Audiology Observation

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Introduction

Since my research interest lies in cochlear implants (CIs), I have requested to observe CI check-ups. It is hopeful that by observing the interface between the audiologists and the CI users will further help me understand the clinical as well as other practical issues related to CI users and their implants. During the course of this semester, I have observed the otology outpatient clinic, with a patient approved to be a CI candidate. I have also witnessed a CI surgery. In this report, two cases of CI check-up observations are documented and other general CI related comments made by the audiologists are also reported and discussed.

23 year old female CI check-up

This patient was implanted with the Nucleus Spectra-22 when she was in her 6th or 7th grade. She is currently using the SPEAK strategy, which is designed to pick the spectral peaks that would normally be associated with the first two formants of vowel utterances in normal speech. She achieves an open set score of ~70% for her speech intelligibility tests.

The reason for her visit was that she noticed her speech intelligibility in normal environment has degraded. She believed that there are possibly hardware malfunctions for her current behind-the-ear (BTE) receiver. After some investigations at the clinic, it was confirmed that the source of the problem was the BTE microphone malfunction.

The patient expressed how much she dislikes the inconvenience caused by her CI (hardware) malfunctions. Dependency on the implant has been developed by the user – she would stop the car to change the batteries while she is driving. While implant research often concentrates on improving speech intelligibility, it is also necessary to realize the importance of other non-hearing type of research such as design for low-power CI or other engineering improvements for the implant design, e.g., better microphone arrays for BTE devices.

76 year old male CI check-up

The patient was implanted with an Advanced Bionic device. He has recently been switched to the Hi-Res-S (16 channels, mono-polar excitation pattern), now the preferred turn-on strategy at MEEI, which is based on the continuous interleaved sampling (CIS) signal processing and neural coding technique. He previously used the earlier version of CIS strategy (8 channels paired excitation pattern), which has a lower excitation rate.

The patient visited the clinic for an evaluation of his speech recognition ability using his new speech processing strategy, to which has only been switched for two weeks. He was first evaluated using the NU6 test. In this test, the listener is asked to repeat (or write down) the keyword, which is in a consonant-vowel-consonant phonemic format, prompted by a carrier phrase – “Say the word: [keyword]”, and the test is scored both on phoneme and total word recognition. This is an open set test with no contextual cues. The phonemic score is generally higher than the whole word score but a confusion matrix is not used to trace whether there are systematic phonemic confusion patterns. His previous NU6 scores were: 50% for word recognition; 68% for phoneme recognition, while using the new strategy: 28% for word recognition; 46% for phoneme recognition. It is expected that these scores will improve as the user is more accustomed to the higher rate excitation patterns provided by Hi-Res-S speech processor. He will be retested 2 months from this visit.

After the NU6 test, a CID test, based on commonly used sentences, was used to further assess his speech recognition performance. This is yet another open set test but with contextual cues and keyword recognition is scored. As expected, the score on this test is higher than the NU6 test due to the extra contextual cues.

From this observation, I come to realize that it is important to understand the exact details of speech recognition test, especially when it is quoted by researchers to compare different implant strategies. It is generally accepted that open set tests are harder test batteries compared to the closed set speech recognition tests, but contextual cues and the scoring criteria (phonemic or whole word based) could still influence the reported performance of a particular implant strategy. Care must be taken when results from different test batteries are compared to evaluate the performance of a particular implant strategy.

Discussion / Other interesting points

I was interested in how a change in speech processing strategy could affect the intelligibility and the perceived sound quality by the users. In engineering terms, the MSP strategy has a number of different parameters compared to the SPEAK strategy employed by the Nucleus group in the early 1990's, especially in terms of extending the processing bandwidth to better process consonant utterances. However, I was told that the CI users do not notice a huge difference except that they often complain about the new "shriek" timber of sound, not knowing that the added high frequency component has provided them with better cues for consonant discrimination, which is also reflected in their speech intelligibility scores.

I was also told that it is now fashionable in the US (not at MEEI) for speech therapists to be present for a "customized" tuning of the strategy parameters (especially for young CI users), in order to maximize their speech production / recognition abilities, e.g., discriminating between /s/ and /z/.

It is important for clinicians in the hearing and speech domain to appreciate the plasticity nature of the brain. Despite the brain has an amazing ability to decode the crude representation of acoustic sound that a CI provides, given the constraints present at the electro-neural interface; such plasticity takes time. If the parameters were changed according to the child's performance on discrimination / production tasks assessed on a weekly basis, this could, in my opinion, jeopardize the plasticity process of the brain.

This also raises the question whether the implant companies should provide so many degrees of freedom in terms of changing the parameters of a signal processing strategy in an *ad hoc* manner through the software provided for the clinicians. While customizing based on proven scientific research methods could be beneficial, manipulating the parameters without any knowledge of how it would affect the CI user could be harmful. It can be argued that, just like hearing aid fittings, it is an art for the audiologists to tune the bands to maximize the benefits for the patients. In any case, these parameters should not be changed dramatically on a weekly basis. While it is attractive for CI companies to advertise to the clinicians how versatile their products can be through simple software controls, one should question whether it is beneficial to provide that many degrees of freedom at all to clinicians in that many CI centers.

Another interesting point of discussion is how the CI companies should behave in this almost duopolized industry. The recent meningitis scare was exploited by one company to use as a smear campaign, as I have been told, without thorough investigations on the cause of the problem. It will be interesting to observe how these established companies react to other upcoming, smaller CI companies that provide low-cost CI options for the less mature markets in Asia. One hopes that future decisions made by CI companies are based on prudent scientific research and further endeavor helping hearing clinicians to maximize the CI benefits for the deaf and hard of hearing.