from standard pre-surgical MRI using machine learning. The models have superior predictive ability of high versus low spoken language improvement compared to traditional predictive characteristics such as age at implant. Brain areas most predictive of outcome are unaffected by auditory deprivation and involved in higher level auditory processing. Accurate prediction of spoken language after CI is an important first step in development of custom therapeutic strategies for children at risk for poor language outcome. This study involves pre-surgical diffusion tensor imaging (DTI), a non-invasive imaging technique to measure of brain connectivity. We hypothesize that neural connections measurable by DTI may be affected by auditory deprivation and that these differences may be predictive of speech perception ability.  
Methods: Similarity of neighboring brain regions were compared using multi-voxel pattern similarity (MVPS). CI candidates were compared to those of normal hearing children using between group MVPS analysis. This information was used to create predictive models of brain connectivity using support vector machine learning approach. Children under 3.5 years were divided into two groups based on a median split of their speech perception scores at baseline and after 6 months of CI experience for two sets of predictive models. Predictive models using neural and non-neural measures (age at CI and residual hearing) were compared. Brain connectivity maps were generated to determine brain areas most predictive of classification of performance at baseline and at 6-months.  
Results: 51 children younger than age 3.5 years (range 6-41 months) were used for prediction of pre-CI score. Of these children, 31 were available for prediction of improvement after 6-months of CI experience. Using prediction models of the DTI measures, prediction of scores was achieved with 72% accuracy (AUC=73%, sensitivity=75%, specificity=69%) for baseline and 85% accuracy (AUC=94%, sensitivity=91%, specificity=80%) for improvement at 6-months. Accuracy of outcome based on age at CI and residual hearing was 68% (AUC=78%, sensitivity=64%, specificity=70%) for baseline and 67% (AUC=55%, sensitivity=55%, specificity=78%) for improvement at 6 months. Addition of non-neural characteristics did not improve the accuracy of prediction models. Regions of the brain most predictive of baseline score did not substantially overlap with those regions predictive of 6-month improvement scores.  
Conclusions: DTI results support our previous study that areas of the brain unaffected by auditory deprivation are essential to improvement after CI, not brain affected by auditory deprivation. Use of brain based neural predictors derived from brain scans is more accurate than age at CI and residual hearing to predict improvement. Expansion of our study to include more children, longer post-CI language outcome interval, and evaluation of the impact of behavior therapy to improve language performance are necessary.
**Session:** CS2-2  
**Session:** Surgical Techniques & Technologies, Part II  
**Title:** Spiral Ganglion-on-a-Chip  
**Presenting Author:** Ilkem Sevgili, MRes  
**Author Block:**  
Ilkem Sevgili, Master of Research (MRes), Manohar Bance, MD, PhD; Clinical Neurosciences, Univ. of Cambridge, Cambridge, Cambridge, United Kingdom.  
**Abstract:**  
**Introduction:** Hearing loss is the most widespread sensory disability in the world. Cochlear implants (CIs) are currently the most reliable hearing restoration strategy for patients with severe to profound hearing loss. CIs operate by bypassing the defective or lost cochlear hair cells, a common cause of hearing loss, and electrically stimulating spiral ganglion neurons (SGNs) directly. Thus, the outcomes of CIs depend on a population of excitable SGNs. The main issues affecting the performance of CIs are the reduced frequency resolution and the loss of spatial selectivity. Additionally, SGNs can degenerate and lose their functions with age or upon damage and do not regenerate spontaneously. To address these issues, a better understanding of how CIs interact with SGNs is required. This cannot be done in vivo as currently available models are significantly limited. Thus, there is a need for a reliable model that can serve to optimize CI performance and CI-SGN interaction.  
**Methods:** Human induced pluripotent stem cells (hiPSCs) were produced from human skin cells (fibroblasts) employing a retroviral transduction method with the four Yamanaka factors (OCT4, SOX2, KLF4 and c-MYC). In the next stage, using the otic inducing factors FGF3 and FGF10, iPSCs were induced to differentiate into otic progenitors. After induction, two morphologically distinct cell colonies were formed, namely otic epithelial progenitors (OEPs)- progenitors of hair cells- and otic neural progenitors (ONPs)- progenitors of SGNs. As we were interested in inducing SGNs, ONPs and OEPs were separated, and ONPs were further induced to differentiate into SGNs, which we call iSGNs. As a positive control, we developed procedures to grow spiral ganglion explants of neonatal rodents in vitro. Following the expression of key markers via immunostaining and gene expression analyses, we started growing the spiral ganglion explants and iSGNs on microelectrode arrays (MEAs) to assess the electrically mature phenotypes of iSGNs via electrophysiology recordings.  
**Results:** Using immunostaining and RT-PCR, we confirmed that the neurons differentiated from hiPSCs were human SGN-like cells. We are currently investigating the functionality of hiPSCs derived-SGNs on MEA systems as well as comparing them to the electrophysiology measurements of SGNs dissected from neonatal rodents. We will soon be able to understand the SGN firing activity in response to varying electrical stimuli such as pulse duration, rate, shape and amplitude.  
**Conclusion:** In this project, we aim to develop platforms bridging the gap between the physiological context of in vivo studies and the advantages of in vitro manipulations, ultimately creating a spiral ganglion-on-a-chip. The human spiral ganglion-on-a-chip will ultimately allow us to investigate the impact of different stimulation parameters on SGNs and thus improve cochlear implant performance and validate computational models of the auditory nerve firing.
**Session:** CS2-2  
**Session:** Surgical Techniques & Technologies, Part II  
**Title:** How Much Pain Does Cochlear Implantation Cause?  
**Presenting Author:** Valerie Dahm, MD  
**Author Block:** Valerie Dahm, MD, Justin Lui, MD, Trung Le, MD, Joseph Chen, MD, Vincent Lin, MD; Sunnybrook Hlth. Sci. Ctr., Toronto, Canada.

**Abstract:**

**Introduction:** There is an increasing problem with the abuse of opioids, especially in North-America. Surgeons play a significant role in this “opioid-crisis” and often prescribe opioids in excess. Additionally, patients do not dispose of unused drugs safely. To address this issue, we designed a study to determine the degree of pain patients have after specific surgeries and how well it is treated with pain medication.  

**Methods:** Patients undergoing cochlear implant surgery and endaural stapedotomy or tympanoplasty were included in the study. A baseline questionnaire to assess for chronic pain disorders and substance abuse was carried out. In total, there were three different groups. Group 1 received a local anesthetic at the end of surgery and one non-opioid plus one opioid prescription for postoperative pain. Group 2 was the same as group one minus the local anesthetic. Group 3 only received two different non-opioid analgesics. Patients were asked to keep a daily pain diary assessing for pain and medication use. Finally, a follow-up questionnaire determined how unused medication was disposed of, overall satisfaction with pain medication and overall pain levels as well as typical side effects from opioid and non-opioid drugs.  

**Results:** Analysis of pain scores after cochlear implant surgery in comparison to endaural ear surgery will be presented. Additionally, satisfaction with pain medication, how excess medication was disposed of, typical side effects to analgesic therapy will be presented.  

**Conclusion:** It is of utmost importance to reduce the number of opioids prescribed. One important step to achieve this goal is to assess postoperative pain and patient satisfaction with certain post-operative analgesic therapies.
Session: CS2-2
Session: Surgical Techniques & Technologies, Part II
Title: The Impact of Patient Factors on Wound Complications Following Cochlear Implantation
Presenting Author: Brady Ekman, BS
Author Block:
Brady Ekman, BS1, Jackson Laureano, BA1, Beverly Balasuriya, MS2, Anthony Mahairas, BS2, Matthew L. Bush, MD, PhD2;1College of Medicine, Univ. of Kentucky, Lexington, KY, 2Otolaryngology - Head and Neck Surgery, Univ. of Kentucky, Lexington, KY.

Abstract:
Introduction: Cochlear implantation has been shown to improve quality of life in all age groups; however, wound complications can jeopardize the function of the device and may pose a risk of further surgical intervention. There is a lack of understanding in the field regarding patient factors (i.e. age, medical conditions, medications) that are associated with a higher risks of cochlear implant skin flap and wound complications. The objective of this systematic review and meta-analysis was to review the literature regarding wound complications following cochlear implantation and to identify patient factors associated with wound complications following cochlear implantation.

Methods: We performed a systematic review of studies in PubMed and Web of Science databases following the PRISMA checklist. The primary research question was: what patient factors (specifically, age, race, gender, sociodemographics, pre-existing medical conditions, and patient medications) are associated with cochlear implant wound complication incidence? Inclusion criteria for this study included: 1) original studies in English describing wound complications following cochlear implantation, 2) studies identifying patient factors, and 3) studies comparing rates of wound complications in different patient groups. Case reports and systematic reviews were excluded. Only studies with paired samples were included in the quantitative meta-analysis while uncontrolled studies were qualitatively described.

Results: The search yielded 2,124 unique articles. A total of 38 studies met inclusion criteria for qualitative analysis, and 10 of those met our criteria for meta-analysis and included 12,298 patients. Age was the only patient factor that reported paired samples; thus meta-analysis was conducted on only this factor. From the 10 paired samples studies, the total wound complication rate was 2.73% with wound infection being the most reported with a rate of 1.4% (113 cases in 7901 included patients). A meta-analysis of all types of wound complications in these 10 studies revealed a non-statistically significant trend toward slightly higher wound complication rates in adults (2.95%) compared with pediatric patients (2.47%) (RR 1.29, P=0.06, 95% CI 0.99-1.68). Six studies did not specify the type of complication and a meta-analysis of those six studies identified a significantly higher wound complication rate in adults (2.93%) than in children (1.47%) (RR 1.84, P=0.0004, 95% CI 1.32-2.56). Some of the studies reported incidence of specific types of complications and there was no significant difference between adults and children. Adults had a hematoma rate of 1.46% and children had a rate of 0.27% (RR 2.32, P=0.27, 95% CI 0.52-10.31). Adults had a seroma rate of 2.11%, and children had a rate of 2.68% (RR=1.13, P=0.83, 95% CI 0.38-3.38). Adults had a wound infection rate of 1.36% and children had a rate of 1.45% (RR 0.93, P=0.73, 95% CI 0.62-1.39). The average rate of wound complications reported in unpaired studies was 1.8% in children, 6.2% in adults, and 1.5% in elderly adults.

Conclusion: Cochlear implant wound complications are low in all age groups and wound infection is the most common type of complication. There is evidence of a higher incidence of wound complications in adult cochlear implant recipients compared with children. There is a need for high quality paired-sample research that investigates the association of wound complications with other sociodemographic and medical factors.
**Session:** CS2-2  
**Session:** Surgical Techniques & Technologies, Part II  
**Title:** Quality Control After Cochlear Intralabyrinthine Schwannoma Resection and Cochlear Implantation  
**Presenting Author:** Ingo Todt, MD  
**Author Block:**  
Hoger Sudhoff, Prof, Conrad Riemann, Dr, Hans Björn Gehl, Prof, Lars Uwe Scholtz, Dr, Ingo Todt, PD Dr med;Klinikum Bielefeld, Bielefeld, Germany.  

**Abstract:**  
**Introduction:** MRI observation is part of the regular follow-up after vestibular schwannoma (VS) or intralabyrinthine schwannoma (ILS) resection. Because cochlear implantation (CI) after resection is part of the audiological rehabilitation process, the MRI behaviour of CI systems needs to be considered. In light of recent developments in MRI artefact positioning and pain prevention, this study evaluates reproducible MRI observations after tumour resection and CI surgery as part of follow-up and quality control of the surgical procedure. Especially in cases of cochlear ILS complete resection is challenging. The aim of this study was to perform a long term follow up after cochlear ILS resection.  
**Methods:** In a retrospective study, we evaluated 7 patients with a T1 KM Gad/ T2 sequence MRI observation with a min. of two years after cochlear ILS resection and CI. Different surgical techniques (cochleostomy pull out, first turn push out, drill out) were chosen dependent from the extent of tumor size.  
**Results:** We observed in all of the seven cases no MRI pattern of reoccurrence/ residual cochlear ILS. In the case of drill out no T2 fluid signal was persisting.  
**Conclusion:** MRI follow-up after cochlear ILS resection and CI is reproducibly possible and necessary. It acts as a regular follow up but even as a quality control of the surgical procedure. In contrast to vestibular ILS, cochlear ILS can potentially incompletely removed. The area behind the modiolus is possible area of residual ILS.
Session: CS2-3
Session: Psychosocial Considerations
Title: Impact and Exposure of COVID-19 in Parents of Children with Hearing Loss: Relationship with Mental Health and PTSD
Presenting Author: Ivette Cejas, PhD
Author Block:
Ivette Cejas, PhD, Jennifer Coto, PhD, Chrisanda Sanchez, AuD;Otolaryngology, Univ. of Miami, Miami, FL.
Abstract:
Introduction: Early childhood deafness presents unique and long-term challenges, including communication difficulties, social/emotional delays, increased medical/audiological care, and educational challenges. While most research focuses on the child or patient, it is essential to assess parental functioning as parental involvement affects overall CI outcomes. Studies have consistently reported higher levels of parenting stress in parents of children with CIs. Given the pandemic, mental health and overall functioning have been areas of concern worldwide. To date, no studies have investigated the impact of the pandemic on mental health and parent functioning in children with hearing loss. Understanding the impact of COVID-19 on children and families is essential to better understand how it may impact overall outcomes and determine targeted areas of intervention.
Methods: The investigative team developed an electronic survey in English and Spanish via Qualtrics that included measures that assess parenting stress (Parenting Stress Index), mental health (Patient Health Questionnaire, Generalized Anxiety Disorder, Impact of Events Scale-Revised), and impact and exposure of COVID (COVID-19 Exposure and Family Impact Survey). Surveys were administered to all families in our pediatric listserv. One hundred and three parents of children with hearing loss completed all the questionnaires. The majority of parents were mothers (86.4%) with a mean age of 38.39 (SD = 8.70) who were married (62.1%). Over half of parents (65%) were working on-site, from home or a combination, while 10.7% had been laid off or furloughed. Children had a mean age of 9.72 (SD = 4.16), with the majority using cochlear implants (52.4%) or hearing aids (37.9%).
Results: Linear regressions were conducted to examine the associations between family exposure and impact of COVID-19 on parenting stress. Impact and exposure were both independently associated with parent symptoms of PTSD, with parents who reported a higher impact [F(1,97) = 32.49, p < .001, B = .90], and higher exposure [F(1,97) = 11.32, p < .001, B = 2.02], respectively, endorsing higher PTSD symptoms. However, when both impact and exposure were placed in a model, exposure was no longer significantly associated with PTSD symptoms [F(2,97) = 18.36, p < .001] and only higher ratings of impact were significantly associated with higher reports of PTSD symptoms (B = .79, p < .001). Furthermore, anxiety levels were significantly related to COVID-19 impact above exposure [F(2,98) = 11.39, p < .01], with parents who reported higher impact ratings endorsing more anxiety symptoms (B = .20, p < .001). Similarly, depression levels were significantly associated with COVID-19 impact above exposure [F(2,98) = 30.49, p < .01], with parents who reported more impact endorsing elevated depressive symptoms (B = .33, p < .001).
Conclusion: Overall, 28% of our families who completed the survey reported that COVID has made caring for their child worse or a lot worse and over 50% reported heightened levels of stress. More importantly, only 5% had consulted with a mental health specialist or were using strategies to help them cope with their distress. These data show that parents are reporting a significant amount of stress and elevated mental health concerns. Mental health and stress negatively affect child outcomes. Thus, close monitoring of parents functioning is needed to help identify parents in need of intervention as they are key members of the treatment team.
**Session:** CS2-3  
**Session:** Psychosocial Considerations  
**Title:** Impacts of the COVID-19 Pandemic on Communication and Healthcare Access for Adults with Hearing Loss  
**Presenting Author:** Harper Wilson, MD  
**Author Block:**  
Harper L. Wilson, MD, Jacob Crouch, BS, Marissa Schuh, MPH, Jennifer Shinn, PhD, Matthew L. Bush, MD PhD; Otolaryngology Head and Neck Surgery, Univ. of Kentucky Med. Ctr., Lexington, KY.  
**Abstract:**  
**Introduction:** The COVID-19 pandemic has had massive social, economic, and health impacts across the globe. Vulnerable populations, such as rural residents, who already face inequities in health and healthcare may be disproportionately negatively affected by this global pandemic. Additionally, adults who are deaf or hard of hearing (DHH) represent a population that may have underlying barriers to communication and healthcare access. There is evidence that the pandemic-related changes to means of communication, business practices, and public health recommendations have had significant impacts on the DHH community. However, a gap remains in our understanding of pandemic-related communication challenges, healthcare access, and the impact of social isolation on DHH adults that requires further study.  
**Methods:** Prospective cross-sectional questionnaire study performed at a tertiary referral center. Inclusion criteria included adults with documented hearing loss currently using hearing aids (HA) and/or unilateral or bilateral cochlear implants (CI). Sociodemographic data and county of residence were collected from all patients. We developed and distributed a 48-item questionnaire including 5 main categories: communication challenges during the pandemic, pandemic preparedness and information gathering, access to healthcare, access to hearing healthcare, and mental and emotional health during the pandemic. Patients actively using HAs alone were compared to patients using unilateral or bilateral CIs with or without concurrent HA use. Patients living in urban settings were compared to patients living in rural settings using Beale codes.  
**Results:** A total of 614 patients responded (27.8% response rate). Compared to HA users, CI users reported more difficulty communicating with family/friends (53% v. 41%, p=0.017), obtaining up-to-date pandemic information (10% v. 3%, p=0.002), and understanding live broadcasts (47% v. 17% (p=0.001) during the pandemic. CI users were also less likely than HA users to seek general healthcare services (52% v. 69%, p=0.001) or hearing healthcare services (20% v. 34% p=0.002). Rural residents reported greater difficulty than urban residents communicating with friends and family (53% v. 39%, p=0.001), obtaining food and supplies (41% v. 20%, p=0.004), understanding live broadcasts (31% v. 20%, p=0.001) during the pandemic. Compared to urban residents, rural residents reported greater difficulty accessing general healthcare (57% v. 42%, p=0.004) and hearing healthcare (49% v. 34%, p=0.043). Rural residents reported overall poorer mental and emotional health than urban residents.  
**Conclusion:** Our findings suggest that the DHH community are facing unique challenges with communication, gathering information about the pandemic, and accessing healthcare during the COVID-19 pandemic. CI and rural patients often endorsed a greater level of difficulty than HA and urban patients. It is paramount to explore methods to safely maximize communication strategies and expand access to care for this patient population during the pandemic.
Session: CS2-3
Session: Psychosocial Considerations
Title: Social Self-efficacy and Social Isolation in High-performing Adults with Cochlear Implants Compared to Older Adults with Normal Hearing
Presenting Author: Christy Ray, PhD
Author Block:
Christy Ray, PhD, Terrin Tamati, PhD, Aaron Moberly, MD; Otolaryngology, Ohio State Univ., Columbus, OH.
Abstract:
Introduction: Social isolation (SI) is a detrimental consequence of both aging and hearing loss. Nonetheless, SI is not routinely measured or explicitly targeted in the treatment of severe-to-profound hearing loss. While it is well-established that cochlear implants (CIs) improve hearing and speech understanding outcomes, less attention has been given to functional social outcomes. Further, we have not acknowledged how CI patients experience hearing loss as a chronic disability, regardless of performance on traditional speech recognition measures. This study used age-equivalent groups of experienced CI users (ECIs) and older adults with normal hearing (ONHs) to examine the relations of hearing status and social self-efficacy (SSE) with participant-reported SI.
Methods: Eighteen ECIs (mean age=72.2 years) and 15 ONH control participants (mean age=71.1 years) completed SSE and SI questionnaires. All ECIs scored above 70% on a word recognition test for inclusion. Independent t-tests assessed group differences and linear regression analyses were used to determine the relation of hearing status with each social outcome and to examine if hearing status related to SI through a mediating effect of SSE.
Results: ECIs reported significantly higher SI and lower SSE than ONH participants. Large effect sizes were found for both comparisons. The initial regression analyses found that hearing status accounted for 20.6% of the variance in SI and 13.2% of the variance in SSE. SSE partially mediated the effect of hearing status on SI. The direct relationship between hearing status and SI remained statistically significant, but was attenuated when SSE was entered in the overall equation.
Conclusion: SI scores reflect the negative social consequences of hearing loss experienced by ECIs despite excellent speech recognition performance. Particularly for adults with hearing loss, the importance of self-confidence and self-advocacy for maintaining social relationships is highlighted by the impact of SSE on SI. These findings support a broader focus on social outcomes in future research and rehabilitation approaches for optimizing CI effectiveness and supporting the successful aging of adults with hearing loss.
Session: CS2-3
Session: Psychosocial Considerations
Title: Adoption of Children with Hearing Loss: Parents' Perspectives
Presenting Author: Elaine Smolen, PhD, LSLS Cert. AVEd
Author Block:
Elaine R. Smolen, PhD, CED, LSLS Cert. AVEd1, Elizabeth A. Rosenzweig, PhD, CCC-SLP, LSLS Cert. AVT2, Maria C. Hartman, PhD1;1Health and Behavior Studies, Teachers Coll., Columbia Univ., New York, NY, 2Yeshiva Univ., New York, NY.
Abstract:
Introduction: Due to changes in international adoption regulations and increases in domestic adoption, over 90% of international adoptions from top sending countries, are now of children classified as having “special needs” (U.S. Department of State, 2015). Anecdotally, there is a community of parents who are interested in adopting children with hearing loss and/or already have, as evidenced by active social media groups. Professionals who work with families who have adopted children with hearing loss also express a desire for resources and support. However, to our knowledge, no published research explores the topic of adoption of children with hearing loss, including those with CI. This study investigated the qualitative experiences, perspectives, challenges, and needs of parents who have adopted children with hearing loss, whether internationally or domestically, to better inform the practice of physicians, audiologists, speech-language pathologists, and deaf educators.
Methods: Families were recruited via social media and professional networks. Forty-nine parents provided quantitative data regarding their children, such as age of adoption, degree of hearing loss, communication method(s) pre- and post-adoption, and use or non-use of hearing technology. Twenty-two of these parents completed semi-structured, one-hour qualitative interviews with members of the research team, and their responses were transcribed. Thematic analysis was used to identify themes across these parental interviews using close, repeated reading of the transcripts by the research team (Braun & Clark, 2006)
Results: Shared themes identified across families who had adopted children with hearing loss included motivations for adoption, common challenges and supports, decision-making processes regarding technology and communication methodology, and implications for family-centered listening and spoken language intervention. Social networks, both online and in-person, played a significant role in parents’ decision-making regarding communication and technology for their children. The theme of time was highlighted by several participants, who expressed that they had “lost time” in early intervention or using technology, such as CI, with children who were adopted at preschool age and older. Social-emotional aspects of becoming a family and reactions to children’s identification with hearing loss (whether pre- or post-adoption) were also highlighted.
Conclusion: The results of this thematic analysis have important implications for physicians, teachers, and therapists who work in family-centered intervention. Many parents expressed that professionals were often knowledgeable about either hearing loss or adoption, but not both. Understanding the shared experiences and perspectives of parents who have adopted children with hearing loss will enable professionals to work sensitively and effectively with this growing group of families.
Session: CS2-3  
Session: Psychosocial Considerations  
Title: The Experience of Siblings of Children with Cochlear Implants  
Presenting Author: Kathryn Wiseman, AuD, PhD  
Author Block:  
Kathryn Wiseman, Au.D., Ph.D.1, Andrea Warner-Czyz, Ph.D.2, Jackie Nelson, Ph.D.2; 1Boys Town Natl. Res. Hosp., Omaha, NE, 2The Univ. of Texas at Dallas, Richardson, TX.  
Abstract:  
Introduction: While growing research examines the role of the family in the habilitation of children with cochlear implants (CIs), fewer studies focus on the individual family members, particularly the siblings. Siblings play a central role in the lives of children, providing emotional support and advice, modeling social interactions with peers, and affording experience with conflict resolution. However, the presence of a hearing loss in one child may affect the dynamic of this relationship. This study examines quantitative and qualitative perspectives of children and adolescents with typical hearing (TH) who have a sibling with hearing loss who uses a cochlear implant.  
Methods: Thirty-six siblings with TH (mean age=11.6 years) of CI users (mean age=11.9 years) participated in this study. Siblings completed two quantitative questionnaires: one on their perspective of their brother or sister with CIs (23 items; α=.86); and another on the effect of hearing loss on the TH sibling (16 items; α=.73). The siblings with TH were also given open-ended prompts to provide allow for qualitative responses. Additionally, the siblings provided demographic (e.g., birth order) and communication-related (e.g., ratings of speech recognition ability) information about themselves and the CI users. These responses were used to examine the relationship between these factors and their response to the quantitative questionnaires via correlational analysis.  
Results: In general, siblings with TH had a positive perception of their brother or sister with CIs. They expressed feeling little effect (positive or negative) of having a CI user in the family. Siblings who rated the CI users’ communication skills (i.e., speech intelligibility, speech in noise) higher felt more positively about the CI user and less impacted by their hearing loss. Responses to both quantitative and qualitative items showed similar views on the close relationship between siblings and positive feelings towards the CI user, but differed relative to unequal attention from parents. For instance, open-ended responses suggest parents spend more time with the CI user than the sibling with TH (e.g., “It feels kind of sad that my sister is center of attention because I have to do everything on my own”). Siblings also commented on the challenges of social communication for CI user in real-world situations.  
Conclusion: These data suggest that while many siblings of children with CI have positive relationships, some still may struggle with particular aspects of having a child with HL in their family, particularly when the child has poorer communication skills. Issues involving relationships among the parent, CI user, and sibling underscore the importance of considering the whole family when working with children with hearing loss.
Session: CS2-3
Session: Psychosocial Considerations
Title: Our First Five Years: Effects of Socio-demographics on Timing of Cochlear Implantation and Early Speech Recognition in Children
Presenting Author: Grace Johnson, BS
Author Block:
Grace A. Johnson, B.S.1, Kimberly Otero, AuD2, Elizabeth Hernandez De Jesus, M.A., CCC-SLP3, Timothy Maul, CCP, PhD4, Cedric Pritchett, M.D.1; 1Otolaryngology, Nemours Children's Hosp., Orlando, FL, 2Audiology, Nemours Children's Hosp., Orlando, FL, 3Speech Therapy, Nemours Children's Hosp., Orlando, FL, 4Nemours Children's Hosp., Orlando, FL.
Abstract:
Introduction: Social determinants of health are important factors in pediatric health outcomes. Over 70% of children treated at our hospital receive Medicaid and over 30% speak a primary family language other than English. Multicultural and underserved patients may face barriers that increase time to implantation and time to mastery of Ling sounds. In an effort to adapt our growing pediatric cochlear implant (CI) program, we explored literature reported sociodemographic inequalities related to CI, and their potential impacts in our program.
Methods: We performed a review of children receiving CI at Nemours Children’s Hospital over a five-year period. Demographics variables, including gender, age, insurance status, parental primary language, race/ethnicity, county of residence (proxy as distance from hospital), were obtained. Time intervals were calculated for diagnosis to initial/secondary implantation and duration of time post implantation to successful identification of all six Ling sounds. Comparisons between sociodemographic groups were made using Fisher’s exact test or Kruskal-Wallis ranked sums, as appropriate. Kaplan-Meier analysis was performed for time to achieve mastery with Mantel-Cox comparisons.
Results: Sixty-four children received CIs, 25 of whom underwent sequential contralateral. Equal numbers of patients (32) were identified as Hispanic and non-Hispanic. Five primary languages were represented; most commonly English (69%) and Spanish (27%). The children came from 13 counties; 34% from the same county as the hospital, and 52% in immediately bordering counties. Fifty-one patients (80%) had Medicaid insurance and 12 (19%) had commercial coverage. Mean age at initial CI was 76 months, and did not change over time (p>0.25). Mean time from diagnosis to primary and secondary CI was 24 months (S.D. 21; range 2-96) and 38 months (S.D. 27; range 8-101), respectively. These did not vary statistically based on race (p=0.45 and p=0.15), insurance (p=0.72 and p=0.68), or primary parental spoken language (p=0.26 and p=0.92). During the study period, 46 children (72%) demonstrated mastery of the six Ling sounds after primary CI; with mean of 14 weeks from activation. The mean time to mastery for children from English, Spanish and other language speaking families demonstrated trends at 7 weeks, 22 weeks (p=0.07), and 23 weeks (p=0.10) respectively. Similarly the mean time to mastery was different based on insurance state (commercial 7 weeks vs Medicaid 15 weeks) but did not achieve statistical significance (p=0.19).
Conclusion: Recognizing historical patterns of societal disparities, pediatric CI centers can aid in leveling the playing field. Preventing patient sociodemographics from impacting timing to care or early clinical outcomes requires intentionality and resources. Our program is growing, and continued review of data trends as sample sizes increase remains necessary for future interpretation and focused efforts to serve this population.
Session: CS3-1
Session: Objective Measures in Cochlear Implantation

Title: Transimpedance Measurements to Characterize the Electrical Properties of the Perimodiolar Cochlear Implant Electrode Arrays and Surrounding Tissue

Presenting Author: Angel Ramos de Miguel, PhD

Author Block:
Angel Ramos de Miguel, PhD1, Juan C. Falcon, PhD1, Timo Stöver, MD2, Goetz Brademann, MD3, Manuel Manrique, MD4, Ulrich Hoppe, PhD5, Matthias Hey, PhD6, Uwe Baumann, PhD7, Alicia Huarte, MD8, Robert Cowan, PhD9, Tim Liebscher, PhD5, Christopher Bennett, PhD10, Nicole Neben, PhD11, Angel Ramos, MD PhD12; 1Acoustic lab - Audiology, Complejo Hosp.ario Universitario Insular Materno-Infantil de Gran Canaria, Las Palmas, Spain, 2Otorhinolaryngology - Head and Neck Surgery, Klinikum der J.W. Goethe-Univ., Frankfurt, Germany, 3ENT Clinic., UKSH, Kiel, Germany, 4Otorhinolaryngology - Head and Neck Surgery, Clinica Univ. de Navarra, Pamplona, Spain, 5Audiology, Univ.skleinlbum Erlangen, Erlangen, Germany, 6ENT Clinic, UKSH, Kiel, Germany, 7Audiology, Klinikum der J.W. Goethe-Univ., Frankfurt, Germany, 8Audiology, Clinica Univ. de Navarra, Pamplona, Spain, 9HEARING CRC., Univ. of Melbourne, Carlton, Australia, 10Cochlear Ltd, Maquarie University, Australia, 11Cochlear Deutschland GmbH & Co. KG, Hannover, Germany, 12Otorhinolaryngology - Head and Neck Surgery, Complejo Hosp.ario Universitario Insular Materno-Infantil de Gran Canaria, Las Palmas, Spain.

Abstract:

Introduction: The Gold standard to verify correct cochlear implant electrode array position is radiological imaging (cone beam CT, CT scan or X-ray). It is most useful to confirm the electrode position intra-operatively, directly after insertion of the electrode array. However, imaging is time consuming, costly and exposes the patient to radiation. Therefore, a reliable objective measurement to characterize the position of the CI array avoiding radiological imaging would be advantageous for the procedure and benefit the patient. Transimpedances were measured to characterize the electrical properties of the electrode array in the cochlea after insertion. Transimpedance is a proxy measure for current field spread, normalized for electrode voltage. Transimpedance values depend on the distance between stimulating and recording contacts as well as the electrical properties of the electrode-tissue interface and intervening tissue. A matrix of transimpedance values (TIM) was generated using all electrodes for stimulation and recording. A tip fold detection algorithm which employed the TIM measures was tested for sensitivity and the relationship between transimpedance and modiolar proximity explored.

Methods: 158 Cochlear Nucleus® CI512 and CI532 cochlear implant recipients were enrolled over a period of 15 months from centres in Germany, Spain and Australia. Objective measures such as the transimpedance matrix (TIM), electrically evoked compound action potentials (ECAP), and electrode impedances were obtained as well as radiological imaging. The test battery was conducted intra-operatively, during first activation and 3 months post-operatively to explore the association between the TIM measurements, ECAP thresholds and the radiological findings.

Results: TIM measures were successfully recorded for 148 ears. Morphology for individual arrays, derived from the multidimensional scaling analysis of TIM values, correlated well with images. The sensitivity of the tip fold detection algorithm was 98.6% (C.I. 95.8-99.8%). TIM measures were characterized in terms of the transimpedance slope of the electrodes adjacent to the stimulating electrode and showed that as the electrode-modiolus distance increased, the transimpedance slope decreased.

