SIGNED AND SPOKEN LANGUAGE ABILITIES OF DEAF AND HARD-OF-HEARING STUDENTS

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ABSTRACT

Deaf students with and without cochlear implants (CIs) vary widely in their language skills and communication preferences. Those who enter secondary and postsecondary education settings frequently lack the language skills necessary to benefit optimally from classroom instruction. However, research has found that deaf students overestimate their comprehension to a greater extent than hearing peers and are less knowledgeable about repairing communication breakdowns. Linguistic and metalinguistic abilities were examined in university students varying in their signed and spoken language skills: deaf students using CIs, deaf students not using CIs, and hearing students. Assessments included tests of speech perception and production, plus expressive and receptive sign language skills. Students also provided self-assessments of their abilities in those domains. Students implanted before age five did well with speech perception and production ability and all CIusers were successful in predicting these skills. Only those implanted before age 5 were successful in predicting sign skills. Those who used hearing aids (HAs) did better with speech perception and speech production than those who wore no aids but were not as successful as CIusers in predicting these skills. Deaf non-CIusers were better at predicting expressive sign skills, but did not accurately estimate their sign comprehension.The present results indicate the need for caution in accepting deaf students' self-assessments of their communication skills, yet CI users tend to more accurately predict speech perception and production abilities than their counterparts who use HAs.

BACKGROUND

Currently deaf and hard-of-hearing (DHH) students enteringcollegeform an eclectic group regardingcommunication backgrounds.Variable skills in speech perception, speech production,andsign pose a challenge to institutions of higher education when it comes to meeting educational needs. In addition, students may not always know where their communication strengths and weakness lie. This paper explores the relationship between communication skill and awareness level in students entering college.

Listening and understanding speech is challenging for those with hearing loss.Adolescentswho are consistent HA users and who have hearing thresholds of 80-90 dB HL, or "severe" hearing loss, may average about 52-88%correct on tests oflistening and speechreading simple sentences (Geers& Moog, 1992). This accuracy tends to decrease as hearing thresholds reach "profound" hearing levels (> 90 dB HL), and adolescents with thresholds greater than 110 dB HLmay score only 20-60% on the same task.Those without consistent engagement in listening may score lower still.In contrast,adolescents with profound hearing loss who use CIs may average up to 77% accuracy on sentence tests with listening alone, without the aid of speechreading(Geers, Tobey, Moog,& Brenner, 2008).

Speech production outcomes for those with profound, bilateral hearing loss vary with their ability to use and gain speech perception skills with either HAs or CIs.The range in speech production accuracy can be as limited as 20%(Monsen, 1983) to as high as 68-71.5% for those who have used CIs for extended lengths of time (4-6 years) (Tobey, Geers, Brenner, Altuna,&Gabbert ,2003; Peng, Spencer,&Tomblin, 2004).

Metacognition involves awareness and control of cognitive processes.Borgna, Convertino, Marschark, Morrison andRizzolo (2011) described the ‘double burden’ of being unskilled and unaware with regard to poor language comprehension as they documented that DHH students were not proficient at self-monitoring comprehension of what they saw via interpreters or what they read.Marschark, Sapere, Convertino, Seewagen and Maltzen (2004) and Marschark et al. (2005) found that DHH students recovered significantly less from an interpreted lecture than did their hearing peers as measured by their scores on multiple-choice testing, but thought they gained more than they did.

Our purpose is to assess linguistic abilities of university students who vary in their signed and spoken language skills and to determine the extent to which the students are able to self-assess their *speech perception*, *speech production* and *receptive and expressive sign language skills*.

METHODS

Speech recognition tests were conducted in a sound-treated booth with the seated participant facing the loudspeaker.Participants who used HAs or CIs were tested with their instruments on.Participants repeated stimuli in their preferred modality, either speaking, signing, or writing.If a participant completely missed the first ten items on any test list, then testing was aborted to reduce frustration and a score of zero was recorded.Stimuli were calibrated before each session using a calibration tone.

One hundred and three DHH participants completed all or part of the testing protocol as described below. Fifty were CIusers, and 53 did not use CIs. An additional 67 hearing students participated.Mean (SD) ages of the groups were:19.28 (1.3), 19.23 (1.1) and 18.9 (2.33) consecutively, with no significant difference between mean ages.

Audiovisual sentence perception (listening and lipreading) was assessed via the open-set, high-context*Iowa Sentence Test* (Tyler, Preece, &Tye-Murray, 1986), using the Tye-Murray, Sommers, and Spehar (2007) adaptation. The number of words in each sentence correctly repeated determined the sentence score. Tests were performed in quiet for DHH participants and with 20-talker babble for hearing participants. Sentences were presented at a constant 60 dB SPL. Participants viewed visual stimuli consisting of the head and neck of the talker on a 48-cm LCD monitor approximately 81 cm from their eyes.

