Jailhouse Audiology

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Most forensic audiology encounters are for industrial or civil medical-legal cases. However, criminal cases may occasionally require an expert witness in audiology to evaluate an inmate and provide a written or oral testimony. These cases involve defendants who are suspected to have hearing loss and for whom an audiological assessment is requested as a part of the defense attorney's due diligence. Unlike civil cases, criminal cases present with several obstacles, and the jail system can be very intimidating and stressful—especially when the audiologist is not fully prepared for a difficult-to-test situation in an unfamiliar and potentially dangerous environment.

THE EXPERT WITNESS

Expert witnesses must have "knowledge, skill, experience, training, or education" which will "help the trier of fact to understand the evidence or to determine a fact in issue" (Federal Rules of Evidence, 2015). An audiology expert witness has two primary functions: first, to collect test results and evaluate the evidence; and second, to provide a forensic evaluation that conveys an opinion and its foundation to the court. Written and oral communication skills are paramount. A background check along with supporting documents such as publications, licenses and certifications, history of rebutting Daubert challenges, and past trial testimony help attorneys and the court qualify an expert.

Challenges to an expert's opinion are made by Daubert Motions, which can be the deciding factor in whether a case is won or lost (The Expert Institute, 2017). These motions attack the credibility of the expert based on competence, relevance, and reliability.

THE CRIMINAL JUDICIAL PROCESS

When a person is arrested for an alleged crime, the District Attorney's (DA) office reviews the case and may decline or pursue charges for a misdemeanor, felony, or both. In felony cases, this is followed by an initial appearance in the arraignment court at which time, the charges, maximum penalty, and rights to an attorney are presented to the defendant. Throughout this process, the defendant remains in jail while waiting for some procedural activities, including a status conference on the direction of the case, a preliminary hearing during which the DA's office presents its case to the court, followed by a settlement conference, a plea hearing, trial, sentencing, and any appeals thereafter. During this process, the defense attorney makes every effort to mitigate the merits and strength of the DA's case, such as revealing the inmate's inability to appear cooperative because of a hearing loss and the resultant communication failure.

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The Americans with Disabilities Act (ADA) would also be discussed, especially in comorbid conditions. An audiological evaluation is generally done early in the process, but the trial or deposition when the testimony is given may occur months after the initial evaluation, so it's important to make copious notes.

THE FACILITY AND EQUIPMENT

Prior to evaluating an inmate in the jailhouse, the defendant's attorney will need to provide the facility with the audiologist's identification documents, as well as photos and identification information of the tools and equipment that will be brought in for the evaluation. Once these documents are reviewed and approved, a date and time will be set with the attorney. A two- to three-hour window should allow for all the necessary tests.

Prior to testing, the audiologist should check that the equipment and tools work well. Have an appropriate range of portable equipment to measure hearing sensitivity, speech discrimination in quiet and in background noise, otoacoustic emissions, auditory brainstem evoked potentials (ear insert receivers), immittance testing, screening for central auditory processing, and direct otoscopy. Bring curette and/or swab and extension cords as well. Use ear insert receivers or a circumaural headset to reduce ambient noise as much as possible since testing is typically done in various rooms, with no guarantee on the level of ambient noise from the HVAC and nearby activities. Therefore, a sound level meter is a necessity.

Be sure to request a small room in the quietest area possible that has an observation window for the officers to monitor the inmate and the clinician.

On the examination day, be sure to arrive 30 minutes early at the facility. Present your IDs at the intake window and present the equipment for visual inspection. Do not bring anything other than those previously approved. For example, since pens, paperclips, and staples are considered contraband that can be fashioned into a weapon, it is advisable to bring a laptop instead.

Officers will direct the audiologist to the appropriate room that can be set up for audiological testing. Once the inmate enters the room, it is important to be courteous and respectful to elicit the cooperation needed for accurate testing. The audiologist should not pose a threat as the purpose of the evaluation is to identify and qualify the inmate's ability to hear and communicate. However, malingering is to be suspected and investigated in the presence of abnormal findings.

The evaluation should be done as it is usually performed in the clinic. All data should be digitally recorded for future analysis. A comprehensive history should be followed by a physical examination of the head, neck, and ears. The tests should cover hearing sensitivity, auditory system pathways and reflexes, electrophysiology if time allows, and central auditory processing. The auditory system review should be comprehensive, accurate, relevant, and centered on the merits of the case in the event of a qualified disorder.

