WORD AND WORLD KNOWLEDGE AMONG DEAF LEARNERS WITH AND WITHOUT COCHLEAR IMPLANTS

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Abstract

Deaf students frequently demonstrate significantly less vocabulary knowledge than hearing peers. Studies involving other domains of academic knowledge suggest similar lags with regard to world knowledge. Such gaps often are attributed to deaf children'slimited access to conversations of others which impacts incidental learning. Cochlear implants (CIs) have been described as facilitating such access,leading to the suggestion that children with implants might catch up to their hearing peers over time. Two experiments evaluated this possibility through the assessment of word and world knowledge among deaf/hard-of-hearing (DHH) college students with and without CIs,together with a comparison group of hearing peers. Results across all but one task indicated that hearing students significantly outperform deaf students both with and without CIs(with no significant differences between the latter two groups). Separate analyses revealed no advantages for a subset of CI users who received their implants at a young age, and age of implantation was not related to performance on any of the tasks. Results are discussed in terms of incidental learning and the fact that CIs do not transform deaf learners into hearing learners.

WORD KNOWLEDGE AND DEAF LEARNERS

Although there have been numerous studies documenting young DHH children's limited vocabularies (see Luckner& Cooke, 2010, for a review), less is known about their word and world knowledge or the vocabularies and world knowledge of postsecondary deaf learners. Our study concerns the incidental learning of word and world knowledge by deaf students, including those with CIs whomay be more accustomed to spoken language in the environment.

Many studies have used versions of the Peabody Picture Vocabulary Test (PPVT) to explorelanguage growth among deaf children.Sarchet, Marschark, Borgna, Convertino, Sapere, and Dirmyer (2014) used the PPVT to examine the vocabulary knowledge of DHH as compared to hearing college students and DHH students who primarily used spoken language (with and without CIs) as compared to those who primarily used sign language. Relations of vocabulary knowledge to print exposure, communication backgrounds, and reading and verbal abilities also were explored. PPVT scores were significantly related to reading and verbal abilities for both DHH and hearing students, but hearing students showed significantly larger vocabularies than the deaf students.

Several studies involving high school and college-age students have found CI use unrelated to reading and classroom learning (e.g., Convertino, Marschark, Sapere, Sarchet, &Zupan, 2009; Marschark, Shaver, Nagle, & Newman, in press). Hayes, Geers, Treiman, and Moog (2009), Fagan, Pisoni, Horn, and Dillon (2007), and Connor, Craig, Raudenbush, Heavner, and Zwolan (2006), however,optimistically suggested that providing young deaf learners with access to incidental learning via CIs could foster, over time, vocabulary knowledge that is equivalent to hearing peers.The goal of the present study was to examine explicitly whether CIs allow deaf learners' word and world knowledge to catch up with hearing peers' over the long term. Deaf college students with and without CIs, along with hearing peers, participated in two experiments.

The first examined the effect of CI use on vocabulary knowledge through an extension of theSarchet et al. (2014) study. Sarchet et al. had found deaf students to greatly

overestimate their vocabulary knowledge, relative to their performance,in the standard picture version of the PPVT.To give students ample opportunity to demonstrate theirvocabulary knowledge,it was assessed in three different ways in the present study. One third of the students received the same picture version of the PPVT developed by Sarchet et al. (2014, see below); one third received a version in which theywere asked to select the correct word to fit the definition of each PPVT word; and one third received a version in which they were asked to select the correct word to fit a sentence using each PPVT word.

EXPERIMENT 1

Method

Participants.A total of 274 students participated in the study, all of whom were enrolled at Rochester Institute of Technology and were paid for their participation. These included 89 hearing students, 93 deaf students who used CIs, and another 92 deaf students who did not use CIs.

Materials and Procedure. For all participants, the study involved PPVT-4 vocabulary drawn from Sets 9 (age 10) through 18 (adult). Each PPVT-4 stimulus set contains 12 words, making a total of 120 test items for each student.

The "picture version" of the task involved scans of 120 PPVT stimulus pictures placed on PowerPoint slides, with an item number and the appropriate stimulus word printed in the center of each. Students worked through the 120 items on a tablet, tapping the appropriate response picture on the screen, which was recorded by the tablet.

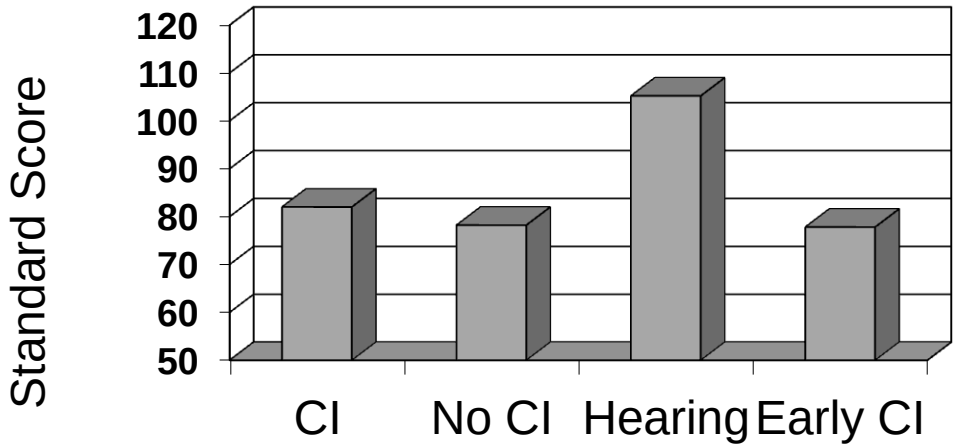
For the "definition version" of the task,participants were asked to fill in the letter ofthe word that matched the definition of each PPVT item (e.g., "Branched horn-like outgrowths from the frontal bones of male deer" ____) from a list of 18 words provided for each set. The available items included the 12 correct target words for the set and six pseudo-words.