Conclusion: Objective transimpedance matrix measurements can provide information about cochlear implant electrode array morphology and thus replaces some of the utility of radiological imaging. The tip fold detection algorithm was sufficiently reliable to be incorporated into a surgical software tool application. Further development is required to refine provide electrode-to-modiolar distance indicators, as well as detect scala dislocation.
**Session:** CS3-1  
**Session:** Objective Measures in Cochlear Implantation  
**Title:** Intraoperative Impedance-based Estimation of Cochlear Implant Electrode Array Insertion Depth  
**Presenting Author:** Philipp Aebischer, MSc  
**Author Block:**  
Philipp Aebischer, M. Sc.1, Marco Caversaccio, Prof. Dr.2, Wilhelm Wimmer, Dr.1;1ARTORG Center for Biomedical Engineering Research, Univ. of Bern, Bern, Switzerland, 2Department of ENT, Inselspital, Bern Univ. Hosp., Bern, Switzerland.  
**Abstract:**  
**Introduction:** Objective measures on cochlear implant electrode placement are valuable to assess surgical outcome. The placement within the scala tympani can be verified by medical imaging (for example computed tomography), but this exposes patients to additional radiation, prolongs anesthesia and is therefore rarely performed intraoperatively. In this work, we present a method for estimating the insertion depth of cochlear implant electrode arrays from the implants’ impedance measurements which are routinely recorded for implant verification.  
**Methods:** The insertion depth estimation is based on a phenomenological model, that correlates estimated tissue resistances with the linear insertion depth measured in computed tomography images. Tissue resistances of all electrodes were estimated using bivariate spline extrapolation from transimpedance recordings of intraoperative telemetry data of 20 subjects implanted with the same lateral wall cochlear implant model. Electrode positions were determined in postoperative computed tomography images. In order to consistently define the local cochlear coordinate system, a robust cochlear axis detection algorithm was applied in preoperative computed tomography images which were registered to the postoperative recordings.  
**Results:** Using a leave-one-out cross validation process, the proposed method allowed the linear insertion depth of all electrodes to be estimated with an average absolute error of 0.76 ± 0.53 mm (mean plus/minus standard deviation) compared to the ground truth values obtained in computed tomography data. A conversion to angular positions incorporating the cochlear size, which can be obtained from preoperative imaging, resulted in an absolute error of the angular insertion depth estimation of all electrodes of 15° ± 12°.  
**Conclusion:** The proposed method can be used to objectively assess electrode array placement during and after cochlear implantation based on non-invasive and readily available telemetry recordings. A potential application of this method could be the verification of electrode placement after implant management, that is, after winding the electrode lead into the mastoidectomy and wound closure, where visual assessment is no longer possible.
**Session:** CS3-1  
**Session:** Objective Measures in Cochlear Implantation  
**Title:** Utility of Cervical Vestibular-evoked Myogenic Potentials in Mapping Current Levels Among Cochlear Implant Recipients  
**Presenting Author:** Prawin Kumar, PhD  
**Author Block:**  
Prawin Kumar, PhD (Audiology), Niraj K. Singh, PhD, Priya K. P, M.Sc (Audiology); Audiology, All India Inst. of Speech and Hearing (AIISH), Mysore, India.  
**Abstract:**  
**Introduction:** The proximity of the vestibular nerve fibers to the auditory nerve fibers and a common fluid environment throughout the inner ear could potentially render the vestibular system predisposed to the undesirable electrical stimulation by the cochlear implant (CI). This might be a potential reason for the persistent dizziness long after the surgery. However, there is a shortage of studies to prove this assumption. Therefore, the present study aimed at identifying the presence of vestibular stimulation due to CI and studying the efficacy of the information obtained from the cervical vestibular-evoked myogenic potential (cVEMP) in controlling the undesirable vestibular stimulation by the CI.  
**Methods:** We conducted this study in 3 phases. In Phase I, 14 children with unilateral CI (age range = 3-7 years) underwent tone-burst (500-Hz, 109 dB SPL) induced cVEMP using insert earphones. In Phase II, we used impedance-matched loudspeaker for stimulation (tone burst, 500 Hz, 85 dB SPL and 60 dB SPL) and recorded cVEMP in the “CI switched-off” and the “CI switched-on” conditions. Phase III included those with the presence of cVEMP in the “CI switched-on” condition, but not in the “CI switched-off” condition, for stimulus intensity of 60 dB SPL (n=2) were included in. Phase III involved remapping of the C-levels, pure-tone and speech audiometry before and after the remapping, and re-administration of cVEMP at both stimulus intensities and in both the device conditions (“CI switched-on” and “CI switched-off”).  
**Results:** In Phase I, cVEMPs were present in 8 (57%) children. Those with the presence of cVEMP in the implanted ear in Phase I, moved to Phase II. At 85 dB SPL in Phase II, cVEMPs were present in all 8 (100%) participants in the “CI switched-on” condition and 5 (62.5%) in the “CI switched-off” condition. At 60 dB SPL, cVEMPs were absent in all participants in “CI switched-off” condition but present in 2 participants in the “CI switched-on” condition. In Phase III, we remapped the CI by reducing the C-levels by 3 current levels, and re-recorded the cVEMPs. The presence of cVEMP at 60 dB SPL in 2 children in the “CI switched-on” condition, but not in the “CI switched-off” condition, in Phase II is a testimony to the assumption that the current level used for auditory stimulation can cause an undesirable stimulation of the inferior vestibular nerve. Further, there was no evidence of cVEMP at 60 dB SPL in either of the device conditions after the remapping, which confirmed that the current spread to the inferior vestibular nerve stopped because of the lower current levels from the device.  
**Conclusion:** The electrical current generation by CI could cause undesirable vestibular stimulation in a few CI users. Therefore it is imperative that, in addition to monitoring non-auditory stimulation, like the facial nerve stimulation, one should also watch for the vestibular system stimulation, and cVEMP could play a pivotal role in deciding the C-levels during the mapping.
**Session:** CS3-1  
**Title:** Electrical Stapedial Reflex Thresholds in Cochlear Implant Programming and Effects on Speech Perception in Noise  
**Presenting Author:** Diane Martinez, AuD  
**Author Block:**  
Diane Martinez, AuD, Sandra Velandia, AuD, Carly Misztal, B.S., Stefanie Pena, M.S., Stefania Goncalves, MD, Simon Angeli, MD, Fred Telischi, MD, Christine T. Dinh, MD; Otolaryngology, Univ. of Miami, Miami, FL.  
**Abstract:**  
**Introduction:** Cochlear implant (CI) patients with longstanding hearing deprivation may have difficulty judging loudness and pitch due to decrement in auditory memory over time. Therefore, objective CI programming using electrical stapedial reflex thresholds (ESRT) may overcome these challenges and potentially improve speech understanding.  
**Methods:** A retrospective chart review was performed for all patients that received CI surgery between January 2014 and December of 2018. Of the 425 patients, there were 61 adults programmed by either subjective or objective methods for most comfortable (C) levels. Demographic information, surgical details, post-operative speech outcomes using English word and sentence tests, and CI measurements (reflexes, impedances, and C levels) were collected. Descriptive statistics and mixed model analysis of variance for repeated measures were performed.  
**Results:** Of the 61 patients, 23 (37.7%) received objective programming and 38 (62.3%) received subjective programming. The average age was 53.3 and 69.7 years, and the mean follow-up time was 30 and 24 months for objective and subjective cohorts, respectively. Overall, CNC, AzBio in Quiet, and AzBio +5dB SNR increased with time (p<0.001), with average improvements of 42%, 50%, and 12% at 24-months, respectively. There were no significant differences in CNC and AzBio in Quiet between patients programmed with objective and subjective strategies. However, patients with objective programming had higher scores on AzBio +5dB SNR than those with subjective programming (p=0.004), particularly at the 3-month, 24-month and >24-month time categories (p=0.020, p=0.0016, p=0.0010, respectively). The average post-operative scores for AzBio +5dB SNR at >24 months were 56% and 23% for objective (95% CI: 28.0-83.1%) and subjective (95% CI: 8.4-36.8%) programming, respectively. We also found an inverse relationship between C levels and impedances at different time points and describe differences between subjective and objective programming with all three implant companies.  
**Conclusion:** Objective programming techniques using ESRTs have been in use for over 20 years but are not widely applied. Although CI patients with objective and subjective programming performed similarly on CNC and AzBio in Quiet, patients that received objective programming had improved speech understanding in noise. Further investigations are warranted to determine whether objective CI programming can offer an advantage in challenging listening environments and improve quality of life.
Session: CS3-1
Session: Objective Measures in Cochlear Implantation
Title: Using Electrically-evoked Compound Action Potentials to Select Electrode Stimulation Sites in Cochlear Implant Users
Presenting Author: Kara Schwartz-Leyzac, AuD, PhD
Author Block:
Kara C. Schwartz-Leyzac, AuD, PhD1, Teresa A. Zwolan, PhD2, Bryan E. Pfingst, PhD2;1Department of Otolaryngology, Head and Neck Surgery, Med. Univ. of South Carolina, Charleston, SC, 2Department of Otolaryngology, Head and Neck Surgery, Michigan Med., Ann Arbor, MI.
Abstract:
Introduction: Previous studies in humans have shown that not all stimulation sites in a cochlear implant electrode array contribute equally to the implant’s efficacy and that turning off selected sites can improve speech recognition in some subjects. Various strategies are used for site selection including measures that reflect nerve survival near the individual electrodes. In cochlear-implanted guinea pigs, the density of spiral ganglion neurons (SGN) accounts for about 40-50% of the variance in peak amplitude of the electrically-evoked compound action potential (ECAP) amplitude-growth function (AGF). Moreover, the change in the peak amplitude or linear slope of the ECAP AGF as a result of increasing the interphase gap (IPG) of the biphasic pulse (the “IPG Effect”) also reflects SGN density; related studies in humans suggest that the ECAP IPG measures could be used to select sites for inclusion in a cochlear implant programming map, in order to improve speech recognition performance.
Methods: Participants were 14 adult human subjects (18 ears) with cochlear implants. ECAP AGFs were collected using two interphase-gap conditions (7 and 30 μIPG), and the IPG Effect was calculated for peak amplitude measures on each electrode. Two experimental maps were created, in which the five sites with the five largest (best) or the five smallest (worst) ECAP IPG Effect were systematically deactivated. The deactivation strategy maintained tonotopicity with respect to the subjects’ everyday maps. Performance on sentence recognition in noise and consonant recognition in quiet was assessed while subjects used the two experimental maps and when they used their normal everyday map. Testing was completed using a double-blinded design. Post-operative computerized tomography was completed for 11 ears.
Results: Performance when listening to a map for which the electrode sites with the largest (best) ECAP IPG values were selected resulted in significantly better sentence recognition in noise (5.92 dB SNR at 50% accuracy) compared to performance when listening with a map in which the electrodes with the lowest (worst) ECAP IPG values were selected (6.83 dB SNR). Results using the experimental map with the highest ECAP IPG values were comparable to those when subjects used their everyday map (6.02 dB SNR). Consonant information transmission analysis showed better performance for place cues when listening with the larger-IPG-Effect map. For subjects with CT data, we found that the advantage of site selection based on the higher IPG Effect map was greatest in subjects with a greater percentage of electrodes located within the scala tympani vs scala vestibuli.
Conclusion: The ECAP IPG Effect can be used to select stimulation sites in human CI processor maps and either improve or worsen performance in adult CI recipients. This result reinforces the importance of nerve survival for cochlear implant performance.
**Session**: CS3-1  
**Session**: Objective Measures in Cochlear Implantation  
**Title**: Use of Electrical Field Imaging and Surface Potential Measurements to Diagnose Partial Short Circuits in Cochlear Implants  
**Presenting Author**: Yu Tam, MSc  
**Author Block**:  
Yu C. Tam, MSc1, Susan T. Eitutis, MSc1, Manohar L. Bance, MB, ChB, MSc, FRCS, FRCSC,  
ABOto2;1Emmeline Centre, Addenbrookes Hosp., Cambridge, United Kingdom, 2Clinical Neurosciences,  
Cambridge Univ., Cambridge, United Kingdom.

**Abstract**:  
**Introduction**: The clinic noticed a decline in listening performance over a short period of time in a group of cochlear implant (CI) recipients, however integrity tests showed the implants were working within specification. To investigate what caused this change, electrical Field Imaging (EFI) and Surface Potential Measurements (SPM) were used to measure the output of these implants.  
**Methods**: EFI is a nearfield technique where one electrode is stimulated and the voltage is measured across all other electrodes in the electrode array. This is process measured for all electrodes on the array and results are manually interpreted. SPM uses scalp electrodes to measure the stimulus artefact of each active electrode. The stimulus is provided by CI programming software, interface box via the speech processor and telemetry coil. This stimulus is synchronised to the measurement system with an external trigger, to an evoked potential system (effectively an eABR setup). The peak voltage for each phase is measured to check for charge balance, and the stimulus is measured at 30µ, 60µ and 120µ (75us pulse width) to check for loudness growth. The stimuli are usually below hearing threshold or quiet in the case of 120µ stimulus. The data is imported into an Excel spreadsheet for analysis and graphing.  
**Results**: The EFI is a very good indicator of which electrodes are affected by partial short circuits. Changes in the EFI traces can be used to monitor the stability of the partial short circuits. The SPM provides a more detailed assessment of the output from each electrode in the array. This data can be normalised to unaffected electrodes on the same array to help determine how electrodes with partial shorts should be programmed or deactivated.  
**Conclusion**: The EFI takes a matter of minutes to perform and analyse. With several hundred potentially affected implants, our clinic now uses EFI to monitor for partial shorts. As the health care system adapts to the changing demands and restrictions from COVID-19, our clinic has implemented a drive through monitoring approach. Cochlear implant recipients can drive up to a manned ‘pod’ and have an EFI measurement completed without leaving their car. Here, the clinician passes the coil, wrapped in a rubber glove attached to a long cable, to the recipient in the car and takes the measurement without needing to be in contact with the implant user. The coil and cable are returned to the clinician and wiped down after each test. If the EFI results for partial shorts are inconclusive, or for paediatric recipients, a SPM is performed to determine the extent of the problem which the partial shorts are causing. Program parameters can be changed to try and compensate for any reduced electrode output caused by partial shorts. Initially SPM took around 2.5 hours per implant plus a day to analyse. This has been sped up to about 30 mins per implant plus 30 mins for initial analysis. Programming changes can be made during the session after the data analysis or at a later date.
**Session:** CS3-2  
**Session:** Hearing Preservation  
**Title:** Does Hearing Preservation Matter for Speech Perception Performance with Slim Perimodiolar Electrode?  
**Presenting Author:** Amit Walia, MD  
**Author Block:**  
Amit Walia, MD, Matthew Shew, MD, Carla Valenzuela, MD, Cameron Wick, MD, Jonathan McJunkin, MD, Nedim Durakovic, MD, Craig Buchman, MD, Jacques Herzog, MD; Otolaryngology - Head and Neck Surgery, Washington Univ. in St. Louis, St. Louis, MO.  
**Abstract:**  
**Introduction:** Preserving hearing is likely an important modifiable factor for improving post-operative open set speech perception performance in hearing preservation (HP) cochlear implant (CI) candidates. Thus, there has been an emphasis on electrode design and its impact on intrascalar positioning and less traumatic insertion to improve postoperative performance over time. Within the literature, there are two directions regarding electrode design and HP: (1) lateral wall electrodes minimize intracochlear trauma, avoid scalar translocation, and potentially preserve hearing for electro-acoustic stimulation, making it better suited for HP candidates; (2) perimodiolar (PM) electrodes maximize electrode placement close to the modiolus to minimize distance between electrode and spiral ganglion cells, making it best for patients without residual hearing. Few studies have assessed the newer, less traumatic slim perimodiolar electrode (SPE) in terms of HP and whether it impacts speech recognition scores. Long-term audiologic outcomes in HP CI candidates with SPE electrodes are presented in this study.  
**Methods:** 203 adult patients undergoing HP CI with SPE (CI 532/632) were retrospectively analyzed. Patients were considered HP candidates if low frequency PTA (LFPTA) (125, 250, and 500 Hz) threshold was ≤80 dB based on preoperative audiograms. Postoperative audiograms were obtained at various time points and were categorized as either “early” (activation or 3 months) or “late” (6 or +12 months). The worse audiogram in the “early” vs “late” time points were analyzed and HP postoperatively was defined as LFPTA ≤80 dB. Audiologic open speech perception testing was obtained and compared between HP and non-HP cohorts using consonant-nucleus-consonant (CNC), AzBio sentences, and hearing in noise test (HINT).  
**Results:** For patients with preoperative LFPTA ≤80 dB, mean shift in LFPTA at the “early” time point was 25.9 ± 16.2 dB and “late” time point was 29.6 ± 16.9 dB. 117 patients met a stricter preoperative HP candidacy defined by a LFPTA ≤60 dB, and early and late LFPTA mean shifts were 19.5 ± 12.3 dB and 32.6 ± 17.2 dB, respectively. 45.5% of patients (N = 66) demonstrated HP at “early” timepoint and 43.7% (N = 38) at “late” time point. We did not observe a significant difference in postoperative speech perception testing between HP vs non-HP groups both in the short- and long-term. Tip rollover rate was 7.4%, and there was one scala vestibuli translocation. Patient cohorts were further divided into 3 separate groups: preoperative LFPTA ≤80dB, LFPTA ≤60dB, and LFPTA 61-80dB, keeping in mind AAO-HNS minimum reporting standards. Early HP rates for patients with LFPTA ≤60dB was 61.1%, compared to HP rates for patients with LFPTA 61-80dB was 23.4%.  
**Conclusion:** SPE is a less traumatic electrode with a HP rate at activation that approaches 60-70% with just over 50% patients maintaining this long-term. While definitive conclusions are limited given extent of this study, our analysis suggests that HP is clearly feasible with SPE, but may not ultimately matter for open set speech performance. Finally, AAO-HNS definition for preoperative HP CI candidates using LFPTA ≤80dB may skew our understanding. Future efforts to standardize reporting within our literature will need to readdress this definition and consider LFPTA ≤60dB as the proper criteria for preoperative consideration for HP.
Session: CS3-2  
Session: Hearing Preservation  
Title: Dose-dependent Reduction of Impedances After Steroid Application Via a Cochlear Catheter in Human Cochlear Implantation and First Results in Patients with Residual Hearing  
Presenting Author: Nils Prenzler, MD  
Author Block:  
Nils K. Prenzler, MD, Thomas Lenarz, Prof. Dr., Lutz Gärtner, Dr., Athanasia Warnecke, Prof. Dr.; Hannover Med. Sch., Hannover, Germany.  
Abstract:  
Introduction: Insertion trauma seems closely related with fibrotic tissue formation and raise of impedances after cochlear implantation. Thus, the performance of the implant may be limited and adjuvant treatment for the control of inflammation and fibrosis during cochlear implantation is necessary. Application of steroids to the inner ear may present a therapeutic option. In order to realize distribution of the drug in all cochlear turns, a cochlear catheter has been developed and was used to apply triamcinolone to the inner ear.  
Methods: Patients with residual hearing that were not candidates for EAS were implanted with a 28 mm long electrode array and included in the present study. Triamcinolon was applied via the cochlear catheter (low dose: 4mg/ml and high dose: 20mg/ml). Postoperative PTA thresholds, impedances and electric evoked compound action potentials were measured and compared between the groups up to 12 months after implantation. Patients implanted with the same device but no steroid application at all served as controls.  
Results: There were no adverse effects associated with the steroid application via the catheter. Low dose steroids lead to delayed rise of impedances during the first weeks after implantation compared to control group. A significant reduction at 10 days post-operative was shown. By contrast, high dose steroids led to reduced impedances over a longer period with significant reduction at time of first fitting. But the reduction did not last longer then up to 3 months. Hearing preservation was at least similar to that of the standard collective as measured at first fitting.  
Conclusion: The cochlear catheter seems to be a safe and effective method for the application of steroids also to more apical regions of the cochlea, with which even residual hearing can be maintained. This type of application is thus also interesting for other applications such as various pharmacological or cell-based therapies to treat diseased cochlea or to attenuate intracochlear trauma and scarring in the course of cochlear implantation.
Session: CS3-2
Session: Hearing Preservation
Title: Outcomes in Children with Cochlear Implants and Preoperative Residual Hearing: Electric Only and Electric-acoustic Stimulation
Presenting Author: Lisa Park, AuD
Author Block:
Lisa R. Park, AuD, Erika Gagnon, AuD, Margaret Dillon, AuD; Otolaryngology/Head and Neck Surgery, Univ. of North Carolina at Chapel Hill, Chapel Hill, NC.
Abstract:
Introduction: The current FDA-approved criteria for cochlear implantation in adults includes patients with much more residual hearing than the criteria for children. Research and clinical experience have shown that children who meet adult criteria benefit from cochlear implant (CI) use. When these non-traditional pediatric CI recipients maintain residual hearing, they can be fit with electric-acoustic stimulation (EAS). When residual hearing is lost, they are fit with full-electric stimulation (FES). Families and clinicians may be hesitant to pursue or recommend cochlear implantation due to concerns over loss of residual hearing, despite the growing evidence of the effectiveness of EAS and FES use over preoperative abilities with conventional amplification. The present report reviews preliminary data from a prospective clinical trial comparing the performance for children who either maintain residual hearing and use EAS versus children who lose residual hearing and are fit with FES.
Methods: Pediatric CI recipients who presented with a low-frequency pure-tone average (LFPTA; 125, 250, and 500 Hz) of 75 dB HL or better at the preoperative evaluation were considered for inclusion. Those who maintained acoustic hearing were fit with EAS and those whose LFPTA exceeded 75 dB HL were fit with FES. Ten participants had data available at the 12-month post-activation test point: Five from the EAS group and five from the FES group. Participants completed a subjective questionnaire (i.e., the Speech, Spatial, and Qualities for Children questionnaire; SSQ), responded to recorded speech perception materials (i.e., CNC words and BKB-SIN), and provided data for a prosodic perception task at regular post-activation intervals. Preoperative CNC and SSQ data were available for all participants and were compared to post-activation performance. Outcomes were compared between groups across the first 12 months of device use.
Results: Participants experienced significantly improved CNC word scores and subjective benefit in the post-activation period as compared to preoperative performance, and BKB-SIN scores improved over time for both groups. While speech perception was similar between groups, the EAS group experienced less variability and reached asymptote more quickly. On measures of prosodic perception, EAS users were more accurate than FES users for stimuli with male speakers. Post-activation low-frequency acoustic thresholds were strongly correlated with prosodic perception. Audio examples will be included during review of the prosodic perception task outcomes.
Conclusion: Children with normal-to-moderate low-frequency hearing and severe-to-profound high-frequency hearing loss demonstrated significant benefit after cochlear implantation -- whether hearing was preserved or not. Children who were fit with EAS experienced speech perception benefits more quickly than those who used FES. The degree of post-activation residual hearing confers benefits for prosodic perception.
Session: CS3-2
Session: Hearing Preservation
Title: Neurophysiological Evidence that Residual Hearing on the Non-implant Side Affects the Early Auditory and Speech Perception Development of Bimodal Infant-Toddler Cochlear Implanters: A Longitudinal Study from Functional Near-infrared Spectroscopy Brain Imaging
Presenting Author: Yuyang Wang, PhD
Author Block:
Yuyang Wang, Peking university1, Meiyun Wu, Beijing Normal University2, Chaogang Wei, Peking university1, Yuxuan Zhang, Beijing Normal University2, Yuhe Liu, Peking university1;1Department of Otorhinolaryngology Head and Neck Surgery, Peking Univ. First Hosp., Beijing, China, 2Beijing Normal Univ., Beijing, China.
Abstract:
Introduction: By using Functional Near-Infrared Spectroscopy (fNIRS) brain imaging we aimed to investigate the early relationship between speech perception following cochlear implantation and auditory cortical activation in bimodal infant-toddler cochlear implanters. Simultaneously, we also studied the effects of residual hearing on the non-implant side on the auditory cortical activations. And we observed their development through multiple follow-up tests.
Methods: 1. Participants 22 participants (6 girls) participated in the test after their parents signed an informed consent form. They are all bimodal infants and toddlers, age at implantation was 15-78 months (average 33.05 months), Before the operation, the non-implanted side low-frequency below 1kHz average hearing threshold was ≥70dB HL in 10 persons, and in 12 persons with <70dB HL. 2. Procedure: 2.1 Preoperative test: After confirming that the participants meet the criteria for cochlear implantation, the fNIRS test was performed, and the temporal area were mainly observed. Acoustic stimuli are excerpts from fairy tales read by a female voice, which are played in blocks design. 2.2 Postoperative test: Participants will complete the Infant-Toddler Meaningful Auditory Integration Scale (IT-MAIS) and fNIRS test. The tracking test times are: the day of power-on, 1 month after power-on, 3 months after power-on, 6 months after power-on, and 12 months after power-on.
Results: Residual hearing on the non-implanted side ≥70dB HL group: The beta weight of the left temporal area and the ITMAIS score changed from a positive correlation in the early stage to negative later, and the right side changed from a positive correlation in the early and middle stages to negative in the later stage. The beta weight increases in the left temporal area, and first increases and then decreases on the right. The most significant activation channel changes on the left and right are different. Functional connectivity first increases and then decreases.<70dB HL group: Beta weight and ITMAIS scores showed no correlation on both sides and in each period. The beta weight increases in the left temporal area, and first increases and then decreases on the right. The most significant activation channel changes on the left and right are different. Functional connectivity weakens first and then increases.
Conclusion: To the best of our knowledge, this longitudinal study provides the first neurophysiological evidence for the influence of residual hearing on the non-implanted side on the early auditory cortex remodeling and development of bimodal infant and toddler CI implanters. Our research results show that: 1. The correlation between speech perception and auditory cortex activation changes with time in infants and toddlers’ auditory development within 1 year after cochlear implantation; 2. When the residual hearing on the non-implanted side is less than 70dB HL, the auditory cortex remodeling and development of infants with cochlear implants can be significantly affected. 3. The impact of residual hearing on the non-implanted side on the outcomes after implantation is achieved through different cortical activation modes and functional connectivity. This will enrich the understanding and provide the basis for the decision-making of cochlear implantation and the development of a rehabilitation training plan beneficial to the performance of the cochlear implant.
Session: CS3-2
Session: Hearing Preservation
Title: Access and Polar Electrode Impedance Changes in Relation to Delayed Loss of Acoustic Hearing in Hybrid Cochlear Implant Users
Presenting Author: Viral Tejani, AuD, PhD
Author Block: Viral D. Tejani, Au.D., Ph.D.1, Hyejin Yang, Ph.D.2, Jeong-Seo Kim, Au.D., Ph.D.1, Helin Hernandez, M.S.3, Jacob J. Oleson, Ph.D.3, Paul J. Abbas, Ph.D.4, Carolyn J. Brown, Ph.D.4, Marlan R. Hansen, M.D.1, Bruce J. Gantz, M.D.1; 1Otolaryngology-Head and Neck Surgery, Univ. of Iowa Hosp. and Clinics, Iowa City, IA, 2Biomedical Engineering, Univ. of Ulsan, Ulsan, Korea, Republic of, 3Biostatistics, Univ. of Iowa, Iowa City, IA, 4Communication Sciences and Disorders, Univ. of Iowa, Iowa City, IA.
Abstract:
Introduction: Preservation of acoustic hearing after cochlear implant (CI) surgery allows for electric-acoustic stimulation (EAS) in the implanted ear post-operatively. A percentage of patients experience partial or complete loss of residual hearing months post-surgery, the cause of which is unknown. Increases in electrode impedance loss has been reported from several CI clinics (Scheperle et al, 2017; Shaul et al, 2020; Thompson et al, 2020), which could reflect physiological changes in the cochlea. These studies measured total impedance, which consist of access and polarization components. Access resistance reflects the electrode environment (e.g. buildup of fibrous tissue); polarization resistance reflects the electrode-electrolyte interface (Tykocinski et al, 2005). We hypothesized that these two impedance components would provide different insights into cochlear status at time of hearing loss. We also explored if impedance changes were localized to specific locations along the electrode array.
Methods: Longitudinal access resistance, polarization impedance, and total impedance were measured from adult EAS CI users (n = 75 total; n = 43 for access and polar) at each clinical appointment, starting with initial activation. Impedance changes were analyzed for basal, middle, and apical electrode sections. Subjects were categorized into two groups based on changes in pure-tone average of audiometric thresholds at 125, 250, and 500 Hz. Those with thresholds within 10 dB of initial activation were categorized as stable hearing. Those who lost >10 dB and the rate of loss was 5 dB / month were categorized as having a precipitous loss.
Results: On average, greater rises in total impedance was seen in the hearing loss group, consistent with past EAS literature (Scheperle et al, 2017; Shaul et al, 2020; Thompson et al, 2020). Both the stable and hearing loss group, on average, showed decreases in polarization impedance and rises in access resistance over time for middle and basal regions, generally consistent with reports in standard CI users (Newbold et al, 2014; Tykocinski et al. 2005). At time points 5 to 60 months after CI initial visit, the model estimated mean access resistance and polar impedance were significantly greater in the hearing loss group compared to the stable hearing group. Analysis is ongoing to determine if subject-specific increases in total impedances are primarily driven by their respective increased access resistance or polar impedance over time. Preliminary evidence suggests average changes in access impedance are greater than average changes in polar impedance for the hearing loss group.
Conclusion: Access resistance and polar impedance measures gives greater insight into possible pathophysiology of delayed hearing loss. Increased access resistance may imply an intracochlear fibrotic reaction compromising cochlear mechanics and leading to loss of hearing (Choi & Oghalai, 2005).
Session: CS3-2  
Session: Hearing Preservation  
Title: Electric Acoustic Stimulation in Children with Residual Hearing  
Presenting Author: Angelika Illg, PhD  
Author Block:  
Angelika Illg, PhD1, Daniel Kley, M.S.1, Barbara Esser-Leyding, PhD2, Anke Lesinski-Schiedat, Prof.1;  
1ENT, Med. Univ. of Medicin, Hannover, Germany, 2ENT, Cochlear Implant Ctr. "Wilhelm Hirte", Hannover, Germany.  
Abstract:  
OBJECTIVES  
Preservation of the low-frequency residual hearing offers to use the advantages of electric-acoustic stimulation (EAS). The aim of the retrospective study was to investigate if children can benefit from EAS use.  
METHODS  
Data of 13 children (18 ears, mean implantation age: 8.7 ± 3.2 years) with pre- and postoperative residual hearing were retrospectively evaluated. All children received bilaterally or unilaterally a Synchrony Implant (MED-EL Medical Electronics, Innsbruck) with different lengths of the FLEX electrodes. The speech tests material consisted of the Freiburg monosyllabic word test (FMT) in quiet and the German HSM sentence test in quiet and in noise at 0° azimuth (S0N0) at a 10 dB signal-to-noise ratio (SNR).  
RESULTS  
In all children low-frequency hearing was preserved during cochlea implantation and gave the possibility to use EAS. Median low-frequency hearing loss (125Hz-1.5kHz, pre- to post-operative) was 6.7 dB at initial fitting (IF, N=17). EAS children measured in direct coupling (N=3) achieved in average 80.0% with the FMT, 88.4% with the HSM in quiet and 77.0 % with the HSM in noise at 10 dB SNR. EAS children measured in free field (N=5) achieved in average 51.0% with the FMT, 90.6% with the HSM in quiet and 47.1 % with the HSM sentence test in noise at 10 dB SNR. To compare the advantage of EAS additionally case reports are illustrated.  
CONCLUSION  
Children with preserved residual hearing can benefit from EAS. First results show better speech perception in noise compared to electric stimulation only.
Session: CS3-3
Session: (Re)Habilitation
Title: Cognitive Improvement after Cochlear Implantation in Older Adults with Severe or Profound Hearing Impairment: A Prospective, Longitudinal, Controlled, Multicenter Study
Presenting Author: Griet Mertens, PhD
Author Block:
Griet Mertens, PhD1, Ellen Andries, MSc1, Annes Claes, PhD1, Vedat Topsakal, PhD, MD1, Paul Van de Heyning, PhD, MD1, Vincent Van Rompaey, MD, PhD1, Miryam Calvino, MSc2, Isabel Sanchez Cuadrado, MSc2, Elena Munoz, MSc2, Javier Gavilan, MD, PhD2, Katarzyna Bienkowska, MSc3, Weronika Swierniak, MSc3, Piotr Skarzynski, MD, PhD3, Henryk Skarzynski, MD, PhD3, Lynne Tapper, MSc4, Catherine Killan, MSc4, Jillian Ridgwell, MSc4, Janet McGowan, MSc4, Christopher Raine, MD, PhD4, Dayse Tavora-Vieira, PhD5, Roberta Marino, PhD5, Aanand Acharya, MSc5, Luis Lassaletta, MD, PhD2; Otorhinolaryngology, Head & Neck Surgery, Antwerp Univ. Hosp., Edegem, Belgium, 2Hosp. Universitario La Paz, Madrid, Spain, 3World Hearing Ctr., Warsaw, Poland, 4Bradford Royal Infirmary, Bradford, United Kingdom, 5Fiona Stanley Hosp., Perth, Australia.
Abstract:
Introduction: To compare the cognitive evolution of older adults with severe or profound hearing impairment after cochlear implantation to that of a matched group of older adults with severe hearing impairment who do not receive a cochlear implant (CI).
Methods: In this prospective, longitudinal, controlled, and multicenter study, 24 older CI users were included in the intervention group and 24 adults without a CI in the control group. The control group matched the intervention group in terms of gender, age, formal education, cognitive functioning, and residual hearing. Assessments were made at baseline and 14 months later. Primary outcome measurements included the change in the total score on the Repeatable Battery for the Assessment of Neuropsychological Status for Hearing impaired individuals (RBANS-H) and RBANS-H subdomain scores to assess cognitive evolution in both groups. Secondary outcome measurements included self-reported changes in sound quality (Hearing Implant Sound Quality Index (HISQUI)), self-perceived hearing disability (Speech, Spatial, and Qualities of Hearing Scale (SSQ12)), states of anxiety and depression (Hospital Anxiety and Depression Scale (HADS)), and level of negative affectivity and social inhibition (Type D questionnaire (DS14)).
Results: Improvements of the overall cognitive functioning (p = 0.05) and the subdomain ‘Attention’ (p = 0.02) were observed after cochlear implantation in the intervention group; their scores were compared to the corresponding scores in the control group. Significant positive effects of cochlear implantation on sound quality and self-perceived hearing outcomes were found in the intervention group. Notably, 20% fewer traits of Type D personalities were measured in the intervention group after cochlear implantation. In the control group, traits of Type D personalities increased by 13%.
Conclusion: Intervention with a CI improved cognitive functioning (domain ‘Attention’ in particular) in older adults with severe hearing impairment compared to that of the matched controls with hearing impairment without a CI. However, older CI users did not, in terms of cognition, bridge the performance gap with adults with normal hearing after one year of CI use. The fact that experienced, older CI users still present subnormal cognitive functioning may highlight the need for additional cognitive rehabilitation in the long term after implantation.
Session: CS3-3  
Session: (Re)Habilitation  
**Title:** Receptive Vocabulary and Reading Performance in Children with Cochlear Implants: An Exploration of the Impact of Consistent Intensive Early Intervention  
**Presenting Author:** Marie Wright, MSEd  
**Author Block:**  
Marie Wright, MSEd, Dorothy White, PhD, Meredith Ouellette, MS, Nancy Mellon, MS;The River Sch., Washington, DC.  
**Abstract:**  
**Introduction:** Language and literacy outcomes in young children with hearing loss vary widely (Geers and Hayes, 2011). Children with CIs are at risk for delays in vocabulary development due to lack of early auditory access (Covertino, Marschark, & Durkin, 2014; Lund & Douglas, 2016; Lund, 2015). They must develop vocabulary at a faster rate in order to catch up (Bobzien et al., 2015). Delays in phonological awareness and print knowledge have also been observed (Ambrose, Fey, Eisenberg 2012; Rvachew, 2006), skills that typically predict reading outcomes. Prior literature has identified strategies that improve reading outcomes. Bobzien et al. (2015) evaluated the efficacy of repeated book reading and explicit instruction to improve the vocabulary skills of children with hearing loss in an oral setting. Lund and Douglas (2016) compared different vocabulary instruction conditions, including explicit, direct instruction, follow-in labeling, or labeling objects, and incidental vocabulary exposure in preschool children with hearing loss. These studies suggest that direct instruction can promote vocabulary skills and academic success. Our literacy program uses a systematic approach to help children learn to make letter-sound correspondences, blend sounds, practice reading words, and identify word families. Children must employ strategies effortlessly to become fluent readers--examining letters at the sound level, and then within words. Oral motor, auditory processing, speech production, vocabulary and concepts, and phonological awareness skills are targeted daily. Retrospective analysis was conducted using data from the annual evaluations of 68 children with CIs in our program. This presentation will explore the relationship between receptive vocabulary and reading and spelling outcomes when intensive intervention in vocabulary and phonological awareness has been consistently provided.  
**Methods:** Vocabulary measures: Peabody Picture Vocabulary Test (PPVT) and Receptive One-Word Picture Vocabulary Test (ROWPVT). Standard scores were combined into a composite measure representing overall receptive vocabulary development. Reading and Spelling measures: Word Reading and Spelling subtests of the Wide-Range Achievement Test (WRAT), administered in K and grade 2.  
**Results:** Current analyses indicated vocabulary delays of 9.7 months at baseline, as compared to same-aged peers on the PPVT. Average PPVT scores at time of first measurement fell at the 13th percentile. In contrast, the mean standard score for the Word Reading subtest was solidly within the average range (SS=108.5). The mean standard score on the Spelling subtest was also within the average range (SS=106). Correlation between the initial PPVT and the Word Reading subtest was not significant (r=.025), nor was the correlation between the PPVT and the Spelling subtest (r=-.0005). Spelling and Word Reading subtests were strongly correlated (r=.88).  
**Conclusion:** Vocabulary scores were expected to predict academic outcomes, but in this sample, the relationship was not significant. Our program may be mediating the relationship between vocabulary and reading outcomes. Despite early delays in vocabulary at baseline, academic achievement was assessed to be at grade level by Kindergarten. An intensive focus on emergent literacy and direct instruction in phonological awareness and print knowledge resulted in strong, age-appropriate reading and spelling skills in children with CIs in our program.
Session: CS3-3  
Session: (Re)Habilitation  
Title: Home Language Maintenance in Bilingual Children with Cochlear Implants and Normal Hearing  
Presenting Author: Ferenc Bunta, PhD  
Author Block:  
Ferenc Bunta, PhD, Anny Castilla-Earls, PhD; Communication Sciences and Disorders, Univ. of Houston, Houston, TX.  
Abstract:  
Introduction: Spanish- and English-speaking bilingual children raised in the United States often show a strong preference for English early on, and by their adolescent years report to have higher proficiency in English than in Spanish. This shift in preference and proficiency is the result of complex cultural, educational, and sociolinguistic circumstances. Spanish language maintenance is ideal for many families, but it is not a common outcome in bilingual context such as the United States. This shift in language proficiency and preference for English might affect children with hearing loss differently: children with hearing loss who receive cochlear implants in the US also tend to receive intensive speech and language therapy in English.  
Methods: In the current study, we investigated home language (Spanish) maintenance in Spanish- and English-speaking bilingual children with normal hearing (NH) and their peers with cochlear implants (CIs) and also compared the performance of the groups on language and word recognition measures at two time points about 7 months apart. Twenty-two bilingual children (11 with NH and 11 with CIs) between the ages of 4;6 and 7;11 participated in the study, who were matched as closely as possible on chronological age, time between samples, gender, and age of exposure to their languages across groups. We compared group performance on the Preschool Language Scales - 5th edition (PLS-5) and the Word Intelligibility Picture Identification at each time point as well as home language maintenance calculated based on item responses on the PLS-5.  
Results: Our results indicated differences on all measures at both time points between the performance of children with NH and their peers with CIs in that the former group outperformed the latter. We also found that bilingual children with NH maintained their home language at a higher level than their peers with CIs. Further, the data also showed that despite the group differences, both groups displayed maintenance of their home language and that individual variability was more prevalent in the CI group.  
Conclusion: We conclude that home language maintenance is not only possible, but it should be encouraged for both bilingual children with NH and their peers with CIs.
Session: CS3-3
Session: (Re)Habilitation
Title: Parent-child Vocal Contingency Predicts Language Development in Children with Cochlear Implants
Presenting Author: Yuanyuan Wang, PhD
Author Block:
Yuanyuan Wang, Ph.D., Chi-Hsin Chen, Ph.D., Derek Houston, Ph.D.; Otolaryngology, The Ohio State Univ., Columbus, OH.
Abstract:
Introduction: According to the transactional model of language development, child vocalizations can elicit developmentally appropriate responses from the caregiver, which in turn lead to greater child vocal skills that subsequently receive more complex language input from the caregiver (Sameroff & Chandler, 1974). This dynamic interplay provides a scaffold for subsequent language development (Tamis-LeMonda, Kuchirko, & Song, 2014). However, the parent-child vocal contingency might be affected by the auditory and communicative characteristics of children with cochlear implants (CIs), which may negatively affect their language development. The primary objectives of this research were: (1) to determine whether the contingency between child vocalizations and adult responses differ as a function of child hearing status; and (2) examine the relationship between parent-child vocal contingency and language outcomes in children with CIs.
Methods: To answer these questions, we collected and analyzed the microstructure of caregiver-child interaction from 184 naturalistic recordings using the Language ENvironment Analysis (LENA) system. Thirty-eight children with NH and 17 children with CIs between 8 and 32 months participated in the study. Three measures were extracted from each LENA recording: (1) the total number of child vocalizations (CV) normalized by the duration of the recordings (CV/hr), (2) the proportion of child vocalizations that received adult responses within 1 s (adult response rate, ARR), and (3) the proportion of adult responses followed by child vocalizations (child response rate, CRR). We also measured children’s expressive vocabulary by MacArthur-Bates Communicative Development Inventory.
Results: For each measure, we fitted a mixed-effects model with Hearing status (NH, CI) and Age as the fixed factors, and Participant as a random intercept using the lmer function (Bates et al., 2015) in the R environment (R Core Team, 2014). No significant main effect of Hearing status (NH, CI) was found for the measure of CV/hr, $F(1,63) = .05, p = .824$, suggesting that children with CIs produced a similar number of vocalizations as children with NH; ARR was significantly higher in the NH group than in the CI group, $F(1,59) = 8.30, p = .006$; similarly, CRR was significantly higher in the NH group than in the CI group, $F(1,61) = 6.63, p = .012$. Finally, both ARR and CRR were positively correlated with child vocabulary scores, $r(12)= .612, p = .034$, and $r(12)= .567, p = .054$, respectively.
Conclusion: These findings suggest that although hearing loss does not affect the quantity of child vocalizations, it affects the contingency between child vocalizations and adult responses, leading to reduced opportunities for children with CIs to learn from their caregivers. We also showed that reduced contingency negatively associated with child language outcomes for children with CIs. These findings provide additional evidence-based information to support a focus on caregiver-child interactions to improve child language development.
Session: CS3-3
Session: (Re)Habilitation
Title: AVT Meets AAC: CIs and Complex Needs
Presenting Author: Blair Richlin, MS, LSLS Cert. AVEd
Author Block:
Blair Richlin, M.S., CCC-SLP LSLS AVEdEar Institute, New York Eye & Ear Infirmary of Mt. Sinai, New York, NY.