Speech production accuracy was assessed using the McGarr sentences (McGarr, 1981, 1983). Participants who were uncomfortable using their voice opted out of this assessment, and80 of 103 DHHstudents participated. Participants viewed the sentences on a monitor and read them aloud while positioned approximately 30 cm from a condenser microphone. Input was recorded via PC in waveform audio file format. Two independent pairs of speech and hearing clinicians who were skilled in phonetics then transcribed the students’ speech samples using broad phonemic transcription. Correlation between the two pairs’ transcriptions was 0.83 using a Lambda analysis (Hays, 1973).

The Sign Language Proficiency Interview (SLPI) is a widely used tool for evaluating sign language skills consisting of a one-to-one signed conversation between interviewer and interviewee(https://www.rit.edu/ntid/slpi/). All participants who indicated that they had sign language skills (1or higher on a 0 to 5 Likert scale) were administered a SLPI. The interviewer and two additional interpreters, all of whom underwent SLPI training, rated the participants. Ratings followed the standard SLPI 11-point scale, from "No Functional Skills" to "Superior Plus."

All students who qualified for a SLPI watched a three-minute (3:15)grade 5 narrative passagepresentedin American Sign Language (ASL) (QRI, Leslie & Caldwell, 2001). Immediately after the presentation, participants were asked to retell the story in as much detail as possible. When finished, they were given a 17-question four-foil test on the content. Retelling was scored according to the QRI instructions. Both tests yielded proportional scores, which were added together to provide a composite sign language receptive skill score.

We asked all participants to complete acommunication questionnaire.Threeitems were identified for use in this study including the questions: *Hearing people understand my speech*,*How well do you understand speech when you both speechread and/or use your hearing*,and *Please rate how well you think you would understand a lecture presented in sign language only (without speech)* which students answered usinga 5-point scale.Students also estimated their own sign skills by reading an abbreviatedSLPI rubric and selecting a rating between 0, indicating that the person did not understand sign, and 5, indicating they were able to have a comfortable in-depth conversation.

RESULTS

The mean scores (SDs) for the Iowa Sentence tests are as follows:students who used CIs 74.0 (30.1), for the students who were deaf and did not use CI's 49.4 (39.6), and for hearing students 85.6 (11.2) with a significant difference among the three groups,$F(2, 126)=23.98$, $p=.000$. The means (SDs)of the students, considering age at implant and number of HAs, are listed in Table 1.Students were further divided for analysis as follows:*Group 1*–those who received a CI at or before age 5;G*roup 2*–those implanted between ages 6-10;G*roup 3*–those implanted older than age 10;G*roup 4*–those without a CI who used oneHA;G*roup 5*–those usingtwoHAs, and *Group 6*–deaf students who did not use CIs or HAs. There was a significant difference among the 6 groups,$F(5, 98)=9.83$, $p=.000$. Post hoc tests revealedthat although Group 1's mean score was higher than all other groups, the only significant difference was that Group 6 scored lower than all other groups.Correlations between students' self-reports of their speech reception skills and their actual sentence recognition scores, also listed in Table 1, were positive and significant for all groups except Group 4.

Table 1

Mean and standard deviation of scores on the Iowa Sentences test of audiovisual speech recognition, and correlations between self-rated and actual recognition skills.

Group		*M*	*SD*	*n*	*r*	*p*
	CI users					
1	CI at or before age 5	80.7	26.3	26	0.681*	0
2	CI at age 6-10	71.9	31.6	16	0.509*	0.044
3	CI age 11 and up	59.6	40.6	7	0.926*	0.003
	HA users					
4	1 HA	65.6	27.8	10	-0.043	0.906
5	2 HAs	71.2	29.5	18	0.727*	0.001
6	No CI / No HAs	23.1	35.9	22	0.878*	0

Note. CI = cochlear implant; HA = hearing aid. *significant at the 0.05 level.

The mean percent correct (SDs) for the McGarrsentences are as follows: for the students who used CIs 74.21 (25.7), and for deaf non-CIusers 75.7 (24.8).Three students with CIs and 20 others declined to participate. There was no statistical difference in the groups,$F(1, 78)=.06$, $p=.797$. The means (SDs) of the students, considering age at implant and HAuse, are listed in Table 2. Post hoc testsrevealedthat both the earliest implantees and the bilateral HA users scored significantlybetter than thelatest CIrecipients and those who did not use any amplification.Correlations between students' self-reported speech production skills and their actual scores on the McGarr Sentence tests are also listed in Table 2. Correlations were positive and significant for all those with CIs and for those without any amplification. Correlations were not significant for HA users.

Table 2

Mean and standard deviation of scores on the McGarr Sentences test of speech production accuracy, and correlations between self-rated intelligibility and actual production skills.

