



TOPICS #1

Speech Communication Training for Young Adults with Cochlear Implants: A Case Study

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Introduction

My work involves a great deal of travel, and I greatly enjoy the opportunity that this provides to meet clinicians and teachers working with children and adults with cochlear implants (CIs). My travels usually include presenting workshops on various aspects of aural (re)habilitation, and I always try to ask teachers/clinicians about specific areas that are causing them concern. Very often, they express a need for more testing and training materials that can be used with teenagers and young adults who have received an implant, usually after many years of successful hearing aid use.

I have worked extensively with this group of CI users, and every time I start with a new client, I'm confronted by a unique set of needs and challenges. Invariably, I find myself developing new training materials to meet the specific circumstances of the individual client, and I'm currently putting these together in a new program that will be published by the Hearing Rehabilitation Foundation (HRF).

One area of concern for many teenagers learning to use their new CI is the access that it provides to the high frequency speech sounds such as [s] and, to a lesser extent, [sh]. For many, this is the first time that they have heard this important information and, at least initially, it can be quite intrusive, and even distracting for the listener. Several years ago, I developed "Speech Sheets," a series of short exercises designed to introduce the sibilant [s] to teenagers who are learning to use their new CIs. This is available without cost from the HRF. If you would like to receive a copy, please contact me at hearf@aol.com.

This first issue of "AR Topics" focuses on the very special needs of a long-term CI user, and highlights the need for specific training approaches for individual clients.

Subject

The subject of this study is an adult male deafened by meningitis at the age of 14 months. Although hearing aids were fitted, these provided little, if any, benefit and the subject's parents introduced Cued Speech at an early age, to encourage the development of speech and language. The subject was an exceptional user of this approach and was fully mainstreamed for his elementary school, middle school, and high school education. He received a CI when he was 11 years old, but, again, this seemed to provide limited benefit. Unfortunately, it appears that little specific auditory training was provided, and the subject's major source of speech information was visual (lipreading and Cued Speech) rather than auditory. Following his undergraduate studies, the subject enrolled for PhD studies in the Harvard-MIT Program in Speech and Hearing Bioscience and Technology. Around two years ago, when he was 25, the subject asked if I would be prepared to provide him with training to improve his speech perception and production skills.

Initial testing revealed that the subject had very limited auditory skills, he could not discriminate reliably between [ba] and [bi] for example, and a decision was made to place the major training emphasis on improving his speech production. We met weekly, and, over time, it became apparent that he also wanted to improve his ability to use the information provided by his CI for speech understanding.

Closed Set Exercises

The first auditory only exercises involved a series of closed set words and sentences.

Numbers 1 - 10 This set of words was chosen for training because they consist of 9 monosyllables and one bi-syllable, which present a good range of vowels, diphthongs, and consonants. In each training session, the ten numbers were presented five times each, in a random order, for identification. The subject's score improved from around 50% correct at the start of this training to approximately 80% correct after 15 sessions.

Days of the week The days of the week consist of six bi-syllables and one tri-syllable, all ending with the syllable "day." These items were initially presented in isolation, but I soon switched to using a carrier phrase such as "I'll see you on ____." The days were presented five times each in a random order, and the subject's score steadily improved from around 75% correct at the beginning of training to over 90% correct after nine training sessions.

Closed set sentences A set of 20 sentences, some short and some relatively long, was constructed, using words drawn from the 500 most-frequently-used words in Dahl's ¹ corpus of spoken American English. Examples of the sentences include: "It's time to go." "How are you?" "Where did you go for your vacation?" "What's the time please?" and "Do you know any more." At first the closed set consisted of only five sentences, but once the subject reached a criterion of 90% correct, the set was increased to 10, 15, and, finally, 20 sentences. The subject was provided with immediate feedback as to the correctness of his response, and when he made an error, I would repeat both the incorrect and correct sentences auditory-visually - "No, I didn't say, 'What's the time?' I said, 'How are you?'" At the completion of this training, the subject was scoring better than 90% correct for the set of 20 sentences presented auditory only. I would sometimes ask the subject what information he was using to identify the sentences, and found it very interesting that he initially appeared to use syllabic patterns for some, while for others he would use a distinctive "segmental marker" such as a sentence final [s]. Over time, however, it became apparent that he was starting to segment the sentences into individual word patterns, and that provided the impetus to start doing some more complex testing.

"Open set" sentences I drew up a new set of 28 sentences using the words and phrases from the closed set sentence task. The sentences ranged in length from 3 - 11 words (average length = 7.3 words) with a total of 204 words presented for identification. I presented the sentences via audition only, and I don't know who was most surprised, the subject or myself, when he scored 60% correct. When I presented the same list two weeks later, the subject scored 65.2% correct.