Abstract:
Introduction: Purpose: This case study focuses on patients and families with diagnosed hearing loss and additional disabilities who participated in aural habilitation/rehabilitation and speech/language focusing on development of listening and spoken language skills with support of alternative and augmentative communication (AAC). Clinical Questions: 1. How effective is speech therapy/aural rehab for patients diagnosed with hearing loss and additional complex needs? 2. How does Alternative & Augmentative Communication support listening and spoken language skills? 3. How is parental involvement different when addressing listening and spoken language skills in conjunction with AAC?

Methods: The current study was conducted according to a qualitative research paradigm using an in-depth case report with content analysis. Therapy sessions were recorded and reviewed to assess patterns with regards to the targeted clinical questions. Qualitative comparisons were drawn from data collected.

Results: Beer et al. (2012) stated that “The presence of any Additional Disabilities, regardless of type, could place a strain on the child, family, and habilitation team that might affect long-term CI performance” (p. 492). Given these strains and the communication delays associated with comorbidities, it is critical that all options for language development be considered and utilized. The field of augmentative and alternative communication (AAC) has evolved substantially over the last 30 years. Researchers have moved from describing individual successes in AAC to understanding broader trends (Romski, Sevcik, Barton-Hulsey, & Whitmore, 2015). Aided language stimulation via parental involvement provides a multi-modal approach to developing listening and spoken language skills. Participants in an AAC study by King, Romski & Sevcik (2020), whose parents were considered strong advocates for their adult children and set high expectations for achievement, tended to have more positive outcomes than children whose parents were less involved in their lives. Access to appropriate and high-quality AAC services also supported positive outcomes. This current case study explores parental involvement in the areas of aural habilitation, listening & spoken language development, and aided language stimulation with AAC.

Conclusion: Ultimately, the crossroads of auditory verbal therapy (promotion of listening and spoken language development) and alternative & augmentative communication (AAC) is parental involvement. As a core tenant of AVT, parental involvement helps show parents how to be their child’s first teacher so families can reach positive listening, speaking, literacy, academic, and social outcomes (Hearing First, 2020). Aided Language Stimulation (ALS) demonstrates the same goals and outcomes for complex communicators (Beck, Stoner, & Dennis, 2009). The current case study confirms the efficacy of AVT and ALS in a patient with hearing loss and complex communication needs.
Session: CS3-3
Session: (Re)Habilitation
Title: Parent Engagement Improves Pediatric CI Outcomes: How and Why
Presenting Author: Meredith Ouellette, MS
Author Block:
Meredith S. Ouellette, MS, Nancy Mellon, MS, Elizabeth Adams, PhD; The River Sch., Washington, DC.
Abstract:
Introduction: Professionals play an important role in intervention for children with hearing loss, but parent engagement is critical to child outcomes (DesJardin & Eisenberg, 2007; Moeller, 2000; Zaidman-Zait & Young, 2008). Family-centered early interventions should capitalize on families’ expertise and strengths, address individual family needs, foster warm and communicative parent-child interactions, and empower parents to take an active and leading role in their child's treatment (Dunst, Trivette, & Hamby, 2008; Houston & Bradham, 2011; McWilliam, 2015; Moeller, Carr, Seaver, Stredler-Brown, & Holzinger, 2013). This presentation will highlight critical parent supports, validated by research, that can improve outcomes in young children with cochlear implants.
Methods: Research suggests that improved parental well-being can result in a warmer parent-child relationship and can positively impact child outcomes, including child language (Biringen & Robinson, 1991). A diagnosis of a hearing loss can disrupt the dynamics of a parent-child relationship. Parents may not receive adequate emotional support after diagnosis and may develop an interaction style that does not effectively facilitate child language development. For example, parents of children with hearing loss have been found to be more directive or intrusive. (Spencer, Erting, & Marschark, 2000). This may negatively affect a child’s language development and disrupt parent-child attachment (Cruz et al., 2013). In Quittner et al. (2013), maternal sensitivity predicted significant increases in language growth for children with cochlear implants (CIs); linguistic stimulation for the child was only related to language growth in the context of high maternal sensitivity. Notably, the effects of maternal sensitivity were similar to the effects found for age of implantation, which has long been considered one of the most powerful predictors of outcomes (Quittner et al., 2013). Other studies have documented the importance of emotional availability and maternal responsiveness to language learning and play for children with hearing loss (e.g., Hudson, Levickis, Down, Nicholls, & Wake, 2015; Pressman, Pipp-Siegel, Yoshinaga-Itano, & Deas, 1999; Roberts, Hensle, & Brooks, 2016; Spencer & Meadow-Orlans, 1996).
Results: Encouraging parents’ engagement and participation in intervention can take many forms. Through its parent-infant programs, support groups, parent workshops, presentations, panels, and Parent-Child Interaction Therapy (PCIT), our program offers an array of choices for parent education and support. Children benefit when parents are empowered learn to integrate effective strategies in daily activities and routines of the family.
Conclusion: Our model optimizes services and delivers the highest quality of care across settings to patients and families through interprofessional education and practice, and in the context of a fully inclusive program. This presentation will outline the continuum of supports and services that can result in higher parent engagement and improved child outcomes, and identifies the research basis on which the choice of specific techniques and strategies rely.
Session: CS4-1
Session: Economics, Public Policy, Practice Management
Title: Implementation of Remote Programming to Improve Productivity in the Post-COVID-19 Clinical Setting
Presenting Author: Samantha Morgan, AuD
Author Block:
Samantha Morgan, Doctor of Audiology, WIHD/WMC, Valhalla, NY.
Abstract:
Introduction: The restrictions of interpersonal relations in a post COVID-19 world mandated modifications to clinical care. Reopening our center required our team to reimagine what the standard of care for cochlear implant recipients and their families could look like. The introduction of remote programming created a new avenue to provide patients with the care they needed, while ensuring safety for patients and clinicians alike. This presentation encompasses both advantages and challenges in administrative, clinical, and fiscal domains as a result of remote programming.
Methods: Remote programming appointments were offered to pediatric implant recipients, in lieu of in-person mapping appointments. Literature explaining the capabilities of remote programming were provided to pediatric patients and their families. Grant funding was pursued to obtain the equipment and cover the shipping costs for a pediatric population largely insured by state-funded programs. Remote sessions were scheduled by request. Remote appointment times were added between in-person appointments. In the first three months after outpatient services resumed at our regional tertiary and quaternary hospital following COVID 19 related closures, six families requested remote sessions. Families that requested remote sessions were either uncomfortable coming into the clinic due to COVID 19 or had to travel over an hour to reach the facility. These patients included those reporting acute concern as well as recently implanted patients who required frequent follow-up. A laptop with required software was shipped from The Center to the patient’s home. Patients were provided with instructions on laptop setup. Two HIPPA compliant communication methods were used in tandem for real-time communication via video and text during setup and the duration of the remote session. After the session was completed, the clinician organized shipment pick-up and the equipment was returned to the center.
Results: Implementation of remote programming allowed for more patients to be seen than would have been possible if all sessions were held in-person. The remote sessions allowed for an overall higher number of billable patient visits to occur while still abiding by all COVID 19 precautions. Remote sessions provided a way for patients to adhere to their optimal clinical follow up timeline while limiting potential exposures for patients, family members, and clinical staff.
Conclusion: Remote programming is a valuable tool for the cochlear implant audiologist during times in which social distancing is mandated however, this tool is anticipated to persist well beyond COVID 19 mandates. Remote programming provides a new route for clinical care in which a patient can maintain their recommended clinical course while their time and travel related expenses can be considerably reduced. Additionally, this technology provides the clinic with the same number of billable opportunities. It is the intention to continue to offer remote sessions and to expand this offering to the adult population.
Session: CS4-1
Session: Economics, Public Policy, Practice Management
Title: Optimizing Care Delivery by Applying a Shared Medical Appointment Model in a Cochlear Implant Practice
Presenting Author: Sarah Sydlowski, AuD, PhD, MBA
Author Block:
Sarah Sydlowski, AuD, PhD, MBA, Cara Donovan, AuD, Jordan McNair, AuD, Katie Hahn, AuD, Karen Petter, AuD, Tina Marks, AuD, Tom Haberkamp, MD, Anh Nguyen Huynh, MD, PhD, James Podriznik, BA, Erika Woodson, MD; Cleveland Clinic, Cleveland, OH.
Abstract:
Introduction: As indications for cochlear implantation (CI) continue to expand and access to CI increases, already busy CI centers will be challenged to manage increased patient volumes. Our program has implemented innovative practices to optimize efficiency in delivering clinical services. One such innovation is the utilization of a shared medical appointment (SMA) model as the entry point for CI candidacy evaluation. Studies examining the efficacy and outcomes of the shared medical model have found that the SMA model provides patients with increased satisfaction (Levine et al., 2010; Heyworth et al., 2014; Egger et al. 2015; Kirsh et al., 2017), increased education (Zantingeet et al., 2009; Kirsh et al., 2017; Wadsworth et al., 2019), and better access to care (Heyworth et al., 2014; Wadsworth et al., 2019). In addition, patients seem to value the contact and connection to other patients that is provided with a SMA (Zantingeet et al., 2009; Kirsh et al., 2017; Wadsworth et al., 2019). SMAs that provide follow-up care can maintain these effects long term (Heyworth et al., 2014). Shared medical appointments (SMA), wherein multiple patients are seen by one or more providers in one coordinated visit, have been successfully implemented in many other settings, but have not been utilized for determining CI candidacy.
Methods: Potential adult CI candidates with a recent audiogram (completed within 6 months) who currently use at least one hearing aid are preferentially scheduled for an SMA as the first step of their CI evaluation. The SMA accommodates up to six candidates (and at least one family member) in one 180 minute session. Patients have access to both a surgeon and audiologist during the session, as well as the unique opportunity to interface with other potential candidates. Each session consists of medical intake and evaluation, aided speech recognition screening with patient hearing aids and programmed and verified clinic hearing aids, education on the anatomy and physiology of hearing (naturally and with hearing devices), medical aspects of CI, expectations following CI, and possible outcomes of the screening appointment. Subjective questionnaires are also completed and inform the screening process. Patients leave the appointment with orders for imaging, vestibular testing, additional aided testing, and other medical follow-up as needed. Appointments are scheduled before departure.
Results: After more than one year of utilization, the SMA format has increased efficiency of patient scheduling and progress through the CI candidacy process. In particular, surgeon access has been improved and patients are ready for team evaluation and approval in a more coordinated fashion, both expediting and simplifying the candidacy process. Provider time is optimized by accommodating more patients in a shorter, but more effective timeframe. Patient feedback has also been positive.
Conclusion: The current climate of healthcare demands that providers introduce creative and innovative approaches to maximize the efficacy and efficiency of patient care. Using the SMA format as part of a CI candidacy evaluation has offered our large CI program an opportunity to improve access for patients while providing more upfront education that enhances the patient experience. Group visits offer a viable solution for improving productivity while enhancing quality in a busy academic medical center setting. Due to COVID, we are actively reformatting for a virtual application.
Abstract:

Introduction: Black, Indigenous, and People of Color (BIPOC) are being disproportionately affected by the COVID-19 (Coronavirus) pandemic. Racial and ethnically diverse communities are experiencing higher virus transmission rates, hospitalization, and economic losses. These communities have been affected by racial health disparities prior to the current global pandemic, relating to social, economic, and environmental disadvantage. Implicit bias and structural racism contribute to the creation and implementation of racial health disparities. As health care professionals, it is important to be culturally sensitive and aware in order to provide the best healthcare to our increasingly diverse patient populations. This presentation explores systemic examples of social determinants of health that ultimately impact patient health-related behaviors and outcomes.

Methods: Throughout this presentation elements that make-up racial health disparities are discussed; such as housing, education, and access to food. Concepts and terminology relating to structural racism are defined and reviewed. Systemic examples of racial disparities are outlined and supported by research studies to help hearing care professionals better understand the effects that racial health disparities and structural racism have played on the health of their patients. Cultural differences also influence patient health-related behaviors and outcomes. Dr. Brittney Sprouse and Dr. Eva Lopez will discuss cultural differences among African-American and Latino communities in the United States, referencing historical examples and looking at trends among these diverse communities.

Results: The racial and ethnic breakdown among audiologists demonstrates that audiologists, collectively, serve a more diverse population. Because we serve a more diverse population, it is important that we actively work on becoming more culturally competent in order to provide culturally sensitive interventions in audiology. Dr. Sprouse and Dr. Lopez will provide recommendations for ways that the field of audiology can provide services that are culturally appropriate and culturally sensitive. Case studies and professional examples will be discuss to support the use of culturally sensitive interventions in clinical practice. Tips to consider during the COVID-19 pandemic, pertaining to the needs of your patients, will also be shared to incorporate into your daily patient interactions.

Conclusion: Cultural competence and cultural sensitivity are concepts that we as healthcare professionals should continue to work on and expand on, to facilitate their incorporation into the audiological services and support that we provide all of our patients.
Session: CS4-1
Session: Economics, Public Policy, Practice Management
Title: Building a Multi-site Interdisciplinary Cochlear Implant Team: The Memphis Cochlear Implant Collaborative
Presenting Author: Sarah Warren, AuD, PhD
Author Block:
Sarah E. Warren, AuD, PhD1, Jordan A. Coffelt, AuD1, Josh Wood, MD2, Charles B. MacDonald, MD2, Jennifer Bidelman, AuD3, Robert J. Yawn, MD4; 1School of Communication Sciences and Disorders, Univ. of Memphis, Memphis, TN, 2Department of Otolaryngology, Le Bonheur Children's Hosp., Memphis, TN, 3School of Communication Sciences and Disorders, Le Bonheur Children's Hosp., Memphis, TN, 4Department of Otolaryngology, Univ. of Tennessee Hlth. Sci. Ctr., Memphis, TN.
Abstract:
Introduction: Cochlear implants (CIs) require a high level of interprofessional care for successful outcomes, which may be of particular importance when working with underserved communities. Coordinating care poses challenges for cochlear implant teams, particularly in situations where team members work at different institutions. Our team serves a large American city which has had historically inconsistent access to cochlear implant care. There are two speculated reasons for this limitation: 1) our city has historically poor collaboration between multiple institutional allegiances, and 2) our city is ranked as one of the most impoverished medium-sized metropolitan areas in the country, with approximately a quarter of its residents living in poverty (Delavega, 2017). Generally, lower SES is associated with higher rates of CI postoperative complications, poorer follow up, and fewer decisions to pursue cochlear implantation (Change et al., 2010). In 2019, clinicians and researchers from three institutions in our city established a collaborative team to provide more comprehensive, coordinated care for children and adults seeking cochlear implant care in our region. Our goal is to expand cochlear implant services in our community, provide comprehensive care, educate clinical students at our respective intuitions, and produce scholarship with a particular focus on health equity. Professionals involved with this initiative include audiology, otolaryngology, speech language pathology, psychology, and social work. This approach is unique as it includes multiple professions several different institutions and may provide useful information to other centers who are interested in collaborating with other institutions to create multidisciplinary teams.
Methods: This project is a descriptive review of outcomes from approximately one year after establishment of a multi-site cochlear implant team in an underserved area. Data included in this presentation will include demographics, number of procedures, surgeries, referrals, clinical outcomes, scholarly accomplishments, as well as educational metrics.
Results: To date, we have provided over 100 cochlear implant related audio logical appointments including 32 cochlear implant evaluations and 19 adult cochlear implantation surgeries (numbers reflect a period of inconsistent practice due to COVID-19). in the first year of introducing multidisciplinary clinical services to an underserved area. In addition, other noteworthy outcomes include a conference presentation, three grant submissions, and 1 community outreach event, as well as the development of a multi-site interdisciplinary protocol. Description of educational opportunities to students will also be included.
Conclusion: As evidenced by our rapid growth in cochlear implant patients and community interest, it is possible to establish a specialized tertiary cochlear implant center that provides comprehensive care for cochlear implant patients in an historically underserved population, even when professionals are affiliated with different institutions. In this presentation, challenges and solutions to developing a multi-site interdisciplinary team are shared.
Development of the Cochlear Implant Use Questionnaire to Assess Habits and Barriers to Use

Jourdan Holder, AuD

Jourdan T. Holder, AuD1, Lindsay S. Mayberry, PhD2, René H. Gifford, PhD1;1Hearing and Speech Sciences, Vanderbilt Univ., Nashville, TN, 2General Internal Medicine & Public Health,., Vanderbilt Univ. Med. Ctr., Nashville, TN.

Abstract:

Introduction: There is significant variability in average daily cochlear implant (CI) use in the adult population ranging from 0 to 24 hours per day with an average of about 10 hours per day. Two studies have shown a moderate to strong correlation between average daily CI use and speech recognition outcomes in adult recipients. These data suggest that daily CI use may account for a significant portion of the variability in speech recognition outcomes in CI recipients. In an effort to better understand recipients daily CI use habits, we created a questionnaire based on the Information-Motivation-Behavioral skills (IMB) model of adherence to probe daily routines and barriers to daily CI use in a quantitative and qualitative manner. We hypothesized that recipients who reported a greater number of barriers to daily CI use would show lower daily CI use as measured via data logging in the CI software.

Methods: Clinical audiologists were asked to provide a list of most commonly reported barriers to CI use. Items were then created based off of these responses and mapped onto the IMB model. Additional items that aligned with the IMB model were also added following consultation with IMB model expert. The finalized items were compiled to form the Cochlear Implant Use Questionnaire (CIUQ). The first section probes the following: employment status, living situation, time of day they put the CI on, time of day they take the CI off, activities for which they remove their CI, number of hours per day they think they wear their CI, their surgeon/audiologist’s recommendation for how often they should wear their CI processor, and any additional information they would like to share about their daily CI use habits. The second section contains quantitative questions that probe specific barriers to daily CI use using a five-point scale. The quantitative responses were added together for a total between 0 and 100 such that a higher total corresponded to a greater number of reported barriers to CI use. We collected responses to the CIUQ from 100 adult CI recipients. We also collected objective daily CI use information from the CI software.

Results: The average total score for the quantitative section of the CIUQ was 23.3 (SD = 11.3), and total scores ranged from 3 to 54. The correlation between total score and data logging was significant (r = -0.561, p<0.0001) demonstrating construct validity-- the questionnaire is valid for its intended purpose. Respondents’ subjective daily CI use report was 2.6 hours higher than the objective data logging collected from the software on average. 43% of respondents reported that they did not remember or no recommendation was made by their surgeon or audiologist concerning daily CI use. Most commonly reported barriers to CI use were concerns about moisture, feeling ill, and lack of support.

Conclusion: The CIUQ is a newly developed tool to measure CI use habits and barriers to daily CI use. It is quick and easy to administer, and it shows evidence of construct validity via a significant correlation with data logging. Clinicians should consider implementing this questionnaire to identify and overcome barriers to consistent, full-time CI processor use.
Session: CS4-1
Session: Economics, Public Policy, Practice Management
Title: Use of Tablet Based Technology for Remote Cochlear Implant Programming
Presenting Author: Keri Colio, AuD
Author Block:
Keri Colio, AuD, Julie Purdy, PhD, Kristen Baisley, AuD; Audiology, Rady Children's Hosp., San Diego, CA.
Abstract:
Introduction: While studies have shown that remote programming of cochlear Implants yields equivalent results to inperson programming and that this practice was approved by the Food and Drug Administration in 2017, very few centers have successfully adopted this practice. Barriers in assuring personal data is SAFELY-maintained and understanding equipment needs have proved daunting to many centers. Our center has recently overcome these hurdles, employing a process that can be easily adopted by other interested centers.
Methods: Our process involves the use of inexpensive, durable Microsoft Surface Tablets, USB Type-C adaptor and wireless programming pods. Once we have identified that a family requires remote programming, we follow the following steps: 1. We mail the family the powered-off tablet, adaptor and programming pod(s) along with a pre-paid return shipping label. 2. We schedule a Cochlear implant programming appointment as a tele-audiology appointment. 3. We contact the family by phone at the scheduled appointment time and guide the family through Surface setup: a. Powering on the device; b. Entering a password that that we created prior to shipping; c. Connecting to their personal Wi-Fi and initiating a zoom session; d. Joining a meeting using a meeting ID provided by the clinician; e. Sharing their screen and accepting the clinician's request to access their screen remotely. 4. We log into the cochlear software which has been installed on the surface using our clinic password. 5. We advise the family to connect the CI recipient's fully-charged battery to the yellow wireless pod. Once the pod is connected, the family will then connect the processor/s. We program the devices. 6. We export the patient's file to the desktop and advise the family to: a. Open the zoom meeting chat box and click the "file" button; b. Add the CDX file and send. 7. Once the file has been received, we move the CDX file from the Surface desktop to the recyclebin and empty. We delete/archive the patient file from the Cochlear software and close. 8. In the Surface search bar, we enter "change password" and follow the instructions to change the password. 9. The family is asked to power down and return the equipment using the prepaid label. 10. We import the CDX file into our shared database and record the new password in our log for the next session.
Results: We have successfully implemented this process using inexpensive equipment options and a system that insures the safe transfer of patient information via secured zoom access.
Conclusion: While COVID-19 has been a driving force for many centers in implementing remote cochlear implant programming, it is also another way for centers to remove barriers to accessing Audiology services in deaf and hard of hearing children with cochlear implants who are either medically challenged or geographically distant.
Session: CS4-1
Session: Economics, Public Policy, Practice Management
Title: Current Estimates of Cochlear Implant Utilization in the United States
Presenting Author: Ashley Nassiri, MD, MBA
Author Block: N/A
Abstract:
Invited Presentation
Session: CS4-3
Session: Telehealth Part 2, What we’ve experienced in Education and Surgery
Title: Telemedicine in Neurotology
Presenting Author: Erika Woodson, MD
Author Block:
N/A
Abstract:
Invited Presentation
Session: CS4-3
Session: Telehealth Part 2, What we’ve experienced in Education and Surgery
Title: The Virtual Nursery: Staying Connected During COVID-19
Presenting Author: Kayley Mayer, MAT, TOD
Author Block:
Kayley Mayer, M.A.T, TODMountain Lakes EIP/Sound Start Babies, Mountain Lakes EIP/Sound Start Babies, Mountain Lakes, NJ.
Abstract:
Introduction: The importance of socialization for toddlers, especially those with hearing loss, is widely supported by research. When the COVID-19 pandemic forced the closure of many center-based programs, families and practitioners were faced with new challenges as to how to provide a group learning experience.
Methods: From March 17, 2020 to September 25, 2020, families of children with and without hearing loss participated in a virtual nursery program for toddlers 18 to 36 months of age. The curriculum was organized by Teachers of the Deaf, Speech Language Pathologists, a Physical Therapist and supported by paraprofessionals and an educational audiologist. Daily live activities were provided for 30 minutes each including Music, Story Time, Yoga, Sign Language, Art, and Show and Tell. Live classes were supplemented with recorded content (songs, read alouds, and circle time routines), daily lesson plans (with at home activities), and parent education handouts. All curriculum material followed the program’s typical themes. Demographics included various socio-economic statuses, geographic locations (5 counties in New Jersey), and family dynamics. Types of assistive listening technology included unilateral and bilateral cochlear implants, hearing aids, and bone-anchored softbands.
Results: In March of 2020, 14 families of typically hearing (TH) children and 9 families of children with hearing loss (HL) participated in the groups. April 2020 TH=11, HL=9; May 2020 TH=9, HL=9; June 2020 TH=5, HL=7; July 2020 TH=1, HL=5; September 2020 TH=0, HL=5. Parent report and clinical observation indicated that social emotional and communication skills continued to develop while the families were quarantined at home and routines were enhanced by access to the program. Family feedback revealed the value parents saw in having their children have opportunities for social language exchanges with peers, even if virtually.
Conclusion: This presentation will discuss the design of the virtual nursery program including challenges that arose in the planning and execution. A brief overview of the program prior to the COVID-19 pandemic will be shared. Trends in the participation of both demographics will be presented as well as limitations and factors that contributed to the results. In addition, parent testimonials and case examples will be discussed.
Session: CS4-3
Session: Telehealth Part 2, What we’ve experienced in Education and Surgery
Title: Test-retest Reliability of Language Measures Administered Via Tele-assessment for Children with Hearing Loss
Presenting Author: Krystal Werfel, PhD
Author Block:
Krystal L. Werfel, PhD1, Emily A. Lund, PhD2, Brittany Grey, MA1, Michelle Johnson, MS1;1Communication Sciences and Disorders, Univ. of South Carolina, Columbia, SC, 2Texas Christian Univ., Fort Worth, TX.
Abstract:
Introduction: The COVID-19 global pandemic and associated widespread closings of school and businesses has upended service provision in the field of speech-language pathology. Prior to this pandemic, only a minority of speech-language pathologists had engaged in telepractice during the last five decades. Perhaps as a result of this slow adoption of telepractice, little research has evaluated telepractice, including tele-assessment, methods for SLPs. We are conducting a longitudinal investigation of the growth of spoken language, emergent literacy, and literacy skills of children with hearing loss who use spoken language across preschool and elementary school. During preschool, children participate in assessment of spoken language, phonological processing, and print knowledge skills at six-month intervals from age 4 to age 6. Pre-COVID, these sessions took place in our research assessment rooms at a university, the child’s school, the child’s home, or a local public library. In March 2020, our universities restricted travel and in-person research. The nature of this longitudinal study is based on specific timing of assessment intervals, so it was essential for us to quickly shift our in-person assessment to a virtual environment.
Methods: It was important for us to determine if our assessments could be reliably administered in a virtual environment, particularly given concerns about sound access for children with hearing loss. Therefore, before commencing virtual testing sessions, we completed a small pilot study to evaluate the methods. In this study, we invited all participants who had completed an in-person testing session within the month previous to the COVID-related shut-down. Of 23 children, 15 agreed to participate in this virtual follow-up; all were preschool-aged. We administered virtual versions of many of our study measures and calculated test-retest reliability for the in-person to virtual format.
Results: Our findings revealed very high test-retest reliability for speech and language measures (e.g., articulation, vocabulary, morphosyntax; .715 - .955), as well as print measures (e.g., alphabet knowledge, conceptual print knowledge; .854 - .950). Test-retest reliability for phonological processing measures varied. Phonological awareness was high (.925), but phonological memory and phonological recoding were unacceptably low, with the exception of digit span (-.102 - .786). The majority of low test-retest reliability occurred on timed measures.
Conclusion: Our findings suggest that virtual assessment is feasible and reliable for many areas of language assessment for children with hearing loss. Measures that are timed or rely on nonword speech perception and production may not be reliable in a virtual format.
Session: CS4-3
Session: Telehealth Part 2, What we’ve experienced in Education and Surgery
Title: Case Presentations of Aural Rehabilitation Via Teletherapy for Culturally and Linguistically Diverse Families
Presenting Author: Sneha Bharadwaj, PhD
Author Block:
Sneha Bharadwaj, Ph. D1, Linda L. Daniel, MS MA FAAA CCC-A2;1Communication Sciences and Disorders, Texas Woman’s Univ., Denton, TX, 2Hear in Dallas, Dallas, TX.
Abstract:
Introduction: Aural rehabilitation practitioners are increasingly providing services to culturally and linguistically diverse families. Among the various factors that affect optimal outcomes of intervention are the factors that pertain to culture and linguistic diversity and cultural competence of the clinician. This study examined these factors through ethnographic interviews and clinician self-assessments.
Methods: Ethnographic interviews were conducted via teleconferencing with three mothers of children with hearing loss living in Belize, Kenya, and the Philippines. All three of the mothers and their children were receiving aural rehabilitation services via teletherapy with a practitioner who was raised in the Midwestern region of the US. Following the interview, each child’s individualized therapy plan was modified in collaboration with the caregivers and the practitioner. The goal was to align the family’s cultural preferences with the practitioner’s suggestions to accomplish the parents’ goals for their child. Following four months of intervention, the mothers were interviewed to evaluate their perceptions of the cultural awareness of the practitioner and the effects of the modifications made to their intervention services. Clinician completed a self-assessment on cultural competence before and after the 4-month intervention period.
Results: Ethnographic interviews with the three mothers of children with hearing loss led to the identification of distinct issues for each family that were addressed in subsequent intervention sessions. Post-interviews indicated caregiver satisfaction with respect to culturally-adapted therapy. Lastly, clinician self-assessment revealed improved scores in clinician cultural competence and led to the development of future therapy goals.
Conclusion: The ever-increasing diversity seen within the population of people with hearing loss is changing service delivery models of aural rehabilitation. This presentation will address the importance of (1) ethnographic interviews, (2) clinician’s ongoing development of cultural knowledge, and (3) culturally-adapted treatments when serving the needs of culturally and linguistically diverse families.
Session: CS4-3
Session: Telehealth Part 2, What we’ve experienced in Education and Surgery
Title: Opinions on Telehealth: The Perspective of Hearing-impaired Adults During COVID-19
Presenting Author: Catherine Sucher, BSc, DipAud, MAud, AuD
Author Block: Catherine M. Sucher, BSc, DipAud, MAud(Research), AuD, Robert H. Eikelboom, BEng, MApplSc, PhD, Rebecca J. Bennett, BSc, MAud, MBus, GradDipCounselling, PhD, Azadeh Ebrahimi-Madiseh, B.Sc, M.Clin.Aud; Ear Sci. Inst. Australia, Subiaco, Australia.
Abstract:
Introduction: The COVID-19 pandemic has highlighted the vulnerability of our older population, and also health professionals, to disease transmitted through the kind of close contact associated with many face-to-face audiological appointments. Thus there is an urgent need for flexibility in the models of delivery of clinical care. There are huge opportunities afforded by digital technology (telehealth) to enable better equity and continuity of access to care. Telehealth has been a recognised method of health-care service delivery for several decades, however uptake of telehealth has been sporadic. Whilst telehealth services more commonly utilise phone or videoconferencing services, they may also use apps, websites or wearable medical devices to monitor health conditions, provide medical feedback, and facilitate rehabilitation. The COVID-19 pandemic has provided the impetus to re-evaluate telehealth, in particular from the perspective of the older members of the population. We know that older age is one of the strongest barriers to the acceptance of telehealth services. We also know that older adults are more likely to experience hearing loss and using hearing services. This study aimed to investigate hearing impaired adults use of, and attitudes towards telehealth.
Methods: An invitation to complete an online survey was emailed to clients of a large Western Australia audiology service. Participants included 538 adults who had only received a hearing test, or who also used assistive listening devices, hearing aid/s, bone conduction implant/s, middle ear implant/s or cochlear implant/s.
Results: Only 27% of respondents had previously utilised telehealth services, with older adults and males significantly less likely to have used telehealth services. Mode of telehealth used was primarily telephone consultation (75%), followed by online consultation with video (28%). Of those who had used telehealth services, the primary benefits noted were “access to health services from work or home” and “spending less time and money travelling to appointments”. The primary dislikes were related to lack of face-to-face contact and concerns that a health issue may be missed or mistaken. Respondents were also asked about their ability to use various technologies routinely used for telehealth services. Significant differences were noted between the difficulty ratings for each form of technology and respondent’s age and subjective hearing difficulty. Older adults have significantly more difficulty with computer, tablet and smart phone technology. Adults with more subjective hearing disability having significantly more difficulty using standard (non-internet connected) phones.
Conclusion: To ensure improved uptake of telehealth services into the future, and improved equity of care, the needs and preferences of older adults, and those with hearing impairment should be considered when designing a telehealth audiology service.
Session: CS4-3
Session: Telehealth Part 2, What we’ve experienced in Education and Surgery
Title: The Future of Telepractice Service Delivery to Children & Adults with Hearing Loss
Presenting Author: K. Todd Houston, PhD, LSLS Cert. AVT
Author Block:
N/A
Abstract:
Invited Presentation
Session: CS5-1  
Session: Cochlear Implant Outcomes  
Title: Speech Outcomes in Bilingual Cochlear Implant Patients Using English and Spanish Tests  
Presenting Author: Sandra Velandia, AuD  
Author Block:  
Sandra Velandia, AuD, Diane Martinez, AuD, Stefanie Pena, MS, Carly Misztal, BS, Stefania Goncalves, MD, Simon Angeli, MD, Fred Telischi, MD, Christine T. Dinh, MD; Otolaryngology, Univ. of Miami, Miami, FL.  
Abstract:  
Introduction: Because of inherent differences in the phonology, morphology, and syntax of the English and Spanish languages, determining cochlear implant (CI) candidacy and post-operative outcomes in bilingual Hispanic patients introduces unique challenges. For these patients, the Spanish language may be easier to hear and understand because it possesses greater acoustic energy from the use of more low-frequency vowels, syllables, and consonant-vowel combinations. In comparison, the English language has more high-frequency consonant clusters that can be difficult to hear and differentiate. In this study, we analyze speech perception outcomes in bilingual Hispanic CI patients using Spanish and English tests and describe important considerations for determining CI candidacy and post-operative testing in the bilingual Hispanic population.  
Methods: A retrospective chart review was performed for all patients that received unilateral CI surgery between January 2014 and December of 2018 at a tertiary care center. Of the 425 patients, there were 41 adults that were bilingual in English and Spanish. Fourteen of these patients had speech testing in both languages (English CNC and AzBio, Spanish Bisyllables and HINT). Demographic information, surgical details, and post-operative speech outcomes were collected. Descriptive statistics and paired t-tests with Bonferroni correction were utilized for statistical analysis.  
Results: Of the 14 bilingual CI patients with aided speech tests in both English and Spanish, 8 patients (57.1%) reported Spanish as their primary language. The average age was 58.5 years, with a range of 34-82 years. In this cohort, 28.6% were males and 71.4% were females. The patients received either Cochlear (57.1%) or MED-EL (42.9%) implants. The mean follow-up period was 38 months (range 19-60 months). When evaluating aided word tests, bilingual patients scored significantly higher on Spanish Bisyllable tests when compared to CNC scores overall (p<0.0001), with a mean difference of 25% between the two tests. The mean Bisyllable scores were greater than the CNC scores at several time points, which was statistically significant at 3-months (64% versus 50%; p=0.0043) and >24-months (75% versus 63%; p=0.0001). When analyzing aided sentence tests, bilingual patients also scored higher on Spanish HINT when compared to English AzBio in both Quiet (98% versus 62%; p<0.0001) and +5dB SNR conditions (94% versus 32%; p=0.0001). Patients also did better on Spanish HINT at 0dB SNR than English AzBio at +5dB SNR (81% versus 36%; p=0.001). However, there were no significant differences in Spanish HINT with 0dB SNR when compared to English AzBio in Quiet, suggesting that these tests may be of equivalent difficulty over both languages.  
Conclusion: Bilingual CI patients achieved higher scores on Spanish speech tests in both Quiet and at +5dB SNR when compared to English tests, suggesting how inherent differences in both languages may affect speech understanding in their daily listening environments and/or highlight limitations in available tests. Thus, testing in both English and Spanish will provide important insights into how bilingual CI patients perform in their everyday lives and should be considered when determining CI candidacy. Furthermore, because bilingual Hispanic CI patients perform so well on Spanish speech tests in Quiet and +5dB SNR post-operatively, our findings support the use of Spanish HINT testing to at least 0dB SNR to track progress over time.
Session: CS5-1
Session: Cochlear Implant Outcomes
Title: Longitudinal Changes in Speech Recognition After Cochlear Implantation: Differences between Group and Individual Patient Outcomes
Presenting Author: Cheng Ma, BS
Author Block:
Cheng Ma, B.S., Erick Yuen, MD, Shaun A. Nguyen, MD, Kara C. Schwartz-Leyzac, AuD, PhD, Judy R. Dubno, PhD, Theodore R. McRackan, MD, MSCR; Otolaryngology, MUSC, Charleston, SC.
Abstract:
Introduction: On average, patients receiving cochlear implants (CIs) achieve improvements in speech recognition during the first 3-6 months after activation and then performance plateaus. However, longitudinal changes in speech recognition during the first year after CI activation for individual patients are not widely known. This information is important for understanding CI benefits and for patient counseling, as individual patient experiences may not reflect average trends. This study assesses individual differences in longitudinal changes in speech recognition over the first year after CI activation and compares these results to group mean changes in scores.
Methods: This is a retrospective analysis of our institution’s prospectively maintained adult CI database. Inclusion criteria were postlingually deafened adults receiving their first CI. Patients receiving bilateral or revision cochlear implantation were excluded. Speech recognition ability was assessed by Consonant-Nucleus-Consonant (CNC) word recognition scores and AzBio sentence recognition scores in quiet at baseline and 3, 6, and 12 months post-implant. Average post-implant time to speech recognition plateau was determined using repeated measures ANOVA. Individual patient changes in scores between time periods were compared to each task’s 95% confidence interval.
Results: The study sample included 114 patients with mean age at implantation of 66.9 years (range 19 to 94 years). Group mean CNC scores significantly improved from pre-CI to 3 months (d=1.49; 95% CI [1.13, 1.86]) and 3-6 months (d=0.29; 95% CI [-0.03, 0.62]) but remained constant from 6-12 months (d=0.19; 95% CI [-0.13, 0.52]). In contrast to group means, CNC scores remained constant from pre-CI to 3 months for 25.7% of patients and significantly improved from 6-12 months for 17.7% of patients. Group mean AzBio quiet scores significantly improved from pre-CI to 3 months (d=1.75; 95% CI [1.35, 2.16]) and from 6-12 months (d=0.35; 95% CI [0.00, 0.70]), but remained constant from 3-6 months (d=0.17; 95% CI [-0.18, 0.52]). Similar to CNC, AzBio quiet scores improved from 3-6 months for 20.3% of patients, but scores for 64.1% of patients remained constant from 6-12 months. Additional analyses will determine associations between patient characteristics, such as age at implantation and duration of hearing loss, and longitudinal changes in speech recognition.
Conclusion: Although mean results for groups of patients can provide a broad overview of CI benefits as indicated by improvements in post-CI speech recognition ability, results for individual patients revealing large individual differences may more closely represent patients’ experience in the post-implant period. As such, results that show ranges in outcomes or other individual results rather than means may provide enhanced information needed for more nuanced counseling for patients, such as expected time intervals for improvement and performance plateau.
Session: CS5-1  
Session: Cochlear Implant Outcomes  
**Title:** The Impact of Late Cochlear Implantation for Prelingually Deafened Adults: A Systematic Review and Meta-analysis  
**Presenting Author:** Cheng Ma, BS  
**Author Block:** Cheng Ma, B.S., Jacob Fried, MD, Shaun A. Nguyen, MD, Theodore R. McRackan, MD, MSCR, Paul R. Lambert, MD; Otolaryngology, MUSC, Charleston, SC.  
**Abstract:**  
**Introduction:** Prelingual hearing loss is defined as deafness that occurs prior to speech and language development in children. In such patients, early cochlear implantation (CI) is often recommended to augment hearing and assist with auditory speech acquisition. The benefits of later implantation in the pediatric prelingually deafened population is well-studied, however in the early-deafened, late-implanted (EDLI) adult population, its effects are unclear. Here, we study the impact of late cochlear implantation on hearing outcomes and quality of life in pre-lingually deafened adults.  
**Methods:** A systematic review was performed by searching Pubmed, EMBASE, SCOPUS, and Cochrane Library through September 2020 using a combination of subject headings and keywords related to CI and prelingual hearing loss. English articles reporting on speech recognition hearing outcome measures and quality of life measures for prelingually deafened adult CI recipients were selected. Demographic, speech recognition, and quality of life data were extracted and included in our meta-analysis.  
**Results:** A total of 33 studies reporting on 886 prelingually deafened adult CI recipients (mean age of implantation 36.07 years, range 18-74) were included. Meta-analysis of open-set sentence recognition in quiet and open-set recognition of phonemes demonstrated improvement following implantation, with mean differences of 25.51 [95% CI: 6.69, 44.32] and 26.52 [95% CI: 19.44, 33.60], respectively. In addition, open-set word recognition testing was performed in three studies with two showing improvement and the third demonstrating no change. Quality of life as measured by the Abbreviated Profile of Hearing Aid Benefit (APHAB) and the Speech, Spatial, and Qualities of Hearing Scale (SSQ) also showed modest improvement, but data were limited to two studies.  
**Conclusion:** Late cochlear implantation in prelingually deafened adults is associated with improved speech recognition. Patients also reported an overall improvement in quality of life as measured by absolute score difference, however, further studies are warranted in larger populations to assess the clinical and statistical significance.
Session: C5-1
Session: Cochlear Implant Outcomes
Title: Cortical Reorganization by Auditory Deprivation Predicts Cochlear Implant Performance in Deaf Adults
Presenting Author: Hong Ju Park, MD, PhD
Author Block:
Hong Ju Park, MD PhD1, Zhe Sun, PhD candidate2, Ji Won Seo, MD3, Min Young Kwak, MD4, Hosung Kim, PhD2;1Otolaryngology, Asan Med. Ctr., Seoul, Korea, Republic of, 2Department of Neurology, USC Stevens Neuroimaging and Informatics Inst., LA, CA, 3Otolaryngology, Samsung Changwon Hosp., Sungkyunkwan Univ. Sch. of Med., Changwon, Korea, Republic of, 4Otolaryngology, Eulji Univ., Daejeon, Korea, Republic of.
Abstract:
Introduction: Long-term hearing loss in postlingually deaf adults may lead to progressive structural changes in the cerebral cortices that process auditory and language functions, and these alterations may affect the outcomes of cochlear implantation. We aimed to predict cochlear implantation outcomes by evaluating imaging features and quantifying cortical structural changes.
Methods: We studied 94 postlingually deaf patients who underwent cochlear implantation and 37 recent sudden hearing loss patients who were expected to show no brain structural changes. We performed voxel-based morphometry to compare the brain gray matter probability between postlingually deaf patients and sudden hearing loss subjects.
Results: Compared to those with sudden hearing loss, we found decreased gray matter probabilities in bilateral superior, middle, and inferior temporal cortices; pre-/post-central cortices; as well as the thalamus in the postlingually deaf group, most of which are regions related to auditory and language processing functions. As the deafness progresses, however, the aforementioned brain areas except the middle temporal cortex displayed gradually reverse increases in gray matter probability, whereas the middle temporal cortex showed constant gradual decreases. Gray matter clusters in the left superior temporal cortex, left middle temporal cortex, and bilateral thalami showed the most accurate prediction of post-cochlear implantation word recognition scores (mean absolute error = 10.1%, r = 0.82), which was significantly better than when clinical variables used (12.1%, p<0.05). The prediction was slightly improved when the gray matter features were combined with clinical variables like deafness duration and age at cochlear implantation (8.5%, r = 0.9).
Conclusion: Our findings suggest that early hearing deprivation induces initial gray matter volume loss in the superior temporal cortex and thalamus, while the cross-modal plasticity that enables these regions to process other modal sensory inputs reverses the volume decrease trend when deafness becomes persistent for years. However, volumes of the middle temporal cortex, which processes higher-level language comprehension, persistently decrease over time, suggesting this area’s association with the degradation of speech comprehension in patients with long-term postlingual deafness. These imaging features of the cross-modality and progressive atrophy of language processing areas might play a key role in predicting outcomes of cochlear implantation.
Session: CS5-1