For the "sentence version" of the task, sentences were drawn from online dictionaries and similar sources as examples that used the target word (e.g., "In wide open fields we saw a herd of deer, some with huge ____"). Each sentence contained a blank, and participants were asked to fill in the letter of the word that "best" completed it, selected from the same 18 words and pseudo-words that were used for the definition version of the task.

RESULTS AND DISCUSSION

Results replicated findings obtained by Sarchet et al. (2014) indicating that deaf students both with and without CIs showed significantly less vocabulary knowledge than hearing students as indicated by the PPVT. Providing students alternative ways to demonstrate their vocabulary knowledge (i.e., the definition and sentence versions of the test) did not improve performance.The performance of a sub-group of deaf students who had received their CIs by age 3.5 years did not differ from that of the other deaf students (see Figure 1). These results suggest that CI use is not a panacea thatleads to deaf children "catching up" to hearing peers in their English vocabulary knowledge,[1] at least by college-age.

Figure 1. PPVT performance of deaf college students with cochlear implants, deaf students without cochlear implants, and hearing peers.



EXPERIMENT 2

Taking into consideration that vocabulary knowledge is largely acquired incidentally (Hirsch, 2003), enhancedhearing viaa CI, alone,appears insufficient to increase vocabulary acquisition of deaf students to levels comparable to hearing peers.Experiment 2 therefore examined worldknowledge likely to be acquired incidentally to determine how deaf students with CIs compare to those without CIs (and hearing peers) in such knowledge.

Method

Participants. All of the students who participated in Experiment 2 also had participated in Experiment 1.

Materials and Procedure. World knowledge from five different domains was assessed.

A **History** task asked participants to put in chronological order, 20 world events between the end anchors of "1492 – Christopher Columbus finds the 'new world'" and "World Trade Center is destroyed by terrorists." A **Famous People** task asked participants to choose the appropriate category for 60 famous people: actors, inventors, athletes or politicians. A **Geography** task involved identifying 30 U.S. states. Participants were given a map of the lower 48 United States with 30 of them numbered 1-30; highly distinctive states such as Texas and Florida were excluded. The 30 state names were provided in a list, and participants had to match the numbers from the map with the corresponding state names. A **Magnitudes** task asked participants questions about the weight, size, length, or quantity of 11 real-world items (e.g., how much does a large egg weigh?).

The above four tasks all were presented in paper-pencil format. A fifth, **Estimation** task asked participants to provide estimates of weight, size, length, or quantity at 11 laboratory stations (e.g., the number of marbles that would fit in a shoebox). For the Magnitude and Estimation tasks,there was a low probability that the students' answers would be exactly correct. To compensate, three scores were calculated for each: the proportion exactly correct, the proportion correct within $\pm$ 10%, and the proportion correct within $\pm$ 20%.

RESULTS AND DISCUSSION

Analyses of Estimation,History, Famous People, and Magnitudes tasks, all yielded the same pattern of results, with hearing students significantly outperforming deaf students both with and without CIs (which did not differfrom each other).The Geography task was the only one that showed all three groups scoring at about the same level (67% to 73%), with no significant differences among them (see Table 1). Identification of the U.S. states was also

the only task that would have tapped explicitly-acquired rather than implicitly-acquired knowledge (knowledge of events in the History task might have been acquired explicitly, but their relative ordering would have been acquired implicitly, or incidentally).As in Experiment 1, the subgroup of deaf students who received CIs by 3.5 years of age were compared to the larger group of 65 students who received their implants later. Again, there was no difference in their performance and, more generally, age at implantation was not significantly related to performance on any of the tasks.

Table 1. Means on five world knowledge tasks for deaf students who use cochlear implants (CIs),deaf students who do not use cochlear implants, and hearing students.

	Deaf with CIs	**Deaf No CIs**	**Hearing**
Task	Mean	Mean	Mean
History	.18	.14	.27
Famous People	.40	.36	.54
Geography	.73	.67	.69
Magnitude Exact	.05	.05	.06
Magnitude ± 10%	.09	.08	.12
Magnitude ± 20%	.15	.13	.19
Estimate Exact	.05	.03	.07
Estimate ± 10%	.09	.07	.14
Estimate ± 20%	.14	.11	.20

GENERAL DISCUSSION

The results of the two experiments described here are easily summarized: Evaluation of word knowledge usingthe PPVT and world knowledge measured through a set of pencil-and-paper tasks consistently found that hearing college students significantly outperformed deaf peers. More importantly for the present purposes, none of the tasks revealed significant differences between deaf students who used CIs and those who did not. Although the scores of the CI group usually fell between the other two groups, the differenceswere extremely small.

The present study in no way disputes the potential benefit of CIs for deaf children, althoughresults of these experiments consistently indicated that deaf students with CIs were not performing significantly better than peers without CIs with regard to word or world knowledge. At the same time, the results from the Geography task in Experiment 2 indicated that the DHH students with and without CIs can acquire world knowledge comparable to that of hearing peers when that information is taught explicitly.The present findings suggest that deaf children who use CIs – like those without CIs –needto be taught in a way that both builds on their strengths and accommodates their needs if they areto benefit fully from the opportunities offered by this technology.It should not beassumed that the enhanced hearing (and perhaps spoken language) facilitated by CIs is sufficient to support incidental learning comparable to hearing children.

[1] "English" is intended generically here to refer to any spoken/written vernacular. See Rinaldi, Caselli, Onofrio, and Volterra (2014) for evidence concerning deaf children's total vernacular + sign language vocabularies.

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