Sentence Matrices I often use sentence matrices for testing and training,² and felt that the approach would be appropriate for this subject. The first matrix consisted of the following items.

JUNE	BUYS	TWO	GREEN	BIKES
JAMES	SAW	THREE	BLUE	PLATES
SHANE	HAD	FOUR	RED	CAPS
JOHN	HAS	FIVE	NEW	CUPS
SUE	SEES	SIX	OLD	CHAIRS

Another sentence matrix used the format shown below to generate sentences such as "I'll see you on Monday at six o'clock." I chose this format because it provided me with the opportunity to use

¹ Dahl, H. 1979. **Word Frequencies of Spoken American English**, Verbatim, Essex, CT

² Plant, G. "Using matrices for training," **Listen-Hear!** Number 19.

http://www.medel.com/english/50_Rehabilitation/Free-download/documents/ListenHear/Listen-Hear-19.pdf

I'LL	SEE		MONDAY		ONE	
			TUESDAY		TWO	
			WEDNESDAY	AT	THREE	O'CLOCK
SHELL	MEET	YOU ON	THURSDAY		FOUR	SHARP
			FRIDAY	AROUND	FIVE	FIFTEEN
			SATURDAY		SIX	THIRTY
			SUNDAY		SEVEN	FORTY-FIVE
					EIGHT	
					NINE	
					TEN	
					ELEVEN	
					TWELVE	

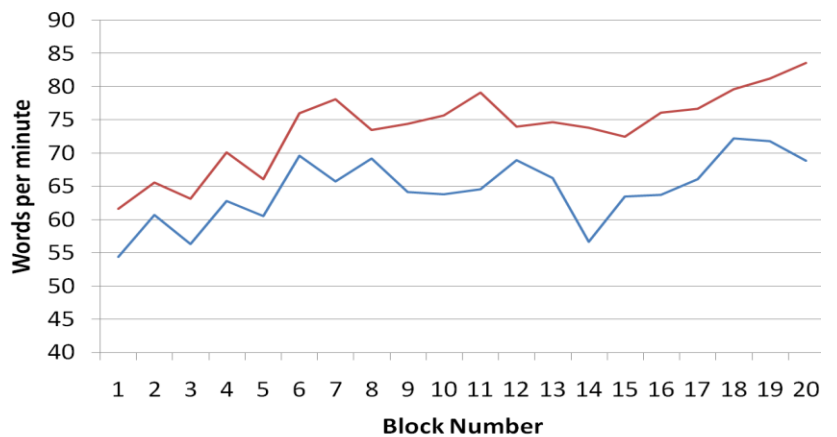
previously trained words (days of the week and numbers) in a sentence context. I presented different sets of twenty sentences made up of words drawn from this matrix across five training sessions. The subject's scores from session 1 - 5 were 77.5%, 80.8%, 81.7%, 84.2%, and 88.3% correct respectively. Especially pleasing were the subject's scores for the previously trained days (82%) and numbers (75%).

Bilateral Training

The subject elected to receive a second CI in the summer of 2008, and following "switch on" of the second device he attended training around two to three times per week for the next six months. In discussions with the subject, it was decided to focus on training that emphasized using the two CI's to supplement lipreading, and to attempt to develop his listening alone skills.

Speech Tracking The first part of each training sessions consisted of 4 x 5 minute Speech Tracking sessions using a new Windows-based version of the KTH Tracking Procedure³ developed in conjunction with the Rehabilitation Engineering Research Center on Hearing Enhancement at Gallaudet University.⁴ In each session, two 5-minute Speech Tracking segments were presented via lipreading alone (LR), and 2 x 5 minute segments were presented via lipreading plus the bilateral CI's (LR+CI). The order of presentation was varied from session to session to minimize any possible order effects. The subject's Speech Tracking rates (in words-per-minute) for the two conditions are presented in Figure 1, with LR only shown in red and LR+CI shown in blue. Each datum point is the mean Tracking Rate obtained for 5 x 5 minute Speech Tracking segments, which means that these represent a total of 500 minutes of Speech Tracking in each presentation condition. Although the subject's Tracking Rates for the LR condition are very impressive, they are around 10 words-per-minute better in the LR+CI condition.

Figure 1 Speech Tracking Rates obtained in the LR (blue) and LR+CI (red) conditions



³ Plant, G. "Speech Tracking," *Listen, Hear!* # 5

http://www.medel.com/english/50_Rehabilitation/Free-download/documents/ListenHear/Listen-Hear-05.pdf

⁴ Plant, G., Bakke, M., Marcus Bernstein, C., Levitt, H., Burger, B., and Oden, C. 2007. "A Windows-based version of the KTH Tracking Procedure," Paper presented at the Fourth International Adult Aural Rehabilitation conference, Portland, ME

The computer program automatically calculates the number of blockages that occur in each 5-minute Speech Tracking segment. This is based on the number of times a word or series of words has to be

Figure 2 The average number of blockages obtained in the LR (blue) and LR+CI (red) conditions.