Session: Cochlear Implant Outcomes

Title: Functional Near-infrared Spectroscopy to Evaluate Brain Activity in Children Who Have Cochlear Implants and Disparate Language Outcomes

Presenting Author: Jace Wolfe, PhD

Author Block:
Jace Wolfe, PhD1, Mickael Deroche, PhD2, Sara Neumann, AuD1, Vincent Gracco, PhD3, Lindsay Hanna, M.S.1, Will Towler, B.S.1, Alex Bien, M.D.4, Caleb Wilson, B.S.S;1Hearts for Hearing, Hearts for Hearing, OKLAHOMA CITY, OK, 2Concordia Univ., Montreal, Canada, 3Haskins Lab., New Haven, CT, 4College of Medicine, Univ. of Oklahoma, OKLAHOMA CITY, OK, 5Univ. of Oklahoma, OKLAHOMA CITY, OK.

Abstract:

Introduction: A high level of variability exists in the listening and spoken language outcomes of children with cochlear implants (CI). A portion of this variability may be attributed to differences in brain development associated with auditory deprivation secondary to hearing loss. Functional near-infrared spectroscopy (fNIRS) is a non-invasive functional neuro-imaging technique that is used to evaluate activity in the cortical areas of the brain. Use of fNIRS to evaluate the brain activity of CI recipients is attractive because fNIRS measurements are not compromised by electrical artifact from CI stimulation, and infrared measurement poses no safety risks or measurement artifacts related to the CI magnet. In the current study, fNIRS was used to record brain activity in children who have CIs and disparate spoken language outcomes as they were engaged in a battery of various functional tasks. The primary objective was to determine whether underlying differences in brain activity are related to spoken language outcomes.

Methods: Fifty CI recipients, ages 7 to 17 years old, and 25 age-matched children with normal hearing were evaluated with fNIRS. Twenty-five of the children with cochlear implants had age-appropriate spoken language development (as indicated by a standard score of 100 or greater on the Core Language portion of Clinical Evaluation of Language Fundamentals [CELF] test), whereas twenty-five children of the children with cochlear implant had delays in their spoken language development (CELF score < 85). Age of implantation was different for the two groups with, on average, earlier implantation for the age-appropriate group. FNIRS measures were used to record regional changes in hemodynamic activity (i.e., oxygenated and deoxygenated hemoglobin levels) while the children were involved in auditory, visual, auditory-visual, resting-state, somatosensory, and motor tasks.

Results: Significant differences existed in the brain activity recorded via fNIRS in the children with delayed spoken language outcomes compared to the children with age-appropriate spoken language outcomes. Children with better spoken language outcomes were more likely to show sharper, more robust (greater amplitude) responses in modality-specific areas of the brain corresponding to the specific functional task. For instance, children with better language outcomes tended to show more robust responses in the temporal and occipital regions in response to auditory and visual tasks, respectively. Additionally, children with language delays were often less likely to inhibit the auditory areas of the brain during visual tasks. The fNIRS responses of the children who had cochlear implants and age-appropriate spoken language outcomes were similar to the outcomes of children with normal hearing.

Conclusion: The current data provide evidence of the potential for fNIRS to identify neural adaptations and functional differences in CI recipients who differ according to age of implantation and language performance. Age-appropriate language outcomes were associated with neural activity similar to that of the normal hearing group although some interesting differences were noted. In contrast, delayed language outcomes were associated with neural activity suggesting cross-modality interference that may have negatively affected their language outcomes.
Session: CS5-1
Session: Cochlear Implant Outcomes
Title: It Takes A Village: The Apical Electrode Hack
Presenting Author: Mario Svirsky, PhD
Author Block:
N/A
Abstract:
Invited Presentation
Session: CS6-1
Session: Asymmetrical Hearing Loss and Single-Sided Deafness
Title: Management of Pediatric Single-sided Deafness via Cochlear Implantation Clinical Successes and Pitfalls
Presenting Author: Celine Richard, MD, PhD
Author Block:
Celine Richard, MD, PhD1, Christine Schafer, AuD2, Lauren Wills, MA, CCC-SLP3, Tran Bourgeois, MPH4, Prashant Malhotra, MD, FAAP1, Oliver F. Adunka, MD, FACS5, Ursula M. Findlen, PhD1;1Pediatric ENT, Nationwide Children's Hosp., Columbus, OH, 2Division of Clinical Therapies, Nationwide Children's Hosp.- , Columbus, OH, USA., Columbus, OH, 3Division of Clinical Therapies, Nationwide Children's Hosp., Columbus, OH, 4Center for Surgical Outcomes Research, Nationwide Children's Hosp., Columbus, OH, 5Department of Otolaryngology - Head & Neck Surgery, OSU Eye and Ear Institute, The Ohio State Wexner Med. Ctr., Coll. of Med., Columbus, OH.
Abstract:
Introduction: While a consensus protocol was recently suggested for adults with unilateral sensorineural hearing loss, heterogeneity of protocols, and lack of evaluation tools persist in children. Our main objective is to describe how our pediatric program has evolved along with the changes of management approaches for single-sided deafness and how we have learned from our experience. Our second objective is to present and discuss the short-and long-term results from the center cohort, in the light of the rapidly changing healthcare landscape and the recent situation created by the COVID-19 pandemic.
Methods: The first part of the report consists of reviewing our center’s multidisciplinary approach including the Otolaryngology, Audiology, and Speech-language Pathology Departments for formulating and refining an evidence-based clinical practice guideline for children with single-sided deafness (SSD). This process occurred over the course of 6 years and included evaluating different measures to assess the available treatment options for children by age, including contralateral routing of signal (CROS) via air and bone conduction pathways, monitoring, and ultimately cochlear implantation when indications were expanded. A retrospective chart review study was then initiated to evaluate outcomes for children with SSD under the age of 18 years who opted for cochlear implantation as their management choice. Children with bilateral hearing loss, history of CMV, cognitive deficits, multiply handicaps or severe cochlear anomalies were excluded. Clinical data including medical history, audiologic thresholds and speech perception testing pre- and post-implantation, surgical course with documented complications, device wear time, speech/language results pre- and post-implantation, and aural rehabilitation course were documented at 5 different specific time points from 1 to 24 months following surgery. Outcomes are analyzed for trends regarding changes in speech perception, language abilities, and subjective quality of life.
Results: Thirty-five children from 11months to 17 years (mean=7.3 years) have been implanted by our center between 2015 and 2020, with additional surgeries scheduled for the remainder of 2020 and into 2021. This cohort included children with both congenital hearing loss and acquired hearing loss, with mean duration of deafness of 4.8 years (range = 6 months to 15 years). Comparison of pre- and post-implantation speech perception testing revealed slow improvement in ipsilateral speech perception and speech in noise abilities in the bimodal condition over the first year to 18 months of implantation. Nineteen of the patients engaged in long-term aural rehabilitation while five engaged in brief aural rehabilitation sessions. Aural rehabilitation through direct-connect stimulation in-person and via telehealth has been effective in supporting progression of auditory skills and acceptance of the device.
Conclusion: Cochlear implantation has proven to be a safe, effective treatment for children with SSD. Our center’s experience has shown a slow progression of speech perception abilities but ultimately positive outcomes for children. Development of additional clinically-feasible test measures will be necessary to fully evaluate outcomes in this unique population.
**Session:** CS6-1  
**Session:** Asymmetrical Hearing Loss and Single-Sided Deafness  
**Title:** Cochlear Implant Outcomes in Adults with Single-sided Deafness and Asymmetric Hearing Loss  
**Presenting Author:** Sarah Sydlowski, AuD, PhD, MBA  
**Author Block:**  
Sarah A. Sydlowski, AuD, PhD, MBA1, Carmen Jamis, AuD1, Marisa Carrozza, BS1, Nathan Farrokhian, BA, BS2, Erika Woodson, MD1;1Cleveland Clinic, Cleveland, OH, 2Case Western Reserve Univ., Cleveland, OH.  
**Abstract:**  
**Introduction:** The viability of cochlear implant (CI) as an efficacious treatment in cases of single-sided deafness (SSD) and asymmetric hearing loss (AHL) has become increasingly apparent. Numerous reports note improved speech recognition in both quiet and noise, effective tinnitus suppression, improved localization and quality of life. Notably, improvement tends to be the norm rather than the exceptions with multiple studies reporting improvement for all recipients (Sullivan et al, 2020; Arndt et al, 2017). Yet, despite strong evidence and recent labeling of one manufacturer’s device for use with these indications, CI is still not embraced by all providers as a first option or routine management approach. Insurance coverage is often a limiting factor, but two clinical factors may also influence provider recommendations. First, prior reports in the literature suggest that improvement in speech recognition capability may be modest. In the largest series to date, Sullivan et al (2020) reported average CNC word recognition improvement of not more than 42.3% compared to patients with binaural hearing loss who improve by 61% on average (Holden et al, 2013). Second, indications for implantation in SSD and AHL favor patients with profound unilateral hearing loss and there are more limited data for patients with greater degrees of measurable function in the ear to be implanted. Sullivan et al (2020) and Holder et al (2017) reported pre-operative word recognition scores of 8.4% and 2.9% respectively. Anecdotally, we have observed more significant improvement in our recipients, particularly when they are very diligent in participating in direct-streamed auditory training activities in the immediate post-activation timeframe. Additionally, our clinic considers CI on an ear-specific basis whenever word understanding capability is less than 50%.  
**Methods:** We conducted a retrospective chart review of >65 adult patients with SSD or AHL implanted in our center since 2016. AHL was defined as one ear that would not meet CI candidacy criteria (i.e., >50% CNC word recognition in that ear) and any degree of hearing loss that would benefit from CI in the other ear (i.e., <50% CNC word recognition in that ear). SSD was similarly categorized except the contralateral ear had pure tone thresholds completely within normal limits. Speech recognition ability pre- and post-CI was quantified using CNC Words and AzBio Sentences. Subjective indicators of hearing handicap (HHIA/E) and quality (SSQ), and tinnitus handicap (THI) were also reviewed pre- and post-CI.  
**Results:** Preliminary results suggest that outcomes can potentially exceed those previously reported in the literature. These results could be important for advancing the utilization and coverage of implants in the SSD and AHL populations.  
**Conclusion:** CI is not only a viable option for patients with SSD and AHL, but it may also be more efficacious than previously reported.
Session: CS6-1
Session: Asymmetrical Hearing Loss and Single-Sided Deafness
Title: Time-to-Peak Speech Perception Score after Cochlear Implantation in Single-sided Deafness
Presenting Author: Ashley Nassiri, MD, MBA
Author Block:
Ashley M. Nassiri, MD, MBA1, John P. Marinelli, MD2, Christine M. Lohse, MS3, Katherine P. Wallerius, MD1, Colin L. W. Driscoll, MD1, Brian A. Neff, MD1, Aniket A. Saoji, PhD3, Matthew L. Carlson, MD1;1Otolaryngology, Mayo Clinic, Rochester, MN, 2San Antonio Military Med. Ctr., San Antonio, TX, 3Mayo Clinic, Rochester, MN.
Abstract:
Introduction: While indications for cochlear implantation (CI) have been expanded to include single-sided deafness (SSD), our understanding of outcomes in this unique patient population is limited. Notably, traditional CI candidates with bilateral severe to profound hearing loss frequently have changes in speech perception scores up to 12 months after device activation. In comparison, prior studies have suggested that the SSD population may more quickly advance to peak speech perception scores. The current study examines 1) speech perception scores over time and 2) time-to-peak speech perception scores for patients with SSD undergoing CI.
Methods: Adults who underwent CI for SSD between 2014-2019 were retrospectively identified. Time-to-peak speech perception score analysis was performed; a study participant was considered to reach relative peak score if within 80% of mean peak scores for SSD patients reported in prior studies (60% CNC and 70% AzBio in quiet). Time-to-peak scores were analyzed using time-to-event methodology; patients who did not achieve peak scores during observation were censored at last follow-up.
Results: Thirty-six patients met inclusion criteria. Median age at implantation was 52.5 years (IQR 38-60.5), while the median duration of deafness was 2.0 years (IQR 0.9-4.4). The median CNC scores at 1, 3, 6, and 12 months postoperatively were 54%, 46%, 50% and 55% respectively, while AzBio sentences in quiet scores were 77.5%, 78%, 68.5% and 72%, respectively. Of the 34 patients with available CNC scores, 24 reached relative peak CNC score at a median of 3 months (IQR 1-6). Similarly, of the 35 patients with AzBio scores, 31 reached relative peak AzBio score at a median of 3 months (IQR 1-12). Of the patients who had speech perception data at 1 month postoperatively, 43% (9/17) had reached relative peak scores. Duration of deafness was negatively correlated with CNC scores (correlation coefficient -0.13; p=0.51) and AzBio scores (correlation coefficient -0.14; p=0.46) at last follow-up, but these associations were not statistically significant.
Conclusion: Patients with SSD who undergo CI may experience a shorter time-to-peak speech perception score when compared to previously reported rates in traditional CI candidates. Continued auditory input from the contralateral normal hearing ear may “coach” the implanted ear, thus improving speech perception more rapidly; further research is warranted to test this theory.
Session: CS6-1  
Session: Asymmetrical Hearing Loss and Single-Sided Deafness  
Title: Longterm Spatial Hearing Improvement and Suppressive Effect on Tinnitus After Cochlear Implantation in Profoundly Single-sided Deaf Patients  
Presenting Author: Griet Mertens, PhD  
Author Block:  
Griet Mertens, PhD, Paul Van de Heyning, MD, PhD, Vincent Van Rompaey, MD, PhD; Otorhinolaryngology, Head & Neck Surgery, Antwerp Univ. Hosp., Edegem, Belgium.  
Abstract:

Introduction: The authors previously demonstrated that tinnitus resulting from unilateral hearing loss (UHL) can be treated with a Cochlear Implant (CI). The study aimed to do a long-term evaluation of tinnitus relief and binaural auditory outcomes in UHL CI recipients up to 10 years.  
Methods: Long term evaluation was derived from 23 subjects with UHL and accompanied incapacitating tinnitus. A structured interview was conducted. The tinnitus loudness Visual Analogue Scale (VAS) and the Tinnitus Questionnaire (TQ) were obtained pre-operatively, one, three, six, 12, and 36-months post-operatively and at the long-term evaluation. Speech perception in noise and sound localization were assessed for the CIOFF and for the CION condition.  
Results: The structural interview revealed that all patients still wear their CI seven days a week at the long-term evaluation. In the SSD group, tinnitus suppression is still the primary benefit reported (83%), whereas in the AHL the majority of the subjects (55%) report that the primary benefit shifted to improved hearing. The VAS and TQ scores significantly improved up to three months after the first-fitting and remain stable up to the long-term evaluation. In the SSD group, a significant combined head shadow effect and an SRM benefit were found. In the AHL group, the summation effect, the squelch effect, the combined head shadow effect, and SRM benefit were significant at long-term evaluation. A significant benefit in the CION condition was found for sound localization compared with the CIOFF condition in the UHL study cohort.  
Conclusion: CI can significantly restore binaural hearing in SSD. The accompanied tinnitus relief appears to be stable over long-term follow-up.
Session: CS6-1
Session: Asymmetrical Hearing Loss and Single-Sided Deafness
Title: Benefits of Cochlear Implant in Adults with Single-sided Deafness or Asymmetric Hearing Loss
Presenting Author: Christine Kim, MD

Author Block:
Jack Wazen, MD1, Christine S. Kim, MD1, Carmelo Ortega, AuD1, Sarah Shepherd, AuD2, Seth R. Schwartz, MD2, Daniel Zeitler, MD2;1Silverstein Inst., Sarasota, FL, 2Virginia Mason Med. Ctr., Seattle, WA.

Abstract:
Introduction: Single sided deafness (SSD) has been shown to create significant handicaps in hearing from the deafened side and sound localization. Such patients have been successfully treated with CROS hearing aids or bone anchored hearing systems, by eliminating the head shadow effect. Neither technology, however, could resolve the sound localization difficulties or suppress the tinnitus SSD patients suffer from. Direct stimulation of the affected ear with a cochlear implant could, however, help with sound localization and tinnitus suppression. The purpose of this study was to evaluate the benefits of unilateral cochlear implantation in adults who met conventional indications for implantation in one ear but did not meet the conventional indications for implantation in the other ear.

Methods: This was a prospective IRB-approved study. Fifteen adult patients who met the inclusion criteria underwent cochlear implantation in the worse hearing ear. There were 11 females and 4 males. Fourteen of them were followed up to 12 months post-operatively. Pure tone audiometry and speech perception tests were conducted at baseline and at 3 months, 6 months, and 12 months post-operatively. Those included unilateral CNC words in quiet, bilateral AzBio sentences in noise (60dBA + 5 signal to noise ratio), and bilateral lateralization tests. AzBio sentence testing was performed under three test conditions with the speech always coming from the speaker that the subject is facing and the noise coming from the front or coming from the speaker facing the ear to be implanted/implanted ear or contralateral (better hearing) ear. Subjective questionnaires included the Speech, Spatial, and Qualities of hearing (SSQ), the Glasgow Benefit Inventory (GBI), the Tinnitus Handicap Inventory (THI), and a special post-implant questionnaire designed for cochlear implants in SSD patients. All measures were subjected to a statistical evaluation, and patients were followed at 3, 6, and 12 months visits.

Results: The mean pure tone average of the implanted ear at baseline was 93 dB HL and the mean pure tone average of the contralateral ear at baseline was 28 dB HL. The mean CNC word recognition in quiet at baseline was 2.1 ± 7.5. At 3 months, 6 months, and 12 months, the mean CNC word recognition in quiet was 58.7 ± 22.7, 58.1 ± 24.9, and 61.1 ± 20.2, respectively. The average baseline AzBio measures with speech and noise in front were 87.4 ± 15.4, and 88.8 ± 16.8, 91.1 ± 16.1, and 91.2 ± 13.0 at 3, 6, and 12 months, respectively. As expected in this population, subjects performed worse if the noise was coming from the front or was directed to the better performing ear. Most subjects that completed follow-up visits showed improvement under these two conditions. Lateralization testing revealed improvement in all patients post implantation. Out of 11 patients who suffered tinnitus pre-operatively, 10 reported improvement in their THI.

Conclusion: Cochlear implantation in patients with SSD or asymmetric hearing loss has been shown to be beneficial in restoring hearing to the worse ear, improving lateralization, reducing tinnitus, and improving quality of life measures. Furthermore, it did not interfere with hearing from the better side. Patients with SSD ought to be given the option of a cochlear implant in addition to the traditional CROS or bone anchored hearing devices options with decisions based on patient preference and insurance coverage.
Session: CS6-2
Session: Music Appreciation
Title: "To Understand Lyrics": Beyond Speech in Noise
Presenting Author: Virginia Driscoll, PhD
Author Block:
Virginia D. Driscoll, PhDMusic Education and Music Therapy, East Carolina Univ., Greenville, NC.
Abstract:
Introduction: Successful music perception continues to be a challenge for cochlear implant (CI) recipients. This study presents the second phase of a sequential exploratory mixed methods study involving experiences and desires of CI recipients in complex listening experiences involving music. New developments with electroacoustic, or hybrid, hearing has resulted in greater successes. However, many implant recipients still experience challenges in environments involving noise or background music regardless of implant type or listening condition. A particular challenge reported by implant recipients is the ability to recognize lyrics in music from both familiar and unfamiliar songs. The ability to recognize lyrics can assist in understanding meaning, emotion, and intent as well as connecting socially. To date few measures exist to evaluate perception of sung lyrics in CI recipients. This study evaluated the performance of two groups of listeners on the Modified Sung Sentence Recognition Test, content validity, and the test-retest reliability of this measure.
Methods: Participants included 30 adults: 15 normal hearing (NH) adults and 15 CI subjects with a variety of devices, listening combinations, and months of use. Both groups were tested on a newly developed test, the Modified Sung Sentence Recognition Test (SSRT-M) in two conditions: background accompaniment and quiet. Background accompaniment consisted of a solo guitar strumming pattern and was presented in -7 dB SNR for NH participants and +10 dB SNR for CI subjects. Age and music background experience were evaluated as potential correlations with performance. Content validity was examined by correlating results from the SSRT-M with scores on the AzBio in quiet and noise. Test-retest reliability was evaluated by presenting a subset of lists.
Results: CI subjects demonstrated considerable variability in perceptual accuracy and were significantly less accurate than NH cohort in both conditions: quiet and background accompaniment across all sung sentence lists (all p<.0010). When tested in quiet, CI subjects scored significantly higher on only five of 12 lists presented, highlighting challenges that extend beyond speech understanding alone. Music experience was not significantly correlated with performance across groups in background accompaniment or in quiet. In evaluating content validity, a significant correlation was found between the AzBio and SSRT-M in quiet (r=.87, p=.0001), but for the same tests in background/noise (r=.31, p=.30). No significant differences were found between the mean scores of the first and second presentations for either CI or NH listeners, supporting the argument for test-retest reliability.
Conclusion: This new measure of sung sentence perception offers a new perspective, not only for CI subjects who express challenges in perception of lyrics in songs, but also a new and challenging tool for CI recipients who may perform extraordinarily, those "star" performers. Even subjects who had superior AzBio scores experienced challenges in at +10 db SNR. Findings of this study may provide insight into frustrations expressed by CI recipients on accurate music perception and lead to new approaches for improving rehabilitation options for adult recipients.
Session: CS6-2
Session: Music Appreciation
Title: Composing Music for Cochlear Implant Users
Presenting Author: Georgios Papadelis, PhD
Author Block: N/A
Abstract: Invited Presentation
Session: CS6-2
Session: Music Appreciation
Title: Music-Related Quality of Life in Adults with Cochlear Implants: Relationship among Demographic Factors, Musicianship, and Audiological Factors
Presenting Author: Stephanie Fowler, AuD
Author Block:
Stephanie L. Fowler, AuD1, Anthony M. Tolisano, MD2, Charles Saadeh, MD2, Kyle Robbins, BS2, Jacob B. Hunter, MD2, Andrea D. Warner-Czyz, PhD1;1Speech, Language and Hearing, The Univ. of Texas at Dallas, Dallas, TX, 2Otalaryngology, UT Southwestern, Dallas, TX.
Abstract:
Introduction: Adults rank music as one of the most important acoustic signals, second only to speech. Unfortunately, it is also one of the most complex. Although adults with cochlear implants (CIs) score on par with hearing peers on tasks related to rhythm and tempo, they consistently have more difficulty accessing spectral content such as pitch, melody, and timbre tasks. Current research addresses perception of these characteristics of music, though limited data exists on how adults with CIs feel about the importance of these and other musical characteristics. One instrument, the Music-Related Quality of Life (MuRQoL), addresses these varied characteristics and situations. This exploratory research assesses the relationships among MuRQoL scores, age, gender, musicianship, and hearing aid use. A secondary analysis examines the impact of residual hearing on post-implantation MuRQoL scores.
Methods: Adult CI users were recruited from a large, regional university hospital to complete an online survey investigating: (a) the breadth and importance of music related characteristics and activities via the 36-item MuRQoL questionnaire; and (b) participant history of musicianship via an ad hoc questionnaire. The electronic medical record was accessed to provide information on gender, age, use of hearing aids at the time of CI evaluation, and post-operative unaided thresholds.
Results: Data collection is ongoing. Preliminary results of 80 CI users (50.0% female) suggest males and females score similarly regarding the breadth and the importance of music characteristics and situations. Breadth or importance of music characteristics and situations did not differ based on use of hearing aids at the time of CI evaluation, chronologic age, or history of formal musical training. Significant moderately positive correlations emerged between the breadth of music and its importance to adult CI users ($r = .31$, $p < .05$), suggesting that when CI users find music important, they tend to experience a wider breadth of music characteristics and situations. The relationship between breadth and importance of music strengthened for CI users with a history of formal musical training ($r = .60$, $p < .05$), whereas this relationship was not significant for non-musicians. Post-operative unaided thresholds at 250 Hz have been reported for 44 patients, with 17 of those patients reporting preserved residual hearing (i.e., unaided 250 Hz thresholds of < 85 dB HL). Those with preserved residual hearing did not differ in breadth of music compared to those without preserved residual hearing, but reported significantly greater importance of music ($M = 67.38$ vs. $51.28$, respectively). Unaided 250 Hz thresholds were significant and moderately negatively correlated with breadth ($r = -.45$, $p < .05$) and importance of music experiences ($r = -.48$, $p < .05$). This suggests that individuals who are able to experience preserved residual low frequency hearing are more likely to report a higher importance of music post-operatively.
Conclusion: Results suggest that breadth and importance of music to the individual after implantation is not affected by age, use of hearing aids at the time of CI evaluation, or musicianship. However, the relationship between the importance and breadth of music is stronger for musicians than non-musicians. Finally, preserved residual hearing seems to be an important factor to consider for the patient's post-operative music experiences.
Session: CS6-2
Session: Music Appreciation
Title: Group Differences among CI Users in Objective and Subjective Measures of Music
Presenting Author: Stephanie Fowler, AuD
Author Block:
Stephanie L. Fowler, AuD, Andrea D. Warner-Czyz, PhD; Speech, Language and Hearing, The Univ. of Texas at Dallas, Dallas, TX.
Abstract:
Introduction: Research investigating objective and subjective measures of music within a diverse CI population remain limited. However, the auditory experiences of CI users with pre- versus postlingual deafness likely affect their abilities and experiences when engaging with music.
Methods: Adult CI users were recruited to participate in this study. Participants completed a survey and four music perception tests. The survey consisted of the 36-item MuRQoL questionnaire assessing the breadth and importance of 18 music-related items and demographic, audiological, and musicianship characteristics. Then, participants completed four objective measures of music perception: (a) three subtests of the Clinical Assessment of Music Perception (CAMP), including pitch, familiar melody, and timbre; and (b) the melody subtest of the Profile of Music Skills (PROMS). A typical hearing (TH) control group was also recruited to this study.
Results: Data collection is ongoing. To date, 20 TH participants, 4 postlingual CI participants, and 6 prelingual CI participants have been recruited. TH listeners scored M = 0.69 semitones in pitch discrimination; M = 81.81% in recognition of isochronous familiar melodies; M = 87.71% in recognition of musical instruments; and M = 67.50% in discrimination of novel melodies. TH listeners self-report high abilities in musical skills (M = 79.79) and high importance of music (M = 67.24). Prelingual CI users scored higher than postlingual CI users on all measures except the recognition of familiar melodies. Both prelingual and postlingual CI users can discriminate between two pitches that are about 2 semitones (i.e., a whole step) apart (M = 1.91 for prelingual vs. 2.15 for postlingual). Prelingual CI users recognize slightly more instruments (M = 49.31%) than postlingual CI users (M = 46.88%). Prelingual CI users (M = 51.85%) discriminate more novel melodies than postlingual CI users (M = 43.06%). However, postlingual CI users (M = 41.67%) recognize more isochronous familiar melodies than prelingual CI users (M = 23.23%). Prelingual CI users rate themselves higher in both ability and importance of musical experiences, (M = 60.63 and M = 64.35, respectively) than postlingual CI users (M = 47.92 and M = 46.53, respectively).
Conclusion: Unsurprisingly, TH participants scored better on all subjective and objective measures than CI peers. In general, prelingual CI users perceive discrete musical characteristics better and report better music abilities and higher importance of music than postlingual CI users. Interestingly, a reversal emerges when measuring melody perception in two different ways. Though prelingual CI users score more accurately than postlingual CI users on novel melody discrimination, they score less accurately on recognition of isochronous familiar melodies. In considering design of test measures to assess musical skills, especially as relates to melody, pre- and postlingual CI users may need to be evaluated differently.
Session: CS6-2
Session: Music Appreciation
Title: Music Listening Habits and Perception in Cochlear Implant Users
Presenting Author: Ramon Bustos, BS

Author Block:
Ramon Bustos, BS, Charles Limb, MD; Univ. of California, San Francisco, San Francisco, CA.

Abstract:

Introduction: Cochlear implant (CI) users demonstrate limitations in music perception, therefore we designed a study to compare music listening habits in CI users and individuals with normal hearing (NH). The goal of this exploration of music listening habits was to improve our understanding of the impact CIs have on hearing restoration in an everyday, real-world context.

Methods: We conducted a survey-based cross-sectional study to examine music listening habits in CI users and NH individuals. A Qualtrics survey was distributed August 2019-2020 and advertised via online support groups (Cochlear, MED-EL, Advanced Bionics, Facebook), SurveyCircle, and physical bulletin board postings. Eligible participants included children (>14 years) and adults; we excluded CI users that were activated within three months of the survey. Our primary outcome measures were differences in music listening habits between NH individuals and CI users. Responses were analyzed by two-tailed, unpaired t-test.