THE CASE

A 17-year-old man was arrested for not pulling over during a routine traffic stop that turned into a police chase. When the suspect was cornered, he ran from the car, didn't stop when ordered, and shot at the police with a handgun. The police returned fire without harming the suspect, who quickly surrendered. Upon booking, it was revealed that the suspect was intoxicated and high on illicit drugs. Because the suspect failed to respond to the police and was unaware of hearing the officer's demands, his attorney petitioned the court to do an audiological evaluation by an expert witness.

Upon examination, the inmate reported a history of chronic middle ear disease as a child and attending firearms practice without any hearing protection. Prior to testing, a 69-dBA sound level meter reading was measured inside the testing room, suggesting that a reverse curve may occur in the audiogram. The inmate's comprehensive evaluation showed a mild-to-moderate, moderately sloping, sensorineural hearing loss bilaterally. A slight reverse curve is seen in the lower-frequency audiograms consistent with the HVAC noise level.

Speech discrimination in quiet was within normal limits. However, hearing in background noise, measured using the QuickSIN, revealed a moderate degree of signal-to-noise ratio loss from either ear. Other tests were done to confirm the hearing loss, and these findings were presented as new discovery to the DA's office prior to trial and in open testimony to the jury. Although the findings did not significantly influence the outcome of the case at sentencing, the hearing loss may present a more compelling argument in a less serious offense. Furthermore, ADA accommodations should be discussed as they are part of the audiologist's responsibilities.

Forensic audiology is an interesting field that requires expertise. Although not a common practice, performing an audiological evaluation in a jailhouse setting can be made easier when the audiologist is prepared to deal with the rigors of the justice system. HJ

SPEECH INTELLIGIBILITY

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domain and the spectrogram of clean speech signal, unprocessed noisy speech, and modified speech in noise for an SNR of 0 dB.

As shown in the spectrograms, most of the speech frequencies are covered by noise in the unprocessed noisy speech, whereas a large amount of the frequencies of clean speech is visible in the modified speech.

PERFORMANCE EVALUATION

To evaluate the performance of the proposed algorithm, 30 sentences from the Timit database with a length of approximately three to five seconds are used. In addition, four common noises were used: traffic babble, factory, and chainsaw noises from the Noisex-92 database in SNRs of –20, –15, …, 0dB.

Two objective measures, SII and short-time objective intelligibility measure (STOI), were used to evaluate the performance of the proposed method. SII is an objective speech intelligibility measure based on the SNR. STOI evaluates the intelligibility of noisy speech based on the correlation between the noisy speech energy and the clean speech energy in one-third octave frequency bands. The inputs of this measure are clean speech and noisy speech, and the output—between 0 and 1—shows the amount of speech intelligibility.

The proposed method was compared with a reference method of improving speech intelligibility called "maximum power transfer," an SNR modification method based on a simple human hearing model (IWAENC, 2006). In this model, the speech signal is processed in the ear after passing through the auditory filters. It is also assumed that frequency bands with low SNR are eliminated in the hearing filter. Therefore, in the Sauert method, bands with low intelligibility are initially eliminated and their energy is transmitted to other bands to transfer the maximum speech power to the ear. Figure 3 shows the results of the performance evaluation of the proposed algorithm.

Tested in all noise conditions, the proposed method performed better than unprocessed noisy speech and the maximum power transmission method in the SII measure, as expected. In addition, the SII scores for the maximum power transmission were close to the proposed method in the high SNRs of the babble and factory noises. (Fig. 3).

Figure 4 shows that the proposed method significantly improves speech intelligibility in almost all noise conditions compared with unprocessed noisy speech in the STOI measure. The proposed method didn't considerably improve intelligibility in factory noise, but it did in chainsaw noise. The STOI was notably increased in traffic and babble noises especially in low SNRs. The proposed method also outperformed the maximum power transfer method in traffic, chainsaw, and babble noises.

The proposed algorithm features a simple structure that is very important in online speech processing. The study findings show that this method improves speech intelligibility in the noisy settings, offering a promising alternative to other existing methods. HJ