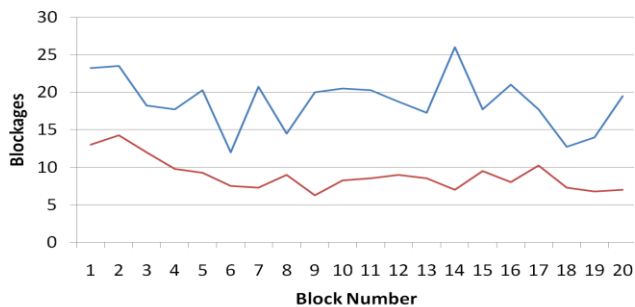
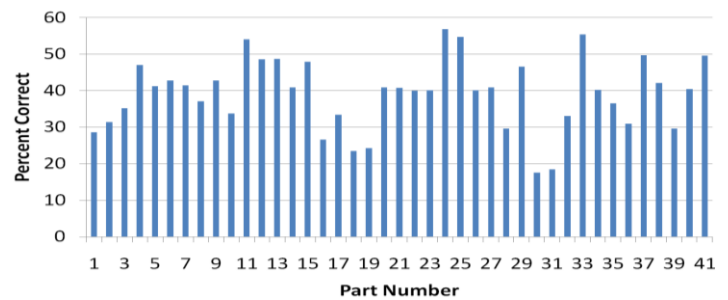


Figure 3 The subject's scores for "TeenTrain" materials presented in the auditory only condition.



repeated during each 5-minute session. The results obtained across the training period are shown in Figure 2. Again, each datum point shows the mean scores obtained for 5 x 5 minute Speech Tracking segments. The results show that there are from 5 - 10 fewer blockages in the LR+CI condition.

TeenTrain I also wanted to provide some training in auditory only perception of connected speech. This was done using "TeenTrain,"⁵ which presents a rather long story, line by line, for identification. I read one page per session, and scored the subject for each word that was correctly identified. At the end of each page, I calculated the number of words correctly identified as a percentage of the total number of words presented. The subject's scores for this task, which averaged around 40 - 50 % correct, are shown in Figure 3. There are a number of sessions (16 - 19 and 30 -32), where the subject's scores are quite low. On each of these occasions, one of his CI's was malfunctioning, and the subject was wearing only one CI. The subject was extremely pleased when I showed him these results at the end of the training period, as they confirmed his belief that he was able to hear better with the two CI's.

Sentences I used a number of other sentence-based training exercises drawn from materials developed for MED-EL and the HRF over the past 10 years. These included topic-centered sentences from "Syntrain,"⁶ a picture-based test called "Contentest,"⁷ and a set of 10 sentence lists from "Speech Stuff."⁸ These latter materials are, once again, made up of words taken from the 500 most-frequently-occurring words in spoken American English. Each of the 10 lists in this set consists of 25 sentences each of which contains a total of 200 words. The average length of the sentences is 8 words, but they range from 4 to 12 words, as I feel it is important to include both "long" and "short" sentences in such testing. The ten lists were presented to the subject via audition alone, and his average score for these materials was 23.5%.

Conclusion I was very happy with the outcome of this study, and am confident that the subject would continue to improve with further training. Unfortunately, I will not be able to provide this ongoing training, as the subject is relocating to another city to take up a post-doctoral fellowship. I hope that

⁵ Plant, G. **TeenTrain**, MED-EL, Innsbruck, Austria

⁶ Plant, G. 2002. **Syntrain**, MED-EL, Innsbruck, Austria

⁷ Plant, G. 2004. **An AR Sampler**, MED-EL, Innsbruck, Austria, & The Hearing Rehabilitation Foundation, Somerville, MA

⁸ Plant, G. 2001. **Speech Stuff: Speech Testing & Training Resources for Teenagers & Young Adults**, Hearing Rehabilitation Foundation, Somerville, MA

he is able to find a therapist in his new location, and that he will be able to build on the skills that he has developed over the past two years.

I am often asked whether providing training to young adults with apparently minimal benefit from their CI's is worthwhile, and my response is to emphasize that it is impossible to make any blanket generalizations, and that each subject needs to be considered individually. In the present case, the subject's auditory only speech perception skills were very poor, but he did show a great willingness to work on improving them. It was this motivation to improve that encouraged me to shift from speech production to speech perception training, and his performance over the course of the training program supported this decision.

If readers would like any further information on the materials and approaches used in this study, please contact me at hearf@aol.com. I look forward to hearing from you!