Results: A total of 44 CI users (43 adults, 1 child) and 71 NH individuals (all adults) participated in this study, totaling 115 responses. Of these, 37 (84.1%) CI users and 65 (95.8%) NH individuals listened to music. We found that CI users utilized their implant’s microphone (n=31, 49.2%), streamed wirelessly (n=20, 31.3%), and/or used direct-line audio input (n=12, 15.8%) for music listening. Less CI users (n=21, 53.8%) spent more than one hour per day listening to music compared to NH individuals (n=54, 83.1%). The top three music genres CI users listened to were Classical (n=26, 59.1%) Rock (n=25, 56.8%), and Oldies (n=24, 54.5%) while NH individuals preferred Pop (n=48, 70.6%), Rock (n=46, 67.6%), and Hip-hop (n=43, 63.2%). Similar proportions of CI users and NH individuals enjoyed listening for the beat, melody, or timbre of a musical piece (p=0.20, 0.46, 0.47, respectively). Of those three musical elements, CI users (n=14, 43.8%) rated melody as the most enjoyable (p=0.18). Both groups further displayed similar proportions of individuals who enjoyed listening to music at home, through a hand-held device, in a vehicle, and at a live performance. However, CI users (n=21, 58.3%) reported that listening to ambient music in public locations was perceived as less enjoyable than listening in a quiet-focused environment compared to NH listeners (n=18, 27.3%) (p=0.002). Finally, few CI users (n=5, 14.3%) demonstrated discomfort while listening at a live performance compared to NH individuals (n=40, 61.5%) (p<0.0001).

Conclusion: CI users demonstrate different genre preferences and spend less time listening to music compared to NH individuals. Interestingly, CI users demonstrate less auditory discomfort to live performance listening in comparison to NH listeners. These differences in music perception shed light on the limitations of CI-mediated listening, but also suggest that many CI users are regular participants in musical activities.
Session: CS6-2
Session: Music Appreciation
Title: Development of a 360-degree Tool for Longitudinal Assessment of Music-related Experience After Cochlear Implantation: A Feasibility Study
Presenting Author: Tiffany Hwa, MD
Author Block:
Tiffany P. Hwa, MD, Shadi Ahmadmehrabi, MS, Kirsten Sandgren, BA, Virginia Axline, N/A, Graham Janson, N/A, Jason A. Brant, MD, Steven J. Eliades, MD, PhD, Douglas C. Bigelow, MD, Michael J. Ruckenstein, MD;Otolaryngology-Head and Neck Surgery, Univ. of Pennsylvania, Philadelphia, PA.
Abstract:
Introduction: Music appreciation and enjoyment remains an elusive, but highly sought-after outcome in cochlear implantation (CI). While much has been accomplished in this field, the current literature on music experience after CI is limited by sample size and a lack of longitudinal outcomes data. A number of validated assessments exist in the CI literature for the purpose of research, but none have been implemented in routine, widespread clinical use. In this investigation, we sought to evaluate the feasibility of a shortened, 360-degree assessment of objective and subjective music experience after CI.
Methods: This was a prospective cohort study involving the administration of a web-based assessment for music experience among adult CI patients. Our tool includes objective and subjective assessments of music enjoyment, primarily based on Clinical Assessment of Music Perception Test (CAMP) and Music-Related Quality of Life Tool (MuRQOL), both previously validated instruments. The implementation of both surveys have been modified into a unified, clinically feasible instrument. Inclusion criteria include age > 18 years, English-speaking status, and minimum of 3 months cochlear implant experience. Results were evaluated for median and range of response, and the distribution of results were assessed for normality based on the Kolmogorov-Smirnov (K-S) Test of Normality.
Results: 13 adult subjects participated in this study, including 6 males and 7 females with a mean age of 63.7 years (range 43-75). With respect to subjective measures, 69% (n=9) reported fatigue or frustration while listening to music. Music engagement was trended low for the average user, with a mean score of 2.43 of 5 across multiple metrics. For objective testing, the median score was 50% for melody recognition (range 0-100%), 60% for instrument identification (range 20-100%), and 60% for pitch discrimination (range 20-100%) with normal distribution in all three categories of testing. 62% of subjects were able to complete the test in 5 minutes or less, and 77% were able to complete the test in 10 minutes or less. The maximum length of time required to complete the assessment was 25 minutes by a single individual.
Conclusion: Our 360-degree tool for assessment of music experience after CI was able to quantify and capture a wide variety of experience among adult CI users while decreasing the length of assessment, yielding results with normal distribution among all three objective tests and among subjective measures of music engagement. A supermajority in this cohort able to complete the assessment in under 10 minutes. Continued investigation is required to validate this assessment in a larger cohort, to further refine its contents, and to further demonstrate its clinical feasibility for routine longitudinal assessment.
**Session**: CS7-1  
**Session**: Cochlear Implant Outcomes, Part II  
**Title**: Cochlear Implant Outcomes in Patients with Otosclerosis: A Systematic Review  
**Presenting Author**: Chon Meng Lam, BSc (Hons), MBBS  
**Author Block**:  
Chon Meng Lam, BSc (Hons) MBBS1, Hannah L. Cornwall, BA BMBCh1, Abdullah Chaudhry, MBChB2, Jameel Muzaffar, MSc FRCS(ORL-HNS)2, Manohar Bance, MSc FRCS FRCSC3, Peter Monksfield, MSc FRCS(ORL-HNS)2;1Cardiff and Vale UHB, Cardiff, United Kingdom, 2Department of Ear, Nose and Throat Surgery, Univ. Hosp. Birmingham NHS Fndn. Trust, Birmingham, United Kingdom, 3Department of Clinical Neurosciences, Univ. of Cambridge, Cambridge, United Kingdom.  
**Abstract**:  
**Introduction**: Otosclerosis is a condition in which spongyotic bone replaces normal bone in the ossicular chain. Focal deposits may also be found within the cochlea leading to sensorineural hearing loss refractory to conventional treatment such as hearing aids and stapes surgery. Cochlear implantation can play an important role in the management of otosclerosis in these patients. Patient Reported Outcome Measures (PROMs) provide insight into the impact of disease on quality of life and allows clinicians to monitor disease progression. This is particularly important in patient’s with otosclerosis who can expect to live for many years with their cochlear implants. The aim of this study is to perform a systematic review of cochlear implantation in patients with otosclerosis and to synthesise the data from this to establish hearing outcomes and PROMs.  
**Methods**: Systematic review and narrative synthesis. Databases searched: Medline, PubMed, Embase, Web of Science, Cochrane Collection and ClinicalTrials.gov. No limits placed on language or year of publication. Review conducted in accordance with the PRISMA statement.  
**Results**: Searches identified 474 abstracts and 180 full texts with 68 studies meeting the inclusion criteria and reporting outcomes in a minimum of 481 patients with at least 516 implants. The methodological quality of included studies was modest, predominantly consisting of case reports and non-controlled case series with small numbers of patients. Significant heterogeneity existed in terms of outcomes and methods of reporting, which precluded a meta-analysis. Audiological outcomes were reported using a wide range of measures and were generally good across all studies. In total 44/67 studies reported both pre- and post-implantation audiological outcomes involving at least 309 patients. Improvements were reported in all but 5 of these studies - 3 of these studies reported worse outcomes in a total of 3 patients, the remaining two studies both report findings as the number of patients who were below the 25th percentile or below the mean cohort score and as such it is not possible to assess pre- vs post-implant outcomes. PROMs were reported in 5 studies involving 51 patients - reported outcomes were overwhelmingly positive. Surgical outcomes and pre-operative radiological assessment were reported in 36 and 38 studies respectively. Of the studies that reported on both post-operative facial nerve stimulation (FNS) and radiological severity of otosclerosis, 24/28 cases of FNS were seen in patients with cochlear otosclerosis (Rotteveel grade 2 or 3). At least 5 studies identified the measures required to achieve symptom control for FNS as being an important contributing factor to poor outcomes.  
**Conclusion**: Access to good rehabilitation support is essential to achieving the good hearing outcomes and PROMs that can be expected by 12 months post-implantation in most cases. There was significant association between the radiological severity of otosclerosis and an increase in surgical and post-operative complications. Post-operative facial nerve stimulation can occur and may require deactivation of electrodes and subsequent hearing detriment. Patients should be counselled on associated surgical complications which may compromise hearing. Modern diagnostic techniques may help to identify potentially difficult cases to aid operative planning and patient counselling. Further work is needed to characterise PROMs in this population.
Session: CS7-1
Session: Cochlear Implant Outcomes, Part II
Title: The Impact of Cochlear Implantation on Health-related Quality of Life in Older Adults, Measured with the Health Utilities Index 23
Presenting Author: Ellen Andries, MSc
Author Block:
Ellen Andries, MSc Audiology, Annick Gilles, Professor, Vedat Topsakal, Professor, Olivier Vanderveken, Professor, Paul Van de Heyning, Professor, Vincent Van Rompaey, Professor, Griet Mertens, Professor; Department of Otorhinolaryngology, Univ. Hosp. Antwerp, Antwerp, Belgium.
Abstract:
Introduction: Researchers have shown growing interest in the change in health-related quality of life (HRQoL) after Cochlear Implantation (CI) in older adults, to enable calculation of cost-utility of CI in this population. A limited number of generic HRQoL questionnaires are currently available to estimate utility, including the Health Utilities Index (HUI). However, generic questionnaires are known to be less sensitive for detection of outcome changes compared to disease-specific questionnaires and could be less suitable to assess HRQoL changes after implantation. The first aim of this study is to assess HRQoL, measured with the HUI, in older CI candidates while comparing with age-and gender-matched normal-hearing controls. The second aim is to study the responsiveness of the HUI by comparing HRQoL after CI with the preoperative situation.
Methods: Twenty CI users aged 55 years and older with bilateral severe-to-profound postlingual Sensorineural Hearing Loss (SNHL) and an age- and gender-matched normal-hearing control group were included in the study. HRQoL was assessed with the HUI Mark 2 and HUI Mark 3 (HUI23). The CI recipients were evaluated preoperatively and 12 months postoperatively.
Results: The auditory HUI3 Single-Attribute score (p < 0.001) and the HUI2 Multi-Attribute score (p = 0.013) differed significantly between the control group and CI users preoperatively. Moreover, these scores improved significantly comparing the postoperative situation with the preoperative measurement in the CI group (p = 0.020; p = 0.047). Nevertheless, no significant difference was found between the pre- and postoperative HUI3 Multi-Attribute scores in the CI group (p = 0.071). Additionally, the HUI3 Multi-Attribute score after CI still remains significantly worse (p < 0.001) than those of the control group.
Conclusion: Subjects with severe-to-profound SNHL demonstrated a lower overall HRQoL compared to the control group. Although a significant improvement in perceived HL and speech intelligibility was found after CI, the overall HRQoL did not improve as much as expected. HRQoL in older CI users is influenced by multiple factors besides HL, which could not be derived from the HUI23 results only. Hence, the HUI3 Multi-Attribute score cannot be considered as a responsive outcome measure to detect HRQoL changes after CI. More research is needed to determine whether disease-specific HRQoL instruments may help to detect improvements after CI.
Session: CS7-1
Session: Cochlear Implant Outcomes, Part II
Title: Measures of Verbal Learning and Memory as Predictors of Speech Recognition in Postlingually Deafened Adults After Six Months of Cochlear Implant Use
Presenting Author: Erin Stefancin Taylor, MA
Author Block:
Erin Stefancin Taylor, MA, CCC-SLP1, David B. Pisoni, PhD2, William G. Kronenberger, Ph.D., HSPP3, Aaron Moberly, MD1, Christy Ray, PhD, CCC-SLP1;1Department of Otolaryngology - Head & Neck Surgery, Ohio State Univ., Columbus, OH, 2Distinguished Professor of Psychological and Brain Sciences and Chancellor’s Professor of Cognitive, Indiana Univ., Indianapolis, IN, 3Department of Psychiatry, Indiana Univ. Sch. of Med., Indianapolis, IN.

Abstract:
Introduction: Rehabilitation approaches for postlingually deafened adults who receive cochlear implants (CIs) are typically based on the traditional assumption that these patients have developed functional language skills. This assumption has shaped the narrative around these patients’ needs: that they merely require a “re-mapping” of the new cochlear implant (CI) signal to an existing, intact language system. Previous research, however, has demonstrated a detrimental effect of hearing loss on verbal fluency, suggesting diminished integrity of lexical representations in long-term memory. Nonetheless, language is rarely assessed or considered in routine hearing health care practice for postlingually deafened adults. The present study compared measures of visual verbal learning and memory obtained pre-operatively from a group of adult CI candidates (CICs) with scores from a group older normal-hearing (ONH) control participants.

Methods: A study was carried out in the research lab using visual presentation of the California Verbal Learning Test, Version 2 (CVLT-II) with a group of older postlingually deaf CICs (N=49) and a group of ONH controls (N=31). Additionally, fifteen separate CICs were tested clinically using the subtests of the Repeatable Battery for the Assessment of Neuropsychological Status for Hearing Impaired Individuals (RBANS-H). Scaled scores for the semantic fluency RBANS-H subtest were examined as a component measure of language function and subtests of list learning, story memory, delayed recall, digit span, and coding were collected to measure memory and attention.

Results: The lab study found that the CIC group showed significantly poorer performance than the ONH group on all primary CVLT-II measures of immediate and delayed recall. Specific deficits in verbal learning and memory were identified in CIC participants on CVLT-II process measures related to semantic clustering, recency and pre-recency free recall, the buildup of proactive interference, and retrieval-induced forgetting. For the group of clinical patients, 80% of all participants fell at or below the 25th percentile on the RBANS-H semantic fluency language subtest, while only 20% of participants performed within normal limits (+/- 1 SD of the mean). Patients scored within normal limits on most subtests of the RBANS-H, with the exception of this semantic fluency task as well as the list learning task, which is similar to the CVLT-II. Performance on both the CVLT-II and the RBANS-H indicate that CICs present with verbal processing deficits.

Conclusion: Verbal fluency, learning, and memory processes are poorer in older adults with hearing loss than those without, independent of the audibility of stimuli. Results provide the basis for continued work to determine the impact of impaired language on speech recognition and other outcomes after cochlear implantation, as well as to examine potential rehabilitative strategies that take language functions into consideration.
Session: CS7-1
Session: Cochlear Implant Outcomes, Part II
Title: Age-stratified Outcome Data: Does Age Affect Speech Perception Outcomes for Adult CI Recipients?
Presenting Author: Sara Unrein, AuD
Author Block:
Abstract:
Introduction: As cochlear implants (CIs) continue to provide significant benefit, greater numbers of people with hearing loss are receiving CIs, especially individuals 65+ years. From 2007 to 2016, the number of CI procedures billed to Medicare increased 124.6% (Agabigum, et al., 2018). While research indicates most CI recipients derive significant communicative benefit from their devices, there is disagreement on whether or not age affects these outcomes. This may be due in part to a wide variety of age groups, speech perception materials, methods, or some combination thereof. Several studies have shown no differences across age groups in quiet (Rohloff, et al., 2017; Wong, et al., 2016; Hast, et al., 2015; Garcia-Iza, et al., 2018; Carlson et al., 2010; but see Blamey et al., 2013; Sladen & Zappler, 2015), whereas others demonstrate poorer performance for older CI recipients in noise (Lenarz, et al., 2012; Mosnier, et al., 2014; Mahmoud & Ruckenstein, 2014; Sladen & Zappler, 2015; but see Carlson et al., 2010). The purpose of this study is to report age-stratified speech perception outcomes of our patient population.
Methods: Retrospective chart review for all adults implanted from January 2010 through December 2019 revealed 1235 ears implanted. Of those implanted, 51% were 65 years or older and 23% were 75 years or older. 232 adult patients were bilaterally implanted. Scores for AzBio-Q and AzBio+5 as well as CNC word scores were compared between 4 age-stratified groups (18-49 [Group 1], 50-64 [Group 2], 65-74 [Group 3], and 75+ [Group 4]) for 3 month, 6 month, 1 year, and 2 year intervals in the implant only condition.
Results: In the age-stratified groups, Group 4 performed significantly poorer than Groups 1 and 2 on all tasks at all intervals. Group 4 performed significantly poorer than Group 3 at all intervals for AzBio-Q, but only at the 3 and 6 month intervals for CNC words. For AzBio+5, Group 3 performed significantly poorer than Groups 1 and 2 at all intervals, with no significant differences between Groups 3 and 4 at any of the intervals. No significant differences between Groups 1 and 2 were seen on any of the tests at any of the intervals.
Conclusion: Our data indicate that the majority of our oldest CI users (75+ years of age) receive significant benefit from CIs in quiet, but less benefit in all speech perception tests when compared to the youngest CI recipients in the CI-only configuration (p<0.03 in all conditions). Greatest differences in performance based on age were noted for speech in noise (AzBio+5). While our data indicate the oldest users also performed poorer on CNC word recognition compared to the youngest groups, across-age differences were less for CNC as compared to sentence-based scores. These data suggest that use of monosyllabic word tests are less affected by listener age and are thus most appropriate pre-op determination for CI candidacy and longitudinal assessment of postoperative outcomes. Knowledge of clinic specific age-stratified data can also assist in both pre- and post-operative counseling for realistic expectations.
Session: CS7-1
Session: Cochlear Implant Outcomes, Part II
Title: Cochlear Implants in the United States Veteran Population: A 10-year Retrospective Analysis
Presenting Author: Siddhant Tripathi, BS
Author Block: Siddhant Tripathi, BS, Scott B. Shapiro, MD, Joseph T. Breen, MD, Ravi N. Samy, MD, Reena Dhandapatil, MD; Otolaryngology - Head and Neck Surgery, Univ. of Cincinnati Coll. of Med., Cincinnati, OH.
Abstract:
Introduction: Veterans suffer disproportionately more hearing loss than their civilian counterparts. For those veterans with hearing loss significant enough for cochlear implantation, there exist specific challenges which have the potential to impact outcomes; these include unique medical, psychological, and social issues that veterans face, in addition to delivering care and audiologic services through the Veterans Affairs medical system.
Methods: Retrospective analysis of clinical and audiology records of veterans with bilateral sensorineural hearing loss implanted with a single cochlear implant at a Level 1 VA Medical Center over a 10 year period.
Results: 124 male patients with an average age of 74.6 years received cochlear implants on a single side with a variety of electrode arrays (both perimodiolar and lateral wall) from a single cochlear implant manufacturer. The mean bilateral pre-operative speech perception AzBio score in quiet was 39.1%, which improved to 67.6% one year after surgery and from 21.3% to 62.2% in the unilateral condition. Testing with 10 dB signal-to-noise ratio showed improvement from 30.1% to 55.4%, and 16.9% to 46.9% for the bilateral and unilateral conditions, respectively. Patients who received perimodiolar versus lateral wall electrodes had similar pre-operative speech perception in quiet in the operated ear (22% versus 24% AzBio respectively, p = 0.943) and there was no statistically significant difference in improvement or final speech perception outcome (p = 0.231). There were no major complications.
Conclusion: There are specific challenges in veterans in regard to cochlear implant evaluation, surgery, and audiologic follow-up. However, veterans with bilateral sensorineural hearing loss realize significant improvements in speech understanding after cochlear implant surgery.
Session: CS7-1
Session: Cochlear Implant Outcomes, Part II
Title: Outcomes of Cochlear Implantation as a Treatment for Translabyrinthine Resection of Acoustic Neuromas
Presenting Author: Sandra Porps, AuD
Author Block:
Sandra L. Porps, Au.D. CCC-A, Karl Doerfer, MD, Nathan Tu, MD, Pedrom Sioshansi, MD, Alex Luryi, MD, Seilesh C. Babu, MD, Robert Hong, MD Ph.D., Christopher Schutt, MD; Michigan Ear Inst., Farmington Hills, MI.
Abstract:
Introduction: Acoustic Neuromas affect 2,000 to 3,000 people each year and present with hearing loss. Translabyrinthine resection of these tumors results in complete hearing loss in the affected ear. Traditional treatments include Contralateral Rerouting of Signal (CROS) hearing aids, bone anchored auditory implants (BAHA), and hearing aids that transmit sound via bone conduction. All of these solutions involve sending the signal from the affected ear to the non-affected ear. This can have a negative impact on hearing in background noise and on speech perception to the affected ear. This study evaluated the audiologic results of simultaneous resection of tumor and placement of a cochlear implant. Performance of the cochlear implant is monitored over time for long term results.
Methods: Fourteen adult patients who had a tumor size less than 1.2cm were invited to participate. Prior to surgery and at 1 month, 3 month, and 6 month, and 1 year post activation of cochlear implant, these patients were tested in the following conditions: sentence testing in quiet with 0 degree azimuth, sentence testing in +10 signal to noise ratio with speech and noise at 0 degrees azimuth, sentence testing in +5 signal to noise ratio with speech and noise at 0 degrees azimuth, and single words to each ear independently in quiet at 0 degrees azimuth. In order to minimize the effect of the opposite ear, the non-test ear was fit with an earplug and a supraural headphone. In addition, all subjects were asked to complete the Speech Spatial Qualities questionnaire (SSQ), the Dizziness Handicap Inventory (DHI), and the Tinnitus Handicap Inventory (THI) prior to surgery and at several points in follow up. These patients underwent translabyrinthine resection of their tumor and simultaneous implantation with a cochlear implant. After one month, the patients returned for cochlear implant activation. Post activation appointments proceeded per clinic protocol with 2 follow up mappings each one week apart, further mapping at 1 month, 3 months, 6 months, and one year post activation.
Results: Currently, nine of the patients have completed their six month testing. These patients are scoring on average 99% on speech understanding in quiet, 98% on speech understanding in +10 signal to noise ratio, and 96% on speech understanding in +5 signal to noise ratio. They are scoring an average of 77% speech understanding to single words presented to the implant ear in quiet. Patients are reporting a decline in their tinnitus handicap and their dizziness handicap. The patients are reporting an increase in their Speech, Spatial, and Qualities questionnaire for the Speech and Spatial Sections. There appears to have been little change in the Qualities section as compared to their pre-op scores.
Conclusion: Traditional methods of treating single sided deafness after acoustic neuroma removal send the signal from the affected ear to the non-affected ear. This can have a negative impact on speech understanding in background noise and in speech perception to the affected ear. For acoustic neuroma removal with ability to preserve the cochlear nerve via translabyrinthine resection, cochlear implantation is a viable treatment option resulting in improved speech understanding in background noise, improved speech perception to the affected ear, and a reduction in tinnitus and dizziness. Long term data will continue to be collected to document findings.
Session: CS7-2
Session: Electrical Stimulation of the Cochlea
Title: Apical Stimulation Without Longer Electrode Arrays
Presenting Author: David Landsberger, PhD
Author Block:
Abstract:
Introduction: Cochlear implant (CI) electrode arrays are only partially inserted into the cochlea, usually leaving more than half of the cochlea unstimulated. Extending the region stimulated by the electrode array improves speech perception and accelerates adaptation to the device. This may be due to representation of low-frequency information closer to the normal cochlear place or improved temporal coding from the apex. However, using longer electrode arrays to access apical regions has several disadvantages, including increasing the likelihood of incomplete insertion and probability of damage to the cochlea. We developed a novel approach to stimulate the apex without increasing the electrode array length. An electrode is placed into the helicotrema (instead of the temporalis muscle) via an apical cochleostomy. Additionally, an electrode array inserted through a basal cochleostomy. In this new configuration, stimulation from electrode array can be grounded to the case electrode providing monopolar (MP) stimulation, whereas grounding to the helicotrema reshapes the electric field towards the apex. Additionally, stimulation in the helicotrema can be provided in MP mode by stimulating with the apical electrode and grounding with the case.
Methods: Three participants have received a CI with an additional electrode placed in the helicotrema. In their clinical programs, the lowest frequency channel is mapped to the apical electrode whereas the remaining channels are present from the electrode in MP mode. Speech perception is evaluated in the clinic with the maps including and excluding the apical ground electrode. Psychophysical measures of pitch ranking, scaling, and multi-dimensional scaling (MDS) are conducted with stimulation grounded to the case and the apex to determine the effect of the apical ground electrode on place-pitch.
Results: All patients have good speech understanding with the new approach. When the channel mapped to the apical ground is removed, speech performance (HINT in quiet and AZBio in noise) drops. This suggests that the new apical channel provides useful and distinct information. Pitch ranking and scaling suggests that stimulation is perceived as lower in pitch when the apical electrode is used as a ground instead of MP mode. Similarly, MDS results suggest that shifting from MP to apical ground mode shifts the percept tonotopically towards the apex. The MDS results also suggest that there were no perceptual differences between MP and apical ground modes other than a change in place pitch.
Conclusion: This new technique allows the use of conventional electrode arrays to stimulate deeper into the apex. The procedure is safe, the outcomes are good, and place pitch is successfully extended. Further work is needed to determine if the intervention is better than conventional implantation and the optimal fittings for the new technique.
Session: CS7-2

Session: Electrical Stimulation of the Cochlea

Title: Influence of Electric Frequency-to-place Mismatch and Peripheral Masking on Initial Speech Recognition for Electric-acoustic Stimulation Users

Presenting Author: Brendan O’Connell, MD

Author Block:
Brendan O’Connell, MD, Michael Canfarotta, MD, Emily Buss, PhD, Andrea Bucker, AuD, Meredith Rooth, AuD, English King, AuD, Harold Pillsbury, MD, Kevin Brown, MD PhD, Margaret Dillon, AuD;UNC, Chapel Hill, NC.

Abstract:

Introduction: Cochlear implant (CI) recipients with residual acoustic hearing demonstrate significantly improved speech recognition when listening with electric-acoustic stimulation (EAS) as compared to either the CI-alone or preoperative conventional hearing aid performance. Despite this well documented benefit, wide variability in performance is observed amongst EAS users. One possible source of individual differences in performance is frequency-to-place mismatch, which is the discrepancy between the electric filter frequency and normal cochlear place. The position of electrode contacts in the cochlea is highly variable, due to differences in cochlear morphology, electrode array design, and surgical approach. Mismatch occurs because the current default EAS mapping procedure uses unaided detection thresholds in the implanted ear to determine the low-frequency filter of electric stimulation and logarithmically distributes higher-frequency information across the remaining contacts irrespective of their location within the cochlea. Mismatch is prevalent in EAS users and occurs in two scenarios: 1) apical contacts lie basal to the acoustic cut-off frequency and deliver frequency information that is lower than their associated place frequency, or 2) apical contacts lie apical to the cut-off frequency and deliver frequency information that is higher than their associated place frequency. Our hypothesis is that in both scenarios early performance with EAS is hindered by the discrepancy between place of stimulation and natural tonotopicty of the cochlea. Performance in the latter scenario could be further compromised by peripheral electric on acoustic masking.

Methods: A retrospective review was conducted of the map settings and initial speech recognition of adult EAS users. Inclusion criteria were: available intraoperative x-ray or postoperative CT imaging, low-frequency hearing preservation (≤65 dB HL at 250 Hz), EAS use, and speech recognition data available at 6 months post-activation. Subjects were fit with the default mapping procedure. Imaging was used to determine an angular insertion depth of the most apical contact. Speech recognition was assessed with CNC words in quiet presented at 60 dB SPL. Frequency-to-place mismatch was determined for the apical most contact.

Results: Fifty-one CI recipients met the criteria for inclusion. Subjects were recipients of either a 24 mm (n=33) or 28 mm (n=18) array. The mean post-operative low-frequency pure tone average was 61 dB HL (SD: 21 dB HL). Aided CNC word scores ranged from 8-88% with a mean of 58% (SD: 21%). Greater variability in word recognition was observed for cases in which significant mismatch was present. Cases with arrays that generally aligned the most apical contact with the default center frequency filter experienced the best performance with less variability.

Conclusions: Placement of the array at the frequency region where unaided hearing detection thresholds begin to exceed the maximum acoustic fitting range results in better speech recognition for EAS users. Peripheral masking that arises when apical contacts reside in acoustic hearing regions, or spectral shifts that result from the apical contact being positioned considerably basal to the acoustic cut-off frequency, can be mitigated by individualized mapping procedures that account for the placement of array; this may support better speech recognition for EAS users.
Session: CS7-2
Session: Electrical Stimulation of the Cochlea
Title: Frequency-to-place Mismatch in Electric-acoustic Stimulation Device Users: Effects on Word and Vowel Recognition and Modified Mapping Procedures
Presenting Author: Margaret Dillon, AuD
Author Block:
Margaret Dillon, AuD1, Michael Canfarotta, MD1, Emily Buss, PhD1, Meredith Rooth, AuD1, Margaret Richter, B.A.1, Andrea Bucker, AuD2, Noelle Roth, AuD2, Sarah Dillon, AuD2, Allison Young, AuD2, Jenna Raymond, AuD2, Kristen Quinones, AuD2, Harold Pillsbury, MD1, Matthew Dedmon, MD, PhD1, Kevin Brown, MD, PhD1, Brendan O’Connell, MD1; Otolaryngology/Head and Neck Surgery, Univ. of North Carolina at Chapel Hill, Chapel Hill, NC, 2Audiology, UNC Hlth. Care, Chapel Hill, NC.
Abstract:
Introduction: Cochlear implant (CI) recipients with hearing preservation experience improved speech recognition with electric-acoustic stimulation (EAS) as compared listening with the CI-alone. Despite the trends for better performance with EAS, outcomes across individuals are variable. These individual differences may be due to the wide variability across CI recipients in the angular insertion depth of the electrode array, which is a function of the array design, cochlear morphology, and surgical approach. The EAS default mapping procedure does not account for the variability in electrode array placement relative to the cochlear place frequency - resulting in varying magnitudes of frequency-to-place mismatch in the majority of patients. Mismatch has been shown to negatively impact the speech recognition of CI-alone users. Some CI-alone users demonstrate the ability to acclimate to mismatch with prolonged listening experience. For EAS users, mismatch may be particularly problematic because acoustic stimulation is resolved at the natural cochlear place, while the electric stimulation is spectrally-shifted. The detrimental effect of mismatch on speech recognition has been demonstrated in normal-hearers listening to simulations of EAS, but has yet to be investigated in EAS users. Better speech recognition may be observed for EAS users listening with a place-based map that aligns the electric frequency filters to the cochlear place frequency to eliminate mismatch. The present investigation assesses the speech recognition of EAS users listening with either default or place-based maps within the initial months of device use to determine the influence of mismatch on early performance growth.
Methods: Adult CI recipients with low-frequency hearing preservation (≤65 dB HL) were randomized to receive either the default filters or place-based filters at initial EAS activation. Subjects listened exclusively with either default or place-based maps and completed speech recognition tasks at initial EAS activation, and at 1, 3, and 6 months post-activation. Speech recognition tasks included vowel recognition and consonant-nucleus-consonant (CNC) word recognition. The vowel recognition stimuli were presented via direct audio input at a comfortably loud volume. The CNC words were presented in the sound field at 60 dB SPL with masking presented to the contralateral ear, when warranted. Performance for both tasks was scored as the percent correct. Mismatch was calculated as the semitone deviation between the electric filter frequency and the 1500 Hz cochlear place frequency.
Results: Thirteen subjects enrolled and completed the initial study intervals by the time of preliminary data review. Poorer performance was observed with greater magnitudes of mismatch for both vowel recognition and CNC words. These data patterns were observed at the initial EAS activation interval and persisted through the 6-month post-activation interval.
Conclusion: Minimizing frequency-to-place mismatch for EAS users may increase acclimatization and result in better speech recognition in the early post-activation period. Investigation is ongoing to determine whether EAS users with greater magnitudes of mismatch eventually acclimate to the spectrally-shifted information and achieve similar speech recognition as observed for EAS users with little or no mismatch.
Session: CS7-2
Session: Electrical Stimulation of the Cochlea
Title: Spread of Excitation Width Differences in Perimodiolar and Straight Arrays in Children and Adults
Presenting Author: Maria Valeria Goffi-Gomez, PhD
Author Block:
Maria Valeria S. Goffi-Gomez, PhD, Robinson K. Tsuji, MD. PhD, Ricardo Bento, MD PhD, Rubens Brito Neto, MD PhD; ENT, Hosp. das Clínicas da Faculdade de Medicina da USP, São Paulo, Brazil.
Abstract:
Introduction: The position of the electrodes in the cochlea is crucial for the adequate interface with the neuronal structures. The inter-electrode distance and the distance from the electrode to the ganglion cells may interfere in the nerve fibers recruitment leading to a reduction in the electrical compound action potential (eCAP) threshold. But closer position to the neural fibers may also reveal a narrower spread of excitation, that may lead to further improvements in speech recognition among cochlear implant patients.
Methods: Retrospective chart review of intraoperative recordings of children and adults implanted with straight (CI 422) and perimodiolar (CI 532 and CI 24 RECA) Nucleus® arrays, were collected from a mid-array (11 or 10), apical (e16) and basal (e6) electrodes. Data from patients with etiologies such as cochlear malformation, meningitis or other infectious disease were excluded. The threshold of the electrical compound action potential (tNRT - neural response telemetry threshold) was recorded using the AutoNRT and the SOE series was recorded through the eCAP at a constant current level above the threshold as a function of the masker electrode through the Custom Sound® EP software. The type of electrode array was collected from patients’ files, and one-way ANOVA and Mann Whitney test was used for the statistical analysis of the TNRT, offset of the stimulus level, peak electrode and amplitude of the peak of the function and SOE width differences (in millimeters) at 75% transectional level.
Results: NRT data collected from 127 adults and 229 children were analyzed. TNRT, offset of the stimulus level, peak electrode and amplitude of the peak of the function and SOE widths were statistically different between both electrode arrays in children and adults. TNRT significant differences were found among the electrode array in all cochlear regions in children and only in the basal region in adults. SOE width was statistically different in the apical and middle region in adults, while in children it was only different in middle electrode (e11).
Conclusion: Perimodiolar arrays shows not only lower thresholds of the eCAP, but also narrower spread of excitation (SOE) width than in the straight electrode array with different profiles in adults and children.
Session: CS7-2

Session: Electrical Stimulation of the Cochlea

Title: Intraday Variations in Cochlear Implant Electrode Impedances

Presenting Author: Madison Graham, AuD

Author Block:
Madison K. Graham, Au.D.1, Aniket A. Saoji, Ph.D.1, Weston J. Adkins, Au.D.1, Charles C. Finley, Ph.D2, Brian A. Neff, M.D.1, Matthew L. Carlson, M.D.1, Colin L. W. Driscoll, M.D.1;1Department of Otolaryngology-Head and Neck Surgery, Mayo Clinic, Rochester, MN, 2Division of Auditory Research, Univ. of North Carolina, Chapel Hill, NC.

Abstract:

Introduction: In select cochlear implant users, electrode impedances have been shown to fluctuate significantly on routine clinical measurements. These fluctuations can affect sound quality, overall speech perception abilities and, if severe enough, lead to the inability to use the device successfully. This study aims to characterize daily patterns of fluctuations by measuring impedances daily a minimum of two times.

Methods: Patients were recruited based on impedance fluctuations that were measured during their routine clinical visits. Results from fourteen cochlear implant ears from eleven patients are reported (three bilaterally implanted). All patients used Cochlear Americas Nucleus devices. Patients were taught how to use the CR220 remote control in conjunction with a CP810 sound processor to measure their impedances at home. Measurements were made at a minimum in the morning before device use and at night following a full day of stimulation (i.e., two measurements daily). Seven patients (nine ears) were able to make various additional measurements during the day. Results were stored on the remote and sent back to the clinic and analyzed after completing the measurement period.

Results: Measurements were made across an average of 47.8 days (range 16-88 days), resulting in an average of 92.1 measurements per patient (range 40-342 measurements). Three daily patterns emerged from the self-monitored impedance measures: rising (7 of 14 ears), falling (3 of 14 ears), and stable (4 of 14 ears) impedance patterns. All three of the bilateral patients included in this study had one ear that showed stable impedances, while the other showed rising impedances with cochlear implant use. One patient was recruited as a control with stable clinical impedances; however, the patient ended up showing a fluctuating falling pattern during the self-monitoring period. Another patient showed fluctuations in clinical impedances but stable self-monitored impedances.