Group		*M*	*SD*	*n*	*r*	*p*
	CI users					
1	CI at or before age 5	82.4	21.5	26	0.454*	0.020
2	CI at age 6-10	68.6	25.8	16	0.619*	0.011
3	CI age 11 and up	57.8	33.7	6	0.852*	0.031
	HA users					
4	1 HA	75.7	20.6	10	0.240	0.504
5	2 HAs	83.1	14.2	14	0.433	0.122
6	No CI / No HAs	59.8	37.4	8	0.725*	0.042

Note. CI = cochlear implant; HA = hearing aid. *significant at the 0.05 level.

The mean score (SDs) on the SLPI are as follows: for the students who used CIs(n=42) 2.36 (1.3), for deaf non-CI users(n=46) 3.4 (1.5), and for hearing students (n=33) 1.09 (1.1) with a significant difference between the three groups $F(2, 118)=27.8$, $p=.000$. Post- hoc tests revealed that there was a significant differencewhen comparing each group with every other group.Scores are further broken down in Table 3. Additional posthoc tests revealed that students without CIs or HAs performed better than all other groups, and significantly outperformedallother groups except unilateral HA users. Group 1,the earliest implantees, scored lower than all other groups, but the comparison was only significant when compared to Groups 2, 4, and 6.

Table 3

Mean and standard deviation of scores on the Sign Language Proficiency Interview test of American Sign Language, and correlations between self-rated and actual sign skills.

Group		*M*	*SD*	*n*	*r*	*p*
	CI users					
1	CI at or before age 5	1.86	1.3	21	0.922*	0.000
2	CI at age 6-10	2.83	1.0	15	0.420	0.119
3	CI age 11 and up	2.50	1.8	7	0.639	0.122
	HA users					
4	1 HA	3.19	0.7	8	0.816*	0.014
5	2 HAs	2.60	1.8	15	0.787*	0.000
6	No CI / No HAs	4.18	1.0	22	0.476*	0.025

Note. CI = cochlear implant; HA = hearing aid. *significant at the 0.05 level.

Correlations between deaf students' self-reported sign skills and their actual SLPI ratingsare listed in Table 3.Correlations were positive and significant for the earliest implanted CI users but not the two other groups of later-implanted CI users.Correlations were positive and significant for both groups of HA users and for deaf students without amplification.Additionally, the correlation for hearing students was positive and significant,r= .839,n=33,p =.000.

A composite sign language reception score was computed from the retelling and the multiple-choice tasks from thenarrative passage.The mean composite scores (SDs) are as follows: for CI users (n=42) .88 (.26), for DHHstudents who did not use CIs (n=46) .94 (.22), and for hearing students (n=33) .96 (.28) with no difference between the three groups F(2, 117)=1.17 p=.315.Only hearing students displayed a strong correlation between self-rated and actual ability to understand a signed narrative, r= .65, n=15, p=.000. CI usershad a weak correlation, r= .314, n=42, p=.043, and further analysis revealed only the early-implanted students were accurate in their predictions, r= .483, n=21, p=.026.Non-CIusers had no significant correlation, r= .251, n=46, p=.093.

CONCLUSIONS

Students with younger agesof cochlear implantation displayed better audiovisual sentence recognition.Mean scores were 80, 70, and 60% for those implanted up to age 5, between ages 6 and10, and after 10 years old, respectively; however this 10% decrease was not statistically significant. All the students with CIs were successful in predicting their speech perception skills, with high and significant correlations between estimated and actual speech perception.

For HAusers, those using two devices had the highest sentence perception, with a mean score of 71%, slightly higher than those wearing one. Sentence perception was not significantly higher forCIusers than for HAusers, nor for bilateral vs. unilateral HAusers, but all students who used either CIs or HAs had significantly higher perception scores than those not wearingamplification. Individuals who wore one HA were not successful in predicting their speech perception skills, but those who used two or no HAs were successful.

The speech production scores were similar for CIusers and HAusers across age of implant groups and number of HAs used.Note there were 20 HA students who declined to participate. Individuals implanted before age 5 had statistically higher production scores than their counterparts who were implanted after age 10, and those who did not use HAs. All the students with CIs were successful in predicting their speech production skills, with high and significant correlations between estimated and actual speech production scores. Neither of the groups who wore HAssuccessfully predicted their speech production skills. Those who did not wear HAs were able to predict their speech production scores, i.e. they knew they had poor speech production.

There were 42/50 CIusers, 46/53 DHH non-users of CIs, and 33/66 hearing students who were proficient enough to take the sign language tests.Deaf non-CIusers performed the best on these tests, yet they accurately predicted their skill levels only for the expressive task and not for understanding a signed narrative. CIusers had significantly lower scoresbut only the early-implanted CIusers were successful in predicting their skills. Hearing students performed the lowest on the expressive test but performed equally to deaf students on understanding the signed narrative, and they were accurate in their self-assessments.These results support previous studies showing deaf students may not be accurate reporters of their own sign language comprehension.

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