Conclusion: Serial self-monitored impedances attempt to fill gaps between clinical visits and provide more fine detail to understand better how patients’ impedances may fluctuate. Fluctuating impedances are shown to be episodic in some users. They can occur unilaterally, as demonstrated by three bilaterally implanted patients having one ear with stable impedances and one ear with fluctuating impedances. While some patients’ impedances fall throughout the day with electric stimulation (falling pattern), others rise following electrical stimulation (rising pattern). These findings shed light on different mechanisms at play during impedance fluctuations. Further research is needed to determine appropriate therapy options to stabilize impedances and optimize performance.
Session: CS8-2  
Session: Other Implantable Devices  
Title: Evaluation of Complications with Active Middle Ear Implant in Patients with Bilateral Aural Atresia  
Presenting Author: Luiz Lourencone, PhD  
Author Block:  
Luiz F. M. Lourencone, PhD, Marina Matuella, M.D., Tyuana S. S. Sassi, Ms, Jennifer C. R. Dutka, PhD, Rubens Brito, PhD; HRAC, Univ. of Sao Paulo, Bauru, Brazil.  
Abstract:  
Introduction: Vibrant Soundbridge® (VSB) is currently the most widely used and studied of the available middle ear implants. It is indicated for patients with sensorineural, mixed or conductive hearing loss who do not benefit from the use of conventional hearing aids or who cannot use them. The use of these implants is an option for patients with aural atresia with uni- or bilateral microtia. This study describe the complications seen in the long-term follow-up of an active middle ear implant model in users with bilateral ear atresia  
Methods: Observational and retrospective longitudinal follow-up study carried out in a tertiary referral hospital for auditory rehabilitation and craniofacial malformation. Twenty-seven patients with bilateral congenital aural atresia were selected (seven with bilateral surgery; therefore, thirty-four ears) who underwent Vibrant Soundbridge® middle ear implant surgery (MedEL, Innsbruck, Austria) and had their medical records reviewed. The surgery should have been performed by the same otology team and using the same surgical technique described by members of this team. Data analysis was performed using descriptive and inferential statistics. The alpha error considered was 5%. The main measures of outcome evaluated were the medical and technical complications observed in the follow-up of these patients.  
Results: Of the thirty-four ears implanted, the median postoperative follow-up was 37.5 months, with a minimum variation of 21 months and a maximum variation of 95 months of postoperative follow-up. There were 35.3% (12) of medical or technical complications in the follow-up of these patients, with 14.7% (5) needing surgical revision. There were no transoperative complications. There were 9 (26.4%) postoperative medical complications. Of these complications 6 are related to the soft tissue reaction in the region of the magnet between the external audio processor and the internal VORP receiver. The average duration of this complication was 21 months, varying from 3 to 35 months of postoperative follow-up, and one case presented extrusion of the implant and required an explant. The remaining cases were treated conservatively. The other medical complications are due to peripheral facial paralysis with complete recovery with conservative treatment (1st month after surgery), acute otomastoiditis with complete recovery with conservative treatment (3rd month after surgery) and cholesteatoma chronic otitis media surgically treated with explant (75th month after surgery). There were 3 (8.8%) technical complications related to failure of the IAOM. These failures occurred at 1, 24 and 64 months of postoperative follow-up. These patients underwent reimplantation surgery.  
Conclusion: The rate of medical and technical complications seen in monitoring the use of active middle ear implant in the population with bilateral aural atresia, demonstrated the safety of these implants when compared to data available in the literature, but it is important to know that there are risks that need to be taken care of to avoid them.
Session: CS8-2
Session: Other Implantable Devices
Title: Implantable Hearing Devices in Patients with Open Cavities: Bone Conduction Implants vs. Middle Ear Implants
Presenting Author: Luis Lassaletta, MD
Author Block:
Luis Lassaletta, MD, Miryam Calvino, MD, Isabel Sánchez- Cuadrado, MD, Javier Gavilán, MD; Otolaryngology, La Paz Univ. Hosp., Madrid, Spain.
Abstract:
Introduction: Patients with canal wall-down cavities usually present poor results with conventional hearing aids or middle ear reconstructive surgery. The aim of this study was to compare the audiological, quality of life (QOL) and quality of sound results among different implantable devices including percutaneous bone conduction implants (PBCI), transcutaneous active bone conduction implants (TABCI), and middle ear implants (MEI) in patients with open cavities.
Methods: Twenty-five patients were implanted with a PBCI, 18 patients with a TABCI and 19 patients with a MEI due to conductive or mixed hearing loss following canal wall-down surgery from June 2004 to February 2020. Data concerning demographics and audiometric evaluations were collected and studied. If a subject had better hearing in the non-implanted ear, this ear was masked during testing. QOL was self-evaluated using the Glasgow Benefit Inventory (GBI) and the Nijmegen Cochlear Implant Questionnaire (NCIQ). Sound quality was self-evaluated using the Hearing Implant Sound Quality Index (HISQUI19).
Results: A significant improvement in the audiometric scores after implantation was observed with all the devices; mean values of the audiometric thresholds at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz in free field shifted from 71±12, 58±14 and 70±17dB to 48±10, 38±8 and 38±8dB in PBCI, TABCI and MEI users, respectively. All patients with bone conduction devices achieved a 100% on the speech perception tests for disyllables in silence at 65dB, whereas in the MEI users their speech discrimination score was 88±22%. The GBI showed an important benefit on the total scale with a mean of +35±16 for the PBCI group, +38±11 for the TABCI group and +38±23 for the MEI group. In the NCIQ, all questionnaire respondents performed significantly better after implantation in all sub-domains (basic and advanced sound perception, speech production, self-esteem, activity and social functioning). Most of the patients also showed a “good” or “very good” subjective perception of the sound. The percentage of long-term users was 48%, 100%, and 78% for the PBCI, TABCI, and MEI respectively.
Conclusion: Both MEIs and bone conduction devices are useful implantable solutions for patients with open cavities, most patients achieving good audiometric, QOL and quality of sound results. Each implantable device should be selected depending on audiometric data, especially bone conduction threshold, ear condition, and patients’ expectations.
Session: CS8-2
Session: Other Implantable Devices
Title: Hearing in Noise: Benefits of FM vs. RM in Children Using Bone Conduction Devices
Presenting Author: Chrisanda Sanchez, AuD
Author Block:
Chrisanda M. Sanchez, AuD, Hillary Snapp, AuD PhD; Otolaryngology, Univ. of Miami, Miami, FL.
Abstract:
Introduction: Despite the significant hearing benefits of bone conduction devices (BCDs) in children with conductive hearing loss, listening in noise continues to be challenging (Snapp et al, 2020). Personal remote microphone (RM) systems allow direct wireless transmission of an acoustic signal to hearing devices to improve the signal-to-noise ratio in complex listening environments, such as classrooms. RMs have been shown to improve hearing in noise in both BCD (Snapp et al, 2020) and cochlear implant (Wolfe et al, 2015) users. However, commonly used classroom-based wireless audio streaming technology to improve the signal-to-noise ratio for hearing device users (generally termed “FM”) uses adaptive digital wireless transmission, which operates on the 2.4 GHz band. Direct audio streaming from digital adaptive FM transmitters to BCDs is limited. In order for BCD users to benefit from digital adaptive FM technology, the FM system must be coupled by way of the personal RM to allow audio streaming of the FM signal to the BCD processor. There are no studies evaluating the effectiveness of audio streaming from an FM system when coupled to a RM system in BCD users. The aim of this study was to evaluate speech recognition in noise performance using a personal RM system with direct wireless transmission to a BCD compared to performance using an FM connected to the BCD via an RM system in children with conductive hearing loss.
Methods: Fourteen children with irresolvable conductive hearing loss (aged 5-17 years) were included for study. All testing was conducted using FDA approved BCD devices coupled with either the manufacturer’s RM system or an adaptive digital FM system. Speech recognition in noise was evaluated in the 1) BCD processor alone, 2) BCD + RM, and 3) BCD + RM + FM listening conditions. Pediatric AzBio sentences were presented at 0 degrees azimuth at a -10dB signal to noise ratio (SNR) amidst diffuse noise.
Results: Speech perception in noise improved significantly in the BCD + RM condition over the BCD alone, demonstrating significant benefit for listening at poor SNRs in children with conductive hearing loss using BCDs with personal RM use. There was no significant performance differences in the BCD + RM + FM listening condition compared to BCD alone, indicating that performance improvements realized with the personal RM system are no longer realized when coupled to the adaptive digital FM system. Overall, the direct wireless audio-streaming through RM was superior to performance using the adaptive digital FM + RM configuration in all experimental conditions.
Conclusion: Direct audio streaming via personal RM provides children with BCDs increased access to speech and significantly improves speech understanding at poor signal-to-noise ratios. The effectiveness of remote audio streaming to improve speech understanding in adverse listening environments is lost when coupled to an FM system. Coupling of the adaptive digital FM to the personal RM negatively affects signal transparency, and no hearing in noise improvements are observed.
Session: CS8-2  
Session: Other Implantable Devices  
Title: Transcutaneous Bone Conduction for Management of Pediatric Hearing Loss: The Clinical Experience  
Presenting Author: Nicole Schuller, AuD  
Author Block: Nicole D. Schuller, AuD, Oliver F. Adunka, M.D., Ursula M. Findlen, PhD; Audiology, Nationwide Childrens Hosp., Columbus, OH.  
Abstract:  
Introduction: An active transcutaneous bone conduction implant (atBCI) received FDA approval in July 2018. FDA approval included children 12 years and older with conductive or mixed hearing loss or with single sided deafness (SSD). The aim of this presentation is to describe the two year clinical experience of a tertiary care pediatric hospital.  
Methods: A retrospective case review of pediatric patients implanted between 2018 and 2020 was completed. Audiometric thresholds for air and bone conduction were obtained pre-operatively as well as speech reception thresholds and speech perception scores. All patients underwent a hearing aid evaluation with an audiologist trained at this device prior to surgery. During this evaluation all appropriate device options were discussed included other surgical and non-surgical bone conduction devices, traditional amplification, and no device use. Approximately one-month post device fitting aided tested was completed using LING detection levels, speech reception thresholds, speech perception scores, and speech in noise scores.  
Results: Nineteen children (average 13 years of age, range 5 to 20 years) were implanted between 2018 and 2020. Indications for implantation included conductive hearing loss (n = 14), mixed hearing loss (n = 1), and SSD (n = 4). Bilateral implantation was pursued for one patient while the remaining 18 patients were implanted unilaterally. One patient had skin irritation over the processor site which resolved. Another patient experienced postauricular wound dehiscence which was closed in clinic. One patient underwent a device revision due to suspected device fixation issue. The overall complication rate (n=3) was 15.8%. The mean pre-operative unaided SRT was 51.9 dB HL (range 30-70 dB HL) and the mean unaided pure tone average (PTA) was 60.3 dB HL (range 35-80 dB HL). The mean post-operative aided SRT was 17.1 dB (range: 15-25 dB HL) and the mean LING detection threshold was 18.75 dB HL (range 10-23 dB HL). Unaided and aided speech perception scores were not significantly different (unaided mean score: 77.3% range 52-96%; aided mean score: 85.7% range 76-100%) however aided testing was completed at a lower intensity consistent with improved audibility. Patients with SSD experienced an average of 3 dB (range 0.5-5 dB) improvement in SNR-50 scores on the BKb-SIN. Mean datalogging for all patients was 7.5 hours per day (range 3-15 hours). The COVID-19 pandemic caused delays in care for 9 patients. Delays included: postponed surgery (n = 6), postponed fitting appointment (n = 1) and postponed follow up appointment (n = 2). Telehealth technology was utilized for one hearing aid consultation to counsel the family regarding the impact of hearing loss and the need for amplification as well as complete a device selection.  
Conclusion: atBCIs offer patients with conductive, mixed, or SSD hearing loss with a safe and effective audiologic solution. The Bonebridge has a low complication rate and favorable audiologic outcomes.
Session: CS8-2
Session: Other Implantable Devices
Title: Comparison between Adhesive and Passive Bone Conduction Implants
Presenting Author: Javier Gavilán, MD
Author Block:
Javier Gavilán, M.D.1, Fernanda Pedrero, MD1, Laura Cavallé, MD2, José Manuel Morales, MD1, Luis Lassaletta, MD1;1Otorhinolaryngology, La Paz Univ. Hosp., Madrid, Spain, 2Otorhinolaryngology, La Fe Univ. Hosp., Valencia, Spain.
Abstract:
Introduction: The first adhesive bone conduction device was introduced in 2017. We compare the auditory outcomes and patient satisfaction between adhesive and passive transcutaneous bone-conduction implants.
Methods: We include 16 pediatric patients with bone conduction threshold ≤ 25dB who were users of passive transcutaneous implants for at least one year, and gave them an adhesive system for one week. Pure tone thresholds and word recognition with bisyllables at 65dB with and without noise were measured for each of the two devices. A specific satisfaction questionnaire, SSQ life questionnaire and the Kindle quality of life questionnaire adjusted to the patient's age were also passed.
Results: The age of the patients was between 5 and 16 years. All of them had congenital aural atresia, 9 unilateral and 7 bilateral. The pure tone average in the studied ear recorded a mean threshold of 52 dB unaided. The mean passive transcutaneous-aided threshold was 27 dB and 29 dB with the adhesive-aided. The average word recognition score was 96% for the passive transcutaneous and 95% for the adhesive system in quiet. The word recognition score in noise at 5 dB SNR was 70% for the passive transcutaneous and 77% with the adhesive device and at 0 dB SNR 50% for the passive transcutaneous and 48% with adhesive implant.
Conclusion: The new adhesive bone conduction system provides comparable auditory results with passive transcutaneous bone conduction implants in free field, in word discrimination in quiet, and word recognition with background noise. The overall satisfaction of the new adhesive device is good.
Session: CS8-2
Session: Other Implantable Devices
Title: Cortical Activation Evoked by Electrical Stimulation of the Vestibular Nerve in Humans
Presenting Author: Nils Guinand, MD, PhD
Author Block:
Nils Guinand, MD, PhD1, Anissa Boutabla, Msc1, Samuel Cavuscens, Msc1, Maurizio Ranieri, Msc1, Pierre Mégevand, MD, PhD2, Vincent Rochas, PhD3, Raymond van de Berg, MD, PhD4, Angelica Perez Fornos, PhD1;1Division of ENT and head-and-neck surgery, Geneva Univ. Hosp., Geneva, Switzerland, 2Division of Neurology, Geneva Univ. Hosp., Geneva, Switzerland, 3Brain and behaviour laboratory, Univ. of Geneva, Geneva, Switzerland, 4Division of Balance Disorders, Maastricht Univ. Med. Ctr., Maastricht, Netherlands.
Abstract:
Introduction: Investigating spatial and temporal patterns of cortical responses resulting from vestibular percepts is crucial in order to understand the mechanisms underlying the integration of sensory information in the multidimensional system of balance. The vestibular implant is an unprecedented setting for such an investigation, allowing direct stimulation of the vestibular pathways without the influence of other sensory modalities (e.g., vision, proprioception).
Methods: This study was conducted in three patients with bilateral vestibulopathy who received a prototype implant with 1-3 vestibular electrodes (MED-EL, Innsbruck, Austria). The cortical responses evoked by the electrical stimulation delivered by one of the vestibular electrodes (biphasic current pulses of variable intensity, 200µs/phase, 400 pulses per second) were recorded using a 256-channel electroencephalography system (Clinical GES 400, Electrical Geodesics Inc, Oregon, USA).
Results: Our preliminary results show cortical activation synchronous with electrical stimulation of the vestibular system. These responses are characterized by cortical vestibular potentials with latencies ranging from 25ms to 150ms. Further analyses are currently underway to determine the topographic distribution of evoked responses, as well as the 3D localization of cortical regions responding to stimulation using inverse solution mathematical models.
Conclusion: These results will contribute to our fundamental knowledge on the cortical integration of vestibular stimuli. This will not only contribute to the development of the vestibular implant, but also to improve our understanding of certain syndromes which remain poorly understood, such as “mal de débarquement” syndromes or uncompensated unilateral deficits.
Session: CS8-2
Session: Other Implantable Devices
Title: Investigation of Systematic Variations of the Stimulation Profile on Responses Evoked with a Vestibular Implant Prototype in Humans
Presenting Author: Angelica Perez Fornos, PhD
Authors Block:
Angelica Perez Fornos, PhD1, Anissa Boutabla, MsC1, Samuel Cavuscens, Msc1, Maurizio Ranieri, Msc1, Celine Cretallaz, PhD1, Herman Kingma, PhD, Professor2, Raymond van de Berg, MD, PhD2, Nils Guinard, MD, PhD1;1Division of ENT and head-and-neck surgery, Geneva Univ. Hosp., Geneva, Switzerland, 2Division of Balance Disorders, Maastricht Univ. Med. Ctr., Geneva, Netherlands.

Abstract:
Introduction: Vestibular implants (VI) are devices that attempt to artificially restore vestibular function in patients suffering from bilateral vestibulopathy, using electrical currents delivered directly to the vestibular nerve branches. In order to optimize the rehabilitation prospects and get the optimal efficiency of the device, the best stimulation paradigm remains to be determined. To this purpose, we investigated the effect of systematic variations of the stimulation paradigm on the vestibular responses evoked with the Geneva-Maastricht vestibular implant prototypes.

Methods: This study was conducted in four patients with bilateral vestibulopathy who received a prototype implant with 1-3 vestibular electrodes (MED-EL, Innsbruck, Austria). We investigated the relative efficacy of systematic variations of the electrical stimulus profile (phase duration, pulse rate, baseline level, modulation depth). For each patient, each electrode, and each parameter set, we first determined the dynamic range (DR) and then evaluated the electrically-evoked vestibulo-ocular (eVOR) and perceptual responses.

Results: In our experimental setting, shorter phase durations and, to a lesser extent, slower pulse rates allowed maximizing the dynamic range available for eliciting a wider range of intensities of vestibular percepts. For the range of parameters investigated, the major parameter influencing total peak eye velocity of the evoked eVOR responses was modulation depth. Baseline level showed very small or no effects at all. Interestingly, the larger DR observed for shorter phase durations and slower pulse rates did not improve the velocity of eVOR responses.

Conclusion: Our results identified important parametric variations influencing the measured responses. Furthermore, we observed that not all vestibular pathways seem equally sensitive to the electrical stimulus when the electrodes are placed in the semicircular canals and monopolar stimulation is used. This opens the door to new stimulation strategies for a vestibular implant, and suggests the possibility of selectively activating only one vestibular pathway.
Session: CS8-3
Session: Listening Effort and Cognition
Title: Assessing the Impact of Pitch Variability on Listening Effort for Cochlear Implant Users Using a Recall Task and Pupillometry
Presenting Author: Yue Zhang, PhD
Author Block:
Yue Zhang, PhD1, Alexandre Lehmann, PhD1, Mickael Deroche, PhD2;1Department of Otolaryngology - Head and Neck Surgery, McGill Univ., Montreal, Canada, 2Department of Psychology, Concordia Univ., Montreal, Canada.
Abstract:
Introduction: Although most adults with severe to profound hearing loss who receive cochlear implants (CIs) derive some benefit regarding speech recognition in quiet, substantial variability and individual differences in both speech performance and life quality still exist. Specifically, CIs do not transmit salient pitch percept due to the envelope-based coding strategies. This limits CI users’ performance on tasks, such as speech-in-noise perception, prosody and speaker recognition. Furthermore, impoverished pitch cues may require CI users to invest additional listening effort compared to normal hearing listeners. This is detrimental for CI users both in the short and long term. The high and sustained level of cognitive load during listening can impair other ongoing cognitive and physical tasks, such as memory and walking. Prolonged fatigue can accumulate from everyday effortful listening and lead to communication retrieval and social isolation. Here, we aimed to demonstrate and quantify the impact of poor pitch fidelity on short-term memory and listening effort, using a paradigm that combines different measures of listening effort (pupillometry, dual-task and subjective rating).
Methods: Adult CI users and age-matched NH participants wore eye-tracking glasses that recorded pupil diameter and word lists were presented. Participants were required to repeat each word. At the end of a 10-word list, participants were required either to recall as many words as possible from the previous 10 words or to move on to the next list. Participants then gave a subjective rating on the effortfulness for each block. Testing materials are either French or English words (for native French or English participants respectively), with F0 manipulated in 4 conditions: 1) naturally intonated 2) monotonised 3) exaggerated and 4) inverted.
Results: Preliminary data collected from 23 CI users showed that intelligibility of monotonised words was HIGHER than unprocessed words. In comparison, results collected from NH listeners showed lower intelligibility of monotonised compared to unprocessed words. Word recall performance did not differ across conditions in both groups. Baseline pupil diameters in repeat-and-recall blocks built up progressively and then plateaued in the later positions (within a list of 10), suggesting an overload of effort in the block requiring recall. Peak pupil dilation was smaller in monotonised than unprocessed words, suggesting lower listening effort during processing monotonised words for CI users. In contrast, NH listeners showed higher listening effort for monotonised words. Data from more CI users and NH listeners are still under the collection.
Conclusion: Preliminary results demonstrate the positive impact of the low pitch variability on word recognition and listening effort for CI users. This highlights the need for more investigation on improving pitch coding in CI devices, to ease the listening effort and avoid detrimental psychosocial consequences for CI users.
Session: CS8-3
Session: Listening Effort and Cognition
Title: Listening Effort and Memory Processing in Cochlear Implant Users: A Pupillometry Study
Presenting Author: Hanna Boenitz, MSc
Author Block:
Hanna Boenitz, M.Sc.1, Dorothea Wendt, PhD2, Mareike Finke, PhD1, Alejandro Lopez Valdes, PhD3, Björn Lyxell, Professor4, Sören Kamaric Riis, PhD5, Andreas Büchner, Professor1, Thomas Lunner, Professor6;1ENT, Hannover Med. Sch., Hannover, Germany, 2Eriksholm Res. Ctr. / Technical Univ. of Denmark, Snekkersten / Copenhagen, Denmark, 3Eriksholm Res. Ctr., Snekkersten, Denmark, 4Oslo Univ. / Linköping Univ. (Sweden), Oslo / Linköping, Norway, 5Oticon Med. A/S, Kongebakken, Denmark, 6Eriksholm Res. Ctr. / Linköping Univ. (Sweden), Snekkersten / Linköping, Denmark.
Abstract:
Introduction: Participating in a conversation can be demanding.Finite cognitive resources must be allocated to several tasks such as processing the speech, retaining and encoding the perceived content, and preparing an answer. This study investigated effort allocation in Cochlear Implant (CI) users. Pupillometry was used to evaluate processing effort within a dual task while applying a noise reduction algorithm.
Methods: A dual task paradigm was tested with 25 CI users and 25 age-matched participants with normal hearing acuity (NH). Sentences were presented via loudspeaker within a 4-talker masker. The participants underwent the sentence final word identification and Recall (SWIR) test. Their task was to repeat back the final word of each sentence. At the end of each list of sentences, they had to repeat back as many of the final words as possible. Simultaneously, pupil dilation was recorded to monitor the allocation of cognitive resources and to quantify processing effort. Task demands were systematically changed with changing the list length. Additionally, an aggressive noise reduction algorithm was applied to evaluate its influence on listening effort as quantified by the pupil size.
Results: The results indicated an increased pupil dilation during sentence presentation, which can be seen as an indicator for listening effort, while larger pupil dilation during the recall indicated memory processing. In conditions with low task demands, CI users showed increased pupillary response. With increasing task demands, smaller pupil dilations were obtained in CI users compared with NH participants independently of the application of the noise reduction. Decreased pupil dilation can be interpreted as signs of disengagement as all cognitive capacity is devoted to listening. No significant effect of noise reduction on pupil dilation was found.
Conclusion: By combining two different measures, i.e. pupillometry and a dual task, we gained insights into cognitive processes in CI users. The combination of the two methods provides a way to disentangle cognitive processes during speech understanding. Our results indicated that CI users allocate their resources differently
Session: CS8-3
Session: Listening Effort and Cognition
Title: Are There Hidden Cognitive Deficits in Older Adult Cochlear Implant Candidates?
Presenting Author: Stephen Trudeau, BA
Author Block:
Stephen Trudeau, BA1, Armine Kocharyan, MD2, Lindsay Zombek, CCC-SLP2, Sarah Mowry, MD2;1Case Western Reserve Univ. Sch. of Med., Cleveland, OH, 2Univ. Hosp. Cleveland Med. Ctr., Cleveland, OH.
Abstract:
Introduction: Previous studies have shown that hearing loss (HL) is independently associated with incident cognitive impairment and rate of decline in older adults. Outside of well-known functions (e.g. speech/language), how HL affects other cognitive functions remains an area of active research.
Methods: The Cognitive Linguistic Quick Test (CLQT) is a cognitive dysfunction screening tool modified and validated for Cochlear Implant (CI) candidates examining 7 cognitive domains using 11 subtests. Scores for each domain are calculated from weighted subtest scores. All scores have a standardized passing cutoff and a final composite score is assigned. All CI candidates aged ≥65 with self-reported normal cognitive function were screened at a single tertiary academic center by two licensed speech pathologists. All scores were normalized for age per CLQT protocol. Because a patient could obtain a passing score on a specific domain or subtest yet still fail the composite (score ≤3.4), and vice versa, each domain and subtest failed by >20% of patients was divided into two subgroups; Group A (patients with a passing composite score >3.4, a total of 54 patients) and Group B (patients with an abnormal composite score ≤3.4, a total of 13 patients). Relative failure rates were calculated within each subgroup. Failure rate for Group A is calculated as the ratio of patients passing the composite but failed the subtest or domain compared to the total number of patients who had a composite >3.4 (54 patients), while the failure rate for Group B is calculated as the ratio of patients failing the composite but passed the subtest or domain compared to the total number of patients who had a composite ≤3.4 composite (13 patients).
Results: Of 67 patients aged 65-93 years old screened from Aug. 2017 to Nov. 2020, thirteen patients (19.4%) had a composite score ≤3.4. Two domains and three subtests had a failure rate >20%; Attention domain- 26.9% (total failure), 11.1% (Group A), 15.4% (Group B); Non-Linguistic Cognition domain- 26.9% (total failure), 9.3% (Group A), 0% (Group B); Clock Drawing subtest- 22.4% (total failure), 13% (Group A), 30.8% (Group B); Symbol Trail subtest- 32.9% (total failure), 18.5% (Group A), 7.7% (Group B); Generative Naming subtest- 25.4% (total failure), 20.4% (Group A), 53.9% (Group B).
Conclusion: Unexpectedly, the Non-Linguistic Cognition domain and Symbol Trails subtest had relatively higher failure rates in Group A compared to Group B. As Group A is unlikely to have global cognitive impairment, and these areas of cognition should theoretically not be affected by HL, our findings suggest CI candidates with normal cognitive screening may have hidden deficits. Moreover, these findings may support growing evidence connecting HL to seemingly unrelated areas of cognitive decline and skill loss.
**Session:** CS8-3
**Session:** Listening Effort and Cognition
**Title:** Speech Outcomes After Cochlear Implantation in Older Adults with Dementia
**Presenting Author:** Christopher Wen, MD
**Author Block:**
Christopher Wen, MD, Tiffany P. Hwa, MD, Jason A. Brant, MD, Steven J. Eliades, MD, PhD, Douglas C. Bigelow, MD, Michael J. Ruckenstein, MD; Otolaryngology, Univ. of Pennsylvania, Philadelphia, PA.

**Abstract:**
**Introduction:** Cochlear implantation has been shown to be safe and effective in elderly populations. As the population ages, it is likely that more and more patients who meet criteria for cochlear implantation may carry or will eventually carry a diagnosis of dementia. Multiple studies have sought to evaluate the complex relationship between hearing loss and dementia, and to further clarify the role that cochlear implantation itself may be able to play. In this investigation, we sought to evaluate speech outcomes after cochlear implantation among elderly patients with and without dementia.

**Methods:** This was a retrospective chart review at an academic cochlear implant center of adults undergoing unilateral or bilateral cochlear implantation. The electronic medical record was queried among 740 cochlear implants in 609 distinct adult patients over 10 years for patients above the age of 65 years. Data were reviewed for medical history including dementia, perioperative data, device data, and audiometric outcomes.

**Results:** A total of 278 patients (335 implants) above age 65 were identified, with 14 implantees (17 implants) having documented diagnosis of dementia in the EMR. 2 patients were diagnosed pre-implantation, while 12 were diagnosed post-implantation. Implantees with dementia were older at first implantation (mean 78.4 years v. 72.4 years, p=0.01). While a lower proportion of patients with dementia saw improvement at 3 months in AzBio scores in quiet (6/12 v 165/200, p=0.01) and in +10db S/N (1/12 v 106/200, p<0.001), a similar proportion of implantees had improved performance at 6 months and a year post implantation for AzBio testing in all three conditions. No significant differences were found in improvements in either AzBio and CNC scores at 6 months and 1 year between the two groups. No significant differences between rates of incomplete insertion (D, 0% v. ND, 3.4%), explantation (D, 7.1% v. ND, 4.5%), complications (D, 0% v. ND 0.4%), or device failure (D, 7.1% v. 2.7%) were seen.

**Conclusion:** Elderly adults with dementia that undergo cochlear implantation experience similar levels of hearing benefit as elderly cochlear implantees without dementia. Additionally, they do not demonstrate increased rates of surgical complications, device failure, or need for explantation.
Session: CS8-3
Session: Listening Effort and Cognition
Title: The Effects of Hearing Loss and Cochlear Implantation on a Cognitive Screening Measure
Presenting Author: Kara Vasil, AuD
Author Block:
Kara Vasil, AuD, Aaron Moberly, MD; Otolaryngology, Ohio State Univ. Wexner Med. Ctr., Columbus, OH.
Abstract:
Introduction: The link between cognitive impairment and hearing loss in adults has garnered attention by the general public and healthcare professionals. Cognitive screening tools to identify patients at risk for cognitive deficits are increasingly being used by clinicians in the hearing healthcare field who work with aging populations. Although some studies show improvements in performance on cognitive screening exams when hearing loss intervention is provided in the form of a hearing aid or cochlear implant (CI), it is worth examining whether these improvements are attributable to increased audibility of test items. This study aims to examine whether performance on the Montreal Cognitive Assessment (MoCA) improves as a result of cochlear implantation, and whether improved performance on auditory-based test items drives changes in the MoCA total score.
Methods: As part of a larger prospective, longitudinal study, data were collected in adult CI candidates pre-implantation and then six months post-implantation to examine the effect of CI intervention on MoCA performance. Participants were 77 adult CI users between the ages of 55 and 85 years. All participants were postlingually deafened and had met candidacy requirements for traditional cochlear implantation. Participants completed the MoCA, administered audiovisually by a trained test administrator, both pre-implantation and six months post-implantation. Cognitive screening pass rates (i.e., MoCA total score of 26/30 or greater) were determined pre- and post-implantation.
Results: Compared to 31 participants pre-operatively, 45 participants passed the MoCA post-operatively. Of the 46 participants who did not pass the MoCA pre-operatively, 21 passed post-operatively. However, this improvement in cognitive screening pass rate was attributed primarily to improvement in the “Delayed Recall” test sub-item, which is an auditory-based task.
Conclusion: The improvement in MoCA pass rate after CI was driven by improvements in an auditory-based sub-item of the test. Therefore, this cognitive screening tool should be interpreted with caution in hearing-impaired populations, even when delivered in an audiovisual fashion. Further studies are needed to investigate the application of cognitive screening tools in patients receiving intervention for their hearing loss.
Session: CS8-3
Session: Listening Effort and Cognition
Title: Implementation of Cognitive and Hearing Handicap Measures into Cochlear Implant Candidacy Evaluations: Methodology and Preliminary Outcomes
Presenting Author: Samantha Morgan, AuD
Author Block:
Dorothy A. White, M.A., Elizabeth Adams, Ph.D., Nancy Mellon, M.S., Meredith Ouellette, M.S., Sharlene W. Ottley, Ph.D.; The River Sch., Washington, DC.
Abstract:
Introduction: Children with CIs generally demonstrate lower performance on standardized measures of language, working memory, and executive functioning compared to hearing peers (Pisoni et al, 2010; Beers et al, 2013). Previous research has delineated cognitive outcomes as they relate to language development (Socher, 2019 and others), but further exploration can be done into whether children with cochlear implants have a unique cognitive profile across domains. The current presentation will share the cognitive profiles of children with CIs, and discuss preliminary findings over a three-year span.
Methods: This study examined verbal comprehension, visual-spatial processing, working memory performance, and full-scale IQ over a three-year span in children who use cochlear implants and attended an inclusive education program. The measures used were the Wechsler Preschool and Primary Scales of Intelligence, 4th Edition (WPPSI-IV; ages 2:6-7:7 years) and the Wechsler Intelligence Scale for Children, 5th Edition (WISC-V; ages 6:0-16:11 years). Participation varied as follows: Time 1, N=26 children (22 WPPSI-IV, 4 WISC-V), Time 2, N=23 children (17 WPPSI-IV, 6 WISC-V), Time 3, N=18 children (10 WPPSI-IV, 8 WISC-V).
Results: As found in previous analyses in this sample, mean VCI, VSI, WMI and FSIQ scores improved across time points, with VCI improving the most (approximately .5 SD). Significant correlations were found within constructs for VCI, VSI, and FSIQ across all three years with moderate to strong effect sizes (r=.50-.81). WMI scores were only significantly correlated with the results of the preceding year. VSI scores, even within the first time point, were not significantly correlated with the other indices (r=.15-.22) WMI at time 1 was significantly correlated with VCI at time 1 (r=.72), time 2 (r=.61) and time 3 (r=.77). VCI at time 1 was also significantly correlated with WMI at time 2 (r=.54) and time 3 (r=.65). These findings were consistent across intellectual ability. Multiple regression indicated that the predictive effects of VCI at time 1 significantly predicted WMI at time 3, even when controlling for WMI at time 1 and at time 2, indicating that VCI is a better predictor of WMI outcomes in this sample than WMI.
Conclusion: In the present study, a general pattern was observed. VCI at time 1 was a significant predictor of overall cognitive outcomes. In this sample, all scores improved over time with VCI improving most. VSI scores were generally not correlated with the other indices. Further predictive analysis should be conducted to better understand the relationships between these indices. Recent studies regarding factor analysis of the WPPSI-IV and the WISC-V have conflicting results, even for children with normal hearing. This subject should be explored further in a variety of samples.
**Session:** CS8-3  
**Session:** Listening Effort and Cognition  
**Title:** Cognitive Profiles of Children with Cochlear Implants: Results from a Sample of Children in the Context of a Supportive Inclusive Model over Time  
**Presenting Author:** Dorothy White, MA  
**Author Block:**  
**Abstract:**  
**Introduction:** With an expanding geriatric population, hearing loss and cognition respectively reflect two considerable societal healthcare concerns. While the relationship between hearing loss and cognition remains to be concretely defined, the need to assess both, regardless of which diagnosis is receiving the primary treatment, cannot be debated. As Medicare continues to request measurable outcome data, further assessment of hearing loss outside of the data an audiogram can provide is vital for the sustainability of the cochlear implant clinic. Collection of additional information related to hearing but reflective of a larger, higher-order issue, provides the opportunity to add value to our clinical practice. This study provides a methodology for implementation of hearing handicap measures and cognitive screenings for adult cochlear implant patients in conjunction with a typical clinical timeline. Trends in pre-operative data, postoperative outcomes, and resultant referrals will be discussed.  
**Methods:** Measures of cognition and hearing handicap were selected and integrated into adult cochlear implant candidacy evaluations. The Montreal Cognitive Assessment Tool (MOCA) and The Hearing Handicap Inventory (HHI) are administered as part of the initial candidacy battery and then re-administered at predetermined points during the first postoperative year. Pre and postoperative data from ten patients will be analyzed to evaluate trends in cognitive performance and perception of hearing handicap over the pre-operative and one-year post-implantation time period.  
**Results:** This presentation will include all pre and postoperative data, including trends in MOCA and HHI scores over time, as well as insight into referrals made to mental health professionals as a result of the outcome data collected.  
**Conclusion:** The MOCA and HHI results provide vital insight into patient motivation, priorities and fundamental needs which are otherwise not represented by traditional candidacy protocols. Using these tools as outcome measures provides insight into a recipient’s overall well being in a way audiometric measures fail to capture.
Session: CS8-3
Session: Listening Effort and Cognition
Title: The Relationship Between Cognitive Factors, Speech Perception, and Language in Children with Cochlear Implants
Presenting Author: Elizabeth Adams Costa, PhD
Author Block:
Elizabeth Adams Costa, Ph.D.1, Nancy Mellon, MS2, Meredith Ouellette, MS2, Sharlene Wilson Ottley, Ph.D.2, Dorothy White, MA1; 1Department of Psychology, The River Sch./RiverREACH Clinic, Washington, DC, 2The River Sch./RiverREACH Clinic, Washington, DC.
Abstract:
Introduction: Studies investigating the cognitive profiles of children with CIs also document variability; some studies report lower scores on measures of verbal abilities (Geers & Moog, 1989; Geers & Sedey, 2011) and working memory tasks (Burkholder & Pisoni, 2003; Geers & Sedey, 2011) compared to hearing peers. Working memory is acknowledged to be critical to the development of spoken language, and positive correlations have been found between working memory and language development in children with CIs (Pisoni & Cleary, 2003). Many children with CIs experience considerable difficulty hearing in noise. Beer et al. (2011) assert that the establishment of early neurocognitive function is inextricably impacted by pre-lingual deafness as well as deficient auditory experience. These early neurocognitive functions are essential to early learning and can be delineated into specific areas of brain function: working memory, short-term memory, retrieval systems, phonological awareness, sequential processing, metacognition, and the capacity for fluid reasoning. Early auditory deprivation can have a multitude of effects on brain development, and may impact cognitive capacities that extend beyond the auditory system. It has been proposed that hearing loss can be considered a “connectome” disease, with individual differences in response to auditory deprivation accounting for variability in outcomes (Kral et al., 2016). The goal of the current study was to investigate the relationship between cognitive factors, language abilities, and speech recognition.
Methods: This cross-sectional study used the test data of 22 children with CIs between the ages of five and eight to examine the relationships between nonverbal cognitive abilities (Fluid Reasoning Index), working memory (Working Memory Index), speech recognition (Articulation Index), listening in noise (Bamford-Kowal-Bench Speech-In-Noise), receptive vocabulary (Peabody Picture Vocabulary Test), and core language (Comprehensive Assessment of Spoken Language).
Results: Significant correlations were found between working memory and speech perception (p=0.02), working memory and core language (p=0.01), and receptive vocabulary and core language (p=0.001). A relationship approaching significance was found between receptive vocabulary and speech detection in noise (p=0.06). The relationship between working memory and core language was only found in children with working memory scores below average (p=0.008), but was not present in children with above average language score (p=0.86). Although activation age was not significantly associated with language standard scores, an older age at activation is associated with a lower language score. None of the examined variables were significantly associated with speech-in-noise scores. Activation age was also not significantly associated with speech-in-noise scores, and unlike with the language outcome, there appears to be less of an effect of activation age.
Conclusion: The results of the current study suggest that relationships are demonstrated between audiological, cognitive, and language factors. Interindividual variability in neurocognitive processing likely accounts for the demonstrated scatter in outcomes for children with CIs.
Session: PH-1
Session: ePoster Highlights I
Title: Cortical Activities Evoked by Frequency Changes in Bilateral Cochlear Implant Users
Presenting Author: Fawen Zhang, PhD
Author Block:
fawen zhang, PhD, Kelli McGuire, AuD, Gabrielle Firestone, BS; Univ. of Cincinnati, Cincinnati, OH.
Abstract:
Introduction: Cochlear implants (CIs) provide effective treatment for individuals suffering from bilateral severe-to-profound hearing loss. Nevertheless, there are substantial barriers that hinder patients’ ability to reach the maximized CI outcomes. For example, CI users typically perform poorly in tasks such as speech perception in noise and music perception that heavily rely on the ability to detect frequency changes in sounds. Moreover, CI users implanted bilaterally have difficulties in integrating sound information from both ears, especially when there is a significant difference in the performance of the two individual ears. Examining brain activation patterns in CI users evoked by sound frequency changes in CI users will be a critical step toward finding effective approaches to improve CI outcomes. This study examines the cortically generated acoustic change complex (ACC) evoked by a frequency change embedded within a pure tone in a group of bilateral adult CI users.
Methods: Eight bilaterally implanted adult CI users participated in this study. Electroencephalographic (EEG) recordings were conducted when the participants passively listened to pure tones at 3 different base frequencies (0.25, 1, and 4 kHz) that contain a frequency change (Δf) of 0%, 10%, and 70%, in the middle of the tone. Psychoacoustic tests were administered to examine the frequency change detection threshold (FCDT), or the minimum frequency change the participant can detect. Speech tests (Consonant Nucleus Consonant word recognition test, AzBio sentence recognition test in quiet and noise, and the Digit-in-Noise test) and a questionnaire of participants’ hearing ability were administered. All sound stimuli were presented in the free field at the most comfortable level through a sound speaker 0.5m away from the participant’s head at 0-degree azimuth. EEG data will be analyzed using waveform analysis to obtain ACC peak measurements (amplitudes and latencies) and source analysis to determine brain activation patterns.
Results: The preliminary data showed that the brain activation patterns for the left and right CI users are different. Further data analysis will determine the effects of the implantation side, the base frequency of the tone, and the magnitude of the frequency change on the ACC. The correlations between objectively ACC measurements and non-physiological measurements (behavioral and questionnaire) will also be examined.
Conclusion: This study provides information on the neural basis of perceptual challenges in bilaterally implanted CI users, which would be the basis for finding approaches to improve their performance on pitch-related tasks.
Session: PH-1
Session: ePoster Highlights I
Title: Cortical Cross-modal Reorganization from Both Visual and Somatosensory Modalities in Children with Cochlear Implants
Presenting Author: Theresa Hennesy, BA
Author Block:
Theresa B. Hennesy, BA1, Garrett Gardon, AuD, PhD2, Julia Campbell, AuD, PhD3, Hannah Glick, AuD, PhD4, Don Bell-Souder, BA4, Anu Sharma, PhD4;1Univ. of Colorado Sch. of Med., Aurora, CO, 2Communication Disorders Department, Brigham Young Univ., Provo, UT, 3Department of Speech Language and Hearing Sciences, Univ. of Texas at Austin, Austin, TX, 4Department of Speech Language and Hearing Sciences, Univ. of Colorado at Boulder, Boulder, CO.
Abstract:
Introduction: Cross-modal reorganization, which occurs when a deprived sensory modality’s cortical resources are recruited by other intact modalities, has been proposed as a source of variability underlying speech perception in hearing-impaired cochlear implant (CI) users. Visual and somatosensory cross-modal reorganization of auditory cortex has been documented separately in children with CIs, but reorganization in these modalities has not been documented within the same subject group. Thus, this study’s goal was to examine cross-modal reorganization across visual and somatosensory modalities within a single group of CI children (n=10) using high-density electroencephalography.
Methods: We analyzed evoked potentials in response to visual and somatosensory stimuli and performed current density reconstruction (CDR) of brain activity sources. Speech perception-in-noise testing was also performed. CDR patterns were analyzed within the entire subject group and across groups of CI children exhibiting good vs. poor speech perception.
Results: Results showed a positive correlation between visual and somatosensory cross-modal reorganization, suggesting that neuroplasticity in different sensory systems may be interrelated. Further, CI children with good speech perception did not show recruitment of frontal or auditory cortices during visual processing, while subjects with poor speech perception did.
Conclusion: The children under study provide evidence of increased recruitment of auditory cortices for processing of both visual and somatosensory stimuli with increased difficulties in speech perception in noise. Additionally, a comparison of cortical activation by visual stimuli between implanted children with good speech perception and poor speech perception showed that the cross-modal recruitment of auditory and frontal cortices by the visual modality is associated with poorer speech perception. In agreement with previous studies, this finding reflects that a child’s behavioral outcomes with their CI may be related to cross-modal reorganization and changes in cortical resource allocation.
**Session**: PH-1  
**Session**: ePoster Highlights I  
**Title**: Objective Measures of Post-implantation Brain Plasticity Reveal Evidence of Compensatory Mechanisms in Post-lingually Deafened Cochlear Implant Users  
**Presenting Author**: Bastien Intartaglia, PhD  
**Author Block**: Bastien Intartaglia, PhD1, Marie-Anne Prud’homme, M.Sc1, Nicholas E. V. Foster, PhD1, Anthony G. Zeitouni, MD2, Alexandre Lehmann, PhD1; Intl. Lab. for Brain, Music and Sound Res., Montreal, Canada, 2Department of Otolaryngology - Head and Neck Surgery, McGill Univ., Montreal, Canada.  
**Abstract**:  
**Introduction**: During prolonged period of deafness or degraded auditory input, individuals rely on the visual modality to compensate for the lack of reliable auditory cues. For instance, cochlear implant (CI) users can use lip and face information to disambiguate the degraded speech sounds they receive due to the coarse auditory fidelity of their neuroprosthesis. Studies have suggested that brain plasticity associated with these compensatory mechanisms accounts for more than thirty percent of the variability in post-implantation auditory performance. Investigating these neural changes could therefore lead to improving rehabilitation strategies and CI outcomes. However, CIs are not compatible with most metabolic imaging techniques, therefore brain reorganization following cochlear implantation is still unknown.  
**Methods**: This study investigates intra- and cross-modal plasticity in CI users using high-density electroencephalography. We measured visual evoked potentials in response to visual motion changes and estimated neural sources in post-lingually deafened CI users (n = 25) and normal hearing matched control participants (n = 25).  
**Results**: Our results indicate intra-modal plasticity in the visual cortex of CI users, revealed by higher P1 and visual mismatch negativity amplitude, as well as greater contribution of the visual cortex during visual motion changes compared to NH controls.  
**Conclusion**: These results indicate a more efficient processing of visual information that may reflect enhanced multimodal compensatory strategies during speech processing in CI users. Furthermore, this study showcases an implant-compatible objective method with the sensitivity to detect functional activation differences reflecting functional organization in CI users. This approach could be used in a clinical setting to measure and longitudinally track cortical plastic changes across time, enabling a better understanding of the link between individual patterns of cortical plasticity and CI outcomes.
**Session:** PH-1  
**Session:** ePoster Highlights I  
**Title:** Expressive Speech and Language Scores in Children with Bilateral Cochlear Implants: A Retrospective Analysis of Device Use  
**Presenting Author:** Deborrah Johnston, MA, AuD  
**Author Block:** Deborrah Johnston, MA, AuDAudiology, DePaul Sch. for Hearing and Speech, Pittsburgh, PA.

**Abstract:**

**Introduction:** The influence of consistent auditory device use during the early childhood years is explored in this retrospective case review. With the advent of cochlear implant software advances allowing data logging, service providers can accurately assess this critical component and its influence on the development of oral language and expressive vocabulary. In addition to presenting retrospective case study analysis of four subjects, this poster will focus on various strategies used to increase daily use in early intervention and subsequent early childhood years.

**Methods:** Retrospective analysis of cochlear implant speech processor use and standard scores on the Expressive One Word Peabody Picture Vocabulary (EOWPVT) and the Clinical Evaluation of Language Fundamentals (CELF) was performed on four (4) children. All subjects were implanted early, either simultaneously or sequentially with a short interval for the second side. Mean age of activation was 17 months with a range of 12 to 22 months. Based on average daily device use, subjects were divided into two groups - Group A with consistent device use averaging 11.6 hours or more per day and Group B with inconsistent device use averaging 8.9 hours or less per day. Data collection and analysis focused on tracking longitudinal changes in standard scores over a four (4) year interval, as well as the highest score prior to transition from an intense, specialized educational setting focusing on Listening and Spoken Language to a regular education.

**Results:** Analysis of EOWPVT and CELF scores relative to data logging demonstrated that device use is a critical variable to the hierarchical development of expressive speech and oral vocabulary skills. On the vocabulary measure, Group A subjects’ standard scores had a mean of 93.5, while Group B subjects’ standard score had a mean of 67.5, representing a 38.5% significant improvement in performance with a 30.3% increase in device use. Children with poor device use did not show incremental improvement in their annual longitudinal EOWPVT scores over a 7 to 14 year period post-activation. By contrast, subjects who demonstrated consistent and adequate daily device use made steady gains in their oral vocabulary scores over a 5 year period post-activation. At transition, subjects in Group A had a mean standard score of 99, compared to a mean of 70 for Group B subjects. This represented a 41.4% significant improvement when correlated with a 30.3% increase in device use. For CELF scores, Group A outperformed Group B by 21% (mean Expressive Language post-LSL treatment) and 24% (mean Core Language post-LSL treatment).

**Conclusion:** Early cochlear implantation at 12 months of age has been shown to result in improved oral language outcomes in the absence of a co-existing expressive speech disorder. Despite early implantation, children who did not achieve adequate device use in the early childhood years show limited progress with respect to oral vocabulary and expressive speech development. This finding has long term implications for the expected outcome of an optimized and automated Auditory Feedback (Production) Loop. Since the use of oral language is a precursor to readiness for participation in regular education, this lack of progress translates into more time spent in specialized educational environments that focus on the development of oral language. Through routine data logging, audiologists can recognize the issue and implement multiple strategies to improve device use.
Session: PH-1
Session: ePoster Highlights I
Title: Factors Influencing the Developmental Trajectory of Speech Recognition in Pediatric Cochlear Implant Recipients
Presenting Author: Meisam Arjmandi, PhD, MSc, BSc
Author Block:
Abstract:
Introduction: Despite successful development of speech perception in many pediatric recipients of cochlear implants (CIs), a large degree of variability across children in their outcomes remains unexplained (Dunn et al., 2014; Tomblin et al., 2005; Wie et al., 2020). One of the main challenges in quantifying speech recognition development in children is the use of different test materials with variable levels of difficulty. The purpose of the present study was to address this issue and examine the extent to which the development of speech perception varies among children with CIs, focusing mainly on the effect of age at CI activation.
Methods: In a retrospective cohort study, data from 37 congenitally deaf children who received their first CI by age 18 (15 unilateral (UnICl) and 22 bilaterally implanted (BiCl)) and also met the criteria of having at least 3 scores at different time points following implantation were analyzed. The data for the first implanted ear was used, or if patients had simultaneous BiCIs, the data for the right ear was used. A scoring system was developed by modifying the Pediatric Ranked Order Speech Perception (PROSPER) score to integrate all available speech recognition scores and build the developmental trajectory of speech recognition scores for each child over time. This scoring system was used to map the raw scores from each test to a PROSPER score and quantify the speech recognition growth curve for children. Trajectory in PROSPER score curves were modeled by fitting a linear regression line for the growth phase and a flat line for the average speech recognition score during the plateau phase. Three parameters of slope of the regression line (growth rate), the time interval between age at CI activation and onset of plateau, and speech recognition score at the plateau were studied to examine the extent of variability and the role of age at CI activation, the device configuration and the time interval between the first and the second CI activation on speech recognition development.
Results: Data showed that the development of speech perception is highly variable across pediatric CI recipients in terms of the growth rate and the performance at the plateau. Age at CI activation accounted for 16% of variation in childrens’ performance at the plateau ($r(35) = -0.4, p = 0.01$). The results showed that the score at the plateau was significantly different across three groups of children with UnICl, sequential BiCl, and simultaneous BiCl. We further found that shorter time interval between the first and second CI activation was associated with faster speech recognition improvements in the first activated ear of children with sequential BiCl. This time interval accounted for 53% of differences in growth rate, as well as 38% of differences in the time to reach the plateau onset.
Conclusion: The results from this study corroborated prior findings that all children with CIs show improvement in their speech perception as they gain more hearing experience through CIs. The findings also confirm that children with congenital hearing loss benefit from earlier implantation and shorter time interval between the first and second implantation. The majority of variability across children in their speech recognition development remains unexplained, which requires further investigation.
Session: PH-1
Session: ePoster Highlights I
Title: Attention to Visual Speech and its Relationship with Novel Word Learning Among Children with Cochlear Implants and Children with Normal Hearing Listening to Cochlear Implant-simulated Speech
Presenting Author: Kristen Thornton, PhD
Author Block:
Kristen Thornton, PhD1, Jillian McCarthy, PhD2, Kathleen Faulkner, PhD3;1Gallaudet Univ., Washington DC, DC, 2Univ. of Tennessee Hlth. Sci. Ctr., Knoxville, TN, 3Oticon Med., Smorum, Denmark.
Abstract:
Introduction: Many children with cochlear implants (CIs) exhibit significant delays in vocabulary acquisition. Oftentimes children with CIs are included in mainstream classrooms and expected to learn new words every day in multi-modal environments; however, the role of auditory-visual (AV) information for vocabulary acquisition is not well understood. While pediatric CI listeners appear to benefit from AV information during speech perception, much less is known about the role of AV information in more complex tasks, such as novel word learning. The increase in task complexity from recognition to learning may alter the benefit of multimodal speech information. This study specifically examined the questions: (1) How does access to AV information impact novel word learning success? and (2) How do individual patterns of visual attention during learning relate to individual word learning outcomes?
Methods: Twelve children with CIs and 24 age- and sex-matched children with normal hearing (NH) completed two novel word learning tasks, AV and auditory-only (AO). Half of children with NH listened to typical speech and half listened to CI-simulated speech. During learning, a speaker was presented on the top half of the screen and narrated a story while the corresponding object to-be-learned was displayed on the bottom of the screen. During the AO task, a black box was positioned over the speaker’s face to block access to visual speech cues. Learning was assessed with a four-alternative forced-choice task.
Results: Within the group of children with CIs, two subgroups of performers emerged, “higher” and “poorer” word learners. Across these subgroups, visual attention patterns corresponded with individual word learning outcomes where word learning was positively correlated with time spent looking at the speaker’s mouth. Age of amplification, age of implantation, and phonological processing skills differentiated the two CI performance groups. For children with NH, listening to CI-simulated speech, a negative correlation between learning success and looking time to the speaker’s mouth was observed.
Conclusion: Outcomes of this study suggest that encouraging children with CIs to orient themselves to the speaker may not be sufficient to improve vocabulary acquisition, particularly for children who demonstrate difficulty acquiring new words. Group differences also emerged where higher and poorer CI performers showed differences in their visual attention to the task, while children with NH listening to CI-simulated speech exhibited an opposite pattern of visual attention. These outcomes indicate that early learning and development of strategies for word learning warrants further investigation. Learning strategies for vocabulary, as they relate to cognitive load for each group, will be discussed.
Session: PH-1
Session: ePoster Highlights I
Title: Enhancing Hearing in Unilateral Cochlear Implant Recipients With Wireless Contralateral Routing of Signal Technology
Presenting Author: Laura Reyes Contreras, MD
Author Block:
Laura Reyes Contreras, MD1, Lesvia Solis Rabago, MD1, Smita Agrawal, AuD2, Carina Rodríguez Martínez, AuD2;1Hosp. Gen. de Mexico, Ciudad de México, CDMX, Mexico, 2Advanced Bionics LLC, Valencia, CA.
Abstract:
Introduction: Although bilateral cochlear implantation has become the standard of care for adults and children with bilateral severe-to-profound sensorineural hearing loss, bilateral implantation may not be feasible for everyone. Because of medical or financial considerations, unilateral cochlear implantation may be the only option. The CROS (Contralateral Routing of Signals) system is an intervention method to minimize unilateral hearing effects. It currently consists of a non-implantable device with wireless communication with the contralateral device and digital noise reduction technology, and directional adaptive microphones. In this way, the user can access the sounds that occur on the side that does not use a cochlear implant (CI) or hearing aid, with the auditory input on the contralateral side.
Methods: Nine adult unilateral recipients of CI with no aidable hearing in the contralateral ear participated in this study. Speech perception in quiet was measured at an individualized level where the performance with CROS OFF was between 30 to 50% correct. This presentation level was then used to test with CROS ON to determine CROS's effect on soft speech levels. The speech was presented by a speaker placed towards the non-CI side. For testing the effectiveness of CROS in noise, the noise was presented from a speaker located towards the CI side at an individualized SNR where CI only score was further reduced by about 50%. The benefit of using a directional mic (StereoZoom (SZ)) was evaluated with SON180. Participants also reported perceiving the difficulty of the listening task after each test condition on a scale of 1 to 5. Finally, the subjects tested the CROS device in real sound environments and provided feedback using a personalized questionnaire focused on the CROS device's characteristics.
Results: Use of CROS significantly increased speech understanding scores by 20.89% (p<0.005) in quiet and by 40.67% (p<0.01) in noise. Use of directional mic led to a 30.11% (p<0.005). Subjects also reported improved speech perception in noise, improved sound awareness, and reduced listening effort. Their accompanying family members also reported being able to communicate more effectively and easily with the CI recipients.
Conclusion: The benefits provided by using the CROS device by unilateral CI recipients can be demonstrated in controlled lab environments and are also experienced by the listeners in realistic sound environments. The CROS device can be an effective solution for unilateral CI recipients for accessing some of the benefits of bilateral CIs.
**Session:** PH-1  
**Session:** ePoster Highlights I  
**Title:** Interleaving Simulated Cochlear Implant Frequency Channels Across Ears Impacts Spatial Hearing and Spectral Resolution  
**Presenting Author:** Bailey Oliver, BS  
**Author Block:** Bailey Oliver, BS, Sterling W. Sheffield, AuD, PhD; Speech, Language, and Hearing Sciences, Univ. of Florida, Gainesville, FL.  
**Abstract:**  
**Introduction:** Cochlear-implant (CI) users have poor spectral resolution correlated with speech perception in quiet and noise. Interleaved processing in CI users may improve spectral resolution and speech perception, but may impair spatial hearing (e.g., Aronoff et al. 2016). Interleaving frequency bands have improved spectral resolution and had limited effects on sound localization. Spectral resolution improvement could be due to decreased channel interaction within one ear or integration of interleaved spectral cues binaurally. Interleaving frequency bands, however, has shown limited speech perception benefit in some individuals. The current study examined monaural and binaural spectral resolution and speech recognition in co-located and spatially-separated multi-talker environments to determine if normal hearing listeners with CI simulations can integrate interleaved frequency bands across ears.  
**Methods:** Normal-hearing adults completed three experiments: an adaptive spectral-temporally modulated ripple test (SMRT), sound localization, and speech recognition. The effects of interleaving frequency bands across ears was tested using 12-channel vocoders with interleaved and non-interleaved channels, unilaterally or bilaterally, with odd channels presented to one ear and even to the other. The adaptive SMRT measured spectral resolution using spectrally and temporally modulated noises resulting in a threshold in ripples per octave. Stimuli were presented at 60 dBA. The sound localization task used non-individualized head related impulse responses (HRIRs) to simulate spatial azimuths in the rear-hemifield three meters from the listener’s head. Stimuli were white noises presented at levels between 50 and 65 dBA at eight different points between 90 and 270 degrees. For speech recognition testing, participants were presented closed-set sentences. Target and masker talkers varied in gender. A speech recognition threshold was measured with co-located and spatially-separated target and masker sentences, 60° and -60° azimuth, using the same HRIRs described above. Co-located speech recognition was tested in unilateral and bilateral conditions to examine binaural integration. The spatially-separated condition was tested binaurally.  
**Results:** Preliminary data revealed that spectral resolution increased with interleaving, but was primarily a monaural effect with little binaural integration of spectral channels for better spectral resolution. There was little speech perception benefit (<1 dB) with both ears in a co-located condition, even with interleaving and complementary information across ears. Degree of error for localization was slightly worse with vocoded than unprocessed stimuli and even slightly worse with interleaved frequency bands. Finally, spatial release-from masking (SRM) was significant but might be somewhat impaired with interleaved frequency channels across ears.  
**Conclusion:** Interleaving frequency bands for CIs may increase spectral resolution but will likely sacrifice spatial-hearing benefits. The results indicate spectral resolution improvements with interleaving may be unilateral resulting from decreased channel interaction. Listeners with CI simulations do not gain much benefit from integrating interleaved frequency bands across ears for spectral resolution or speech perception. SRM results indicate that spatial hearing benefits are often larger than spectral benefits and should be maintained.
Title: Sound Localization Ability in Bilateral and Single-sided Deafness Cochlear Implant Users Depending on Specific Microphone Characteristics of the Sound Processor

Abstract:

Introduction: Directional microphones are beneficial for speech reception in noisy environments but potentially alter localization cues unfavorably and thus, deteriorate localization ability. Our study aims at the assessment of sound localization ability of bilateral cochlear implant (CI) and SSD CI users for each of three different microphone characteristics (Natural, Omni, Adaptive) implemented in the sound processor.

Methods: Localization ability is evaluated in experienced bilateral CI and SSD CI users at least six months after activation of the (second) sound processor, and compared to a group of normal-hearing (NH) subjects. Using a 360° setup of 12 loudspeakers, broadband noise bursts are presented in two different spectral shapes and at two different sound pressure levels. RMS angular errors are determined for bilateral hearing in the NH group and with the microphone characteristics Natural, Omni, and Adaptive in each group of CI users. Furthermore, RMS errors for unilateral listening are assessed on each side, in the CI subjects with Natural, as well as in the NH subjects. A pilot study with three bilateral CI users was conducted to optimize the duration of the localization stimulus. We did not observe any effect of stimulus duration (1s, 2s, 5s, and 10s investigated) on sound localization ability. Hence we opted for the application of a short, 2s stimulus in the main study.

Results: First results for the localization ability related to the characteristics of the microphone show mean RMS angular errors of 56.9° for Natural, 62.7° for Omni, and 57.2° for Adaptive in the bilateral CI group. The NH subjects showed a mean RMS error of 44.8°.

Conclusion: Preliminary results suggest that Natural is the most favorable microphone characteristic for sound localization. The sound source focused Adaptive setting, however, seems to allow comparable localization accuracy, while the omnidirectional setting appears to be less advantageous.
Title: The Development of a Patient-specific Cochlear Implant Pitch Mapping Function

Abstract:

Introduction: Cochlear size and tonotopic distributions vary among individuals, however cochlear implant pitch mapping is generally performed in a patient-independent approach. Mathematical functions relating angular length along the basilar membrane (BM) to BM tonotopic frequency have been proposed to customize cochlear implant pitch mapping for improved pitch perception. However, these techniques are generalized with regards to BM angular length, which can result in large pitch errors. The objective of this work was to develop a function which relates angular length along the BM to tonotopic frequency, which can be individualized based on the BM angular length of cochleae.

Methods: Ten adult cadaveric cochleae underwent synchrotron radiation phase-contrast imaging (SR-PCI) combined with computed tomography (CT). The organ of Corti was traced along the entire BM in SR-PCI CT image slices and three-dimensional volume renderings. The tonotopic frequency of each coordinate along the BM was calculated using Greenwood’s function, and angular depths of each frequency coordinate were measured using reformatted mid-modiolar image slices. An exponential function, dependent on the angular length of individual BMs, was determined to relate angular depth along the BM to tonotopic frequency. A leave-one-out cross validation was performed to assess the errors, measured in semitones, associated with the developed function.

Results: The minimum and maximum BM angular lengths observed in our sample set were 868 degrees and 1073 degrees, respectively. The individualized BM frequency function was observed to have a mean absolute error of 1.5 (95% confidence interval: [1.41, 1.63]) semitones in the leave-one-out cross validation. The maximum absolute error associated with the individualized BM frequency function was observed to be 9.6 semitones.

Conclusion: Previous functions which relate angular length along the BM to tonotopic frequency are limited in that they do not account for the angular length of individual cochleae. To overcome these limitations, an individualized function relating angular length to BM tonotopic frequency was developed using SR-PCI data.
Session: PH-2
Session: ePoster Highlights II
Title: Optimizing Auditory Brainstem Implant Outcomes Using a Team Approach
Presenting Author: Meghann Greear, AuD
Author Block:
Meghann Greear, AuDAudiology, UC San Diego, San Diego, CA.
Abstract:
Introduction: An auditory brainstem implant (ABI) is an option for patients that would not benefit from a cochlear implant (CI) because their auditory nerves are not functioning, they have bilateral cochlear ossification, or absent/severely malformed cochleae. Outcomes with an ABI are variable, but the primary purpose is to restore access to sound and to augment lip-reading comprehension. Our purpose is to spotlight how our village has successfully provided the ABI as a way of restoring access to sound for these populations and ultimately improving their quality of life through our team approach.
Methods: Over the past 2-3 years our center has harnessed a team collaboration for ABI patients. Patients identified as ABI candidates first meet with our acoustic neuroma patient navigator and then surgical and audiology teams review the surgery process, follow-ups, and realistic outcomes. During surgery, eABR is obtained by an audiologist to confirm electrode placement. The ABI is activated over a two-day period using EKG monitoring on day one from our physician assistant and then 1-month, 3-month, 6-month, and annual follow-ups with the audiologist thereafter for programming. Serial imaging and follow-up with the surgeons are scheduled per patient. At-home aural rehabilitation is encouraged. A retrospective chart review was used to examine our ABI recipient outcomes.
Results: Over a 28-month consecutive period, 11 patients underwent ABI implantation and activation and one patient underwent re-activation of an ABI previously placed at an outside center. The indication for placement was neurofibromatosis type II in 11 patients and meningitis with failed CI in one patient. One patient discontinued use due to non-auditory side effects and will be excluded from analysis due to limited follow-up and performance testing. Mean number of active auditory only electrodes was 13 (range: 7 - 19). Median soundfield thresholds were 25 - 35 dB HL from 250-4000 Hz. Mean auditory-only ESP score was 1.91, consistent with primarily pattern perception without visual cues. Mean auditory plus visual ESP score was 3.4, consistent with some word identification. Auditory only phonemic scores on CNC testing was 21%, visual only phonemic score on CNC testing was 33%, and combined auditory/visual phonemic score on CNC testing was 55%. Median absolute improvement in combined auditory/visual phonemic score on CNC testing was 15%. We currently have implanted 10 NFII patients, 1 non-NFII patient, and re-activated an NFII patient previously implanted by our surgeon at an outside center. Specific clinical outcomes will be discussed regarding programming.
Conclusion: An organized team approach is the gold standard for patient’s receiving an ABI. A thorough process maximizes patient outcomes.
Session: PH-2
Session: ePoster Highlights II
Title: Simultaneous Vestibular Schwannoma Resection and CI: The Role of E-ABR
Presenting Author: Christoph Arnoldner, MD
Author Block: Christoph Arnoldner, Prof, MD1, Valerie Dahm, MD1, Christian Matula, Prof., MD2, Dominik Riss, Prof, MD1, Alice Auinger, MD1; 1Department of Otolaryngology, HN Surgery, Med. Univ. of Vienna, Vienna, Austria, 2Department of Neurosurgery, Med. Univ. of Vienna, Vienna, Austria.
Abstract: 
Introduction: Simultaneous vestibular schwannoma resection and cochlear implantation can be a very satisfying option for selected patients. So far, decision for implantation has been based on subjective assessment of the surgeon. With the advent of E-ABR using intracochlear electrodes a new objective assessment is available.
Methods: 20 patients were included in this prospective study in a tertiary care center. After translabyrinthine vestibular schwannoma resection, intraoperative electrically evoked brain stem response audiometry was used to evaluate cochlear nerve conduction. 13 patients had positive results on electrically evoked brain stem response audiometry and received a cochlear implant.
Results: After six months of follow-up there were 10 daily users of the cochlear implant. The mean aided pure tone average was 38 dB HL. The mean word recognition score was 28% at 65dB and 52% at 80 dB.
Conclusion: Simultaneous translabyrinthine vestibular schwannoma excision and cochlear implantation based on intraoperative electrically evoked brain stem response audiometry measurements is a good option for hearing rehabilitation. Preoperative exact assessment of the vestibular schwannoma extension, audiometric testing, and promontory stimulation electrically evoked brain stem response audiometry could improve preoperative patient selection, help manage patient expectations, and predict the possibility of cochlear implantation.
**Title:** Is the Vestibular Function of Deaf Children and Adolescents Impaired After Cochlear Implant Placement Surgery? Systematic Review  

**Presenting Author:** Fabiane Vaz, MSc  

**Author Block:**  
Fabiane D. Vaz, M.SC, Fayez Bahmad, PhD, Leonardo Petrus, PhD, Jade Lima, Estudent, Nycolle Santos, Estudent; Health Sciences, Univ. of Brasilia - UNB, Brasilia, Brazil.  

**Abstract:**  
**Introduction:** Problem: There is an inconsistency in the literature findings regarding the complications caused by the implantation of electrodes in the cochlea, it is mentioned as the most likely vestibular alterations and balance disorders. Objective: To assess the presence of impaired vestibular function and balance in children and adolescents as a side effect of cochlear implant placement surgery. Hypothesis: Is there a deficiency in the vestibular function of children and adolescents undergoing cochlear implant placement surgery?  

**Methods:** Systematic review based on observational cohort, case-control and cross-sectional studies. Information sources: Databases between 1980 and 2020: (1) PubMed, (2) Cinahl, (3) Web Of Science, (4) Cochrane and (5) Scopus. The automatic search strategy was developed by combining the following Mesh terms: “Child”, “Children” “Cochlear Implantation”, “Postural Balance”, “VEMP”, “Posturography”, “cochlear implant”, “pediatric”, “dizziness”, “Vertigo”, “DHI”, “VENG”, “HIT” and “VHIT”. Inclusion criteria: Studies with patients from 0 to 18 years old; Intervention: Cochlear implant placement surgery; Comparison: Analysis of vestibular function with results of vestibular tests and pre- and postoperative symptoms; Outcome: Studies with vestibular function tests, including at least one of the following: Vectoelectronystagmography (Veng), Vestibular Evoked Myogenic Potential (VEMPs), Caloric test, Video Head Impulse Test (VHIT), Head Impulse Test (HIT), Videonystagmography (VNG) and static and dynamic posturography. Exclusion criteria: studies only with the elderly, adults or the population with other health conditions. After registration in Prospero, screening based on reading abstracts and titles performed independently by two evaluators. At the end, with the intermediation of a third evaluator, manuscripts were included. Bias risk analysis performed by two other authors of the manuscript will be performed using Strobe followed by Axis.  

**Results:** Searches returned 4,457 studies, of which 3,778 were found in the PubMed database, 475 in the Scopus database, 66 in the Cinahl database, 120 in the Web of Science database and 16 in the Cochrane Library database and 2 found by manual search in references. 218 duplicates and 4202 studies were excluded after analyzing the titles and abstracts. The analysis was concluded with 22 articles included for full reading. Test most used in the studies: VEMP (70%), caloric test (20%), vHIT and posturography (15%) and HIT (10%). Of the subjective symptoms reported by the patients after the surgery, vertigo and dizziness were the most recurrent.  

**Conclusion:** There is variability of results in this population, such as age, cause of deafness and surgical technique, which influence the presence or absence of vestibular changes after surgery. It is necessary to assess children undergoing implantation, before and after surgery, to help identify vestibular disorders.
Session: PH-2
Session: ePoster Highlights II
Title: Pain at the Cochlear Implant Site Requiring Device Explantation in Pediatric Patients
Presenting Author: Eliot Shearer, MD, PhD
Author Block:
Eliot Shearer, MD, PhD1, Alicia Wang, B.S.E.1, Maranda Lawton, M.S. PA-C1, Catherine Lachenauer, M.D.2, Jacob R. Brodsky, M.D.1, Dennis Poe, M.D. Ph.D.1, Margaret Kenna, M.D. M.P.H.1, Greg Licameli, M.D. M.H.A.1;1Dept of Otolaryngology & Communication Enhancement, Boston Children's Hospital, Boston Children's Hosp., BOSTON, MA, 2Department of Infectious Disease, Boston Children's Hosp., BOSTON, MA.
Abstract:
Introduction: Cochlear implantation is a relatively safe procedure; however, complications related to the implant may still occur, potentially resulting in device explantation with subsequent need for reimplantation. Common reasons for explantation include infection, device failure, or extrusion of the device. Idiopathic pain at the cochlear implant site outside of the immediate postoperative period is an uncommon occurrence, but may ultimately necessitate device explantation. We sought to describe the clinical course for pediatric patients with cochlear implant site pain who ultimately underwent device explantation.
Methods: We performed a retrospective database review of pediatric patients who underwent cochlear implantation at a large tertiary referral center for pediatric cochlear implantation. We identified patients who presented with delayed, idiopathic, persistent pain at or near the cochlear implant device site and ultimately required explantation between January 2006 and September 2018. We examined cultures from tissue, device, and surgical site and response to therapy.
Results: 791 total cochlear implantations were performed on 542 patients during the study period. From those, plus two implanted at other institutions who came under our care, we identified 15 subjects (2.4%, 16 devices) who presented with idiopathic pain at the cochlear implant device site and who required surgical device site exploration and ultimately device explantation. The majority (11, 73%) of the patients were female and the average age of pain onset was 15.4 years old (range 8-24 years). Cultures were performed from tissue and fluid during every wound site exploration (n = 28) and every device explantation (n = 16). Multiple cultures were taken at each intervention, and in total 370 separate cultures were reviewed. Overall, at least one culture was positive for 86% (24/28) of site explorations and 81% (13/16) of explantations. Propionibacterium acnes (42% of positive cultures) and Staphylococcus non-areus (31% of positive cultures) were the most commonly identified organisms.
Conclusion: In pediatric patients with pain presenting at the device site outside of the immediate postoperative period we identified evidence of chronic bacterial colonization in the majority of cases. We hypothesize that chronic infection and cochlear implant biofilms may be an important primary source of persistent cochlear implant pain that ultimately may require device explantation. Further research is required to determine the source of this bacteria and best treatment algorithms for these patients.
Session: PH-2
Session: ePoster Highlights II
Title: The Influence of Cochlear Volume in Temporal Changes of Impedance Among Cochlear Implant Patients
Presenting Author: Henrique Pauna, MD, PhD
Author Block:
Henrique F. Pauna, MD, PhD1, Maria S. A. Amaral, MD, PhD1, Rodrigo Pessini, MSc2, Daniela S. Fonseca, AuD1, Alexandre C. Guimarães, MD, PhD3, Vagner A. R. Silva, MD, MSc3, Miguel A. Hyppolito, MD, PhD1; Ophthalmology, Otorhinolaryngology and Head and Neck Surgery, Ribeirão Preto Med. Sch., Ribeirão Preto, Brazil, 2Department of Radiology, Ribeirão Preto Med. Sch., Ribeirão Preto, Brazil, 3Otorhinolaryngology, Head and Neck Surgery, Univ. of Campinas, Campinas, Brazil.
Abstract:
Introduction: The considerable interest from the scientific community and manufacturers regarding the bioelectrical and physiological engineering of the ear have clarified many unknown aspects of the functioning of the cochlea and the engineering beneath the electronic devices for hearing restoration. The objective of our study, in addition to previous studies, was to evaluate the impedance variations over time in patients implanted with a cochlear implant system with a follow-up of one year and correlate to the residual volume of the cochlea.
Methods: The study protocol included repeated assessments, intra-operatively and post-implant, at the following intervals: 3 months; 6 months and one year. In every case, the same type of perimodiolar array was implanted with the same surgical technique (cochleostomy). Electrode impedances were measured using software supplied by the manufacturer. MRI scan was carried out with a 1.5-T unit before every surgery in order to obtain a residual volume for each ear.
Results: Third-four patients (10 [29.41%] male patients and 24 [70.59%] female patients) implanted at our Department were evaluated. Patients were implanted between 2008 and 2017. Mean age of implantations was 13±17.17 years. Mean time from implantation to activation was 37.20±8.86 days. We included 8 (23.53%) patients with post-lingual hearing loss and 26 (76.47%) patients with pre-lingual hearing loss. Twenty-one (61.76%) patients were implanted on the left ear and 13 (38.24%) patients were implanted on the right ear. All patients had their etiology of deafness classified as idiopathic, with no malformation of the inner ear, as well as no fibrous tissue or ossification was found in their MRI scans. The average of hearing thresholds of the right ear was 110.69±7.95 dBHL and 112.95±7.13 dBHL for the left ear (unaided ear; p=.801). The average of hearing thresholds of the right ear after one year of the CI surgery was 34.55±12.37 dBHL and 30.45±5.98 dBHL for the left implanted ear (p=.101). Mean cochlear volume of the implanted ear, after 3-D reconstruction, was 68.16±10.74 mm3 (for the right ear) and 56.54±13.75 mm3 (for the left ear; p<0.01). We observed an increase in basal electrodes impedance at the 3rd month. Yet, for the apical electrodes' impedance, there was a decrease in averaged values. The impedance of the apical portion decreased after surgical analysis, for both ears and for both modes (CG and MP1+2), and it was significantly reduced up to one year. The correlation coefficient for goodness of fit (R²) and the corresponding P value for the linear regression lines was assessed. We conducted the statistical analysis for each cochlear region by differentiating electrodes into their basal, middle and apical segments. The absolute values of the basal impedances are much higher at the majority of the times.
Conclusion: Post-operative impedance measurements indicate an increase when compared to the intraoperatively measured basal values. It is thought that newly formed connective tissue around the electrode is the cause of the higher impedance values. The variation of global impedance significantly changed after CI surgery for both CG and MP1+2 modes. Our data indicating a higher basal segment impedance are consistent with the literature with higher impedances at the basal turn up to one year.
after CI surgery. The larger volume in the basal turns may explain the higher impedances that are necessary to stimulate the residual spiral ganglion neurons.
Session: PH-2
Session: ePoster Highlights II
Title: Access Resistance and Polarization Impedance in Cochlear Implant Patients with Fluctuating Impedances
Presenting Author: Madison Graham, AuD
Author Block:
Abstract:
Introduction: Electrode impedance is defined as the resistance to the flow of energy (current) between an index electrode and the ground. Soft tissue, bone, and other intracochlear contents between the electrode and the ground contribute to overall impedance to varying degrees; that is, the impedance reflects the electrode’s status and the surrounding tissue. Standard clinical practice calculates total impedance \( [Z_e] \) using a 25 \( \mu \)S/phase charge-balanced electric stimulus to measure across the electrode; however, total impedance can be broken into two components, access resistance \([Ra]\) and polarization impedance \([Zp]\). Access resistance is attributed to material surrounding the electrode, while polarization impedance is attributed to the electrode-electrolyte interface on each electrode’s surface. Standard clinical practice measurement tools do not allow for the extraction of these variables, instead looking at the total impedance \( [Z_e = Z_a + Z_p]\). This study investigates the different components of impedance, which may yield answers to mechanisms of fluctuating impedances.
Methods: This study was conducted by examining access resistance and polarization impedance using Trans Impedance Matrix Software (TIMS) in conjunction with standard clinical impedance measures in both the Cochlear Custom Sound and Custom Sound EP software. All patients used Cochlear Americas devices. Subjects utilized a loaner CP910 Sound Processor to complete TIMS measurements. TIMS measurements were collected on a total of 57 patients with Nucleus cochlear implants. As this study aims to collect normative data for this measurement tool, recruitment targeted patients with clinically stable impedance during routine clinical visits. Two patients with known fluctuating impedance were compared to the normative results to identify changes.
Results: Internal device type ranged between seven implants: CI24RE Contour Advance (8 patients; 13%), CI422 (6 patients; 10%), CI512 (1 patient; 2%), CI522 (12 patients; 20%), CI532 (2 patients; 3%), CI622 (29 patients; 48%), and CI632 (2 patients; 3%). There was a strong correlation between access resistance and polarization across all 22 electrodes (\( R=0.88-0.92 \)). Patients with known fluctuations show large changes in polarization impedances accompanied by small changes in access resistance.
Conclusion: Progress in the separation of total impedance into access resistance and polarization impedance can provide insight into the differing mechanisms of fluctuating impedances. If access resistance increases, there is likely a change surrounding the electrode array (i.e., fibrous tissue build-up or new bone growth). If polarization impedance increases, there is likely an electrochemical change at the surface of the electrode. This insight may be valuable in the clinical management of the individual patient and guidance for the development of electrode designs with improved functionality.
Session: PH-2
Session: ePoster Highlights II
Title: Electrode Impedance, Programming and Speech Recognition in a Clinical Dataset of Adult Cochlear Implant Patients
Presenting Author: Benjamin Caswell-Midwinter, PhD
Author Block:
Benjamin Caswell-Midwinter, PhD1, Elizabeth M. DesRoche, AuD2, Barbara S. Herrmann, PhD1, Julie G. Arenberg, PhD1;1Massachusetts Eye and Ear, Harvard Med. Sch., Boston, MA, 2Audiology, Massachusetts Eye and Ear, Boston, MA.
Abstract:
Introduction: Speech recognition ability varies widely amongst adult cochlear implant patients. Study of clinical datasets, with diverse, longitudinal data on large samples, may help explain this variation, and also provide reference for clinical management and device development. This study retrospectively analyzed a clinical dataset of cochlear implant patients to: i) report electrode impedance, programming levels and speech recognition scores; ii) examine what factors were associated with these measures; iii) inform longitudinal speech recognition performance.
Methods: The data of 424 implanted ears from 399 postlingually deafened adults were retrospectively analyzed. Patients attended follow-up appointments between July 2003 and July 2018, and had a minimum of 5-months experience with Advanced Bionics implants. Data, extracted from patient databases and programming software, included patient biographics, implant information, impedance, programming levels and speech recognition scores (using the Consonant-Nucleus-Consonant test). Mixed-effects models were used to examine which factors were associated with impedance, maximum comfort levels (M-levels) and speech recognition scores. Logistic functions were fit to the longitudinal word scores of 92 ears, to estimate the time taken for performance to plateau.
Results: Basal electrode impedance was greater (median = 7.0 kΩ) than apical electrode impedance (median = 4.9 kΩ). Impedance was positively associated with implant experience. M-levels for ears with the HiRes processing strategy were greater (median = 234 CU) than those with the Fidelity 120/Optima current steering strategies (median = 204 CU). M-levels for ears with the current steering strategies were positively associated with implant experience and age implanted. The median phone and word scores for ears with the HiRes strategy were 64% (range = 3 - 93%) and 42% (range = 0 - 98%), respectively. The median phone and word scores for ears with the current steering strategies were 79% (range = 10 - 99%) and 58% (range = 0 - 96%), respectively. Word scores for ears with the current steering strategies were positively associated with implant experience, and negatively associated with age implanted and basal electrode impedance. The mean and median word recognition plateau times were 6.3 and 2.1 months (range = 0.2 - 45 months), respectively. Sixty-eight ears (74%) plateaued within 6-months of activation.
Conclusion: These findings provide insight into clinical cochlear implant measures on a large scale, their contributing factors, as well as longitudinal speech recognition performance. Impedance patterns and growth over time, suggesting underlying cochlear physiology, were related to speech scores. M-levels increased with implant experience and age implanted, which could aid programming in patients unable to provide behavioral feedback. Speech recognition scores demonstrate cochlear implant benefit, although the variation was considerable, as in previous research. The factors related to this variation can be used to guide candidacy, programming and counselling. While word recognition performance mostly plateaued before 6 months of activation, there was variation, and several patients took years to plateau.
Session: PH-2
Session: ePoster Highlights II
Title: Cochlear Implant Uptake Rates: The Influence of Hearing Loss Configuration
Presenting Author: Catherine Sucher, BSc, DipAud, MAud, AuD
Author Block:
Catherine M. Sucher, BSc, DipAud, MAud(Research), AuD1, Robert H. Eikelboom, BEng, MApplSc, PhD1, Dona Jayakody, PhD, MSc. (Audiology & SLP), BSc. (Audiology & SLP) Inge Stegmen, PhD2, Marcus Atlas, MB BS, FRACS1;1Ear Sci. Inst. Australia, Subiaco, Australia, 2Department of Otorhinolaryngology - Head and Neck Surgery, Univ. Med. Ctr. Utrecht, Utrecht, Netherlands.

Abstract:
Introduction: Recent improvements in cochlear implant (CI) outcomes have led to a substantial expansion in CI candidacy criteria resulting in significantly greater numbers of individuals, with varying hearing loss configurations, becoming eligible for a CI. However, it is unclear how these expanded criteria have affected CI uptake rates. This study aimed to determine the impact of hearing loss configuration on CI uptake rates.

Methods: A retrospective study examined the CI uptake rates of 624 adults referred for a CI assessment and found to be audiologically suitable for a CI. Basic referral information, including the client’s audiogram, age, approximate onset of hearing loss and gender were collected. Based on the audiograms obtained at the implant assessment, the four frequency average hearing loss (4FAHL) for each ear was calculated. Subjects were placed into one of five hearing loss (HL) groups; Symmetrical hearing loss (SYM) - those with ≤20 dB asymmetry in 4FAHL, Asymmetrical Hearing Loss 1 (AHL1) - those with >20dBHL and ≤60 dBHL asymmetry in 4FAHL, Asymmetrical hearing loss 2 (AHL2) - those with >60 dBHL asymmetry in 4FAHL but with at least one hearing threshold >30dBHL between 250 and 4000Hz, Single-Sided hearing loss (SSD) - those with hearing ≤30 dB between 250 and 4000 Hz in the better ear and a severe, unaidable hearing loss in the poorer ear, and Electric Acoustic Hearing Loss (EAS) - those individuals whose hearing thresholds fell within the criteria for the MedEl EAS and/or Cochlear Hybrid electric-acoustic implants and had a 4FAHL asymmetry of ≤20dBHL.

Results: There were no significant differences in candidates’ age or gender between groups except for the SSD group, who were significantly younger (mean age: 51.5 years, p<0.001) than all other HL groups (AHL1: 69.29 years; AHL2: 63.3 years, EAS: 71.6 years, and SYM: 66.5 years) and had a higher proportion of females (p=0.044). The overall CI uptake rate was 44.39%. Uptake rates for each hearing loss configuration were as follows; AHL1 (48.32%), AHL2 (25.00%), EAS (38.00%), SSD (22.06%), and SYM (61.57%). Multiple logistic regression analysis revealed a significant impact of both hearing loss configuration and age on CI uptake rates however the impact of age was functionally very low. Gender was not a significant factor.

Conclusion: When considering CI uptake in the context of expanded CI candidacy criteria, hearing loss configuration must be considered when counselling patients and managing their expectations. It should also be considered in the context of allocation of clinic and clinician resources. Further research is required into the barriers experienced by candidates with greater levels of hearing in both the implanted and non-implanted ears and also into CI outcomes with various hearing loss configurations.
**Session:** PH-2  
**Session:** ePoster Highlights II  
**Title:** Preimplant Hearing Threshold: An Important Predictor of Hearing Preservation in Cochlear Implantation With Lateral Wall Electrodes  
**Presenting Author:** Jin Woong Choi, MD  
**Author Block:**  
Geonho Lee, MD, Seulgi Lee, MD, Jee-Hye Chung, BA, Jin Woong Choi, MD;  
**Abstract:**  
**Introduction:** To evaluate the outcomes and association factors of long-term hearing preservation (HP) in cochlear implantation with lateral wall (LW) electrode arrays.  
**Methods:** Study design: Retrospective case review. Setting: Tertiary academic center. Patients: Thirty-four consecutive ears from 32 patients with a ≤ 80 dB HL preoperative low-frequency pure-tone average of 250 to 500 Hz were included. Intervention: Cochlear implantation with LW electrode arrays and the intention of achieving HP. Main outcome measures: HP classifications according to the HEARRRING group and functional HP methods (≤ 85 dB HL of pure-tone threshold at 250 Hz) at 1 year postoperatively.  
**Results:** Based on the HEARRRING classification, complete, partial, and minimal HP was achieved in 7 ears (21%), 12 ears (35%), and 4 ears (12%), respectively. Under functional classification, 14 ears (41%) exhibited functional hearing after surgery. The average threshold shift was 17.1 dB HL (SD = 16.9 dB HL). Among various clinical features, a ≤ 60 dB HL preimplant pure-tone threshold of 250 Hz was associated with HP outcome in both classifications (OR = 12.95, 95% CI = 1.29-130.01, p = 0.029 in HEARRRING classification; OR = 14.36, 95% CI = 1.07-191.40, p = 0.044 in functional classification). The following parameters were not associated with HP (p > 0.05): patient demographics, surgical aspects (insertion route and depth), electrode array size, scalar electrode position, and presence of comorbidity.  
**Conclusion:** With LW electrode arrays, HP was achieved in 68% of HEARRRING group patients and 41% of functional classification patients. A ≤ 60 dB HL preimplant pure-tone threshold of 250 Hz was significantly associated with an increased rate of long-term HP.
Session: PH-3
Session: ePoster Highlights III
Title: Parenting in a Pandemic: Associations Between Parenting Strategies and Stress
Presenting Author: Jennifer Coto, PhD
Author Block:
Jennifer Coto, PhD1, Chrisanda Sanchez, AuD1, Taylor Landis, MS2, Ivette Cejas, PhD1;1Otolaryngology, Univ. of Miami Miller Sch. of Med., Miami, FL, 2Psychology, Florida Intl. Univ., Miami, FL.
Abstract:
Introduction: The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2 or COVID-19) has increased stress, isolation, and mental health concerns worldwide. According to the CDC, individuals with disabilities or developmental delays, people caring for others, children and teens, among others, are at an increased risk for reactions to stress. Our study evaluated how the exposure and impact of COVID impacted parents of children with hearing loss. Specifically, we assessed how the pandemic affected parenting behaviors, as well as parenting stress.
Methods: Parents of children with hearing loss (n = 103) were asked to complete a survey regarding impact and exposure of COVID-19 (COVID-19 Exposure and Family Impact Survey), parent mental health (Patient Health Questionnaire, Generalized Anxiety Disorder, Impact of Events Scale-Revised), and parenting (Parenting Stress Index, Alabama Parenting Questionnaire). The survey was distributed via an electronic survey platform, Qualtrics, to families in our pediatric program listserv. The majority of parents completing the survey were mothers (86.4%) with a mean age of 38.39 (SD = 8.70). The survey was available in English and Spanish, with 83% of parents completing it in English. In terms of employment status due to COVID-19, 65% were working on-site, from home or a combination, while 10.7% had been laid off or furloughed. Families had an average of 2 children living in the home (SD = .95). Children had a mean age of 9.72 (SD = 4.16), most wore cochlear implants (52.4%) or hearing aids (37.9%), and the primary language spoken at home was predominantly spoken language (89.3%).
Results: Linear regressions were conducted to examine the associations between parental distress, parent mental health, and parenting strategies. Given that data was collected during the pandemic, all analyses controlled for COVID-19 exposure as measured by the COVID-19 Exposure and Family Impact Survey. Parent reported anxiety, depression, and PTSD symptoms were independently associated with parental distress, with parents who reported elevated anxiety [F(2,94) = 13.14, p < .001, B = .99], depressive [F(2,94) = 16.58, p < .001, B = .96], and PTSD symptoms [F(2,93) = 8.59, p < .001, B = .24], respectively, endorsing significantly higher parental distress. Furthermore, parental distress was significantly associated with positive and negative parenting strategies [F(3,93) = 5.55, p < .01]. Specifically, parents who endorsed positive parenting strategies reported significantly lower levels of parental distress (B = -.31, p < .001). Conversely, parents who endorsed negative parenting strategies reported significantly higher levels of parental distress (B = .27, p < .001).
Conclusion: In conclusion, our study highlights the impact the pandemic has had on parents with children with hearing loss. It is well documented that children with CIs have more parent reported behavior problems which have been linked with higher reports of parenting stress. These data suggest that parenting stress, mental health, and positive parenting practices are all related. Thus, CI centers need to be aware of the impact the pandemic is having on their families and providing resources to help ameliorate these challenges, as these parenting variables are known to impact pediatric CI outcomes.
Abstract:
Introduction: In 2017, our clinic began implementing a cochlear implant (CI) component within clinical services and education in order to meet a rising need for this service in our rural community and to enhance the clinical education of both speech-language pathology as well as audiology graduate students. Aural rehabilitation services for pediatric clients had been an important area of service in the clinic for many years; however, the recent addition of CI services in the clinic provided increased opportunities for services and collaboration within the preschool language program.
Methods: Our collaborative focus involved a four year old bilateral cochlear implant recipient who attended the preschool language program (PLP) four mornings/week. Preschoolers in the program receive speech/language services through a combination of incidental learning in daily routines (e.g., snack, sharing time, outdoor play) and more structured opportunities (e.g., pull-out therapy, planned small group activities, large group story). Prior to the child’s entry to the preschool, the audiologist provided education about CIs to the SLP students. This orientation to CIs included information regarding the equipment, basic troubleshooting, and instructions on performing daily listening checks with the child using the Ling 6 sounds. During the school year, most collaboration between the audiologist and SLP occurred in unplanned contacts. In the 2018-2019 school year, the AuD and PLP team consulted 12 times regarding this patient. The collaboration between the audiologist and SLP evolved as this child began transitioning to a public elementary school and ultimately included other members of the child’s educational team at the annual case review meeting.
Results: We observed that this collaborative model of patient care benefited the professionals, students, and patient. Collaboration with CI patients creates the opportunity for improved professional connections and professional satisfaction, increased comfort with CI equipment, and creates a greater appreciation for the expertise of each provider. Students gained practical CI skills, while learning how to work with colleagues and address challenging classroom listening environments. The CI patient and her family benefitted from efficient comprehensive care due to the team-based approach to the child’s needs.
Conclusion: This patient saw improved communication skills and self-advocacy. In addition, colleagues and students benefitted from patient-focused problem-solving and service delivery. As we look to the future, we are exploring the potential benefits of having a specific team assigned to each cochlear implant client that would consist of the speech-language pathologist and his/her student, the audiologist and his/her student, and (when applicable) the preschool teacher. The team would communicate regularly to share information about client progress and ongoing needs and to resolve any immediate difficulties. The collaboration among colleagues and students would expand the perspectives and enhance the problem solving to optimize each client’s benefit and functioning.
Session: PH-3  
Session: ePoster Highlights III  
**Title:** Effectiveness of Teletherapy for Improving Phonological Awareness Skills in Preschool Children with Hearing Loss  
**Presenting Author:** Danielle Marshall, SLP  
**Author Block:**  
Danielle K. Marshall, Speech-Language Pathology, Emily Lund, PhD Speech-Language Pathology; Texas Christian Univ., Fort Worth, TX.  
**Abstract:**  
**Introduction:** The purpose of this pilot study is to determine the effectiveness of teletherapy on improving the phonological awareness skills of preschool-aged children with hearing loss. With the spread of the global pandemic, the demand for teletherapy has grown substantially. Additionally, teletherapy is also a convenient alternative for families who live in rural communities. However, there is a notable lack of rigorous, controlled studies that define best practices for teletherapy service provision to children with communication disorders.  
**Methods:** One five-year-old child who utilizes cochlear implants is participating in the multiple baselines across behaviors single-case study research design. The child participates in 18 20-minute sessions, three times a week remotely via Zoom Healthcare. The study targets three different phonemes (e.g., /m, d, b/) and consists of two conditions, the baseline and intervention. The participant completed three initial baseline assessments, which included 30 words (10 for each target phoneme) and the intervention condition divided into three-five session segments that include explicit teaching. The first five sessions provide instruction for the phoneme /m/ and focus on improving the child's initial sound judgment, identification, matching, and segmenting abilities. The next five sessions include the same activities but cease instructions for /m/ and start instructions for the phoneme /d/, and the last five sessions follow the same procedure but target the phoneme /b/. Each intervention session includes singing the ABC's to reinforce the child's alphabet knowledge, 15-minutes of explicit instruction, and a probe assessment to monitor the child's progress. These probes consist of 16 words (10 words with that week's target phoneme, and six that include the other target sounds).  
**Results:** Data collection is underway and will be completed in November of 2020. Data will be analyzed using a combination of Percentage of Total Nonoverlapping data and visual analysis. Tau-U will be used to gauge the size of the effect and will be compared to data from Werfel & Schuele et al., 2014, who used the same protocol in an in-person design.  
**Conclusion:** The central hypothesis is that there will be a functional relationship between intervention delivered through teletherapy and a preschool-aged child with hearing loss’s ability to complete phonological awareness tasks. Studies have shown that explicit phonological awareness instruction is effective for children with hearing loss and that teletherapy is a feasible way to improve children with hearing loss outcomes (Behl et al., 2017; Werfel & Schuele, 2014; Werfel, Douglas & Ackal, 2016). We expect to find similar results when conducting explicit phonological awareness instruction to children with hearing loss via teletherapy.
Session: PH-3
Session: ePoster Highlights III
Title: Teledelivery of Aural Rehabilitation Therapy for Adult Cochlear Implant Users
Presenting Author: Diane Brewer, MA
Author Block:
Diane M. Brewer, MA1, Claire Bernstein, PhD2, Dominique Calandrillo, Doctoral Student2, Nancy Muscato, AuD3, Kailey Intocasio, Doctoral Student3, Cassandra Bosworth, AuD4, Sarah Sydlowski, AuD, PhD5, Gina Stillitano, AuD5, Rachel Vovos, AuD5, Anne Olson, PhD6;1George Washington Univ., Washington, DC, 2Gallaudet Univ., Washington, DC, 3Univ. of South Florida, Tampa, FL, 4Columbia Univ., New York, NY, 5Cleveland Clinic, Cleveland, OH, 6Univ. of Kentucky, Lexington, KY.
Abstract:
Introduction The aims of this study are to evaluate the effects of a short-term aural rehabilitation (AR) intervention protocol as compared to a cognitive training (CT) protocol for adult postlingually deafened cochlear implant users when provided via telehealth technology. Increasing numbers of adults who receive cochlear implants achieve high levels of speech perception (Holder et al., 2020) and quality of life (Moberly et al., 2020). For those who do not achieve such high levels of success, audiolgic rehabilitation (AR) therapy may be warranted. Previous research showed statistically significant improvement with large effect size in speech recognition and psychosocial measures for an AR treatment group as compared to an active control group (Bernstein, Brewer et al., 2020). Access to these potential benefits are limited by availability of services, mobility, travel, time away from work, and currently the impact of Covid. The present study was designed to evaluate the effectiveness of an AR program delivered via telehealth. Methods The experimental design is a multi-site controlled clinical trial in which 24 postlingually deafened adult cochlear implant users are randomly assigned to either the AR treatment or cognitive training (CT) active control group. Inclusion criteria are postlingual deafness, age 18 years or older, between 3 months and 3 years postactivation, and no prior AR. In addition, participants must demonstrate fluency in English, pass a cognitive screener, achieve sentence recognition scores between 10% and 85%, and a speech tracking score of 20 words per minute or greater. Each group completes 6 weekly 90-minute individual treatment sessions via a telehealth platform. The AR group protocol includes auditory training, informational counseling, and communication strategies training while the CT group completes puzzles and problem-solving activities. Assessments (speech recognition (CasperSent, AzBio); psychosocial outcomes (Hearing Handicap Inventory, HHI; Glasgow Benefit Inventory, GBI; functional communication outcomes (Client Oriented Scale of Improvement, COSI) were completed pretreatment, 1 week and 2 months posttreatment. Results This presentation will report on preliminary results for the first 14 participants. Initial findings of TeleAR intervention on outcome measures including speech recognition, hearing handicap, and functional communication goals will be presented. Conclusion Access to AR services is limited by numerous factors including distance, mobility, time, and available professionals. TeleAR offers an avenue for patients to receive care. Our preliminary work and results from the first 14 participants has shown that an AR program can be successfully delivered via telehealth technology. Results of this controlled clinical trial provide preliminary evidence of the potential effectiveness of a short-term AR intervention via telehealth delivery.
Session: PH-3
Session: ePoster Highlights III
Title: How Self-reported and Significant Other-reported Coping Strategies Relate to Speech Outcomes Following Cochlear Implantation
Presenting Author: Mana Espahbodi, MD
Author Block:
Mana Espahbodi, MD1, Austin Livingston, MD2, William Montagne, MD2, Kristin Kozlowski, AuD1, Jamie Jensen, AuD1, Mark Rusch, PhD3, Michael S. Harris, MD1;1Otolaryngology & Communication Sciences, Med. Coll. of Wisconsin, Wauwatosa, WI, 2Med. Coll. of Wisconsin, Wauwatosa, WI, 3Psychology, Med. Coll. of Wisconsin, Wauwatosa, WI.
Abstract:
Introduction: Cochlear implants function well for most recipients. However, significant variability exists in speech perception following cochlear implantation that is hard to predict and incompletely accounted for by traditional demographic and audiometric factors. The degree to which individual coping strategies may influence speech perception following cochlear implantation is not well understood.
Methods: A prospective analysis of adult, post-lingually deaf cochlear implant recipients was performed. The COPE inventory - a validated, multidimensional self-reported coping scale - was administered preoperatively. Patients’ significant others also independently completed the COPE in reference to their observations of the patients’ coping strategies. Speech perception was measured using consonant-nucleus-consonant (CNC) word scores and AzBio sentence accuracy at three-months and six-months post-operatively. Univariate and multivariate linear regression analyses were performed.
Results: Seventy-two patients were included in this study. Mean age at surgery was 70.16 ± 12.38 years. Mean COPE scoring by significant others was not different from self-reported scoring for all coping strategies except for denial (mean patient rating 5.4 ± 1.78 compared to mean significant other rating 7.25 ± 1.75, p = 0.08). Denial as a coping strategy was found to negatively correlate with CNC word score at three-months and AzBio sentence testing results at six-months (p=0.005 and p =0.016 respectively). Twenty-eight percent of the variability in CNC word score at three-months was predicted by maladaptive coping strategies (focus on and venting of emotions, denial, behavioral disengagement and substance use) with denial being an independent predictor of a lower CNC word score (p=0.043). Interestingly, substance use was an independent predictor of a higher CNC word score at three-months (p<0.001). Humor as a coping strategy was positively correlated with AzBio sentence testing results at three-months (p=0.024).
Conclusion: A variety of adaptive and maladaptive coping strategies are used by post-lingually deaf adult cochlear implant users. Maladaptive coping strategies may be more predicative of poor speech performance. Cochlear implant users score their use of denial lower than their significant others do. Denial is an independent predictor of a lower CNC word score.
Session: PH-3
Session: ePoster Highlights III
Title: Social Determinants of Cochlear Implant Compliance in Pediatric Cochlear Implant Recipients
Presenting Author: Sarah Warren, AuD, PhD
Author Block:
Sarah E. Warren, AuD, PhD1, Robert J. Yawn, MD2, Leah M. Strope, B.S.1, Ann E. Vollmer, B.S.1, Charles B. MacDonald, MD3, Jennifer Bidelman, AuD4, Samuel H. Smith, MD2, Josh W. Wood, MD3; 1School of Communication Sciences and Disorders, Univ. of Memphis, Memphis, TN, 2Department of Otolaryngology, Univ. of Tennessee Hlth. Sci. Ctr., Memphis, TN, 3Department of Otolaryngology, Le Bonheur Children’s Hosp., Memphis, TN, 4Department of Audiology, Le Bonheur Children’s Hosp., Memphis, TN.

Abstract:
Introduction: Early detection and intervention of hearing loss is an essential component of achieving optimal speech and language through cochlear implantation. Although the newborn hearing screening has significantly increased the number of individuals whose hearing losses are identified early, challenges remain to ensure that all children with prelingual hearing loss can take advantage of the benefits of timely diagnosis and early intervention (Holte et al., 2012). Research has indicated that there are several barriers to accessing a cochlear implant, including closer geographic proximity to early intervention, racial status, insurance status, parental education, maternal education, and compliance with appointments (e.g. Lai et al., 2014; Walker et al., 2014; Armstrong et al., 2013). While access rates based on insurance type and income disparities have decreased over time, some factors such as racial disparities remain constant (Tampio et al., 2018). Beyond access to cochlear implantation, little is known about the effects of these factors on compliance with intervention recommendations, specifically full-time use of the device. Moeller (2016) found that younger children and children from families with lower education levels were the least regular hearing aid users. Given that young children are in a sensitive period of language development, it is imperative to understand the barriers involved with achieving cochlear implant recommendation compliance to diminish outcomes disparities in pediatric cochlear implant recipients.

Methods: The purpose of this study is to examine social demographic factors that impact full-time device use as measured by data logging in children with cochlear implants. The study is a retrospective chart review of children who received a cochlear implant at Le Bonheur Children’s Hospital in Memphis, TN between 1/1/2000 and 7/1/2019. Approximately 228 patient records are being reviewed to be included in the study. Data to be assessed includes basic demographic information including factors associated with diagnosis and proposed intervention (e.g. age at diagnosis, age at intervention,) as well as compliance measures (appointment attendance, aural rehabilitation enrollment, data logging at approximately 3 months, 6 months, and 1 year post-activation).

Results: Descriptive and comparative statistics will be used to determine differences in outcomes between different social factors. Data collection is ongoing and anticipated to be completed by February 2021.

Conclusion: Data collection is ongoing, and we do not have complete data to state statistical conclusions at this time. We anticipate comprehensive conclusions by the conference in April 2021. Next steps include designing intervention programs to address social factors identified to impact device compliance in this population.
Session: PH-3  
Session: ePoster Highlights III  
Title: Predicting Emotion Perception Abilities for Cochlear Implant Users  
Presenting Author: Sebastien Paquette, PhD  
Author Block:  
Sebastien Paquette, PhD1, Mickael L. D. Deroche, PhD2, Maria V. Goffi-Gomez, MD3, Ana C. H. Hoshino, MD3, Alexandre Lehmann, PhD4,1Psychology, Univ. of Montreal, Montreal, Canada, 2Psychology, Concordia Univ., Montreal, Canada, 3School of Medicine, Univ.e de Sao Paulo, Sao Paulo, Brazil, 4Otolaryngology, McGill Univ., Montreal, Canada.  
Abstract:  
Introduction: For cochlear implant users, perceiving emotional cues is very challenging, and the factors explaining the variability in patients' outcomes are currently poorly understood. Understanding how it relates to auditory proficiency is a major challenge of cochlear implant research and is critical in addressing patients' limitations. To fill this gap, we evaluated different auditory perception aspects in implant users (pitch discrimination, music processing, and speech intelligibility) and correlated them to their performance at an emotion recognition task.  
Methods: Forty-two Portuguese speaking cochlear implant users and 42 controls matched in age (18 to 76 years old) participated in our investigation. Implant users had at least one year of experience with their device (X of hearing deprivation = 12 years). Four aspects of the volunteer’s perception capabilities were evaluated: [1] The Vocal and Musical Emotion Recognition task used 48 stimuli; stimuli were equally allocated to three emotion types (happy, sad, and neutral) and two modalities (voice and music). Half of them were vocal interjections (half female), and half were short musical bursts (half clarinet, half violin). The task consisted of a force choice Identification task where participants answered (happy, sad, or neutral). [2] Pitch discrimination abilities were evaluated using two tasks where the fundamental frequency (F0) of each complex was either flat to create steady notes or linearly rising or falling to create pitch sweeps. The task required differentiating a target note or sweep from two reference notes or sweeps. [3] Music processing abilities were assessed using a short version of the Montreal Battery of Evaluation of Amusia, evaluating six aspects of music perception: scale, contour, interval, rhythm, meter, and incidental memory. In the first four tests, participants were asked to compare two musical phrases and indicate if they are the same or different. For the last two tests, participants were asked to identify which of the melodies were a waltz or a march (meter test) or if they had been heard in the first five tests (memory test). [4] The Speech intelligibility task used a list of 50 phonetically balanced monosyllabic words spoken in Portuguese. Words were presented sequentially, and the participants' verbal responses were scored (as correct or incorrect).  
Results: Whereas, as expected, cochlear implant users performed worse than their controls on all tasks, preliminary analysis indicates that emotion perception abilities can only be predicted with results at the speech intelligibility task and participants' age.  
Conclusion: As previously observed, emotion perception abilities seem in our group seem to decline with age. Interestingly even when some of the emotional stimuli are musical, this ability seems to rely more on processes similar to speech intelligibility than music perception - disting further emotion perception from a direct extrapolation from frequency and temporal changes.
Title: Identification of Facial Expressions by Adolescents With and Without Cochlear Implants

Presenting Author: Delaney Evans, PhD

Author Block:
Delaney Evans, PhD, Andrea Warner-Czyz, PhD, Lyn Turkstra, PhD, Meredith Scheppele, MSc, Julia Evans, PhD; The Univ. of Texas at Dallas, Richardson, TX.

Abstract:
Introduction: Adolescents with cochlear implants (CI) experience significantly more peer problems and higher rates of peer victimization than peers with typical hearing (TH). These negative social outcomes may be due to the effects of prelingual hearing loss on the development of social cognitive abilities such as perception and recognition of emotion. This study uses static and dynamic stimuli to examine the effect of auditory status on the recognition of more life-like facial expressions in adolescents with CI and with TH.

Methods: Participants include 34 adolescents with CI (M = 13.3 years), who had been using their CI for an average of 10 years, and 24 adolescents with TH (M = 13.7 years). All participants completed an adapted version of the Emotion Recognition Task (ERT) that included a static task with photographs of facial expressions and three dynamic tasks with video clips of faces morphing from a neutral expression to different levels of emotion intensity (60%, 80%, and 100% of an expression). Each task consisted of 24 photographs or video clips of 4 individuals expressing 6 emotions (happiness, anger, sadness, fear, surprise, and disgust). Participants were asked to label the emotion from a closed-set list and their mouse-click responses were recorded to examine behavioral outcomes (i.e., percent choice to target emotion).

Results: Auditory status did not affect emotion recognition of full-intensity expressions regardless of stimulus motion (i.e., static or 100% dynamic). Expressions of surprise and sadness were recognized more from static photographs, while all other emotions showed better recognition from dynamic video clips by CI and TH groups. On the three dynamic tasks of varying emotion intensity, adolescents in both groups identified emotions similarly when shown expressions of the lowest (60%) and highest (100%) intensity emotions. However, adolescents with CI significantly differed in percent choice to target emotion from adolescents with TH on the dynamic 80% emotion intensity task (p = .019).

Conclusion: Adolescents with CI and adolescents with TH show similar identification of full-intensity emotions from static photographs and dynamic video clips. However, adolescents with CI interpret facial expressions differently from peers with TH when provided with less emotion information. These results suggest that adolescent CI users need additional emotion information from facial movement to identify more realistic, subtle expressions similarly to adolescents with TH. These findings provide evidence of differences in emotion recognition that could underlie communication difficulties experienced by adolescents with CI and could guide therapeutic intervention focused on shaping social and emotional communication abilities of adolescents with CI.
Title: Relative Fixed Speech to Noise Ratio: Down to a T?

Presenting Author: Maria Giraudo, MA

Author Block:
Maria E. Giraudo, LICENCIADA en fonacudologia, Luciana Maritano, Licenciada en Fonoaudiologia, Maria Chalabe, Licenciada en Fonoaudiologia ;ENT, HOSPITAL ITALIANO DE BUENOS AIRES, CABA, Argentina.

Abstract:
Introduction: Because of the growing number of high speech perception performance achieved by hearing aid and cochlear implant recipients, it’s been necessary to increasingly use more sensitive assessment tools. The use of Speech in Noise Tests to document the benefits of Listening Assistive devices over time has been well described in the past. The ability to listen and understand speech in noisy environments is highly dependent on the speech-to-noise ratio (SNR), which is specific to each subject. The Adaptive SNR (SNR-50%) measurement has been the most used performance metric in the last years to avoid the limitations of the ceiling and floor effects. However, it may provide limited information about the actual performance of the patient since it only considers the SRT (50%). The recording of the Total Speech in Noise Recognition Score with a fixed SNR would provide valuable complementary information. However, it has not yet been possible to normalize a fixed absolute value of SNR that guarantees not under or overestimating the assistive benefits in all cases. This problem has led us to study the possibility of setting the intensity of Speech Signal at a fixed level relative to the patient’s SNR-50% which we named “Relative Fixed SNR” (RF-SNR). It’s a specific value which derives from the sum of 5 dB above the SNR-50% of each subject. The purpose of this study is to describe the clinical value of RF-SNR.

Methods: Retrospective clinical study. There were 61 ears evaluated for the study sample divided into HA (Group A) and CI (Group B) recipients. (Subjects: 52)

Results: The median SNR-50% was significantly higher in Group A (p < 0.001) with an ICR that showed a wide variability intra group (> in Group B). The complete sample significantly improved Speech Recognition Scores compared to the 50% when adding 5 dB over the SNR50% and none reached 100% avoiding the ceiling effect. The higher the SNR50% was, the worse the “rFSNR” Total Speech Recognition percentage acquired. A wide dispersion was observed in the Speech recognition % when the speech signal reached an intensity of 70 and 75 dB (+ 5 and + 10 dB) in both groups.

Conclusion: The present study shows evidence that the use of the “rFSNR” to record a total speech recognition score would be valid to supplement the information provided by the SNR50% since it avoids the ceiling and flooring effects. The test could be further sensitized by adding 3 dB instead of 5 dB for the “Good performers” group.